

DIGITAL PROJECT MANAGEMENT TECHNOLOGIES

¹ Yuliia Dehtiarova

Master student of the Faculty of Information Technology

² Viktor. Morozov

PhD in Engineering Science, Full Professor, Head of the Department of Technology Management

^{1,2} Taras Shevchenko National University of Kyiv

PRACTICAL IMPLICATION OF DIGITAL PROJECT MANAGEMENT TECHNOLOGIES

Abstract. The report describes how digital project management technologies are used on the example of a platform for buying and selling currency. It presents several vital processes in this project: project and recourse planning, backlog and task management, meetings and communication, data management.

Keywords: management processes, project planning, recourse planning, backlog & task management

COVID-19 pandemic forced firms to adopt changes in their working processes in favor of digital technologies. It's now become a routine to conduct online meetings, put tasks on the online boards, and use more digital instruments for project management.

The use of a modern project approach to solving socio-economic problems and tasks, developing management processes, and focusing on achieving results with minimal time and money will form a new generation of leaders and improve socio-economic processes in the country.

Project management requires constant guidance and coordination of the project's human, material, and financial resources. During its life cycle, project management should be carried out through the use of modern management methods and techniques to achieve project results. As stated in [1], "an effective project manager must ensure that all necessary work is carried out promptly, thoroughly, and meet specific requirements. To this end, monitoring is carried out throughout the project implementation phase. "As mentioned in [2, p.21], IT project managers must develop and use new methods and approaches, one of which is based on the use of proactive management methods.

Managing the project of developing a web platform for buying and selling currency is becoming especially important because, from January 1, 2019, Ukrainians have the right to sell and purchase foreign currency through payment devices - terminals and ATMs. Also, the provisions of the resolution of the National Bank №63 [3] came into force, which introduced new rules of currency exchange operations. In particular, it abolished the requirement for a paper document's mandatory issuance confirming the fact of currency exchange. As the innovations will be implemented gradually, today, there is a need to develop web platforms for placing ads to buy and sell currency to meet the urgent need for interactive services. According to a survey

conducted in the summer of 2019, 56 respondents (individuals) out of 80 consider it necessary to create this web platform.

The example of a platform for buying and selling currency shows how digital project management technologies are used. There are several vital processes in this project: project & recourse planning, backlog & task management, meetings & communication, data management. Digital tools play a crucial role in the successful implementation of all the processes.

Project & recourse planning. Pountney [4] highlights the critical role of recourse planning for IT projects. He pays particular attention to contemporary Human Resource Management theory. Pinha, D.C., and Ahluwalia, R.S. explain how project duration and costs can be reduced "by empowering project managers to assess different scenarios" [5]. It is rational to plan resources following the hierarchy of the influence of these restrictions developed by the project manager, depending on a particular project's characteristics. 1. Planning from resource constraints 2. Planning from time constraints.

Backlog & task management. Todd Sedano, Paul Ralph, and Cécile Péraire examined product backlog and proposed the "theory of product backlogs" to be widely applicable by organizations with different software development cultures [6]. One of the essential parts of project management is online meetings with developers to align with project processes. What tools can be used for it? The most widely used and spread now is Zoom, Google Meet, Microsoft Teams. A platform for buying and selling currency project meetings will be conducted through Zoom, which allows all the team to stay safe and be on the same page.

Data management. The process of data management consists of data quality, data design, data lineage, and data cost management. Many companies do not have a clear understanding of what needs to be considered in strategic data management. Meanwhile, there are several clear principles on which the Data Governance strategy is based: make your data accessible; users must work with consistent data; understand what to collect and what to throw away; ensure the safety of your data; take care of security. It is equally essential to ensure the safety of funds. Data is the same asset. In the modern world, it is sometimes even more valuable. So the same rules apply to it: like competent financial management, Data Governance helps to reduce the number of errors, increase business efficiency, and clearly understand what results can be achieved further. Data security is in the first place in the list of priorities of digital project management. It is essential to improve safety by classifying data according to different levels of risk.

All in all, risks in a market economy are an integral part of management. Uncertainty makes it impossible to avoid danger. It is necessary to learn to anticipate risk, assess its magnitude, plan measures to prevent it, and not exceed acceptable limits. Project planning and implementation occur in conditions of uncertainty caused by changes in the internal and external environment.

Risks arising in the process of project preparation and implementation require immediate response and decision-making to reduce them. Since making a decision is a

choice of possible options for developing events (scenarios), this scheme is based on risk analysis for each scenario. The main idea is to select the plan that will be optimal in terms of the "win-risk" ratio, taking into account the actions that need to be taken to mitigate the risks associated with this scenario.

Risk analysis requires, above all, fast and reliable information. In conditions of tougher competition caused by the globalization of markets, it will not be large enterprises that will win over small ones. Still, dynamic ones over those are slowly reacting to a change in the environment. Risk analysis is divided into two mutually complementary types: qualitative, the main task of which is to determine the risk factors and circumstances leading to risk situations, and quantitative, which allows you to calculate the value of individual risks and the risk of the project as a whole

References:

1. Н. П. Юрчук Система моніторингу в управлінні ІТ-проектами/ Н. П. Юрчук//Електронне наукове фахове видання «ефективна економіка». – 2018. – № 4: [Електронний ресурс] – Режим доступу до ресурсу: http://www.economy.nayka.com.ua/pdf/4_2018/58.pdf
2. В. В. Морозов Дослідження моделей взаємодії процесів в іт-проектах на основі проактивного підходу дослідження моделей взаємодії процесів в іт-проектах на основі проактивного підходу / В. В. Морозов, О. В. Кальніченко // Вісник Національного технічного університету «ХПІ». Серія: Стратегічне управління, управління портфелями, програмами та проектами. 2019. № 2 (1327). – с. 20-27: [Електронний ресурс] – Режим доступу до ресурсу: http://repository.kpi.kharkov.ua/bitstream/KhPI-Press/40870/1/vestnik_KhPI_2019_2_Morozov_Doslidzhennia_modelei.pdf
3. Про затвердження Правил з організації захисту приміщень банків в Україні. Постанова правління Національного Банку України від 10.02.2016 № 63: [Електронний ресурс] – Режим доступу до ресурсу <https://zakon.rada.gov.ua/laws/show/v0063500-16>
4. Ph. Pountney (2013). Importance of resource planning. The importance of resource planning during the initiation stage of an IT Project. Retrieved from https://www.researchgate.net/publication/340883012_IMPORTANCE_OF_RESOURCE_PLANNING_G_The_importance_of_resource_planning_during_the_initiation_stage_of_an_IT_Project
5. D.C. Pinha, R.S. Ahluwalia. Flexible resource management and its effect on project cost and duration. J Ind Eng Int 15, 119–133 (2019). <https://doi.org/10.1007/s40092-018-0277-3>
6. T. Sedano, P. Ralph, C. Péreira (2019). The Product Backlog. Conference: International Conference on Software EngineeringAt: Montreal, CanadaVolume: 41st. DOI: 10.1109/ICSE.2019.00036

¹ Snezhana Gamotska

Assistant Professor

² Petro Soroka

PhD in Physical and Mathematical Sciences, Associate Professor

^{1,2}Taras Shevchenko National University of Kyiv

CHOICE OF METHOD OF QUANTITATIVE RISK ASSESSMENT IN RISK MANAGEMENT TASKS OF IT PROJECTS

Abstract. The paper presents a diagram of the algorithm for determining the probability of obtaining a finished product of sufficient quality, which reflects the total effect of risks on the date of completion of the project, its cost and volume of work performed.

Keywords: risk, risk management, uncertainty, IT project, qualitative risk analysis, quantitative risk analysis, simulation.

The task of risk management of IT projects is to reduce the impact of undesirable factors on the project life cycle and obtain results very close to the planned ones. Many different analytical models and methods of risk analysis are known. Their disadvantage is that its application introduces many assumptions and limitations for simplicity of description of the process and possible solution. These methods allow to generalize the process, idealizing and simplifying its elements. An alternative to risk assessment in IT projects may be the use of simulation, which allows you to bring the model as close as possible to the real situation.

The task of risk management of IT projects is one of the most difficult in project management, due to the specifics of such projects. The fact is that IT projects are characterized by a significant degree of uncertainty about the future outcome. It should take into account the stage of the life cycle of the developed product, as for each of them the risk management parameters will be different. This, in turn, requires the use of different methodological apparatus for their analysis and evaluation.

Project risks affect all interrelated constraints of the project, such as content, quality, schedule, budget, resources, and so on. To achieve the planned results and obtain at the end of the project a product of sufficient quality, it is necessary to effectively manage changes in the project and respond in a timely manner to any deviations that occur (Fig. 1).

Known risks are those risks that have been identified and analyzed. Appropriate actions can be planned for such risks. It is not possible to plan appropriate actions for unknown risks. To take them into account, a reasonable solution would be to allocate a

general contingency reserve that includes these unknown risks, as well as all known risks for which the development of specific response measures is for some reason impossible or unprofitable.

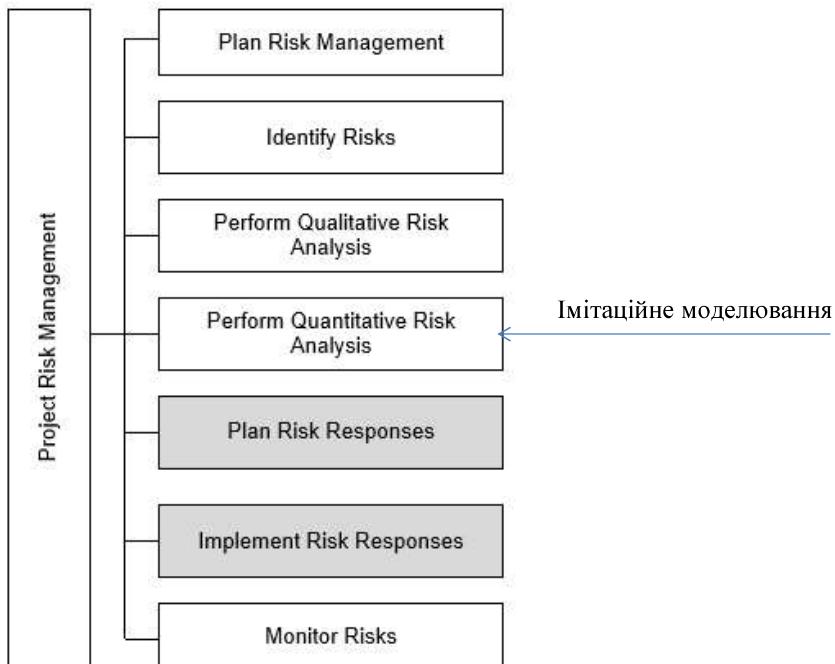


Fig. 1. Risk Management ANSI PMI PMBOK 6th Edition [1,2]

For planned risk avoidance, prevention, acceptance or compensation measures to be effective, their quantitative characteristics need to be assessed after risk identification and qualitative analysis. Approaches such as the method of sensitivity analysis of efficiency criteria, analysis of expected monetary value, analysis of decision tree, simulation modeling can be used for quantitative risk assessment [3].

Today, simulation is a priority in risk assessment in IT projects. It should also be borne in mind that the use of a simulation model does not exclude the need to use analytical models. They can be part of a directed experiment with a simulation model. Analytical modeling is carried out at the initial stage of research. Its results serve as a guide in the subsequent construction of the simulation model and can be used in its validation.

The simulation experiment is in many ways similar to the real thing. However, it has a number of advantages. A significant advantage is its cost, as it is much cheaper than the real thing. In addition, the simulation experiment allows you to calculate the behavior of systems that no longer exist or which do not yet exist. The efficiency and simplicity of this approach allows us to consider many situations with a very large number of combinations of initial conditions and possible effects on the process. The constant process of accumulation of simulation results leads to the formation, on the one hand, a fairly large, and on the other - a finite set of typical situations with a finite number of standard behaviors.

Quantitative risk assessment based on a simulation model. The task of determining the duration of the project can be divided into two: the task of project planning (determining the scope of the project, planning work and resources, etc.) and the task of quantifying the additional reserve of time, money, resources needed to prevent the consequences of risk situations. Next, consider the following problem, let the project be characterized by the presence of n important risks, each of which has a function that characterizes the probability of completion of the project by a certain date, using a certain amount, when performing a certain amount of work. You need to define a probability function that reflects the total effect of risks on the project completion date, its cost, and the amount of work done.

References:

1. A. Guide to the Project Management Body of Knowledge (PMBOK ® Guide) 6th Edition. PMI, 2017. 537p.
2. Features of the evolution risk management process in IT-projects / S. Gamotskaya, A. Vasylevskaya // Information Models and Analyses. V.6, N.2. 2017 – c. 183-194
3. Risk management in high-technology projects: overview and approaches / M.D. Godlevsky, A.A. Polyakov // Problems of the program. - 2006. - N 2-3. - S. 311-319.

¹ **Mariia Kambur**

Master student, department of Technology Management

² **Oleksii Yehorchenkov**

Associate professor, department of Technology Management

^{1,2} Taras Shevchenko National University of Kyiv

SMART KITCHEN DEVELOPMENT PROJECT MANAGEMENT

Abstract. This thesis contains a consideration of public catering establishments automation problems and an exploration of smart kitchen system management and development process.

Keywords: project management, catering, IoT, web, embedded systems.

Currently, the field of catering services is flourishing in Ukraine. In 2018 alone, the number of catering establishments in Ukraine increased by 2.7 thousand units as seen on Figure 1. [1]

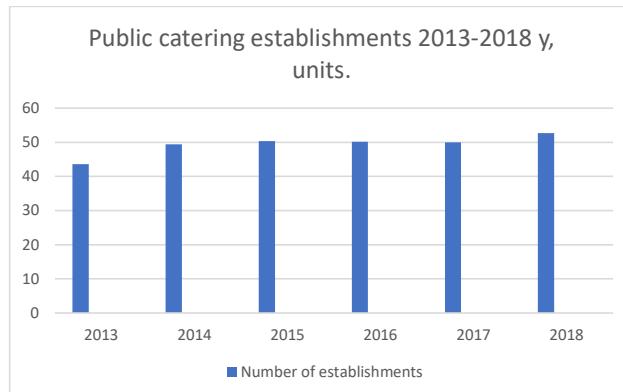


Figure 1 – Number of public catering establishments 2013-2018 years

The restaurant market is one of the most dynamic markets in Ukraine. It is extremely sensitive to the economic situation, exchange rate fluctuations, and social factors. For the last four years (2016-2020), it has been actively trying to recover from the political and economic crisis of 2014-2015. In total, about 5,600 catering establishments have disappeared during this period. According to Rest Consulting, about 1,500 of them closed without surviving the crisis, and a little more than 4,000 remained [2].

In 2020, the world experienced a shock from which it has not yet recovered. The COVID-2019 pandemic has dealt a significant blow to all areas of industry and service delivery, and especially to small and medium-sized businesses. We were able to watch cafes and restaurants close one after the other, as quarantined business owners simply could not afford to pay for food staff.

This problem could be partially solved by creating a comprehensive hardware and software system for a smart kitchen, which would automate most of the cooking process. Such a system still has no analogues on the market and is most often represented by separate devices that do not communicate with each other and still require close human supervision.

The introduction of such a system in catering establishments will allow business owners to reduce labor costs and optimize internal processes of processing and cooking.

The smart kitchen system is an automated control system for kitchen utensils via a web interface.

Thanks to the use of this product, the user can download a map of his kitchen in the web application and place the necessary equipment. Each of the items will have "On", "Off" buttons and a "Mode selection" panel.

All kitchen equipment will be upgraded and will include IoT modules to connect to the network and receive remote commands.

The product allows you to control an automated smart kitchen system (slicing, grinding, microwave, stove, kettle, dishwasher, etc.) via a web interface. The status of the system is displayed on the web interface and when you press the appropriate buttons, commands are sent to a specific device as seen on Figure 2.

Technology stack: embedded systems, microcontrollers, IoT, web programming, web design.

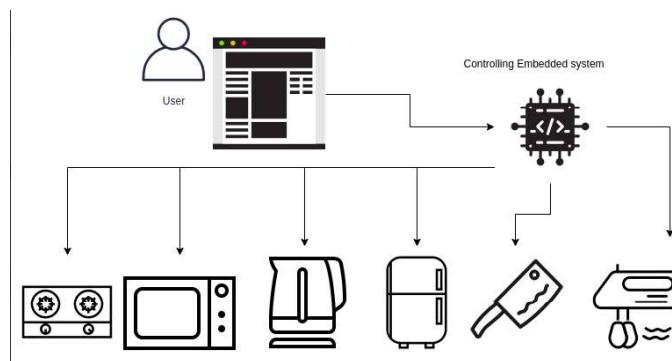


Figure 2 – Smart kitchen system architecture schematics

The system can solve a number of problems:

- 1) Excessive spending and wasteful use of products which is irrational from an ecological and economic point of view.
- 2) The incomprehensible interface of kitchen utensils which can lead to accidentally spoiling a dish or burning the appliance.
- 3) Mandatory presence in the kitchen which is uncomfortable does not allow you to do something else.
- 4) Introduction of IT in the food industry.

The specifics of project data management is the presence of three teams ranging in size from 2 to 8 people and therefore there is a strong need for careful communication planning between the three teams, as the products developed by these teams will be integrated with each other. The project manager must understand modern flexible project management methodologies, communications, and personnel management, as well as have a strong technical background. Also, there is a need to keep in touch with hardware suppliers which means neat procurement management.

Scrum is the Agile methodology which is preferred to manage the Smart kitchen system project. This methodology is best suited for this project, because we have three small teams (web development team, IoT development team, embedded systems development team), clear product requirements, the ability to increase functionality during development at the request of the customer, or when business requirements are changing.

The development process is divided into sprints (2 weeks).

Retrospectives, plannings and daily meetings with the project manager and the team are also involved, where they will discuss what was done the day before, what each team is going to do today and what were the difficulties in completing the tasks.

This synchronizes the work of the each team and adjacent teams, so everyone can be aware of project progress.

Conclusions: catering business is currently promising in Ukraine. However, it may be prone to destabilization in a pandemic or economic crisis times. The smart kitchen system is an innovative project, the product of which can partially solve the problems for the catering business. Such a project can be managed using flexible management methodologies such as scrum with an emphasis on communications management and product integration of different teams.

References:

1. Catering market analysis (HoReCa, catering, and food at gas stations). URL: <https://pro-consulting.ua/ua/pressroom/analiz-ryntka-obshestvennogo-pitanija-horeca-kejtering-takzhe-pitanie-na-azs>
2. L. Hirniak, V. Hlahola, CURRENT STATE, PERSPECTIVES AND TRENDS OF RESTAURANT BUSINESS DEVELOPMENT IN UKRAINE, Economics and Enterprise Management '16, 2018, pp. 71-78

¹ Anastasiya Kovalenko

Student of the Master's Project Management Program

² Ivan Ivanov

Student of the Master's Project Management Program

³ Viktor Morozov

PhD, Professor, Head of The Department of Technology Management

^{1,2,3} Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

RESEARCH OF METHODS OF FORMATION OF THE INITIAL DESCRIPTION OF THE PROJECT OF CREATION AND START-UP OF THE ENTERPRISE ON PRODUCTION OF STREET FURNITURE MADE OF RECYCLED MATERIALS

A century ago, humanity made a significant breakthrough in its development – a synthetic revolution took place. One of its main achievements was the invention of plastic. It was a durable and reliable material that became an alternative to expensive natural materials and therefore quickly gained popularity. In our time, the main advantage of plastic – reliability – became its main disadvantage [1]. Plastic products are usually used once and then thrown into trash. 9% of used plastic is recycled, 12% is incinerated, 79% ends up in landfills and the environment, polluting it and killing its inhabitants. According to researches, every year about 300 species of animals suffer from plastic, a significant number of which die. According to a report by the Ellen MacArthur Foundation, by 2025 the amount of unprocessed plastic will be 100-250 million tons per year, and by the middle of the century it will have reached 33 billion tons per year. Thus, there will be more plastic in the world's oceans than marine life.

The situation in Ukraine is also not comforting [2]. The number of official landfills alone is 6,000, and they occupy an area larger than allocated for natural reserves, 10% vs. 8%, respectively. There are about 35,000 unofficial ones. In total, landfills cover an area of 12,000 km², and there are around 6 million tons of plastic there. At the same time, only 4% of all waste is recycled. In Europe, this number is an order of magnitude higher: 70% on average, in Sweden - 96%. The Swedes even buy garbage from neighboring countries, so that their recycling plants are not idle [3].

The problem of plastic waste worries many people. To attract public attention, many well-known companies collaborate with designers to create interesting and useful things from recycled plastic, which are also easy to recycle. For example, IKEA stores will soon have a collection of home textiles from shopper bags, pillowcases and tablecloths made from recycled plastic caught in the Mediterranean [4]. A Columbian company called Diseclar has gone even further, starting to make garden furniture from recycled plastic, which has an excellent aesthetic appearance, very similar to real wood products, but also strong and insensitive to weather conditions [5].

The global problem of accumulating used plastic in the environment and successful ideas for the use of recycled plastic have inspired the creation of a project to build and launch a factory for the production of outdoor furniture from recycled materials. Given, in particular, the current situation with inorganic waste in Ukraine,

this project is particularly relevant. The organization of enterprise construction and production start-up is quite a difficult task, as it requires careful planning of all processes and allocation of resources, identification of requirements of all stakeholders and coordination of many solutions with them, effective management of time, resources, budget and other important components. All this would be extremely difficult without the use of digital tools, so Airtable - one of the most highly valued services for creating workflows - comes to the rescue.

Compared to Microsoft Project, which is a more known alternative, Airtable is more user-friendly and has many advantages [6]. First of all, it can be used on iOS and Android platforms, which is important for the current fast pace of life. In addition, it has tools for collaboration, such as chat, commenting, communications calendar, email integration, task management, task planning, task scheduling, task tracking, workflow management. It can also integrate with various tools such as GitHub, Gmail, Google Calendar, Google Drive, Slack. Other useful benefits include automatic backup, automatic notifications, budgeting, bug tracking, built-in database, data filtering, data synchronization, social media integration, to-do list.

References:

1. Dmitrienko, Pollution of the planet with plastic is fraught with disaster, the scale of which is difficult to calculate, 2019. URL: <https://profile.ru/society/ecology/zagryaznenie-planety-plastikom-chrevato-katastrofai-masshtaby-kotoroj-slozhno-proschitat-133578/>
2. Mikhedov, Waste and society: how Ukraine is bent from garbage, 2018. URL: <https://platfor.ma/topic/otbrosy-y-obshhestvo-kak-ukrayna-zagyaetsya-ot-musora/>.
3. Society Ukraine is drowning in garbage - is there a way out, 2019. URL: <https://dengi.informator.ua/2019/03/22/ukraina-utopat-v-musore-est-li-vyhod/>
4. IKEA to release a collection made from recycled plastic, 2020. URL: <https://www.retail.ru/news/ikea-vypustit-kollektsiyu-sozdannuyu-iz-pererabotannogo-okeanicheskogo-plastika-30-sentyabrya-2020-198197/>.
5. Diseclar - recycled plastic furniture, 2019. URL: <https://gtracer.com.ua/ru/diseclar--recycled-plastic-furniture>.
6. Microsoft Project vs Airtable Comparison, 2020. URL: <https://www.getapp.com/project-management-planning-software/a/microsoft-project/compare/airtable/>.

¹Tatiana Latysheva

PhD of Technical Science, Assistant Professor of the Department of Technologies Management

²Dmytro Smishchenko

Master student of the Intellectual Technologies Department

^{1,2} Taras Shevchenko National University of Kyiv

PROCESS OF EFFECTIVE PROJECT MANAGEMENT OF DEVELOPING MOBILE APPLICATION FOR CARSHARING

Abstract. Covers process of effective project management of developing mobile application with help of modern management frameworks and development process organization.

Keywords: Application, mobile, SCRUM, shared economy, car sharing

Practice shows that recently the sharing economy is gaining popularity. Traditional consumption of goods and services is not the optimal use of resources. A person does not need to buy or maintain something to use it. In our example, we will consider car sharing. Economic and social research has shown that the idea of carsharing can meet the requirements for comfort and customer service price of a carsharing product (mobile application).

The current results of the project management study do not take into account or do not fully take into account the above problem. The purpose of the work is to study the processes of effective project management to create a mobile application for carsharing, which will be able to solve all the tasks posed by developers and meet user expectations. Therefore, the study of such processes seems relevant, and the problem requires a solution.

The sharing economy is a socio-economic system based on the sharing of human and physical resources [1].

Carsharing is an alternative model of car ownership and use. The idea of car sharing is not new in the world [2]. Thus, in Europe, the list of the first car-sharing companies includes the Swiss club "Mobility", which was founded in 1987. At the beginning of 2015, the members of the Mobility car-sharing club are about 120,000 Swiss citizens, who have the opportunity to use 2,700 cars of various categories. In the classic version, car sharing is the possession of a car with another person or people, i.e. the ownership of a share of the car with the right to use. The car-sharing model is designed to quickly and conveniently meet the traditional human need to move from one place to another [3], and also saves your own money by reducing the cost of sole proprietorship.

The project involves the creation of a mobile application for car sharing. Carsharing is a type of car use when one of the parties is not the owner. This is an option to rent a car from specialized companies (usually for long-distance and / or short trips) or private individuals (for any period and distance of the trip - by arrangement). This car rental model is convenient for periodic use of the vehicle or when you need a

car other than the brand, body type and load capacity from the usual one. Carsharing is one of the global directions of Sharing Economy development, when the population refuses to acquire goods in order to avoid responsibility and costs, but continues to have access to all the achievements of scientific progress, using their joint consumption.

The use of flexible SCRUM methodology is provided for the process of organizing the application development process. Scrum is the backbone of a process that includes a set of methods and predefined roles. The main actors are ScrumMaster, who oversees, leads and works as a project manager, product owner, a person representing the interests of end users and other stakeholders in the product, and a team that includes developers [4].

Scrum is a framework in which people can solve complex adaptation problems while producing products with the highest possible value productively and creatively.

Scrum itself is a simple basis for effective team collaboration on complex products.

Thus, the sharing economy in terms of the use of personal transport gives citizens an advantage in terms of price and convenience of service. The customer of the product can receive all the benefits of having personal transport, without spending time and resources on service of the transport unit, as well as on its purchase. In the form of a simple mobile application, the project solves user problems. In a convenient way, the user can receive car sharing services without spending on the purchase of the car itself.

The mobile application development project involves a long development period and the presence of a development team. For a planned iterative development process, the flexible SCRUM methodology has been identified as one of the leading ones at the moment. Using this methodology in the process of developing a mobile application, the project guarantees the timely execution of work on application development, testing of the application and its release schedule for subsequent updates.

In the future, it is possible to consider additional ideas for the development team depending on the scale and profits of the project. If the application is successful and it is decided to expand it, new development teams may appear, which will work in parallel. In this case, to continue to monitor the progress of development work, product owners can implement the use of the SAFE methodology, which provides for quarterly planning and goal setting for development teams.

Thus, car sharing as an idea can help users of the product in their daily lives. Due to comfortable trips, customers of the application can get more comfort in daily trips than users of public transport or taxis for less money.

References

1. Wang, C., & Zhang, P. (2012). The evolution of social commerce: The people, management, technology, and information dimensions. Communications of the Association for Information Systems, 31(1), 105–127.
2. The CarSharing Handbook (Part 1)"(2016). Rain Magazine.
3. Ноздріна Л.В. Управління проектами: підручник / Ноздріна Л.В., Ящук В.І., Пологай О.І./ За заг.ред.Л.В.Ноздріної. – К.: Центр учебової літератури, 2010. – 432с.
4. Web-resource, access: <https://www.scrum.org>

¹ Oleg Loik

Masters of the Mechanics and Energy Faculty

² Mykhailo Triska

Masters of the Mechanics and Energy Faculty

³ Pavlo Lub

Ph.D., Associate Professor of Department of the Information Systems and Technologies

⁴ Andriy Sharybura

Ph.D., Associate Professor of Department of the Machines Operation and Technical Service of prof. O.D. Semkovych

¹⁻⁴ Lviv National Agrarian University

INFORMATION TECHNOLOGY IN PROJECT MANAGEMENT OF THE AGRICULTURE TECHNOLOGICAL SYSTEMS DEVELOPMENT

Abstract. The prospects of the IT usage for management decisions supporting in agricultural enterprises projects are analyzed. Methods of virtual projects statistical simulation are used. It is shown that the use of IT in the projects management of enterprises technical re-equipment allows to support management decisions and ensure the effectiveness of these projects.

Keywords: IT, projects, production development, information-analytical system, modelling.

The use of IT to manage production projects requires the development and use of specialized simulation models. In particular, it allows to accompany management decisions during the projects implementation for the development of agriculture technological systems. Due to this, at the initial stages of project implementation, goals are defined, components of the external and internal environment are analyzed, and the peculiarities of their interaction and cumulative impact on project performance indicators are revealed.

The goals of such project management information systems (PMIS) also include tasks for the projects development of agricultural enterprises material and technical re-equipment and the formation of production resources. This makes it possible to carry out the tasks of agricultural production projects while ensuring the efficient use of limited resources. In fact, such projects are aimed at taking into account material and information links at the level of the subject area – the fields crops area, a set of specialized machines attached to them, performers, and so on. Coordination of the given parameters by technological systems among themselves allows to provide an extremum of efficiency indicators of both separate projects of technological systems and their efficiency [1,2].

The use of PMIS to match the start-up time of crop harvesting projects (for example sugar beets) and the production area of the crop with the parameters of technical equipment of these projects plays an important role in ensuring the minimum specific total cost. The definition of these cost estimates is carried out on the basis of

functional indicators of production and technological processes, which we obtained on the basis of computer experiments with the developed statistical simulation model (MS Visual Studio C #) [1].

This model is based on the system-event reflection of daily projects work stages, which allowed to take into account: 1) stochastic influence of natural (agrometeorological and biological-subject) component on calendar dates of crop harvesting and naturally allowed time for technical equipment beet harvester); 2) daily weight gain of root crops, as well as the impact of this indicator on the daily rate of harvest; 3) the impact of the production area of the crop and the combine productivity on the duration of these technological process, and hence on the functional indicators of their efficiency.

Execution of the main stages of works modelling in projects and calculations for technical equipment (beet harvester and tractor trailers-loaders of root crops) of different capacity allowed to optimize the production area of S^{opt} culture (Fig.).

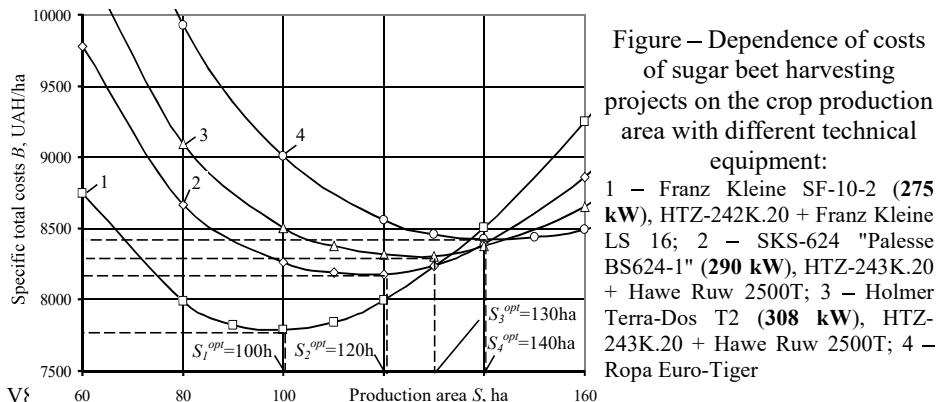


Figure – Dependence of costs of sugar beet harvesting projects on the crop production area with different technical equipment:

1 – Franz Kleine SF-10-2 (**275 kW**), HTZ-242K.20 + Franz Kleine LS 16; 2 – SKS-624 "Palesse BS624-1" (**290 kW**), HTZ-243K.20 + Hawe Ruw 2500T; 3 – Holmer Terra-Dos T2 (**308 kW**), HTZ-243K.20 + Hawe Ruw 2500T; 4 – Ropa Euro-Tiger

The development of PMIS based on statistical simulation models allows us to perform research on these projects, assess the content and timeliness of work and justify management decisions under probabilistic conditions of the project environment. The choice of one or another coordination of component projects (time of their start up, production area of culture with the parameters of technical equipment) must be considered in the context of a particular technological system of a some production environment.

References:

1. Lub, P., Sharybura, A., Pukas, V.: Modelling of the technological systems projects of harvesting agricultural crops. 14th International Conference on Computer Sciences and Information Technologies (CSIT). Vol. 3, 19-22 (2019).
2. Tryhuba, A., Ftoma, O., Tryhuba, I., Boyarchuk, O.: Method of quantitative evaluation of the risk of benefits for investors of fodder-producing cooperatives. 14th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), Vol. 3, 55-58 (2019).

Viktor Morozov

PhD, Professor, Head of The Department of Technology Management

Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

USE OF MACHINE LEARNING METHODS IN DATA ANALYSIS FOR DIGITAL PROJECT MANAGEMENT

Modern conditions for the development of project management technologies are characterized by a significant impact of the mass of restrictions associated with the COVID-19 pandemic. This situation contributes to the search for new technologies, automation of solutions and the introduction of new methods of intelligent processing of project information. Among such methods, machine learning methods occupy a special place. Among them are methods of linear regression, methods using nonlinear models, methods of teaching representation, methods using specialized models [1]. At the same time, the latter are based on consumer choice theory, using polynomial models with logistic distribution, survival analysis models, and auction theory models.

The use of machine learning auction theory models can be used to solve the problems of automated supply of resources for the execution of projects on a competitive basis.

At the same time, the algorithmic approach determines the development of marketing services that can be offered by resource exchanges. An exchange or broker of any other type adds an extra layer of complexity between the provider and the client. This is determined by the fact that in addition to achieving the main marketing goals, both the supplier and the customer must optimize their selling and buying strategies accordingly [2].

The main purpose of a resource exchange is to maintain competition between buyers for a limited resource, such as advertising space. The standard way to solve this problem is to organize an auction, where each buyer places a bid, and the resource put up for auction goes to the participant with the highest bid. However, the auction rules can be configured in different ways [3].

In addition, it is important to understand that potential buyers take part in the auction, because for each of them the auction resource has a certain value. They try to make a profit, trying to get what they want at the lowest possible price. Consequently, it is critically important for bidders to correctly estimate the cost of a resource, and, as a result, we can classify all auctions by some types of cost, which will be reported in a report at the conference [4].

The optimization problem for open auctions may seem dynamic, but in reality it is static and similar to the problem of closed auctions.

The report will consider examples of different types of auctions, in particular, the Dutch auction and the English auction. As a result of such auctions, the participant can

learn from the observed rates.

Also, the Vickrey auction will be discussed in more detail in order to obtain tools for building optimization models that include auctions. The model of such an auction is more convenient for analysis and is widely used in practical applications. There are also other types of auctions that use more advanced analysis methods.

As a result of the research carried out, the author was able to formulate some conclusions proposed for discussion.

1. Many market problems, especially for the supply of resources on a competitive basis, can be expressed in the form of an optimization problem, in which the subject of optimization is the business result, and the variables of the business action.

2. The relationship between activities and business results can often be obtained from historical data. This can be accomplished using supervised learning methods.

3. The main goal of supervised learning is to assess the conditional distribution of the response based on changing input data. In many practical applications, this task can be reduced to finding the most likely outcomes. The two main types of supervised learning problems are classification and regression.

4. Training the model can be considered as an optimization problem, where it is required to select the model parameters that maximize the probability of the observed data following the model distribution.

5. Many supervised learning problems can be solved using linear models that determine either the relationship between input and output as a linear function. The simplest examples of linear models are linear and logistic regression.

References:

1. Pountney, Philip. "Importance of resource planning. The importance of resource planning during the initiation stage of an IT Project." (2013). URL: https://www.researchgate.net/publication/340883012_Importance_of_resource_planning_The_importance_of_resource_planning_during_the_initiation_stage_of_an_IT_Project
2. V.V. Morozov, O.V. Kalnichenko, Research of models of interaction of processes in IT-projects on the basis of a proactive approach, Bulletin of the National Technical University "KhPI". Series: Strategic management, portfolio management, programs and projects, No. 2 (1327), pp. 20-27, 2019. URL:http://repository.kpi.kharkov.ua/bitstream/KhPI-Press/40870/1/vestnik_KhPI_2019_2_Morozov_Doslidzhennia_modelei.pdf
3. N.P. Yurchuk, Monitoring system in management of IT projects, Electronic Science Fakhove Vidannya "effective economy", No. 4, 2018. URL: http://www.economy.nayka.com.ua/pdf/4_2018/58.pdf
4. I. Kravtsov, Machine learning for business and marketing, SPb.: Peter, 2019.

¹ **Viktor Morozov**

PhD, Professor, Head of The Department of Technology Management

² **Maksym Proskurin**

PhD student at the Department of Technology Management

^{1,2} Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

ANALYSIS OF THE PROSPECTS FOR APPLYING METHODS FOR CUSTOMER CHURN PREDICTION USING MACHINE LEARNING IN INNOVATIVE STARTUP PROJECTS

Countries that have managed to establish a continuous process of generating new knowledge and innovative ideas and transforming them into innovative products are now the most efficient and have a leading role in the global economy. The experience of the USA, which brings 85% of innovative products to the market, Japan - 75%, Germany - 55%, Israel - more than 50% is indicative. Unfortunately, the share and innovations in the total volume of manufactured products in Ukraine do not exceed 2%.

Small companies such as startups create favourable conditions for innovation. Start-up is an innovative project for developing new products or services, formed to find a repeatable and scalable business model in conditions of extreme uncertainty. Based on an analysis of the number of startups in 137 countries, Startup Ranking has developed a ranking in which Ukraine took 42nd in 2018 (215 startups). First place went to the USA - 45 004 startups, second place in India - 5203 startups and third place in the UK with 4702 startups. [1].

In recent years, due to the development of cloud computing infrastructure, the SaaS (Software as a Service) software distribution model has become popular among IT startups, as it is more accessible both for creation and use by the end-user.

In 2018, the global SaaS market was estimated at \$134.4 billion and projected to grow to \$220.21 billion, with an annual growth rate of 13.1% by 2022. [2]. But startups working in B2B (Business-to-Business) have problems with long sales cycles because they include a wide range of contact persons, and the client's decision is collective, depends on many factors and is characterized by numerous interactions between companies.

Most SaaS startup founders put much effort into attracting new customers and MRR (recurring monthly income), but often forget about some of the most important parameters as Retention and Churn rates.

In essence, churn is the number of users who stop any interaction with the company. Depending on the area, this may mean that customers have deleted their account, cancelled their subscription, did not renew the contract, did not re-purchase or decided to leave for a competitor.

Churn rate is a metric that calculates the number of customers who leave a product over a given period of time, divided by total remaining customers. If the startup had 100 customers at the beginning of the month and 5 of them cancelled their subscription during the month, this means 5% customer churn (5/100). Here is an advanced formula for calculating customer churn:

$$\text{Churn Rate} = a = \frac{\Delta C_{\text{Cancels}}}{C * \Delta t} \quad (1)$$

where "a" is the customer churn rate, "C" = number of customers, "t" = term (in months), "C_{Cancels}" = number of cancelled subscriptions for a period.

Churn is a direct reflection of the value of the product and the functions that the startup offers its customers. SaaS business should continuously optimize its development to reduce the churn rate.

At first, most startups experience difficulties with outflows. The churn rate can be 15% or more, although, for SaaS services, less than 3% is considered acceptable. It is essential to analyze customer churn in a startup because this will not only help to retain existing customers but also to adapt the product to the market needs. If everything is done correctly, then the outflow rate should decrease and stabilize.

The SaaS model allows software suppliers to collect data on the use of customers that are not available to traditional software suppliers. Although the SaaS and cloud computing market is overgrowing, as far as we know, from a scientific and practical point of view, the subject of churn in B2B SaaS startups has not been sufficiently researched.

The goal of the abstract is to analyze existing and future methods for predicting customer churn using machine learning, which can be applied to B2B SaaS startup companies.

Customer Churn Prediction is one of the classic problems in Data mining. While companies operating in the B2C (Business-to-Consumer) sector, for example, in the telecommunications or banking sector, regularly analyze customer behaviour and have been using customer churn forecasting for many years, B2B pays much less attention to the scientific literature.

There are many similarities between the telecommunications industry and the SaaS industry. As can be seen from Table 1, both areas can control the use of products by the number of times they are used and the duration of their service. Telecom providers record the details of each call, while SaaS providers record the details of each session. The session starts when the user logs in (logging in), and the session ends when the customer logs out, or the session ends due to inactivity. Thus, while most subscribers are active during the call, except the retention time, software users may not be active during the entire session.

Table 1

Comparison of telecommunications industry data with SaaS industry data

Telecom	SaaS
Number of calls	Number of logins (sessions)
Length of call	Length of session
Call targets	Modules used

Most studies on customer churn in telecommunications have studied the business to consumer relationship (B2C), while the SaaS supplier in our research only interacts with business (B2B). Thus, although customer attributes may be similar, further studies should use B2B SaaS data aggregated for all customer employees.

The scientific paper [3] discuss models and methods of proactive product management for complex IT projects. However, the interaction of clients with IT products is not tracked, and the direction of product development to increase client loyalty is not indicated.

Euler [4] has developed a solution tree to identify the types of telecommunications customers that are most likely to be addressed. Euler used the pre-processing capabilities of the KDD MiningMart system to obtain assumed characteristics that were not present in the original data. Coussement and Van den Pol used vector support machines to increase productivity in forecasting churn for the newspaper subscription service. The results of this work show that the interaction between customers and the provider is vital for analyzing churn. Coussement and Van den Pol continued to study the interaction between customer and provider, adding to their model the emotions of customers via email [5]. Hadd et al. [4] determined the prognostic characteristics of customer churn and found that decision trees outperformed neural networks and regression in terms of overall accuracy.

Numerous studies have investigated various machine learning algorithms and their potential for modelling outflows. Since predicting whether a customer will be lost is not a binary classification problem, several models such as Logistic regression have been tested [6], Decision trees [7] Random forest, supporting vector machines and neural networks [8]. Although our review points to numerous studies on SaaS, most work tends to focus on a few programmes. In particular, preliminary work on subscriber subscriptions tends to be based on subscriber data in mobile phone areas [9], credit cards [10] and the provision of Internet services [11].

After an analysis of information sources [1-11], we concluded that there are indeed no integrated models and methods for managing the development of commercial B2B SaaS products, which would allow us to react to various interactions of different classes of customers at the lowest cost. And also to determine, based on the analysis of such data, areas for further improvement and development of such products to increase economic efficiency.

This method significantly expands the opportunities for effective management of startup project development. In turn, the ability to proactively manage the development of innovative IT products based on the methods of predictive analytics to predict customer churn with the help of machine learning allows for taking into account the dynamic interaction on the processes of product development and subsequent management of the startup project.

References:

1. Wang, Xin, Tapani Ahonen, and Jari Nurmi. "Applying CDMA technique to network-on-chip." IEEE transactions on very large scale integration (VLSI) systems 15.10 (2007): 1091-1100.
2. "StartupRanking," [Online]. Available: <https://www.startupranking.com>.
3. "Global Software as a Service (SaaS) Market Report 2020," 2020. [Online]. Available: <https://www.prnewswire.com/>.
4. V. Morozov, O. Kalnichenko, M. Proskurin and O. Mezentseva, "Investigation of forecasting methods the state of complex it-projects with using deep learning neural networks.," *Springer Series Aadvances in intelligent systems and computing.*, vol. 1020, pp. 261-280, 2020.
5. T. Euler, "Churn prediction in telecommunications using miningmart," *Proceedings of the Workshop on Data Mining and Business (DMBiz) at the PKDD*, 2005.
6. K. Coussement and D. VandenPoel, " Improving customer attrition prediction by integrating emotions from client/company interaction emails and evaluating multiple classifiers.," *Expert Systems with Applications*, p. 6127 – 6134, 2009.
7. S. Neslin, "Defection Detection: Measuring and Understanding the Predictive Accuracy of Customer Churn Models," *Journal of Marketing Research American Marketing Association*, no. 43, p. 204–211, 2006.
8. A. Hiziroglu and O. Seymen, "Modelling customer churn using segmentation and data mining," *Frontiers in Artificial Intelligence and Applications*, p. 259–271, 2014.
9. J. Qi, L. Zhang and Y. Liu, "ADTreesLogit Model for Customer Churn Prediction," *Annals of Operations Research*, vol. 168, no. 1, pp. 247-265, 2009.
10. G. Nie, W. Rowe, L. Zhang, Y. Tian and Y. Shi, "Credit Card Churn Forecasting by Logistic Regression and Decision Trees," *Expert Systems with Applications*, vol. 38, no. 12, pp. 15273-15285, 2011.
11. G. Madden, S. Savage and G. Coble-Neal, "Subscriber Churn in the Australian ISP Market," *Information Economics and Policy*, 1999.

¹ **Anhelina Naumenko**

Magister

² **Anna Kolomiets**

PhD in Economics, Assistant Professor

^{1,2} Taras Shevchenko National University of Kyiv

SPECIFIC CHARACTERISTICS OF PROJECT MANAGEMENT IN THE BANKING SECTOR

Abstract. Defined the main differences of project management in the banking sector, researched essential bank projects and the role of the national regulator in them.

Keywords: project management, banking sector, commercial bank, tools, techniques, practices, activity sector, toolsets.

Banking institutions should permanently develop new products and services in the era of total digitalization. One of the ways to stay competitive for banks is to meet customer needs quickly and on time. According to Kerzner, the use of the best project management practices leads to added business value, greater benefit realization, and better benefit management activities [1].

The business function of the banking institution features some differences compared to the business function of commercial companies. Project management in the banking sector should consider specific activities of banking institutions [2]. The general regulator for banking institutions in Ukraine is the National Bank of Ukraine, which also sets certain milestones for the development and areas of activities for banks.

At first glance, it seems that the essential project of banks is to develop new products and services for customers. But the National bank of Ukraine approves regulations to maintain the stability of the banking sector. These regulations require banks to implement projects to improve effectiveness and decrease risks (Table 1).

Table 1
Characteristics of essential projects of banks

	Product	Service	Software
Who requires the development?	Market, competitors	Market, competitors	National bank of Ukraine
Project results users	Customers	Customers, bank employees	Bank employees
Projected results of implementation	Increase in the number of customers	Increase in customer loyalty	Increase in effectiveness and reduction of risks
Examples	Deposit and credit products	Mobile applications for internet banking	Early warning systems

Usually, the banking institution works on the development and implementation of several projects at the same time. Employees from different departments are involved in these projects. This is the main reason why banks need to implement matrix organizational structures. Every department should have project managers to implement projects effectively.

The methodology of project management varies depending on the needs and results of a project. In case of development or implementation of services or products for customers, project managers and teams use Agile methodology for project management, which can be explained by the need to make changes during the development of projects. Competitors may implement options that are more profitable or convenient for customers, or some changes may take place in the market of banking services. Those are the main reasons why banks prefer Agile methodology for these needs [3].

With regard to the development and implementation of software for bank's employees, project managers prefer to use the Waterfall methodology. For these projects, the National bank of Ukraine clearly defines requirements that match regulations for results of projects: necessary functional, the roles in the system, project deadlines, etc. Banks can only make insignificant changes to these requirements, which are usually made in the initial phases of projects.

Also, the main feature in the project development for products, services, and software in the banking sector is that, in the case of delay or refusal of implementation of results of the project for products and services, the consequences for the banking institution will be delayed in time. That is, customers will gradually move to another bank where more convenient service or more profitable products. Accordingly, the bank will feel the financial consequences after a certain period.

At the same time, ignoring or having problems meeting the deadline requirements of the National bank of Ukraine will have immediate implications. Depending on the importance of the project this may result in a penalty charge, a decrease in a rating of the bank during the next audit by the National bank of Ukraine, or license revocation.

At project management in the banking sector, the manager must bear in mind the type of project result: whether it is a product, service or software; and who sets requirements: market or national regulator? It may influence not only a choice of a project management methodology but a functioning of a bank as a whole.

References:

1. Kerzner H. Project Management Best Practices: Achieving Global Excellence / Harold Kerzner. – New York: Wiley, 2015.
2. A Guide to the Project Management Body of Knowledge (PMBOK ® Guide) 6th Edition. PMI, 2017, 586p.
3. Badewi A. The impact of project management (PM) and benefits management (BM) practices on project success: Towards developing a project benefits governance framework / Amgad Badewi. // International Journal of Project Management. – 2016. – №4. – C. 761–778.

¹Ivan Oberemok

PhD, associate professor

²Nataliia Oberemok

PhD, associate professor

¹Kiev National University of Construction and Architecture

²Taras Shevchenko National University of Kyiv

PRIORITY OF VALUES OF PROJECT STAKEHOLDERS

Changes in the market and increased competition lead to the fact that companies that are unable to adapt to these changes lose customers and, as a result, cease their activities. To prevent this from happening, many company executives think about the reasons for customer refusals and loss of competitiveness of their products [1-3].

There can be several reasons for the increased competition in the market, and first, it is a freer transfer of information between countries and territories, as well as a freer exchange of goods and resources. Attempts to restrict access to goods or services of foreign companies do not solve the problem, since the penetration of information also leads to the conquest of the market. Clients are acquainted with new, more advanced products or services of competitors and, as a result, the requirements for local manufacturers increase significantly. This situation is observed in all areas, even in those where until recently local producers dominated. The key differences between competitive products include their quality and complexity [8-10].

It is quite difficult to create a product that would meet the customers' requirements for quality parameters and new technical capabilities and at the same time have an affordable cost price. This is due to the growing differentiation of customer groups [6]. Each of the emerging social groups of customers has its own specific requirements for the company's products. When developing a product, companies are forced to focus on the requirements of customer groups for the quality and technical features of the product. Every year, the differentiation of social groups of clients only increases. Within the framework of already existing social groups of customers, separate subgroups are distinguished, the relation of which to the company's products is insignificant, but differ. Attempting to satisfy both subgroups of customers with the same type of product results in a drop in sales in both subgroups.

In addition to the emergence of new social groups of customers, the attitude towards the company's products in already existing subgroups is changing. This is due both to the directed work of competitors to conquer the market, and to the work of independent media. Information about new developments and product capabilities of

other companies forces customers to think about changing the supplier company and switching to another product.

To meet the changing requirements for the quality and technical complexity of products, companies conduct market research. And if earlier these marketing studies were carried out only when developing a new product, now companies are forced to conduct them on an ongoing basis. By introducing business processes of constant monitoring of the interest of social groups of customers in the products of the company, they try to maintain their leading positions in the market. Based on the results of marketing research, projects are initiated to amend the line of goods and services of the company. Marketing reports are also a document on the basis of which new products and services of the company are developed.

Analysis of current trends shows the orientation in conducting marketing research on customer values. Analysis of the values of target social groups allows you to formulate requirements for the product. By analyzing the values of social groups, the company's marketers assess the degree of influence of products on the needs of social groups of customers.

Implementing a competitive approach in a company has its own complexities. Changing requirements from customers demand the creation of unique products. The implementation of unique products is possible only if the project approach is used. The implementation of new requirements for quality and technological complexity of the product is possible only by using innovative technologies. The choice of a design approach for creating new products is due to the orientation of the approaches, methods and tools of this approach towards creating unique products using unique technologies. In this way, it is possible to ensure competitive production by considering the processes of creation and production of each batch of products as projects [4,5].

In the framework of project management of the consumers of the project products, not only the end users of the main project products are considered, but all the stakeholders of the project. Various stakeholder groups are involved in the project. Each of the stakeholder groups has its own set of values and has different attitudes towards the project product. The project team must create a project product that ensures that the priority values of all project stakeholders are met [7].

It is possible to provide a competitive advantage for a company by creating products that meet the values of stakeholders. The purpose of the research is to describe the approaches and methods for determining the priority values of stakeholders.

Research objectives:

- Principles for prioritizing values, project stakeholders.

- Development of a method for assessing the prioritization of the values of project stakeholders.
- Development of approaches to using the method within the project management processes.

References:

1. Kerzner, H. Project Management: A Systems Approach to Planning, Scheduling, and Controlling [Text] / H. Kerzner. – Ed. 10. – USA, New Jersey: Wiley, 2009. – 1120 p.
2. P2M «Program & Project Management for Enterprise Innovation» [Electronic resource]. – Project Management Association of Japan, 2016.
3. The Standard for Portfolio Management [Text]. – Ed. 3. – Project Management Institute, 2013. – 189 p.
4. Oberemok, I., Oberemok, N., “The stakeholder wide assessment of the impacts of accepted values of stochastic functions of project implementation on their success” International Journal “Information Theories and Applications” 25(4) (2018) 389-396.
5. Oberemok I., Oberemok N. “Development of a schedule of the project on the property board of values stakeholders” Journal of Technology and Exploitation ISSN 2451-148X in Mechanical Engineering Available online at: Vol. 4, no. 1 (2018) 36–42.
6. Morozov V.V., Khrutba Y.S., Khrutba A.S. “Peculiarities of stakeholder interaction in environmental projects” Management of complex systems development, Vol. 37, pp. 32-39, 2019.
7. Oberemok I.I. "Analysis of modern methods of project management of software development." International scientific-practical conference "Innovative development based on technological maturity in project management". Abstracts. K.: KNUBA: (2004) 56-57.
8. Chimshire V.I. "Quantitative assessment of the value of the project activity product." Management of complex systems development. 25 (2016) 80-85.
9. Bushuyev S., Kozyr B., Zapryvoda A. "Agile methods of product formation and the results of an innovative project" // XIV International Scientific and Technical Conference «Computer Sciences and Information Technologies», September 17 – 20, (2019): 136-141.
10. Yehorchenkova N.I. Awareness Management of Stakeholders During Project Implementation on the Base of the Markov Chain / Yehorchenkova N.I., Verenych O., Sharovara O., Dorosh M., Voitsekholvska M., Golyash I.// Proceedings of the 2019 10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS), September 18-21, 2019. Metz, France. P.259-263 (Scopus)

Isus Raichuk

Post graduate student, Department of management technologies of Information technology faculty

Taras Shevchenko National University of Kyiv

MODELS OF DIGITALIZATION OF BUSINESS PROCESSES OF PROJECT-ORIENTED ORGANIZATIONS BASED ON ARTIFICIAL NEURAL NETWORKS

Abstract. The approaches to the integration of artificial neural networks into business processes chains of project-oriented organizations are analyzed. Three kinds of business processes are described. An application of the value-oriented methodology for the adjustment of feedforward neural network are proposed. Key practices of Kanban are analyzed. Conclusions regarding the conducted research are made.

Keywords: project management, artificial neural networks, business processes.

The field of application of artificial neural networks is expanding every year. To date, they can be used in almost all the areas of scientific and applied researches.

The purpose of this research is to analyze the different approaches to the integration of artificial neural networks into business processes chains of project-oriented organizations. Let outline the general characteristics of such an organization:

- the project team participants often work together;
- more organization resources are involved into the working projects;
- project managers are more independent and have considerable powers;
- organization items that report directly to the project manager or provide different additional services are often present [1].

Business process, as a set of interconnected resources and activities that has clearly defined get in and out, and as a result create a value, will be understood. There are three kinds of business processes:

- 1) management processes – business processes that operate the functions of systems. Cooperative and strategic management can be the example of management process;
- 2) the main processes – business processes which comprise the prime businesses of the company and create the major revenue streams. For example, supply, production, marketing, and sale;
- 3) the processes of providing – serving the main business processes. For example, bookkeeping, personnel and information management.

As is well known, artificial neural networks are used for solving the same type tasks, so their integration in the business processes is acquitted; such business processes solve the same type tasks (the searching tasks and decision making). Let's describe the most popular types of artificial neural networks. According to the structure, artificial neural networks are divided into three main types [2; 3]: feedforward neural network, recurrent neural networks (neural networks with feedback), completely linked networks.

In the feedforward neural network, neurons group into layers: an input layer, hidden layers, and an output layer. In such kinds of neural networks each neuron of a certain layer has the direct link to the next layer neurons. The links among neurons do not form the loops. The feedforward neural networks are mostly used for the classification of images, function approximation, prediction, management, etc.

In the recurrent networks the neuron state can influence its future state. In some neural recurrent networks, neurons can link by themselves, while the other recurrent networks – only indirect backward linkages: if an “A” neuron can send a signal to the input of a “B” neuron, the “B” neuron can send a signal to the “A” neuron the same way. The recurrent networks do not always have the accurate defined input and output neurons. In most cases, the recurrent neural networks are applied to the pattern identification, classification, associative memory, noise-tolerant signal transmission.

Completely linked neural networks allow the connection among all the neurons, except connection to links. Besides, the links have to be symmetric. A well-known example of such networks is a self-organized map [3]. Completely linked neural networks are mostly used for the formulation of associative memory, classification.

The neural networks are also classified by the types of studying [3]. The following three studying algorithms are: studying with a teacher, reinforcement studying, and a studying without a teacher.

The study with a teacher. For each input vector there is a target vector which represents a necessary output. These vectors are named a studying pair. The neural network usually studies on the several numbers of studying pairs. An input vector is represented; after an output of network is calculated, a result is compared to the proper target vector. The difference (a mistake) with a help of backward links brings into the network; weights are changed according to the algorithm which minimizes a mistake. The vectors of the training set are given gradually, the mistakes are calculated, and the weight is selected for each vector, until the mistake around the whole educational area reaches an acceptably low level which is defined as one of the training parameters.

While reinforcement studies, after finishing the training sequence, a network gets a reply, which defines whether the result of calculations is either correct or incorrect.

The study without a teacher does not need a target vector for outputs and does not require the comparison with proper answers. The training set consists of only input vectors. The training algorithm selects the weight for neural networks, the way the coordinated output vectors are got. It means a processing of similar input vectors produces the same outputs. As a result, the study defines the statistical properties of the training set and groups similar vectors into classes.

The neural networks can be classified according to the various types of problems that the neural network is able to solve [3]. There are regression and classification problems. For the regression problems the information at the output of the neural network is unbroken. When the classification problem is being preceded at the output of the neural network, discrete data is received. Feedforward neural networks are commonly used for solving the regression problems, whereas an application of any kinds of neural networks is possible while solving the classification problems [4; 5].

In fact, for solving the problems of forecasting implementation the progress of business processes which are regression problems, the application of feedforward neural networks is optimal. The study of such a feedforward network is easily implemented with the use of the study with a teacher algorithm. The application of value approach methodology (figure 1) which is described in the article [6] for the more accurate analysis of the situation, modeling the progress of business processes, and making the optimal decisions is proposed.

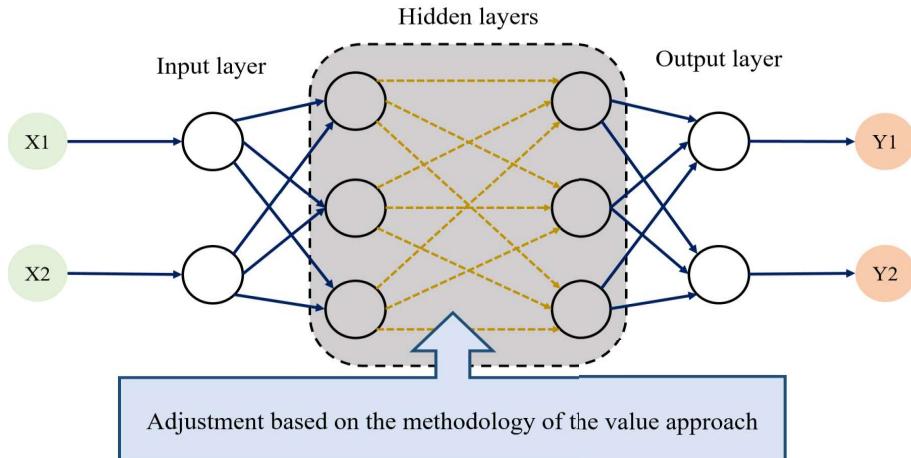


Figure 1 – An application of the value-oriented methodology for the adjustment of feedforward neural network

The modern project management world proposes a great amount of standards and approaches of project management (PMBOK, PRINCE2, P2M, Agile, etc). Since the digitalization projects are IT-projects which need a flexible methodology for their management, it is preferable to use Scrum [7]. For improving the understanding of the general overview of the project process, it would also be appropriate to use Kanban except for Scrum [8]. Scrum is widely used all over the world with the purpose to: discover and find the actual and profitable markets, technologies and product opportunities; develop new products and improve them; release the products and update them several times a day; develop and support cloud technologies (online, safely, on demand) and other environments for the product usage.

Therefore, due to the results of the analysis of Scrum framework, it is possible to make a conclusion that the framework is the one optimal decision for the implementation of digitalization projects. So, the usage of Scrum to manage the research project (the project of digitalization business processes based on the neural networks) is advisable.

In the project of digitalization of business processes based on the neural networks, Scrum is proposed to be used together with Kanban. Speaking of Kanban, it is necessary to remind its six key practices:

1. Visualize. Visualizing working processes help to understand the planning changes properly and implement them according to a schedule.

2. Limit the tasks during the working process. This concept foresees that in the project the system of “pulling” on some parts of the tasks or during the whole working processes of projects has to be used.

3. Operate the working stream. Each turn between the states in the stream has to be monitored, measured, and reported. Therefore, a constant monitoring is needed. Active stream management allows evaluating the positive and negative changing effects in the system.

4. Make the process clear. Until mechanisms or process become clear, it is often difficult or impossible to perform a discussion concerning its improvements.

5. Create feedback mechanisms. The organizations which did not create the second level of the feedback mechanisms (operation review) usually do not observe the improvement of the process beyond the local team level.

6. Make improvements in cooperation; make experiments involving models and the scientific method.

Thus, Kanban provides maximum clarity and realization of implementing project process, whilst Scrum provides the flexibility of project management.

To conclude, the basis for the digitalization of business processes is a selected feedforward neural network. The training of this network worth realizing based on a study with a teacher algorithm using the value approach methodology. The standard of management for digitalization business processes of project-oriented organization with the usage of neural networks project is proposed to base on the framework Scrumban. This project management approach allows providing a flexible, efficient and adaptive management of the project-oriented organization and also a constant improvement of the business processes by using of neural networks.

References:

1. Batenko L. P., The main forms of the projects organization structure, 2020. URL: <https://library.if.ua/books/96.html>.
2. Kriesel D. A., Brief Introduction to Neural Networks, 2007. URL: http://www.dkriesel.com/en/science/neural_networks.
3. Rajesh Bordawekar, Bob Blainey, Ruchir Puri, Analyzing Analytics, 2015, Morgan & Claypool Publishers.
4. Osovsky S., The neural networks for the information processing. Translated from polish I. D. Rudynskii, 2002, Finances and statistic.
5. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An introduction to statistical learning, 2013, Springer Science+Business Media, New York.
6. Timinsky A., Raichuk I., Method of value-oriented stakeholder management of digitization project, 2019, Project management and development of production, Volodymyr Dahl East Ukrainian National University, 3(71).
7. Ken Schwaber, Jeff Sutherland, The Definitive Guide to Scrum: The Rules of the Game, 2017.
8. Max Rehkopf, Kanban, 2020. URL: <https://www.atlassian.com/agile/kanban>.

¹**Anna Samonenko**

Master student, department of Technology Management

²**Oleksii Yehorchenkov**

Associate Professor, department of Technology Management

^{1,2} Taras Shevchenko National University of Kyiv

PECULIARITY OF RPA PROJECTS

Robotic Process Automation (or RPA) is a form of business process automation technology based on metaphorical software robots (bots). According to the prediction of McKinsey & Company, Robotic Process Automation (RPA) will showcase an economic impact of \$6.7 trillion by 2025 [1].

In traditional workflow automation tools, a software developer produces a list of actions to automate a task and interface to the back-end system using internal application programming interfaces (APIs) or dedicated scripting language. In contrast, RPA systems develop the action list by watching the user perform that task in the application's graphical user interface (GUI), and then perform the automation by repeating those tasks directly in the GUI [2].

RPA tools have strong technical resemblance to GUI testing tools. These tools also automate user interactions with the GUI, and often do so by repeating steps performed by a user. RPA tools differ from testing tool in that they allow data to be processed between multiple applications. For example, receiving email containing an invoice, extracting the data, and then typing that into a bookkeeping system.

Here, are some reasons why Robotics Process Automation is advantageous

- A human can work average 8 hours a day whereas robots can work 24 hours without any tiredness.
- The average productivity of human is 60% with few errors as compared to Robot's productivity, which is 100% without any errors.
- Robots handle multiple tasks very well compared to a human being [3].

The next phase of RPA technology will combine artificial intelligence (AI) and machine learning to make it more powerful. AI gets more intelligent over time by assessing the data that RPA can provide. Instead of just completing a programmed action, RPA, with the help of AI is able to determine what action to take based on the data.

So according to this let us have a look at the peculiarity of PRA projects:

- RPA is similar to the traditional automation, because they both use software integration to automate business processes. However, RPA is more sophisticated than traditional automation. Traditional automation use APIs while RPA use software bots in order to understand the user behavior at the UI level. For example, in case of RPA, bots understand the user steps and repeat them. As the result of comparing these approaches it was defined that traditional automation has various limitations, such as restriction in application. Therefore, it is challenging to use traditional automation in

legacy systems. On the other hand, because RPA usually works on the UI layer, it is allowing avoiding these limitations. In RPA, no programming skills are required, user should know how to use RPA tools only, but in traditional automation, automation tests using programming languages should be written. Therefore, it makes RPA faster in implementation, than traditional automation. In addition, RPA offers high level of customization if compared to the traditional automation. RPA has integration with different applications like ERP, email, calendar and other.

- Typical lifecycle of RPA projects has 4 phases – Analysis, Bot Development, Testing and Support. On the phase of analysis team works together to analyze the business process for RPA development. After this team starts working on developing the automated workflow for requirements. On the phase of testing team runs testing cycles in order to understand the quality and find defects. On the last phase, team provides continuous support and helps in defect resolution.

As the result of comparing these approaches it was defined that traditional automation lifecycle to the RPA, it has more phases – analysis, design, development, testing, deployment and support. In general, both lifecycles are similar, but there is a difference on the stage of the development. In traditional automation, on this phase automation tests are implemented, but in the RPA is bot development.

It was also defined management of the RPA projects to the other IT projects, show no big difference. PM should decide what most suitable methodology for team is and implement it in the project. So there is no any specific methodology developed for the RPA project.

References:

1. The evolution of RPA: Past, Present and Future. URL: <https://www.uipath.com/blog/the-evolution-of-rpa-past-present-and-future>.
2. Robotic Process Automation. URL: https://en.wikipedia.org/wiki/Robotic_process_automation.
3. Robotic Process Automation. URL: <https://www.businessdevelopment.blog/robotics-process-automation>.

¹ **Anton Sazonov**

Postgraduate

² **Natalia Yehorchenkova**

Dr. Tech. Sc. Associate Professor

^{1,2} Kyiv National University of Construction and Architecture

CONCEPT OF ORGANIZATION OF PORTFOLIO OF PROJECTS AND PROGRAMS OF FINANCIAL COMPANIES

Abstract. Addressed the problem of managing the portfolio of projects and programs in financial companies. Proposed a new method of portfolio management based on a process approach.

Keywords: portfolio of projects and programs, process approach, PDCA cycle, strategic management.

Today, Ukraine's financial sector is in a difficult macroeconomic climate under the rapidly developing stage, forcing financial companies to change traditional management methods. Competitive pressures for consumers and innovative discoveries in the information and technology environment force financial companies to act on new models and management methods. To increase customers' demand and proper quality of services, financial companies implement projects to improve the efficiency of production processes, create new products and services.

The world experience of improving quality has shown that it is possible to get certain outcomes only within the management process. However, the entry into the workforce of new products and services requires implementation of best global practices of project and process management, since these activities are limited at the time, resources, and coverage area. Taken into account the implementation of certain projects /programs requires a focused results-based management portfolio of projects/programs, thus there is a need for complex and systemic effectuation of project and process management methods to create an appropriate balance between them. It is also worthwhile to note that the existing issue lies in the fact that financial companies are always operating by process activity, that concentrates the relationship between many areas of activity by performing processes in which the outputs (results) of some are inputs (resources) for others, transferring the results of some to others creates added value, which ultimately affects the quality and cost of services. And the main models of project management are mainly focused on project organizations, in which the creation of a new unique result or product is the main source of profit.

Thus, there is a need to find an effective balance of methods and models that are combined to achieve maximum symbiosis of the two approaches to management and ensure the stable development of financial organizations in the current economy.

The authors are invited to suggest new methods and models of projects and programs portfolio in a financial institution through the use of the principles of process management, notably:

1) Sufficiency – the process should be regulated and clearly defined within the limits;

2) Appropriateness – the process should be carried out by the documents regulation;

3) Quality – the process should be completed with a result that meets the expectations of the process consumers (both internal and external).

4) Making the decisions based on facts - decisions on the effectiveness of activity should be based on systematic analysis of actual indicators and reliable certificates.

5) the principle of continuous process management by using the Shuhart-Deming cycle – PDCA (Plan – Do – Check – Act) [1].

6) According to the author's opinion, the PDCA principle can be used as the main method that needs improvement to build the cycle of operation of the project portfolio management process for its effective management. However, scrutiny of the latest research of the management process portfolio also should be taken into account [2].

According to the authors, the most important goal of managing the portfolio of projects for financial companies is the implementation of the strategy. Consequently, the project portfolio management process must meet the following conditions:

1) ensure the implementation of the Strategy;

2) ensure effective interaction of financial company units in the actualization of the portfolio of projects and programs;

3) to provide informing and reporting to stakeholders on the implementation of the portfolio of projects and programs.

The overall model could be used to achieve strategic goals and benefits is set out in Figure 1. Model for Achieving Strategic Goals and Initiatives.

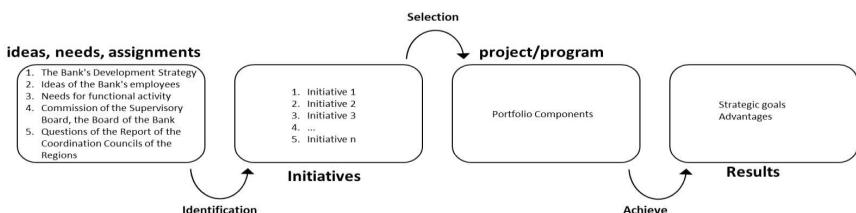


Figure 1 – Model of achieving strategic goals and initiatives

Thus, having examined the latest researches of process and project management there are positive conclusions on the implementation of one and the other approaches. However, there is a need to research new methods of project portfolio management, which will allow performing the process of managing the portfolio of projects in financial companies. In my view, such researches, can have successful results and be useful for use in the environment of financial companies.

References:

1. Deming, W. Edwards (1986). Out of the Crisis. MIT Center for Advanced Engineering Study – 419 pp.
2. Project Management Institute. The standard for portfolio management/14 Campus Boulevard Newtown Square, Pennsylvania 19073-3299 USA, 2017. – 127 pp.

¹ **Tetiana Shelest**

Assistant Professor, Technology Management Department, Faculty of information Technology

² **Anita Rudenko**

Bachelor of Applied Programming, Applied Information Department, Faculty of information Technology

^{1,2} Taras Shevchenko National University of Kyiv

ANALYSIS OF PREREQUISITES FOR THE APPLICATION OF IT PROJECTS IN CONSCIOUS CONSUMPTION MANAGEMENT

Our study aims to examine the prerequisites for the use of IT and their impact on the management of conscious consumption.

At this moment, the fast fashion business model is widespread in fashion technologies. It promotes the rapid production of cheap clothing following new fashion trends. Thanks to committed eco-activists, consumer preferences are changing, and the opposite model, ethical fashion, is gradually spreading. This business model ensures sustainable production, operation and disposal of clothing, footwear and accessories. Among consumers this model manifests itself in the form of conscious consumption. Conscious consumption is a thoughtful approach to shopping, responsibility for ethics and environmental friendliness, as well as reducing consumption [1]. On average, today the population buys 60% more clothes and accessories than in 2000, and 400% more than four decades ago. In the reporting documents for 2017, H&M stated unsold clothes worth \$4.3 billion [2]. And the luxury brand Burberry in 2018 burned its own products for \$37.8 million, confronting counterfeiting and reducing the level of exclusivity [3]. This consumption behavior is harmful to the environment. For example, in 2018, this industry sector emitted 2.1 billion tons of greenhouse gases (Fig. 1) - this is more than in the same period produced by all aircraft and ships in the world [4,5].

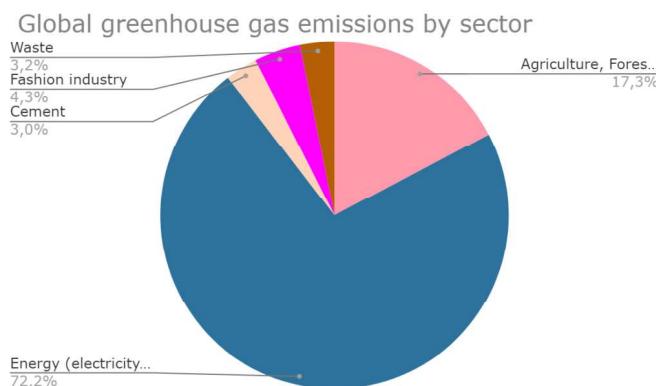


Figure 1 - Greenhouse gas emissions for 2018

Source: grouped by author by [4,5]

Nowadays conscious consumption is getting more popular, people are becoming more conscious and brands are gradually adapting to them. Buyers happen to be the main driver of change. At the end of 2018, the financial company HSBC surveyed more than 8500 different brands and it turned out that almost a third of them began to move to more ethical and environmentally friendly production [6]. A study of Ukrainian brands has shown that there are already brands that help improve the environmental and ethical situation in the country.

Continuing our research, we aim to find an innovative way to teach people to choose things wisely. The digitalization of society contributes to this, indeed, IT technologies can effectively help spread the idea of conscious consumption. We believe that it is necessary to initiate the development of a mobile application that will allow you to succeed in finding the matching clothes. The functionality of the mobile application enables selecting clothes and visualizing a combination of different pieces, which helps avoid impulsive and unnecessary purchases. The mobile application will also be a database on environmental-friendly and ethical companies, who will likely invest in the IT project on creating a mobile fashion application. This IT project will speed up the process of managing conscious clothing consumption.

Analysis of the Ukrainian brands shows that more and more companies are investing in the future. And companies can consciously use existing budgets, launch IT projects and attract human capital for positive transformations in the scope of conscious consumption.

References:

1. Sofia Pylypyuk It's easy to be sustainable in Berlin, 2018. URL: <https://www.the-village.com.ua/village/city/city-experience/276125-sustainable-fashion>
2. Daria Kosareva How luxury has become a responsible consumption. 2018. URL: <https://theblueprint.ru/fashion/industry/new-luxury-consumption>
3. The Guardian Burberry destroys £ 28m of stock to guard against counterfeits, 2018. URL: <https://retailers.ua/news/menedjment/7795-brend-burberry-za-posledniy-god-unichtojil-good>
4. McKinsey & company Fashion on climate, 2020. URL: <https://www.mckinsey.com/industries/retail/our-insights/fashion-on-climate>
5. Hannah Ritchie Sector by sector: where do global greenhouse gas emissions come from? Our world in data, 2020. URL: <https://ourworldindata.org/ghg-emissions-by-sector>
6. Varya Barkalova How does the fashion industry affect the environment? 2019. URL: <https://theblueprint.ru/fashion/industry/moda-i-ecologiya>

¹ Grygorii Steshenko

P.h.D, associate professor, Department of management technologies of Information technology faculty

² Anatolii Buhrov

Undergraduate student, Department of management technologies of Information technology faculty

³ Daria Horban

Undergraduate student, Department of management technologies of Information technology faculty

⁴ Yuliia Timrova

Undergraduate student, Department of management technologies of Information technology faculty

^{1,2,3,4} Taras Shevchenko National University of Kyiv

BASIC METRICS OF STARTUP EVALUATING

Abstract. The purpose of the article describing the key metrics in product development for startup projects.

Keywords: startup, key metrics, business value

Why is that important?

Nowadays, lots of entrepreneurs present different sorts of metrics and indicators that illustrate the health and potential of their companies. Also, there are the same metrics that are being interpreted in different ways. As a result, it makes it difficult to understand whether the business is doing ok.[1]

Key metrics in product management:

ARPU (Average Revenue Per User) is the main indicator for predicting revenue. But it's not that straightforward, there are cases when companies projected revenue based on inflated ARPU, resulting in consistently falling behind their target.

ARPU analysis allows us to assess the correctness of pricing. It allows us to decide if we believe the numbers we see.

CLV (Customer lifetime value) - metric that shows us what profit the average client brings during his “life” (time client works with the company). One of the most famous venture capital investors, David Skok, said that many start-up companies fail just because they don't know about CLV. Or they know, but are too lazy to calculate. Thus, for these startups, the cost of acquiring a new customer outweighs the lifetime cost.[2]

CAC (Customer acquisition cost) - metric that shows how much it will cost to attract a new customer. This is essential, because if you know the value of a customer, then you know how much you can spend on attracting him. Well, if you spend on

acquisition less than one third of CLV (customer value), this is a generally accepted ratio.

Knowing the value of customers makes you understand how effective an advertising channel or a contextual campaign is and whether there are actions required to optimize it.

MRR (Monthly recurring revenue) - another indicator that speaks for itself, but the particular importance in this metric is that it is not an actual revenue, it just shows how fast a company is growing. Generally, it shows how much money we would receive from our entire customer base if they all paid every month and did not use discounts and promotions. It shows the real traction of a startup.[3]

But we should be aware of cases when attracted by the discount, customers made payments for a long period in advance leading to an increased revenue followed by promotion that was beneficial for clients. In this scenario companies simply drag customers' future months payments to the promotion period which entails a very noticeable drop in monthly payments in future.

Cohort analysis

With this analysis, you can quickly notice changes. If the user database is large enough, its behavior changes slowly. If the flow of new interactions has halved in some months, you may not notice it right away due to the use of customers and their payments. Measuring the number of the conversion to paying customers gives an understanding of how successful the actions were in the field of contextual advertising, marketing, and also shows trends in customer behavior. Companies cannot influence such global events as rate races, but based on such information, they can adjust their plans and manage activities.

We'll conclude with a short description of why process performance and efficiency management is the focus of many companies today and how these five metrics are used by specialists around the world. The above metrics are of immense value to a business and should by no means be overlooked. Avoiding these critical metrics can lead to a premature failure. It is essential to understand that revenue is just one of many indicators.[2] If a company wants to have a complete vision of the health of the business it needs to master different approaches to examine it.

References:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Sixth Edition (2017). Project Management Institute, USA, 756 p.
2. Steve Blank. (2006) The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Microsoft Press, USA, 608 p.
3. The Seven Startup Metrics You Must Track // Young Entrepreneur Council. Available at: <https://www.forbes.com/sites/theyc/2014/06/20/the-seven-startup-metrics-you-must-track> (accessed 7 November 2020).

¹ Oleh Suprun

Assistant

² Nina Klimenkova

Bachelor student

^{1,2} Taras Shevchenko National University of Kyiv, intellectual technology department

IT AUDIT AS A KEY COMPONENT OF INFORMATION SYSTEMS EFFECTIVENESS AND DATA SECURITY

Abstract. In modern world, alongside with development of new information and calculation technologies, it is very important to ensure their effective work in combination, same as to provide high level of data security and protection on different scales. This paper provides the basic concept of IT audit and short description of modern methods used worldwide.

Keywords: information systems, IT audit, data protection.

Rapid development of the information society and the application of digital technologies in various spheres of human life and activities constantly pose new challenges and increase the requirements for the quality and efficiency of the methods and technologies used. For example, in recent decades the amount of information processed every hour in a variety of companies has increased dozens of times, requiring the development of new methods of big data computing [1] that use classic methods and at the same time the latest approaches to artificial intelligence, such as neural networks and evolutionary technologies, alongside with pictures identification and computing [2].

An information technology audit, or information systems audit, is an examination and evaluation of the management controls within an Information technology (IT) infrastructure [3]. The IT audit is rather different from other audits, like financial and logistic, since they evaluate the effectiveness and correctness of existing systems, but IT audit also calculates most of possible risks in future, considering the external circumstances, and overall system security at the same time.

The first country that mentioned the information security as part of government law was Great Britain. In 1984, the first Data Protection Act (DPA) was created which defined and formalized the first provisions and the importance of ensuring the information security of citizens and their personal data. In addition to setting a precedent, the UK first passed a law on the "improper" use of information and technology, even unintentionally, in 1990. It considers three types of criminal offenses like using data without authorization.

Shortly after, other European countries passed the laws about information security and illegal data usage, most of them are unified and global security programs are functioning these days.

However, modern IT-audit doesn't cover only the problem of security, it also investigates the problems and risks that the company may meet in future. Therefore, different approaches and methods of IT-audit were created, the most popular are:

- COBIT 5 is a set of standards and guidelines developed by the Association for the Audit and Control of Information Systems (ISACA) in collaboration with the Institute for IT Management (ITGI), which can be used by IT auditors due to its comprehensiveness and completeness;
- ITIL is the best description of international practices in the public and private sectors. It contains information about IT services to the company, documenting the processes, functions and roles of IT Service Management (ITSM);
- Prince 2 is a project management methodology that covers quality management, control and project organization consistently and in line with objectives. Prince 2 is used for IT projects, as well as for many other types of projects;
- ASL is a description of best practices used to standardize processes in Application Management, the basis for creating and maintaining information systems and applications;
- ISO / IEC 27001 and 27002. The international security standard ISO 27001 contains requirements for information security management and the information security management system (ISMS). ISO 27002 contains recommendations for information security management based on best practices.

At the same time, despite the importance and rapid growth of IT industry in Ukraine, the problem of IT audit is still at the initial level that may cause significant issues in future. The most obvious problem is the vulnerability of government infrastructure to external attacks, same as insecurity of national companies, that was seen in 2014 and 2016 years. On the other hand, all companies from Europe, same as Asia and America, require from each of their partners' presence of certificates that indicate the level of company security, such as ISO 27001 certificates. The main problem right now is the disregard of IT security problem by the governance. Even considering some steps, that were made after large attacks, these actions are rather local and do not solve the problem as a whole.

References:

1. N. I. Didenko; D. F. Skripnuk; O. V. Mirolyubova. "Big data and the global economy." 2017 Tenth International Conference Management of Large-Scale System Development (MLSD) 2-4 Oct. 2017, DOI: 10.1109/MLSD.2017.8109611
2. Popreshnyak, S., Suprun, O., Suprun, O., Wieckowski, T., "Personal documents identification system development using neural network.", 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018, p. 129-134, 8526757
3. Gantz, Stephen D. (2014). The basics of IT audit: purposes, processes, and practical information. 2014: Syngress, an imprint of Elsevier.

¹ **Alexander Timinsky**

PhD, associated professor, Department of management technologies of Information technology faculty

² **Nikolay Kerdun**

Undergraduate student, Department of management technologies of Information technology faculty

^{1,2} Taras Shevchenko National University of Kyiv

MS PROJECT AS A DIGITALISATION TOOL OF PROJECT MANAGEMENT SYSTEM FOR PROJECT ORIENTED COMPANIES

The intensive development of information and communication technologies in recent years, together with modern socio-economic trends in the world economy, has led to the formation of new requirements for planning and project management in various areas of human activity.

One of the prerequisites for the effective implementation of projects in recent times has been the use of project management tools and tools based on the use of new information and communication technologies.

In 2020, the activities of almost any modern project, regardless of the duration, scope, budget, intended goals and objectives of the project, cannot be presented without the use of modern software.

Regardless of industry affiliation, a significant part of organizations structure all their activities in the form of projects (engineering, construction, IT, consulting, ship and aircraft enterprises), since each result of their activities is unique. But for organizations that have established service delivery processes, it may be necessary to allocate individual work in the form of projects.

The leading classic project management standard PMBOK of the American Institute of Project Management PMI in its latest edition pays a lot of attention to the digitisation of project management [1].

The development of special software for project planning and management is primarily due to the need for maximum integration of the IT sphere and the most effective methods, tools and tools of project management theory.

Today, according to Gartner Group, the Microsoft Project system is recognized as the leader in the market for project management systems. The company owns 75% of the project management systems market. The platform MsProject implemented corporate systems in such large organizations as Deutsche Bank, Merrill-Lynch, Delphi Automotive, etc. This is possible thanks to the combination of not only lower (compared to competitors) price and high quality in Microsoft solutions. In addition, the product is included in the MS Office package familiar to almost everyone, making it easier for staff to work in a familiar environment. All this significantly reduces the time for preparing the state, as well as the timing of the implementation of the system.

Microsoft Project has indeed become actually a standard on the market, as a means of individual work of project managers, and is expanding in the segment of heavy solutions. For corporate customers, MsProject Professional is the best solution to

cross-departmental issues where the key requirement is automatic scheduling, progress forecasting, and performance tracking.

Microsoft Project is the best choice for organizations using a matrix management structure, that is, project teams include the interaction of employees from different departments.

It is worth implementing Microsoft Project in the activities of project-oriented organizations based on the use of another Microsoft development to implement their own products - the MSF standard [2].

And desktop Microsoft Project and other solutions in the field of calendar and network planning of Microsoft (server version of Microsoft Project Server, cloud solution Project-Online) with a correct and fully functional implementation will allow project-oriented organizations

- Formalize and systematize project activities;
- Develop and monitor project plans;
- Minimize the cost of resources of all types (material labor, financial) when implementing projects;
- Complete the project on time and within the budget;
- Manage project risks, plan and implement effective risk response;
- Manage the project portfolio of the project-oriented company;
- Improve the culture of project management;
- Increase the technological maturity of the company in the field of scheduling and network planning.

Any time-tested scheduling solution can benefit a project-oriented company. Microsoft Project is not the only such tool, but one of the busiest. Scientific and practical research on the implementation of calendar and network planning solutions in the activities of project-oriented organizations may relate to the following: development of models, methods and algorithms for introducing Microsoft Project into the activities of a specific project-oriented organization, taking into account its specifics; the development of scientific foundations for the establishment and development of a corporate project management system; Create creative project team management models based on digitalized project management tools. These tools will ensure the modernity, flexibility and efficiency of the project management system for project-oriented organizations.

References:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Sixth Edition (2017). Project Management Institute, USA, 756 p.
2. Turner, M. (2006) Microsoft® Solutions Framework Essentials: Building Successful Technology Solutions, Microsoft Press, USA, 342 p.

¹ Alexander Timinsky

PhD, associated professor, Department of management technologies of Information technology faculty

² Maksym Patsyuk

Undergraduate student, Department of management technologies of Information technology faculty

^{1,2} Taras Shevchenko National University of Kyiv

TEAM MANAGEMENT MODELS OF SEO-OPTIMIZATION START UP PROJECTS

Abstract. The approaches to the formation and management of start-up SEO optimization projects are described. Hierarchical development of the start-up team of the SEO-optimization project are proposed. The main advantages of this structure are considered. The Tier Meetings Framework for coordination and management of project teams are described. Conclusions regarding the conducted research are made.

Keywords: Digital project management, start up project, organizational structure, Tier Meetings Framework, SEO optimization.

Decades ago, the World Wide Web was used almost exclusively to find the information you needed. Today, the number of web portals exceeds one billion, and the number of users (according to the Facebook report for 2015) is more than three billion people, ie almost half of the world's population.

According to Forrester Research Inc., 81% of people find the right website through search engines. The data clearly shows that it is SEO that helps to attract more users to the site. Moreover, people who find a web resource through a search engine are the most interested target audience, because they enter keywords in the search field, on the basis of which search engine optimization is formed. Yes, the high role of SEO as an internet marketing tool is undeniable [1, 2].

We describe the approaches to the formation and management of start-up SEO optimization projects. At the beginning of the project, the main backbone of the team looks like this (Fig. 1):



Figure 1 – The initial team structure of the SEO-optimization start-up project

At the stage when the start-up project begins to scale [3], the number of tasks increases, new people are recruited. In this case, there are usually two options for

further development of the team - linear and hierarchical. An example of the linear development of the start up project team is shown in Figure 2.



Figure 2 – Linear development of the start-up team of the SEO-optimization project

The main disadvantages of the linear structure of the team are:

- Less time available per employee;
- It is difficult to scale;
- Team development is much slower.

Figure 3 shows an example of hierarchical development of the start-up team of the SEO-optimization project.



Figure 3 – Hierarchical development of the start-up team of the SEO-optimization project

The main idea of the hierarchical structure is to divide workers into subcommands. Thus, junior employees are assigned to a more experienced specialist.

The main advantages of this structure:

- Rapid team development – Middle Specialist hires a Junior Specialist and hone his skills;
- Backup – you always have people who know what is happening with a particular site, can replace it during the holidays, etc.;
- Delegation of tasks and responsibilities;
- Better individual development plans.

Regardless of the structure of the team (linear, hierarchical), in order to understand in which direction the team is moving, it is necessary to set adequate KPIs.

For an SEO startup, the following KPIs are best, which are easy to understand and easy to calculate:

- Site traffic;
- Site keywords;

- Search engine rankings;
- Number of external links.

For projects that already generate traffic and revenue, the best KPIs will be:

- Earned funds;
- Number of sales;
- ROI.

When the company has already gathered more than 5 full-fledged SEO teams, it is recommended to use the Tier Meetings Framework for coordination and management of these teams [4] (Figure 4).

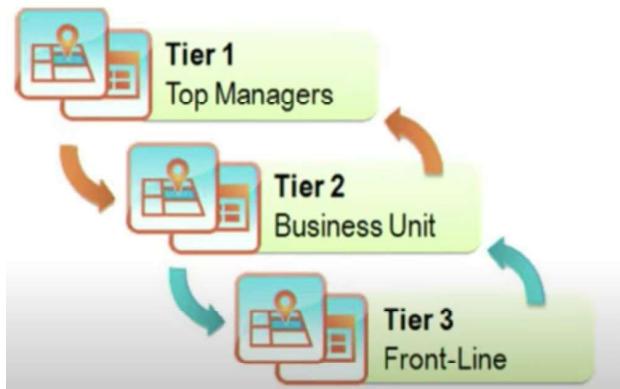


Figure 4 – Tier Meetings Framework structure

The main idea of the Tier Meetings Framework is regular rallies of specialists of the same level with specialists of the highest level. Thus, problems and tasks are transferred from one level to another. Consider the Tier Meetings Framework on the example of an SEO campaign:

Tier 1 Meeting.

Link builders hold a rally between link builders to discuss all the issues, problems and difficulties that may arise during the implementation of their KPI.

Tier 2 Meeting.

A rally between link builders, SEO specialists and Team Lead, at which top-level specialists (SEO and Team Lead in this case) analyze the problems and successes of lower-level specialists (link builders).

Tier 3 Meeting.

Rally between the Leads of various teams from the CMO (Chief Marketing Officer), where serious issues such as: sales, revenue, ROI, etc. are brought up for discussion. During such a rally, Team Lead can bring to the top management problems that prevent his team from achieving greater success.

Tier 4 Meeting.

Rally between senior positions in the company. CMO meets with CEO, Product

Manager, Chief Finance Officer. At such a meeting, participants discuss global issues that affect the business: what is happening with each area, whether any help or additional funding is needed.

Tier 5 Meeting.

Rally between business owners.

We define basic rules of Tier Meeting:

- 1 file in which everyone works, separate for each level;
- 1 rally for everyone;
- 1 hour time limit;
- Once a week, regularity.

Advantages of using the Tier Meetings Framework in SEO start-ups:

- Company synchronization;
- Transparency;
- Exchange of experience;
- Ability to take the problem to the next level;
- Interaction of different teams on a specific issue;
- Regular communication.

In general, the use of the proposed approaches (hierarchical team structure, application of KPIs, level meetings) in team management of start-up SEO-optimization projects is aimed at improving the efficiency of project teams, increasing their flexibility, simplifying the decision-making process.

The above helps to increase the probability of success of start-up projects, which are known to be implemented in a high-risk and poorly predicted market environment.

Future research in the chosen direction will be aimed at developing methods for managing start-up project teams. In particular, the current areas of further development include the following: digitalization of the competency model of project team members, digitalization of business processes of SEO optimization project management, development of separate algorithms for project management, project development models, technological maturity development models of the company implementing SEO optimization projects.

References:

1. Odden Lee, *Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing*, Wiley, 2012.
2. Dover Danny, Dafforn Erik, *Search Engine Optimization (SEO) Secrets*, Wiley, 2011.
3. Peter Thiel, *Zero to One: Notes on Startups, or How to Build the Future*, Currency, 2014.
4. Nidhi Shah, *Ways to make tiered meetings effective*, Kaizen Institute, 2014.
<https://in.kaizen.com/blog/post/2014/01/23/ways-to-make-tiered-meetings-effective.html>.

¹ Volodymyr Yas

Magister

² Anna Kolomiets

PhD in Economics, Assistant Professor

^{1,2} Taras Shevchenko National University of Kyiv

IMPLEMENTATION OF PROJECTS IN THE MEDICAL FIELD USING BIG DATA AND WATERFALL METHODOLOGY

Abstract. Digitalization of medicine is a promising direction that not only simplifies the work of clinics or laboratories, but can also save human lives. Data processing allows making diagnoses more accurate and helps using the accumulated information to predict possible "waves" of diseases. Big data, in addition to the already known and common tasks, can also be used to combat diseases and track the growth of epidemics.

Keywords: Big Data, healthcare, digital development, methodology, management.

Today, significant progress has been made in the tools and cost of data collection and storage. The most relevant problem in data management in the Big Data environment is the development of algorithms for complex analysis and interpretation of data in real time. Permanent collection and analysis of information at the level of advanced analytics not only allows you to notice at an early stage any deviations and anomalies in the readings, but also to identify hidden patterns.

The high relevance of the implementation of Big Data technologies in medicine is associated with new trends in the relationship between doctor and patient in the format of mobile medicine technologies. Medicine is becoming more patient-oriented, for which prognosis, disease prevention and personalization of treatment are important. Standard medical services lag behind the demands of patients who want to receive tools that allow you to control more and more physiological parameters and who are increasingly involved not only in the process of continuous monitoring of their health, but also in health management [1].

Images occupy a significant amount of information in medical information systems, which is an important source of data in the diagnosis, evaluation and planning of therapy. The amount of medical image data can range from a few megabytes per study to hundreds of megabytes per study. Storing such data for a long time requires powerful storage systems, as well as fast and accurate algorithms that provide the ability to automate decision-making processes that are performed using this data. In addition, if during the diagnosis, prognosis and treatment use other data sources obtained for each patient, there is a problem of developing effective methods to cover a wide range of data. Another area where digital development will stimulate returns for pharmaceutical companies - the development and familiarization of methods of advanced analytics, including predictive analysis, construction of simulators and variable models. In this environment, the winners will be those pharmaceutical companies that will be able to influence the algorithm of clinical decision-making,

offering doctors sound information about the best treatment options, based on advanced analytics [2].

The implementation of projects in the medical field requires clearly defined processes and precise deadlines, and therefore the cascade model is best suited here, as each stage of project creation continues the previous one and cannot begin until the previous one is completed. In this case, arbitrary transitions forward or backward are not allowed, and the stages do not overlap each other [3]. This model has a rigid structure. The Waterfall methodology originates in sectors such as construction, finance, and aircraft construction, where there is a clear sequence of work that can only begin after the completion of previous ones.

The main stages of product development: system and software requirements - these requirements are defined in the product requirements document; analysis - reproduced in models, schemes and business rules; design - the internal software architecture, ways of realization of requirements are developed; code writing - software integration; testing - checking the final product, finding errors and defects in the program code; operations - the product is adapted to different operating systems and updated to correct errors found [4].

In the field of health care, there are many people who are familiar with the cascade model approach and confirm its effectiveness. This is directly true for project managers who want to see a sequence of future tasks in the form of a Gantt chart, which provides a visual description of the project. Some health projects that may require final approval by the Food and Drug Administration (FDA) —for example, the design or development of a medical device — may benefit from the Waterfall methodology. This is due to the fact that the FDA, along with other government agencies, requires quality and design verification at various stages of development, which is easier to document using a cascade model [5].

Thus, Big Data technologies can provide (thanks to the increasingly advanced data processing apparatus with accurate conclusions) the desired tool to the doctor, which will take into account the characteristics of each unique organism. And the use of the "Waterfall" methodology will significantly increase the chance of successful completion of the project with a correspondingly high quality.

References:

1. M. Kozin. Application of Big Data in medicine [Zastosuvannya Big Data v medytsyni], 2018. // URL: <https://blog.mednote.life/articles/primenenie-big-data-v-medicine>.
2. D. Reinsel, J. Gantz, J. Rydning. Data Age 2025: The Evolution of Data to Life-Critical Don't Focus on Big Data; Focus on the Data That's Big, 2017. URL: <https://www.seagate.com/files/www-content/ourstory/trends/files/ Seagate- WP-DataAge2025-March-2017.pdf>.
3. E. Samoylova Бессмертная классика Waterfall [Bessmertnaya klassika Waterfall], 2017. URL: <https://worksection.com/ua/blog/waterfall.html>.
4. Winston W. Royce Managing the Development of Large Software Systems // URL:<http://static1.1.sqspcdn.com/static/f/447037/6486244/1270928531727/waterfall+royce.pdf>.
5. B. Simon Healthcare Project Management 101: Experts Share Techniques, Examples and Future Outlook, 2020. URL: <https://www.smartsheet.com/content/healthcare-project-management>.

¹ **Alina Zharikova**

Student of the Master's Project Management Program

² **Viktor Morozov**

PhD, Professor, Head of The Department of Technology Management

^{1,2} Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

PROJECT MANAGEMENT OF DEVELOPMENT BUSINESS MESSENGER FOR COMMUNICATION WITH FOREIGN CLIENTS

Usually busy people have little time. Therefore, business messenger will help them to conveniently manage business, communicate with foreign clients just holding the phone in their hands. The business idea is to create the first business messenger to communicate with people from all over the world, edit documents from the phone and conveniently manage your own business.

This messenger will have cloud storage, it will be available to the user without downloading files it to the computer. Thanks to this, several users will be able to edit documents directly in the chat. Each of the users will see who, when and what edited in the document. Also, if one of your colleagues or partners is in another country and the user does not know the language, you can turn on the automatic translator feature and receive messages from any country in the selected language. Messenger will have the function of making collective audio and video calls, in an urgent meeting the user will not need to find a computer, and will be able to communicate with colleagues only with a phone.

The project has three main objectives:

1. The possibility of increasing the free time of business owners.
2. The possibility of increasing the number of foreign customers.
3. Reducing the chance of losing or damaging documents.

The project team consists of a project manager, business analyst, marketer, sales manager, two developers, two testers and a designer.

Project limitations affect the capabilities of the project manager. Usually projects have three main constraints: time, scope of work and budget. The developed project has the following limitations:

1. Time limit (the project must be implemented in 1 year).
2. Budget restrictions (a total of 884 thousand hryvnias was allocated for the project implementation).
3. Scope of work (the project has an approved scope of work that must be performed to implement the project).

The approved scope of work to be performed for the project is made out in the WBS. The WBS of project is used to detail project results to clearly demonstrate ways to achieve them. The first level of detail indicates the project itself, the second – the main results of the project, and the third – the main work that will help achieve the goals (figure 1).

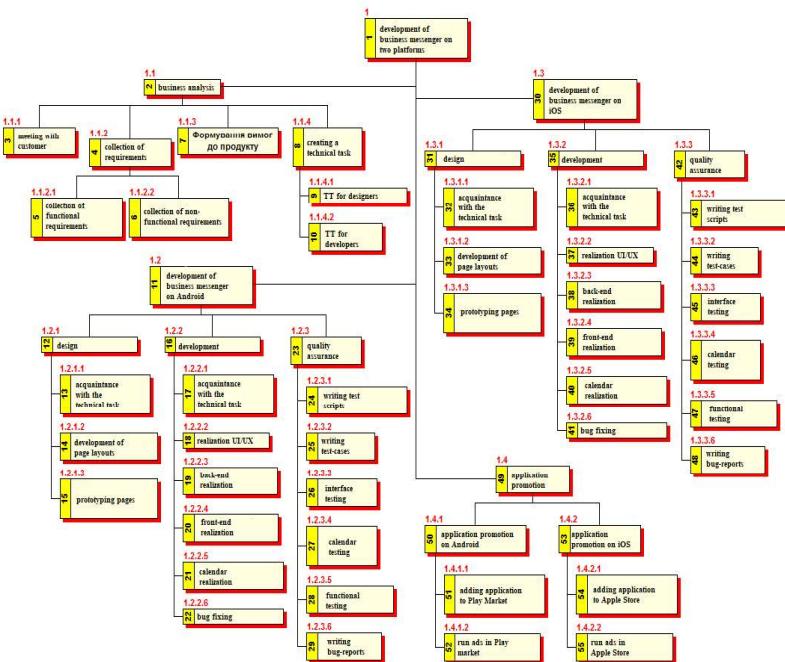


Figure 1 – WBS of the project

The organizational breakdown structure of the project (OBS) is a hierarchical structure of project management and shows the relationship between project participants (figure 2).

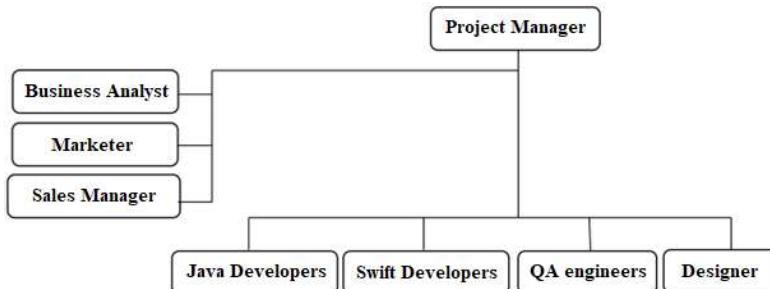


Figure 2 – OBS of the project

PM manages the development team, testers, designers, and is assisted in this by a business analyst, marketer and sales manager.

¹ Dmytro Zubets

VP of Business Development, IIBA Ukraine Chapter

² Grygorii Steshenko

P.h.D., associate professor

¹ Enterprise Solutions Principle, SoftServe

² Taras Shevchenko National University of Kyiv

BUSINESS ANALYSIS IN UKRAINE

Abstract. The purpose of this article introducing the business analysis area in IT and product development. Authors cleared an ambiguity about the profession of a business analyst, which the standards and requirements are for this job, and what the organization has a corner office in this area of expertise.

Keywords: BABOK® v 3.0, business analysis, business analyst, The International Institute of Business Analysis™ (IIBA®)

What is Business Analysis? According to the latest version of the business analysis Bible – BABOK® v 3.0. Business Analysis is the practice of enabling change in the context of an enterprise by defining needs and recommending solutions that deliver value to stakeholders. Now, let's analyze this definition and translate it into simple words.

When we talk about practice, we mean the set of activities, tasks, processes, frameworks, tools, and so on. But there should be some reasons to use all this stuff – this magic question “Why?” All of these activities are about enabling change – getting from one state to the other. Let's look further at the definition. “By defining needs” – again, why? So, any change starts from defining why a person wants to move from the existing state of anything to the future state.

“Recommending solutions that deliver value” – this part of the definition answers the “What?” and “How?” questions. We have some needs to transform something from the as-is state to the future state. But how can we do it? Well, it's up to the business analysts to propose or recommend solutions. However, solutions should deliver value, because without value these solutions are useless. And the last part – “to stakeholders”. Stakeholders are people or organizations that will be affected by the change.

Who is a Business Analyst (BA)? The first answer that comes to mind is a professional who performs the business analysis. And it's correct!

According to the definition given in the BABOK®, a business analyst is any person who performs business analysis, no matter what their job title or the role in the organization is.

In fact, business analysts may have different titles: product owner, product manager, requirements manager, business architect, system analyst, etc. In many cases, these professionals perform not only business analysis activities and tasks. Almost any member of a project team can wear a business analyst's hat. We will dive deeper into

each of the six business analysis knowledge areas which are essential to the success of the business analyst's work.

In other words, a business analyst is a professional who can define and specify the business needs of the change, define the business case for the change, understand the as-is and the future states, propose the solutions, elicit and specify the requirements of all levels, and act as a liaison/a bridge/a translator between the business and the implementation team.

The big part of the BA skills and competencies are the so-called soft skills. A business analyst works with different stakeholders on both sides of the solution development and implementation processes. A business analyst communicates a lot with them, presents deliverables, drives meetings and workshops, and so on. That is why soft skills are a major part of the business analysis's competency model. A Business Analyst wears many hats: negotiator, diplomat, facilitator, skilled listener, motivational speaker, team leader, visionary, troubleshooter, and many more.

One of the main requirements for a business analyst is to be a leader, a person who is not afraid of problems and failures, and who takes responsibility. Another important thing, particularly for the Ukrainian market, which is mostly about outsourcing, is a good command of English.

A Business Analyst has to perform a huge range of tasks and to be able to do it in a correct and professional way. A business analyst should be familiar with many techniques. These techniques can be specific for BA and common for different business professionals. Here you can see the main techniques, which business analysts use in their daily work. For instance, requirements elicitation sessions can be conducted in the form of requirements workshops and focus groups, interviews, and brainstorming meetings. When a BA has to analyze the market, solutions, or customers, he/she can use benchmarking and SWOT analysis techniques. To analyze the as-is state, a BA uses observation, interface analysis, and document analysis. One of the core BA competencies – requirements specification – can be covered by such techniques as user stories, use cases, data modeling, and prototyping. To manage requirements the prioritization techniques are necessary. These are just a few core techniques. The more techniques a BA knows and uses the better. However, you do not need to be an expert in using each and every technique – it's enough to know where each technique can be used, and just read more about it in the book.

Standards in a Business Analysis. The International Institute of Business Analysis™ (IIBA®) is a non-profit professional association serving the growing field of business analysis. As the global thought leader and voice of the business analysis community, IIBA® actively supports the recognition of the profession and works to maintain global standards for the ongoing development of the practice and certifications [1].



Figure 1 – IIBA achievements

Since 2003, the International Institute for Business Analysis™ (IIBA®) has supported professionals working in business analysis and related business roles by maintaining global standards for the practice and certification, our Chapters, and through professional development and career resources, networking and volunteer opportunities. IIBA is a member organization of the Federation of Enterprise Architecture Professional Organizations (FEAPO)[2] [1].

IIBA Goals:

- Creating and developing awareness and recognition of the value and contribution of the business analyst
- Defining the *Business Analysis Body of Knowledge® (BABOK®)*
- Providing a forum for knowledge sharing and contribution to the business analysis profession
- Publicly recognizing and certifying qualified practitioners.

A Guide to the Business Analysis Body of Knowledge® (BABOK® Guide) is the globally recognized standard for the practice of business analysis. It includes such areas of business analysis practice:

- Business Analysis knowledge areas
- Tasks
- Underlying competencies
- Techniques and perspectives

The first version of BABOK was written by The Body of Knowledge Committee (IIBA) in 2005. In 2008 – 1.6, 2009 – 2.0. And the latest one was publicly redacted by teams of experts and practitioners and was officially published in 2015.

Certification opportunities:

In 2020 IIBA has 3 core levels of professional certifications:

- Entry Certificate in Business Analysis™ (ECBA™)
- Certification of Capability in Business Analysis™ (CCBA®)
- Certified Business Analysis Professional (CBAP®)

And 3 specialized:

- Certificate in Cybersecurity Analysis (IIBA®- CCA)
- Agile Analysis Certification (IIBA®-AAC)
- Business Data Analytics Certification (IIBA®-CBDA)

Business analysis skill ranks #6 in the top 15 skills companies need most in 2020 [4] and in future the demand on business analysis skills will be increased dramatically. Therefore, certification helps earn more money for the same job level. Jobs related to business analysis are projected to increase 14% from 2018 to 2028 [5].



Figure 2 – IIBA certification

IIBA in Ukraine. The IT industry has been strongly integrated in the worldwide tech ecosystem for the last ten years. More than 20 cities have created their own IT-clusters. The technology sector became the country's second export industry in 2018. Every year more than 1,000 events related to technology, start-ups and investments are held in Ukraine. Official launch of IIBA Kiev Chapter was in 2012, but the IIBA Ukraine chapter was launched in 2018.

Now we have 140 active members of IIBA Ukraine (ECBA -2, CCBA - 7, CABP -20). Participation and membership is free [3].

Certification results in IIBA Ukraine since 2012: ECBA -4, CCBA - 21, CBAP - 40

Conclusion. Business analysis evolved in independent area between management and product development. It helps better understand client need and deliver the best possible outcomes for stakeholders.

References:

1. <https://www.iiba.org/>
2. https://en.wikipedia.org/wiki/Federation_of_Enterprise_Architecture_Professional_Organizations
3. <https://ukraine.iiba.org/standard-chapter-membership>
4. CNBCTV18. <https://www.cnbc.com/business/linkedin-says-these-are-the-top-15-skills-companies-need-most-in-2020-5037841.htm>
5. United States Department of Labor, Bureau of Labor Statistics.
<https://www.bls.gov/ooh/business-and-financial/management-analysts.html>

**E-COMMERCE, E-GOVERNMENT
AND E-LEARNING
TECHNOLOGIES**

¹ **Olena Bezlutska**

Doctor of Philosophy, Associate Professor, Deputy Head of the Department of Social and Humanitarian Disciplines and Innovative Pedagogy

² **Alona Leshchenko**

Doctor of Philosophy, Associate Professor, Professor, Director of the Science Park "Maritime Industry Innovations"

³ **Alona Yurzhenko**

PhD in Pedagogy, Head of International Affairs Department

⁴ **Alla Paziak**

Specialist of International Affairs Department

¹⁻⁴ *Kherson State Maritime Academy*

INFORMATIONAL VISUALIZATION ON E-COURSES OF HIGHER MARITIME EDUCATIONAL INSTITUTIONS

Abstract. The article is devoted to the problem of informational visualization on e-courses of higher maritime educational institutions. It is highlighted that one of the effective means of visualization of information content is infographics in e-courses. The types of infographics are described. The actions to develop effective infographics are listed. It is concluded that the use of infographics contributes to an increase in the effectiveness of the educational process, forms the interest of students in studying the course.

Keywords: LMS MOODLE, informational visualization, e-course

Infographics as one of the effective means of visualization of information content is used in almost all spheres of public life. Higher maritime education is no exception. In our opinion, infographics is an integration model of presenting information as a result of high-quality data processing, which is subject to acquaintance and study by the interested audience. Teachers use infographics when explaining new learning material and to update basic knowledge.

Due to the rapid development of information and communication technologies, a number of special tools for information visualization have appeared. You can use special resource templates (canva.com, piktochart.com, Easel.ly, Vizualize.me) to create infographics. The positive aspects of using these services are the optional need to understand the basics of design, the ability to use professional templates in the library, customizing images and formatting, the ability to embed on your resource (platform). The most popular tools for creating an educational video are: bandicam.com and icecreamapps.com, etc.

According to the classification of types of infographics and specifics of free economic zones, the most used among teachers are the following types:

1. flow chart (algorithm in the form of blocks that are interconnected in the form of lines and indicate the sequence);
2. the timeline (the cadet can trace the chronological sequence of the process, the phenomenon);

3. useful bait (set of useful information, reference material);
4. versus infographic (comparison of certain processes, models);
5. photo infographic;

To qualitatively create information infographics for future specialists in the maritime industry teachers can use an algorithm:

1. to determine the purpose of the infographic and choose the type according to the classification;
2. to collect data in accordance with the subject of the discipline;
3. to systematize information, organize the presentation of basic and additional information with the help of schematic sketches, choose the sequence of placement;
4. for visual perception it is also necessary to determine the color palette of the elements (not more than 6 basic colors);
5. to follow the process of creating infographics using a specially selected service

While using different services normally following actions should be done:

6. to create an account for the service;
7. to view and select a template by theme or create a new design;
8. to add text and images according to the content of the topic of discipline (or to download this data);
9. to format the text (choose the size, style) and image (size, placement);
10. -to save and copy the link for placement on the e-course of the discipline on the LMS Moodle (or to embed the infographic using another way);

Because of COVID-19 pandemic situation the educational process of all higher educational institutions of Ukraine including maritime ones came into distance format. Kherson State Maritime Academy (KSMA) uses Learning Management System (LMS) MOODLE to maintain its educational process. An important issue became the presentation of material of lectures, practical lessons, independent works etc. It became harder to motivate students because distance education requires student self-discipline. One of the tools to interest students is to visualize the information, present it in more interesting way.

Except those, all the activities of e-course (Assignment, Book, Chat, Choice, Database, External tool, File, Holder, Forum, Glossary, H5P, HotPot, IMS content page, Lesson, Quiz, SCORM package, Survey, Wiki, Workshop) has the option to display its description on e-course main page.

LMS MOODLE also allows to embed the images of gif animation to divide different types of activities in e-course.

The video can also be embedded in the course main page.

However, it should be noted that the disadvantage of information visualization may be in a simplification in understanding ambiguous interpretations of something, the presentation of information is too structured, without additional details. The cadet must understand that the visualization of information is an auxiliary element, and to study the discipline is not enough just pictorial, schematic forms of presentation.

The analysis of scientific knowledge and pedagogical practice demonstrates that

the infographics in e-courses is an effective instrument. We'll analyze the data on the example of English for professional purpose e-course for future marine transport specialist (first-year student). The final goal of e-course was to form the communicative competence of students. By analyzing the data of success after using the e-courses with infographics, one can observe that the current state of formation of the communicative competence of future marine transport specialists of the 2019-2020 at KSMA is better compared with 2018-2019 academic year.

According to the results, we see an increase in the success (by 21%) and knowledge quality (by 13%). Qualitative indicator of success was taken as the number of students by "good" and "very good" multiplied by 100% and divided by the total number of students. An absolute success indicator was taken as number of students by "good", "very good" and "sufficient" multiplied by 100% and divided by the total number of students. The total number of future marine transport professionals taking part in the research is 64 students.

The data was taken from the processing of control testing results on LMS MOODLE of KSMA e-course "English for professional purpose" (Stop and checks activities). Stop and check is testing conducted by the end of every module of e-course and created with the help of quiz activity. Quizzes comprised the questions of various types, including multiple choice, matching, short-answer and numerical.

The statistical results of research have proved the idea on the positive impact of infographics in English for professional purpose e-course of higher maritime educational establishment. The research has also showed low level of digital competence of certain teachers. To solve this problem e-course with module about infographics creation was proposed. The prospects of further research are seen by authors in researching the specifics of infographics in various fields of scientific knowledge, as well as in the possibilities of using it for conducting e-courses to improve the qualifications of teachers of higher educational institutions.

References:

1. G. M. Kvon, V. B. Vaks, A. M. Kalimullin, A. R. Bayanova, A. R. Shaidullina, A. V. Dolzhikova, N. I. Lapidus, Developing the informational and digital environment of a university: Problem analysis and assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, 15(10) (2019) doi:10.29333/ejmste/109503
2. E. R. Amit-Danhi, L. Shifman, Off the charts: User engagement enhancers in election infographics, *Information Communication and Society*, (2020) doi:10.1080/1369118X.2020.1761858
3. V. Kasyanov, E. Kasyanova, Information visualization on the base of graph models, *Sci. Vis.* 6(1), 31–50 (2014).
4. A. Peña-Ayala, *Learning Analytics: Fundaments, Applications, and Trends*. Springer International Publishing (2017).
5. A. Peña-Ayala, Learning analytics: A glance of evolution, status, and trends according to a proposed taxonomy. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 8(3): e1243. (2018). <https://doi.org/10.1002/widm.1243>
6. T. Downer, M. Gray, P. Andersen, Three-dimensional technology: Evaluating the use of visualisation in midwifery education. *Clinical Simulation in Nursing*, 39, P.27-32 (2020). <https://doi.org/10.1016/j.ecns.2019.10.008>
7. R. Eiris, M. Gheisari, Research trends of virtual human applications in architecture, engineering and construction. *Journal of Information Technology in Construction*, 22(9), P.168-184.

(2017).

8. V. Vasenin, A. Itkes, M. Krivchikov, E. Yavtushenko, ChRelBAC data access control model for large-scale interactive informational-analytical systems, Journal of Computer Virology and Hacking Techniques, (2020) doi:10.1007/s11416-020-00365-9.
9. G. Di Battista, P. Eades, R. Tamassia, I.G. Tollis, Graph Drawing: Algorithms for Visualization of Graphs, Prentice Hall, Cambridge (2009).
10. T. Kühl, S. D. Navratil, S. Münzer, Animations and static pictures: The influence of prompting and time of testing. Learning and Instruction, 58, 201-209 (2018) doi:10.1016/j.learninstruc.2018.07.006
11. J. Chicca, K. Chunta, Engaging students with visual stories: Using infographics in nursing education. Teaching and Learning in Nursing, 15(1), P. 32-36. (2020). <https://doi.org/10.1016/j.teln.2019.09.003>
12. O. R. Shefer, S. V. Kraineva, I. I. Bespal, Visualization of the formation of undergraduate competencies, Espacios, 40(29), 1-9 (2019).
13. R. Tamassia, B. Palazzi, C. Papamanthou, Graph drawing for security visualization, LNCS 5417, 2-13 (2009).
14. M. Nowakowski, Analysis and evaluation of information usefulness and user experience for content presentation in electronic media, Procedia Computer Science, 176 3654-3664. (2020). doi:10.1016/j.procs.2020.09.021
15. H. Chen, S. Liu, Practical ability training on visualization teaching design based on information visualization technology, 2018 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS). IEEE, pp. 517-520. (2018). <https://doi.org/10.1109/icitbs.2018.00136>
16. V.N. Kasyanov, I.A. Lisitsyn, Hierarchical graph models and visual processing, Proceedings of 16th IFIP Congress, pp. 179–182 (2000)
17. W. Xu, M. Shehab, G. Ahn, Visualization based policy analysis: case study in SELinux, Proceedings of the 13th ACM Symposium on Access Control Models and Technologies, pp. 165–174 (2008).
18. J. Montemayor, A. Freeman, J. Gersh, T. Llano, D. Patrone, Information visualization for rule-based resource access control, Proceedings of International Symposium on Usable Privacy and Security (2006).
19. Anwar M., P.W.L. Fong, A visualization tool for evaluating access control policies in facebook-style social network systems, Proceedings of the 27th Annual ACM Symposium on Applied Computing, pp. 1443–1450 (2012).
20. K. Vaniea, Q. Ni, L. Cranor, E. Bertino, Access control policy analysis and visualization tools for security professionals, USM'08: Workshop on Usable IT Security Management (2008).

¹ Iryna Domanetska

PhD in Engineering Science, Associate Professor

² Oleh Ilarionov

PhD in Engineering Science, Associate Professor

³ Olena Fedusenko

PhD in Engineering Science, Associate Professor

⁴ Oksana Vlasenko

Specialist

^{1,2,3,4} Taras Shevchenko National University of Kyiv

DYNAMIC ANALYSIS OF THE QUIZ COMPLEXITY IN MOODLE

Testing occupies a prominent place in the modern educational process, which is characterized by the widespread use of modern information technology. Quizes became the predominant technology of knowledge control and formed the methodological basis of training during the COVID 2019 quarantine. Testing provides an opportunity to check a significant amount of educational material, ensures for feedback between a student and educational content of the discipline, allows individualization of work with students.

Previous research in the field of building knowledge control systems has shown the need to divide quiz assignments by the level of complexity [1,2]. Without such a division of assignments, the assessment of knowledge lacks objectivity and often does not correlate with the true level of knowledge of students. It means that if a better student receives only difficult tasks, while a weak student – only easy ones, the assessment shows the same level of knowledge of both students, which is not true. Also, if students with the same level of knowledge receive assignments of different levels of complexity, the knowledge test will reveal a different level of preparedness, which is not objective. The distribution of tasks by the teacher according to the level of complexity introduces subjectivity in the process of assessing students' knowledge as what is considered as an easy task by the teacher is not just as easy for students.

Modern Learning Management Systems (LMSs) are usually equipped with the tools for statistical evaluation of test quality and indirect indicators of the complexity of quiz questions. For example, one of the most widely used LMS, Moodle, has built-in tools for calculating the statistical characteristics of quiz questions. This system uses statistical indicators, which are calculated using the classical (STT - Classical Test Theory) and modern test theory (IRT - Item Response Theory) [3,4,5]. These indicators are calculated based on the final response of the user; they do not consider the dynamics of the process of its formation. In such a model, the evaluation of a question to which the student did not answer at all and a question to which he answered incorrectly will be equivalent. The second aspect to pay attention to is the dynamics of changing the complexity of the quiz questions. If the complexity has a clear tendency to decrease from test session to session, this indicates that the task loses its practical significance and cannot be used to assess the level of knowledge of students. Such a scenario is especially common when using remote testing, when the teacher cannot

control the services active on the student's computer. Capturing information from the screen nullifies the control function of the test, even a massive bank of questions does not help.

To monitor such situations, we suggest the following:

- 1) use low-level access to the LMS Moodle database to obtain more detailed statistical information on the formation of answers to questions;
- 2) to implement dynamic analysis of the received information by specialized means of data mining.

Free Moodle Adminer software is used to access LMS Moodle database information. The LMS Moodle database has a complex structure (421 tables, 3822 attributes) [6]. To solve the problem of dynamic analysis of the complexity of quiz questions, we will need only a limited set of tables, namely a group of tables that directly describe the questions themselves, quiz questions and the students' results.

The values obtained from a query to the Moodle database are a table. Columns of the table - questions from the bank of quiz questions of this discipline, and rows - depersonalized test results ("0" - incorrect answer; "1" - correct answer). Data processing was performed by Rapidminer [7], which is an integrated environment for data preparation, machine learning, in-depth learning, text mining and predictive analytics. A quick analysis of these data revealed "easy" quiz questions (questions that all students answer) and "difficult" (questions that are often not answered correctly). The developed model of data analysis in Rapidminer provides the ability to track trends in the complexity of test tasks over time.

References:

1. Zinkovskyy Yu.F., Mirskykh G.O. Methodology of assessment of complexity level of academic quizzes // Proceeding of the National Technical University of Ukraine "KPI" 163 Series – Radiotechnics, Radio device building. – 2010. - #41, P.157-163
2. Zhunusakunova A.D. Approaches to determination of the complexity level of quiz assignments / A.D. Zhunusakunova. – Text – direct // Young scientist. – 2017. - #4.1 (138.1). – P.55-58. – Available at: <https://moluch.ru/archive/138/39700/>.
3. Lord F.M. Application of Item Response Theory to Practical Testing Problems. Hillsdale N-J. Lawrence Erlbaum Ass., 1980. – 266 p. 11.
4. Rasch G. Probabilistic Models for Some Intelligence and Attainment Tests. With a Foreword and Afterword by B.D. Wright. The Univ. of Chicago Press. – Chicago & London, 1980. – 199 p.
5. Quiz statistics report // MoodleDocs/ - Available at: https://docs.moodle.org/32/en/Quiz_statistics_report
6. Moodle database framework and description of its tables. – Available at: <https://moodle.org/mod/forum/discuss.php?d=319762>
7. Rapidminer official web-site // Docs.rapidminer/ Available at: <https://docs.rapidminer.com/latest/studio/>

Oxana Gradinari

Phd student

*Tiraspol State University, Chisinau, Republic of Moldova***ANALYSIS OF EXISTING MODELS OF INFORMATION COMPETENCE**

Abstract. This article provides a comparative analysis of existing models aimed at the formation and development of information competence. The article identifies their strengths and weaknesses. As a result of the analysis, the structural content of information competence was determined.

Keywords: information competence, didactic models.

Analysis of scientific literature in the languages of international circulation on the design of a model of the process of formation and development of information competence (IC) made it possible to single out didactic models, developed to a greater extent from the standpoint of the systemic and content-activity approaches [1, 2, 3, 4]. The systematic approach, as a rule, is based on the structural content of IC, which is modeled in accordance with the effective development of the information field of future graduates, and therefore is based solely on the teacher-researcher's own experience.

So, for example, Zaitseva E. M. [5] in the structure of IC distinguishes cognitive, active and motivational components. Undoubtedly, this model makes it possible to determine the main directions of work on the formation and development of IC for students of vocational schools, but only taking into account the identification of this phenomenon with competence in the field of information and communication technologies (ICT) [6, p. 85]. This is explained by the fact that in this case, attention is focused only on the knowledge and skills of working with information that are acquired using a computer. Let us list them: (a) knowledge of the principles of information processing and work with a computer and software products used in the educational process (for example, knowledge of methods for processing the results of industrial practice at an enterprise); (b) skills in using information technology means (for example, mastering computer methods of information processing in professional activities). We consider this judgment erroneous.

Argument: despite the fact that ICT competence provides an opportunity to make a high-quality educational service mass and accessible to various categories of students and affects the motivation for success in achieving educational results, it does not give the necessary answer to the question: "How to learn to understand, express, produce, share, collaborate, create and innovate using ICTs?" We believe that in this case, it is necessary to activate the universal thinking skills. These include observation, consistency, the ability to formalize and abstract, analyze, and use abstract models. That is, there is a need, first of all, in the formation and development of IC [7, p.34].

In the work of the authors Kotenko V. V. and Surmenko S. L. [8] there appears an extended version of the pedagogical model, designed from the point of view of a systems approach. These researchers supplement the IC structure with a new component - reflection. The importance of including this component in the content of

the IC is determined by the ability to determine the attitude of the individual to himself and to the world, to his own practical activity.

If we consider the pedagogical model of V. V. Kotenko and S. L. Surmenko through the prism of this study, then it can undoubtedly be applied as one of the options for modernizing the process in training students in vocational schools. The proposed model, in contrast to the previous one, is aimed not only at the formation of ICT competence, but also at mastering the personality's abilities to extract knowledge from information using information tools.

In the scientific work of Khodotova M. I. [9] it is noted that at the basis of any pedagogical system, two initial concepts are clearly traced: a didactic task and an algorithm for its solution. In the content of the didactic task, the goal is put forward in the first place, the achievement of which is due to the pedagogical conditions and the available information of the intended activity. On this basis, in order to model the educational process, taking into account the formation and development of IC in students of vocational schools, we consider it expedient to single out didactic models that are designed according to the principle of the organizational-activity approach (Vasilyeva L. D. [10] and others).

Considering the formation and development of IC from the perspective of personality-oriented pedagogy, we highlight the work of Bogdanova V. A. [11], which focuses on such activities as: cognitive, value-motivational, communicative, technical and technological and reflective. These types of activities contribute to the formation of skills that contribute to the development of the student's personality.

When designing the author's didactic model of the process of formation and development of IC in students of vocational schools by means of curricular and extracurricular activities, we relied on the proposed models of the above authors. But we took into account the specifics of their professional training, characterized by the following intensive changes - an increase in the intellectualization of professional activity, the complication of labor and professional functions, the development of automated and mechanized labor.

Therefore, the structural content of IC should be supplemented with a communicative component, in view of the fact that one of the main tasks of the future worker is interpersonal relationships in professional activity through constructive communication and cooperation using digital tools. We also consider it advisable to single out the creative component that requires from the future specialist in blue-collar professions such personal qualities as: initiative, individual freedom, independence and responsibility, willingness to take risks and independence of judgment.

Thus, the proposed models can serve as a basis for creating your own didactic model, which will allow for the purposeful design of curricular and extracurricular activities.

References:

1. M. V. Goryacheva, Model for training information skills in the process of independent work of students outside the classroom. In: *Izvestia of the Russian State Pedagogical University. A. I. Herzen*, 2008. p. 368-372 ISSN 1992-6464
2. N. A. Afanasyeva, Model of the formation of information competence of future teachers of vocational training. In: *Bulletin of the Bryansk State University*, 2011. 4 p. ISSN 2072-2087
3. G. A. Krutchinina, V. A. Shilova, Fostering the Informational Competence of Students in Engineering Profils. In: *The Education and science journal*. 2013, № 1(2). p. 86-96. URL: <https://doi.org/10.17853/1994-5639-2013-2-86-96>
4. V. Kyva, V. Yahupov, Pedagogical modelling of development of information and communication competence of professors of distance learning military education system. In: *ARTTE* Vol. 7, No. 3, 2019 c. 224-232 ISSN 1314-8788
5. E. M. Zaitseva, *Management technology for the development of information competence of students of radio engineering specialties*: дис. канд. пед. н. Ижевск, 2007. 189 с.
6. S. A. VORONOV, The structure and content of competencies in the use of information and communication technologies. In: *Vestnik ChGPU im. I. Ya. Yakovleva. No. 3 (95). h.1*. 2017. p. 83-89 ISSN: 2073-5499
7. C. S. DOYLE, *Information literacy in information society: a concept for the information age*. New York: Syracuse University, 1994. 83 p. ISBN 0-937597-38-4
8. V. V. Kotenko, S. L. Surmenko, Information and computer competence as a component of professional training of a future teacher of computer science. In: *Bulletin of the Omsk State Pedagogical University*. 2006. 4 p.
9. M. I. Khodotova, Models of formation of information competence of graduates of physical culture universities. In: *Pedagogy: Traditions and Innovations: Materials of the 1 Intern. scientific. conf. Chelyabinsk*, 2011, p. 97-100
10. L. D. Vasilieva, Model of the formation of information and functional competence of students in grades 5-9 in a rural educational school. 2011. №17. URL: <https://urok.1sept.ru/статьи/210223/2>
11. V. A. Bogdanova, Formation of information-functional competence of schoolchildren in the process of implementing a personality-oriented model of the pedagogical process. All-Russian Internet Pedagogical Council. 2007. URL: <http://pedsovet.org/component/option,com_mtree/taskviewlink/link_id,3843/Itemid,0/

Iryna Horbas

PhD in Economics, Associate Professor

Taras Shevchenko National University of Kyiv

"A STATE IN A SMARTPHONE" CONCEPT BY UKRAINIAN GOVERNMENT

Abstract. Ukraine's digitalization drive is currently in its early stages, but main potential benefits are already obvious. As well as reducing the human factor in some public services, digitalization can provide a boost to a range of structural reforms and rapidly raise income levels while cutting government waste.

Keywords: transformation, digitalization, e-governance, e-services, Diia.

President Zelensky and the parliament elected in early elections have launched a "turbo mode" of state changes. At the iForum on May 23, 2019, the Head of state presented a digital action plan for the implementation of "A state in a smartphone" program in order to limit bureaucracy, digitalize the country's economy, simplify and transfer of public services to the Internet [4, 5]. He noted that it is necessary to implement e-governance at 4 levels: information about the state, communication and transactions with the state, involvement in the state management [1].

Deputy Prime Minister Mykhailo Fedorov is responsible for the digitization process and "transformation of the Ukrainians' way of thinking" through heading the Ministry of Digital Transformation. The main goal for the Ministry is to turn Ukraine into a tech nation by 2024 through 100% of public services are available to citizens and businesses online, 95% of towns and their transport infrastructure, social facilities have access to high-speed Internet, 6 million Ukrainians are involved in the digital skills development program, 10% share of IT in the country's Gross Domestic Product [2]. In addition to him, the issues of digitization are also handled by the Minister of the Cabinet of Ministers Dmytro Dubilet. To guarantee that the digitalization will cover the whole of Ukraine the Cabinet of Ministers will establish the responsible persons for the implementation of digital transformation at all levels of government: from the Ministry to the district administration (CDTO - Chief digital transformation officer).

On June 2019, the first expert discussion of the concept was hosted. Representatives of the Coalition of the Electronic State (65 different organizations and experts in the field of IT) provided their recommendations which were related to the development of tools for e-state and democracy, digital infrastructures, digital identification, cybersecurity, restoring order in state registries, electronic democracy and the importance of supporting Ukrainian technological start-ups [4].

During a meeting with government officials in July 2019 the representatives of the European Commission gave their recommendations to Ukrainian initiative: to provide broadband internet access for the entire territory of the country, to develop the country's digital identification system of citizens, to introduce effective management structure for the sphere's development and organize the implementation of the ambitious tasks set [3].

Experts from abroad have already promised to help in solving these issues.

The Japanese (Hiroshi Mikitani — the founder of Rakuten company and co-owner of Viber) have declared their participation in the “State in a Smartphone” program. The Estonian E-Governance Academy is supposed to work on a system enabling data exchange between the existing national registers and on the modernization of these registers. The e-Governance Academy and the Swedish International Development Cooperation Agency (SIDA) have signed (2014) a cooperation agreement to support the Ukrainian government in the introduction of e-governance. The agreement covers the development of policy documents, planning of e-governance activities, development of legislation, enhancement of e-capacity, promotion of involvement in the development of e-governance, and development of e-services for the population and businesses. The e-Governance Academy will implement the agreement in collaboration with experts from Estonia, Sweden and Moldova [10]. IT companies from Poland also ready to play a part in the implementation of the wide digitization program pursued by its eastern neighbour [9]. UNDP in Ukraine has supported "a state in a smartphone" initiative through commissioning the assessment of government transparency and Ukraine's readiness to work with open data.

Nowadays major active projects of e-governance by “A State in a smartphone” concept are the follows [2]:

- a mobile application and a website “Diia” combine all services in one “electronic window” provided by the state and serve as the main channel of digital communication between the government and the country’s citizens. The users have access to a driver’s license and vehicle registration certificate, a digital student ID and the ability to test a biometric passport and ID card. By the end of May 2020, more than 3 512 000 Ukrainians had downloaded this app, by the end of September 2020, there were more than 5 000 000 users [10];

- free info platform of digital literacy “Diia. Digital Education” [6] where experts and celebrities explain Ukrainians basic Internet safety rules and help them to start using the Internet and smartphones. In June 2020, the Ministry of Digital Transformation, in partnership with the Ukrainian Parliament Commissioner for Human Rights and UNDP (United Nations Development Programme), has prepared a new series of educational videos “Personal data protection” for public officials to raise awareness of legislation on access to public information. National digital literacy program of Government should reach 6 million Ukrainians in 3 years [2, 12];

- a state portal “Diia. Business” [7] proposes different services for entrepreneurs, as follows: a guide, a list of legal documents, online and programs services, 39 types of free consultations etc. The online registration of LLCs is made much easier – instead of 88 lines, only 46 lines remained in the application. More than 50 000 private individuals have registered business online at the portal in 2020. Till the end of 2020, the savings due to online business registration will more than UAH 17 million. Due to the use of the electronic format of registration, liquidation and change of data by private individuals Ukraine is expected to save up to UAH 255 million per year [10];

- online service “Diia. E-malyatko” provides 10 services of parenthood by 1 application. By the end of summer 2020 it was available in 10 cities of Ukraine: Kyiv,

Odesa, Lviv, Kharkiv, Kryvyi Rig, Vinnytsya, Lutsk, Mariupol, Zaporizhya, Rivne;

- online service for foreigners "Diia. E-residency" gives the opportunity to remotely access public services and do business in Ukraine from abroad, open a visa or bank account under a simplified procedure etc.;

- investment program "Ukrainian Startup Fund" [8] supports Ukraine-based innovation projects and helps the most talented Ukrainian entrepreneurs create successful companies at scale. By October 2020 there were more than 1800 applications and more than 30 Startups have been funded;

- "Diia. Green cards" brings 5000 high-qualified international tech professionals from all around the world which are available in Kyiv, Lviv, Dnipro, Odesa, and Kharkiv. The app gives permits for work without annual prolongation; work according to the Ukrainian labour legislation; emigration with the family members; the possibility to open company as the individual entrepreneur;

- "Diia City" (at the moment is in the discussion phase) will be a virtual model of a free economic zone for representatives of the creative economy. It will allow Ukrainian and foreign tech companies to open businesses and R&D centres in Ukraine under simplified procedures, to work according to the English Law, and pay 10% of tax etc [10, 11].

In this way, "Diia" is going to be a service of the new generation, a new philosophy of providing e-services and involving citizens to e-governance. "Diia" have already saved UAH 495 million for Ukrainians and provided UAH 2 billion in additional revenues through the elimination of "tax cuts" [3, 11]. It is important to continue to focus on the implementation of such comprehensive and breakthrough electronic services countrywide.

It should be noted that on the way to the digitalization of Ukraine, the following difficulties may arise:

- it is necessary to analyze how much the changes will cost, what practical benefits they will bring and how long will it take,

- the «digital state» should coordinate the work of central, regional, and local authorities by dividing their work into four areas: information (public access to data from institutions and agencies), communication (exchange of data with the state and the citizens), transactional (public services and electronic document management), personalization (content targeting depending on citizens' tasks),

- there are serious problems in the identification of citizens – the existing electronic signature and digital identification systems are based on outdated technologies and have a limited scope of application,

- driven by increased civic activism, Ukrainian citizens now seek to have more control over their lives, which significantly raises e-participation in the country

The creation of a digital state is a complex yet important process accompanied by the resistance of the system, outdated legislation, scepticism and often disbelief, but all the worldwide revolutionary projects have passed this way [1, 11].

References:

1. V. Zelenskyy, I dream about a state in a smartphone, 2019. Official website “President of Ukraine”. URL: <https://www.president.gov.ua/en/news/ya-mriyu-pro-derzhavu-u-smartfonu-volodimir-zelenskij-55585>
2. Official website of the Ministry of Digital Transformation. URL: <https://thedigital.gov.ua>
3. M. Fedorov, EU supports the implementation of “A State in a Smartphone” concept. URL: <https://www.president.gov.ua/en/news/yevropejskij-soyuz-pidtrimaye-realizaciyu-koncepciyi-derzhav-56337>
4. President during the first expert discussion of “A state in a smartphone” concept: I want rapid changes and guarantee political will. URL: <https://en.ukraynahaber.com/2019/06/13/president-during-the-first-expert-discussion-of-a-state-in-a-smartphone-concept-i-want-rapid-changes-and-guarantee-political-will>
5. Overview of 2019: new government, weak reforms, and expectations for brighter future. URL: <https://www.unian.info/economics/10813331-overview-of-2019-new-government-weak-reforms-and-expectations-for-brighter-future.html>
6. Official website “Diia. Digital Education”. URL: <https://osvita.diia.gov.ua>
7. Official website “Diia. Business”. URL: <https://business.diia.gov.ua>
8. Official website “Ukrainian Startup Fund”. URL: <https://usf.com.ua/en/>
9. Official website “Obserwator Finansowy”. URL: <https://www.obserwatorfinansowy.pl/in-english/new-trends/ukraine-in-a-smartphone-is-that-possible-2/>
10. Official website “Government Portal”. URL: <https://www.kmu.gov.ua/en/news/mihajlo-fedorov-ponad-50-tisyach-fop-vidkrito-onlajn-na-portali-diya-u-2020-roci>
11. Starting from September 2021, no institution of the central executive body will require any paper from citizens, 2020. Official website “President of Ukraine”. URL: <https://www.president.gov.ua/en/news/z-veresnya-2021-roku-zhodna-ustanova-centralnogo-organu-viko-64273>
12. Official website “United Nations Development Programme in Ukraine”. URL: <https://www.ua.undp.org/content/ukraine/en/home/presscenter/articles/2016/08/04/ukraine-jumps-by-23-in-un-e-government-development-index-/>

¹Rusudan Makhachashvili

Doctor Habilitated, Associate professor, Head of Department

²Ivan Semenist

PhD, Head of Department

³Anna Bakhtina

Graduate student, Assistant Professor

^{1,2,3}Borys Grinchenko Kyiv University

ICT TOOLS FOR FINAL QUALIFICATION ASSESSMENT SURVEY STUDY FOR EUROPEAN AND ORIENTAL LANGUAGES PROGRAMS

The global pandemic and subsequent quarantine measures and restrictions have posed a challenge to the structure and procedure of university summative assessment process. Qualification assessment for Foreign Languages major programs in particular is a strict regimen process that involves different stages (oral and written exams, final project viva, internal and external review). This study seeks to analyze the practices of Borys Grinchenko Kyiv University digital qualification assessment for students of European (French, Italian, Spanish, English, German) and Asian (Mandarin, Japanese) Languages major programs, employed in the year 2020 due to quarantine measures. The survey and analysis of different ICT tools is used to translate real life qualification assessment practices into online blended format. The investigation also seeks to identify various groups of applied digital skills and collaboration skills, utilized through qualification assessment process by all parties (students, faculty and referees). Comparative results of ICT tools and practices efficiency for respondents of European and Oriental languages programs are provided.

Based on the activity profile (Final Qualification Assessment) a survey was conducted among the participants of the Final Qualification Assessment at Borys Grinchenko Kyiv University Foreign European and Oriental languages programs (Spanish, French, Italian, English, Mandarin Chinese, Japanese major) in order to assess the efficiency of qualification assessment transfer into digital format via various ICT tools employed.

The survey comprised of 12 questions total (multiple choice and scoring), divided into such categories: 1) questions on overall experiences of Final Qualification Assessment participants in all procedures, conducted via ICT tools; 2) questions on digital literacy skills, required of Final Qualification Assessment participants; 3) questions on soft skills, required of Final Qualification Assessment participants; 4) questions, aimed to conduct Efficiency Ranking of most widely used Final Qualification Assessment ICT tools.

The overall digital qualification assessment experience on the scale of 1 to 5 was defined as mostly agreeable (4) by 50% of respondents, most agreeable (5) by 29% of respondents and less agreeable (3) by 17% of respondents across all foreign language programs surveyed. Digital activities got overall rankings of 5-4 from respondents of European languages programs and 4-2 from respondents of Oriental languages programs.

The respondents identified all the ICT digital tools that they have to employ the most in digital qualification assessment process. The highest scoring ICT tools by all the groups of respondents of both European and Oriental language programs were: e-mail (93% of respondents), Google services (76% of respondents), videoconferencing services (84% of respondents), social media platforms (77% of respondents), automated testing systems and learning management systems (31% of respondents).

Respondents from European languages programs identify Information sharing as and overwhelmingly prominent (59,1%) across all ICT tools employed for Final Qualification Assessment. For respondents of Oriental languages programs Speech quality assessment features as prominent as Information sharing across identified ICT tools. The following is inferred as being due to the phonetical and tonal features of Mandarin Chinese and Japanese languages being essential to meaning comprehension and decoding, which is hard to recreate and evaluate in a digital communicative environment.

Respondents of the European languages program have assessed the dominant ICT tools requirements being Intuitive interface (28,8%), elementary digital literacy (26,9) and specialized software (17,3%). *Respondents of the Oriental languages program* have assessed the prominent ICT tools requirements (Figure 8) being Intuitive interface (31,8%), elementary digital literacy (31,8) and bandwidth and advanced digital literacy (9,1).

Video conferencing services (Google Meet, Zoom, Webex) score the highest efficiency ranking for synchronous communication (62.5% for top score 5), but get a surprising ratio of lowest score as well (18,9% for lowest score 1). Learning management systems (29,8% for top score 1) and Google services (25%) get a proportional highest score 5 for efficiency in Synchronous communication in the framework of Final Qualification assessment across European and oriental languages programs.

This sample ranking testifies to the following suppositions: a) the specificity of ICT use for transference of Final Qualification assessment into digital mode for foreign languages programs that may not be encountered outside of this activity framework; b) the specificity of digital literacy, featured by participants of Final Qualification assessment for foreign languages programs.

All procedures and scenarios of the Final Qualification Assessment activities for foreign languages at Borys Grinchenko Kyiv university have been successfully transferred to digital remote format with the use of various sets of ICT tools in the framework of the COVID-19 pandemic adjustments. This transference could serve as a best practice model for other universities of Ukraine and European countries both as an adaptable measure for prolonged lockdown and as a way to further advance of blended learning and further digitalization and democratization of educational process.

¹ Victoria Mironova

Candidate of Technical Science, Associate professor

² Mykola Pyroh

Assistant professor

³ Iryna Harko

Candidate of Physical and Mathematical Sciences, Assistant professor, Senior lecturer

^{1,2,3} Taras Shevchenko National University of Kyiv

³ National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

METHODOLOGY OF BUILDING AGILE-EDUCATION PROCESSES IN HIGHER EDUCATION INSTITUTIONS

Abstract. In this paper the technology of using the popular flexible software development methodology – agile – is considered for the development and construction of courses and semantic links of higher education disciplines for training specialists in the field of information technology. The authors analyze the basic principles of the Agile-Manifest and their application for the formation of the curriculum program. The influence of Agile-methodology on the academic groups success is considered and a statistical comparison with the classical approach to teaching is made.

Keywords: agile-methodology, scrum, education, Information Technology, training of specialists, professional training

Training of specialists in the field of information technologies requires the formation of educational programs and courses using modern technologies, programming languages, libraries and frameworks. However, the rapid growth and changing trends in the IT sector makes it impossible to create such a program even for four years of bachelor's degree [1]. That is, even if at the beginning of the educational cycle, the program was designed taking into account the most relevant approaches and topics, at the time of graduation, it becomes obsolete. To understand the need to adapt to such changes, it is worth estimating the frequency of programming languages standards updates and releases, which are 1-3 years for Java, 3 years for C ++ and from six months to 3 years in C#. And even more, programming libraries and frameworks are released almost each month.

Agile management – an iterative method of planning and managing projects and processes [2].

If we consider the process of training a specialist in higher education in terms of project management, and the specialist – as a unique product, the training can be approached from the standpoint of project management and apply to this process all modern and successful project management methodologies. Due to the success of the Agile approach in industry, software design, marketing and business, foreign experts in the field of education have tried to apply similar principles to the field of education, thus forming the Agile Schools Manifesto [3, 4].

The introduction of flexible methodologies in the educational process optimizes approaches in the training of future IT professionals [5, 6]. The implementations of the

flexible methodology of software development – Agile – in the process of development of educational and methodical support and the proposed approaches in teaching in higher education contribute not only to better understanding and mastering by students of theoretical and practical educational material. This approach also helps students understand the production processes in IT projects that are set up according to the Agile methodology, set themselves to work within Scrum, gives an initial idea of the complexity of the task, mandatory and additional product requirements – their knowledge of the discipline.

Agile and Scrum methodologies [7] allow to develop and implement a modern, adapted to the requirements of the labor market training program for IT professionals and helps to develop skills to find the necessary information and interact with peers, which will also help further training and improve their “soft skills”.

References:

1. D. Semyonov, “Ukrainian higher education is dead. Stay away from it”, Medium, 2016 [Online]. Available: <https://cutt.ly/Mymj2R5>.
2. Agile-software development manifesto, 2001 [Online]. Available: <https://cutt.ly/SyEftwh>.
3. V. Seminozhenko, “Modern educational policy will cause a lack of IT specialists”, Euro Education, 2014 [Online]. Available: <https://cutt.ly/Jymzx4M>.
4. P. Salza, P. Musmarra, and F. Ferrucci, “Agile Methodologies in Education: A Review. In Agile and Lean Concepts for Teaching and Learning”, Springer, pp. 25–45, 2019. Available: <https://cutt.ly/Niu2nzk>.
5. V. Mironova, and M. Pyroh, "AGILE methodology in education as the main tool for building modern educational disciplines of higher education", Economics and Management, №4 (76), pp. 124–130, 2017.
6. V. Mironova, M. Pyroh, and I. Harko, "Agile-methodology and informatization of the educational process on the example of project work in the discipline "Algorithmization and basics of programming""", in VII International. scientific and technical conf. Problems of informatization, Cherkasy, 2019, P. 30.
7. J. Stewart, C. DeCusatis, K. Kidder, J. Massi, and K. Anne, “Evaluating Agile Principles in Active and Cooperative Learning”, in Student-Faculty Research Day, CSIS, Pace University, P. B3, 2009. Available: <https://cutt.ly/piuBBUI>.

¹Nataliia Morze

Doctor Habilitated, Full Professor,

Corresponding Member of the National Academy of Pedagogical Sciences

²Rusudan Makhachashvili

Doctor Habilitated, Associate Professor, Head of Department

^{1,2}Borys Grinchenko Kyiv University

DIGITAL COMPETENCE IN E-GOVERNANCE EDUCATION: A SURVEY STUDY

Factors of social change culminate in the development of the so-called networked society. Subsequently, networked society calls for networked governance. The development of e-government in Ukraine is impossible without appropriate training of relevant qualified professionals. Based on e-governance the activity profile a survey was conducted among the stakeholders of electronic government institutions – in-service government officials and students of government management programs.

The paper objective is to assess the survey as to the needs and possible avenues of E-governance curriculum development for higher educational institutions, in-service government officials and general public. The Master's Program in E-government, developed within the framework of a Ukraine-Estonia joint project on e-governance curriculum implementation, will promote the state policy in the field of information, e-governance, development and use of national electronic information resources, elaboration of the information society.

Based on the activity profile (e-governance) a survey was conducted among the stakeholders of electronic government institutions – in-service government officials and students of government management programs. The survey comprised of 13 questions total (multiple choice and scoring), divided into such categories: 1) questions on overall experiences in e-government; 2) questions on the needs and modes of e-government education; 3) questions on e-democracy as a social framework (to be disclosed fully in the upcoming studies). 70 respondents total took part in the survey.

Group 1 of survey questions - *overall experiences in e-government* - yielded the following results across the board. The prevailing understanding of e-governance by stake-holders (Figure 1) is disclosed by the such top scoring concepts: 1) Round the clock access to information and e-services (35,7%); ICT implementation for interaction of state and community (22,9%); 3) ICT technologies use for corruption surveillance (20%).

Group 2 of survey questions - *the needs and modes of e-government education* - yielded the following results across the board. The educational formats (Figure 5), efficient or sought after in the area of governance digitization is distributed as such: one-off trainings and workshops (40%); persistent online courses (34,3%); webinars (22,9%).

When asked to assess the knowledge needed or lacking to use digital technologies (Figure 7), in-service and in-training governance stakeholders identified the following top scoring priorities: Digital services development (67,1); Digital data

bases operation (60%); Digital literacy and digital skills (58,6%); Digital workplace tools proficiency (48,6); Re-engineering of government services (44,3%).

Digital competences, mandatory for any modern in-service government official (Figure 8) were assessed by respondents according to the following ranking: Digital transformations management (50%); Electronic democracy and social engagement (41,4%); Cybersecurity basics (41,4%); Terminology mastery in the realm of digital governance (34,3%)

The evaluated educational components, skills and practices provide a groundwork for the estimated structure of E-governance education curriculum project.

Survey results in the area of digital competence and structures of knowledge, sought after or in demand by e-governance stakeholders in specialized education, correspond directly to the comprehensive frameworks of digital competences, elaborated and tested in the recent decade.

The survey results corroborate the informed decisions behind elaboration and implementation of a comprehensive curriculum project of an integrated E-governance Master's program.

In the framework of globalization, information society development and social strife against corruption in government, traditional methods of interaction of state and local government with citizens and business become less sufficient. To avoid the emergence of corruption components and to create new and more convenient methods of access to information and services, the state is implementing e-governance - a form of government which provides a new level of open cooperation between the state and society, due to the widespread use of modern ICT, supplying a full range of public services for all categories of citizens and enterprises. The use of new ICT in public government determines the need for training highly qualified specialists in the field of public administration and management, in possession of the ultimate, up to date ICT skills.

Borys Grinchenko Kyiv University proposes a master's program of e-government under the auspices of the Ministry of Education of Estonia and in collaboration with the Tallinn University of Technology.

The curriculum project outline presupposes 4 stages of implementation: 1) Resources accumulation; 2) Theoretical premise of teaching e-democracy development; 3) Teaching e-democracy development methodology development; 4) E-democracy and e-governance studies dissemination.

E-governance curriculum development project corresponds fully to the National standard of e-government implementation in Ukraine. The 8th Framework project of European Commission Horizon 2020 academic collaboration incorporates a specific creed of Europe in the Changing World studies, which unfolds into a range of problematic issues open for project studies and development, including Understanding Europe - Promoting The European Public and Cultural Space, including civil society development as an operative foundation for e-democracy elaboration. E-governance comprehensive curriculum development is also in keeping with key priorities of the 9th Framework project of European Commission Horizon Europe.

¹Nataliia Morze,

Doctor of Pedagogical Sciences, Professor, Corresponding Member of the National Academy of Pedagogical Sciences of Ukraine

²Oksana Strutynska

PhD in Pedagogy, Associate professor, Vice-Dean of Scientific Work and International Activities, Faculty of Informatics

¹Borys Grinchenko Kyiv University

²National Pedagogical Dragomanov University

DEVELOPMENT OF THE DIGITAL TRANSFORMATION MODEL FOR HIGHER EDUCATIONAL INSTITUTIONS

Abstract. The research is devoted to the analysis of the digital transformation processes that are currently taking place in the economy, production, education and society as a whole. There are analyzed approaches to developing a model of digital transformation of education. According to the results of the research, the model of digital transformation of the higher education institution was developed. In response to the impact of digital transformation, it can be used as a roadmap for solutions for the digital transition to an innovative model for the functioning of the modern university.

Keywords: digital transformation, digital transformation model, digital transformation of education, higher educational institution.

Introduction. The basis of modern society is digital technology: artificial intelligence, robotics, IoT, blockchain and 3D technologies, etc. The report of the consulting company Accenture (for 2017) identifies five new digital technologies that can transform global economic development [1, p. 4]: *Internet of Things* (IoT), *Artificial Intelligence* (AI), *Blockchain*, *Big Data*, *Robotic Process Automation* (RPA).

The use of digital technologies is transforming business models, resulting in new products and services; the format of works is changing (outsourcing, online platforms, improved automation, robotics, etc.). Real-time work with digital data fundamentally changes the ways of management, production, sale and use of products [2, p. 42].

Combined digital technologies are increasing their impact on business and social life. Fig. 1 shows the areas in which fundamental changes are expected due to the digital transformation:

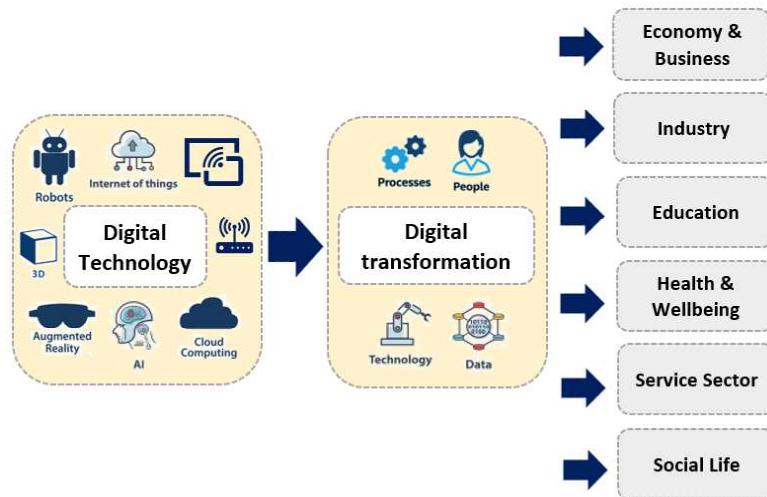


Figure 1 – Areas in which fundamental changes take place due to the digital transformation (Source: own work)

However, the education system is failing behind the general state of digital transformation in society. In our opinion, the main problem is the lack of understanding by the participants of the educational process of the institutions (higher, secondary and vocational) what is the difference between the use of digital technologies and innovations provided by the transformational changes that digital technologies bring to the educational process, and comprehension of concepts, structure, required and sufficient conditions and processes of digital transformation in general and in education in particular. That is why, the purpose of this paper is to define, analyze and develop models of digital transformation that can have a place in enterprises, businesses and educational institutions. The developed model of digital transformation of an educational institution will help educational politicians and leaders of different levels to build a strategy for the development of digitalization, taking into account the characteristics of each educational institution.

Digital Transformation Model for Higher Educational Institutions

Digital transformation (DT) is the result of digitisation and digitalisation of economies and societies. DT is an ongoing process. The introduction of digital technologies creates both new opportunities and new challenges.

In the conditions of intensive development of digital technologies, digitalization, digital transformation of many branches of human activity, fast change of professions demanded in the labor market and, accordingly, professional requirements to competences of experts, educational activity needs updating of the maintenance and methods of training, search for innovative forms of training, expanding access to educational resources, and the implementation of learning opportunities without space-

and time-based restrictions, the introduction of new approaches to the organization of educational services in general. Thus, the digital transformation of education is an integral part of the processes taking place in society today.

The areas of developing the digital transformation of education are following [3]: transformation of goals, content and corresponding methods and forms of educational activities, which are associated with the penetration of new digital tools in various areas of human activity; educational institutions have to master new digital tools that increase the efficiency of the educational process; pupils/students should master new digital tools to increase the efficiency of their educational activities, and their digital competence needs developing; teachers should master: (a) new digital tools to increase the efficiency of their professional activities (b) content, methods and forms of educational activities that are transformed due to the impact of new digital tools on various areas of human activity; (c) new digital tools that increase the efficiency of the educational process, which is also changing; education leaders should master: (a) new digital tools that increase the efficiency of their professional activities; (b) digital tools that increase the efficiency of the organization of the changing educational process.

Thus, authors propose the components that will change within the process of digital transformation of higher education institution (Fig. 2).

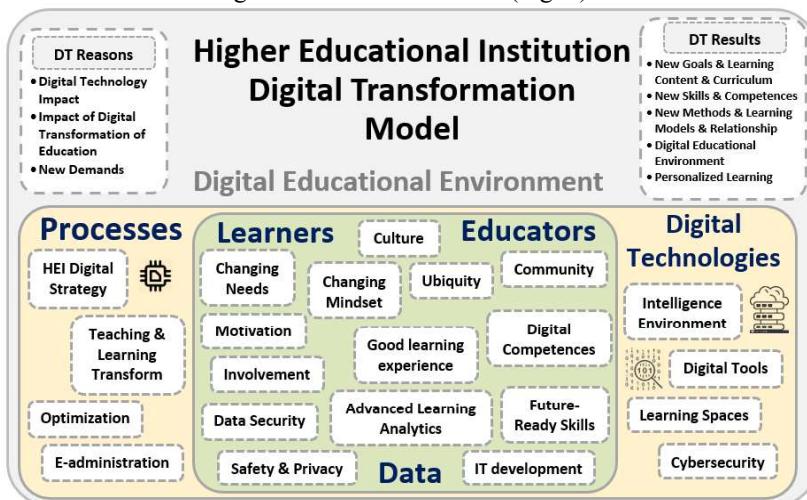


Figure 2 – Higher Educational Institution Digital Transformation Model (Source: own work)

The main components of the proposed model include: educational environment (taking into account conditions of wide use of digital technologies there will be a virtualization of educational process, processes of

communication, cooperation, and educational institution management); technology and tools used by teachers and students; conditions of teachers-students interaction within the digital environment; it is important to overcome the academic digital gap by developing professors' digital skills, as students are already highly motivated to use digital learning tools; management of university process and the internal process in general.

An envisioned model in response to the impact of digital transformation (Fig. 2) can be used as a roadmap for solutions for the digital transition to an innovative model for the functioning of the modern university.

Conclusions. Thus, the result of the digital transformation of education is: creating a modern digital educational environment to provide equal access to quality educational services and resources anywhere, anytime and in order to improve the quality of education; digitalization of all components of the educational process; effective use of modern digital technologies and data through the development of digital skills and competencies of all education stakeholders; formation of new competencies of the educational process participants, i.e., competencies which are necessary for a successful life in the digital society.

References:

1. Ford, F.R. & Lobo, I. (2017). Digital disruption: Development unleashed. Multiply innovation, collaboration and impact through digital in international development. Accenture. Retrieved from: https://www.accenture.com/t20170601T083538Z__w__/usen/_acnmedia/PDF-40/Accenture-Digital-Disruption-Development-Unleashed.pdf (accessed on 25.10.2020).
2. Digitalization of Ukraine's economy: transformational potential: monograph / V.P. Vyshnevskyi, O.M. Harkushenko, S.I. Kniaziev, D.V. Lypnytskyi, V.D. Chekina; NAN Ukrayiny, Instytut ekonomiky promyslovosti. Kyiv. Akademperiodyka [NAS of Ukraine, Institute of Industrial Economics. Kiev. Academic periodicals]. 2020. 188 p. <https://doi.org/10.15407/akademperiodyka.398.188>
3. Uvarov A. On the way to the digital transformation of the school. Education and Informatics. Moscow. 2018. 120 p. ISBN 978-5-906721-12-9.

¹ Roman Ponomarenko

PhP in Physics and Mathematics, assistant

¹ Taras Shevchenko National University of Kyiv

KNOWLEDGE TEST SYSTEMS BASED ON TYPE 2 TAKAGI-SUGENO FUZZY INFERENCE

Abstract. In this article the problems of systems for assessing the quality of knowledge based on test control. The method of complex assessment of students' knowledge based on the Type 2 Tagaki-Sugeno fuzzy model are proposed.

In the modern educational industry, automated methods are increasingly being used to identify and test the quality of students' knowledge. In particular, knowledge testing systems are becoming more and more popular, moreover, gradually moving from an auxiliary tool to the main form of knowledge quality control. Knowledge testing systems have several advantages: the speed of knowledge testing, a unified approach to examiners, the ability of a student to take direct part in the examination process, and compare their results with similar results of their colleagues [1, 2].

Considering various grading scales (100-point, 5-point, 7-point, 12-point, etc.), we can note their common feature - not depending on the degree of graduation, most of them have a linguistic scale: "Excellent", "Good", "Satisfactory", "Unsatisfactory". Moreover, it is not always possible to accurately determine the transition boundary between two neighboring estimates. It can be argued that the process of assessing the quality of knowledge is intellectual in itself, and systems that automate these processes are humanistic systems [3], in which human judgments and the operation of quality indicators play a large role.

Takagi-Sugeno FLS T2 involve the use of interval type 2 (IT2) fuzzy sets (FS) [4] in the antecedents of IF-THEN fuzzy rules of the form:

$$\begin{aligned} R^k: & \text{If } x_1 \text{ is } \tilde{A}_1^k \text{ and ... and } x_m \text{ is } \tilde{A}_m^k \\ & \text{Then } g(x)^k = w_0^k + w_1^k x_1 + \dots + w_m^k x_m, \end{aligned} \quad (1)$$

where $\tilde{A}_1^k \dots \tilde{A}_m^k$ – IT2 FS, k is the number of the rule. IT2 FS have the form

$$\tilde{A} = \int_X \frac{\mu_{\tilde{A}}(x)}{x} = \int_X \frac{\left[\int_{J_x^u} \frac{1}{x} \right]}{x}, \quad J_x^u = \left\{ (x, u) : u \in [\bar{\mu}_{\tilde{A}}(x), \underline{\mu}_{\tilde{A}}(x)] \right\} \subseteq [0, 1]. \quad (2)$$

A method of fuzzy assessment of the quality of knowledge has been developed to obtain a comprehensive characteristic of a student for a training course (module). The Takagi-Sugeno fuzzy inference model with interval fuzzy membership functions of type 2 was taken as a basis. This model allows one to take into account the vague nature of the boundaries of linguistic estimates. Thus, giving at the output a more objective characteristic of knowledge (using the Karnik-Mendel fuzzy inference algorithm [5]).

The Takagi-Sugeno fuzzy model, the fuzzy rule consequents of which are presented in the form of functional dependencies, was not chosen by chance. Since this model allows you to form an expert opinion based on the numerical rating points given to the student during the course.

Figure 1 schematically shows the organization of the fuzzy rule calculations when using the proposed method. Every fuzzy rule R^k of rule block $R = \{R^1, R^2, \dots, R^n\}$ as input parameters $X = \{x_1, x_2, \dots, x_m\}$ in the antecedent are accepts the evaluation x_i for each lesson (topic), where m is number of lessons.

The block of rules for fuzzy inference is drawn up by an expert teacher and can take into account the nonlinear dependencies of a student's knowledge for individual lessons (topics). This may take into account the incompleteness of the student's knowledge, as well as the subjective methodology of teaching and assessing certain academic disciplines.

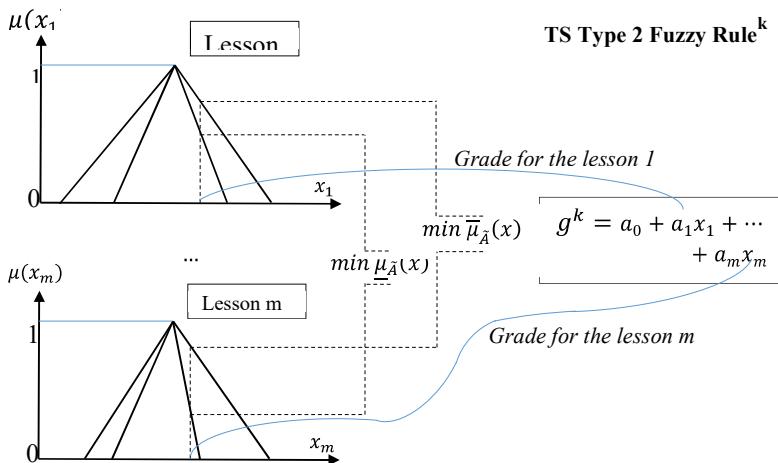


Figure 1 – Organization scheme of the Takagi-Sugeno Type 2 fuzzy rule in the complex assessment of student knowledge

References:

1. T. Gorbunova, Testing Methodology in the Student Learning Process. European Journal of Contemporary Education 6(2) (2017) 254–263.
2. O. Alekseev, Methodological Peculiarities of Diagnosing Students in Learning While Using Imitational Testing Models. Educational Discourse 1(3) (2011) 12–23.
3. L. Zadeh, The concept of a linguistic variable and its application to approximate reasoning. American Elsevier Publishing Company, 1973.
4. J.M. Mendel, Introduction to type-2 fuzzy logic control: theory and application. John Wiley & Sons, Inc., Hoboken, New Jersey, 356 p.
5. N.N. Karnik, Introduction to type-2 fuzzy logic system. Proc. 1998 IEEE FUZZ Conf 5, 1998, pp. 915–920.

¹ Alexander Provtar

Doctor of Physical and Mathematical Science, Head of the Department of Information Systems, Professor

² Maksym Veres

Candidate of Physical and Mathematical Science, Associate Professor

³ Maksym Samoilenko

Postgraduate

^{1,2,3}Taras Shevchenko National University of Kyiv

USING EDUCATIONAL IoT SYSTEM

Abstract. This paper investigates using educational IoT in group of students. There is formal investigation of IoT system approach presented as transition systems and their composition which presented as Petri net with next liveness checking. Paper describes system architecture of IoT system which is the implementation of Petri net model.

Keywords: educational IoT, web server, transition system, Petri net

This paper investigates using educational IoT in group of students. There is formal investigation of IoT system approach presented as transition systems and their composition which presented as Petri net with next liveness checking.

Main purpose of education system is learning programming by coding behavior of IoT device, where each correctly solved task can improve programming skills. Therefore, the group of students can solve common group task where each student has IoT device assigned. Common task is one task for group of students where each student can take a part in task solving by means of IoT device.

IoT system model for education consists of three model: IoT device model itself which assigned to each student of group, task generating service which can create task for each device and can control task solutions from each student in group in context of solving common task and third model is a model of communicating device which is controlled by each of students which can exchange information between task service model and IoT device model.

Task service model, communication device model and IoT device model in the paper are presented as transition systems with sets of states and transitions accordingly. There is a described interaction model of system which is a result of multiplication of three transition systems which is presented as Petri net.

Also, liveness checking of Petri net by means of TSS algorithm is used, which guarantees correct work of IoT system which is implemented by Petri net model.

Paper describes system architecture of IoT system which is the implementation of Petri net model, which consists of three parts: IoT device system, which is controlled by mobile phone system via Wi – Fi, mobile phone as system, which can be controlled by a student which implements the communication between IoT device and task server via restful communication protocol, and task server which can create task for each IoT device and control solutions of student's task.

In conclusion, this paper investigates model of education IoT as Petri net with liveness checking which is multiplication of transition systems and next system implementations of transition systems. System implementations are presented as task service server, mobile device system and IoT system with their communication protocols accordingly.

References:

1. Karatrantou, Anthi & Panagiotakopoulos, Christos. (2008). Algorithm, Pseudo-Code and Lego Mindstorms Programming, Workshop Proceedings of SIMPAR 2008 Intl. Conf. on SIMULATION, MODELING and PROGRAMMING for AUTONOMOUS ROBOTS, Venice(Italy) 2008 November, 3-4.
2. Nielsen, Claus & Adams, Paul. (2015). Active learning via LEGO MINDSTORMS in Systems Engineering education. 489-495. 10.1109/SysEng.2015.7302802, 2015 IEEE International Symposium on Systems Engineering (ISSE).
3. Mylonas, Georgios & Amaxilatis, Dimitrios & Pocero, Lidia & Markelis, Iraklis & Hofstaetter, Joerg & Koulouris, Pavlos. (2019). Using an Educational IoT Lab Kit and Gamification for Energy Awareness in European Schools. This is a preprint version of a paper submitted toFabLearn Europe'18, Proceedings of the Conference on Creativity and Making in Education. DOI: 10.1145/3213818.3213823.
4. Lloret, Jaime & Sendra, Sandra & Gonzalez Ramirez, Pedro & Parra, Lorena. (2019). An IoT Group-Based Protocol for Smart City Interconnection. 10.1007/978-3-030-12804-3_13. Springer Nature Switzerland AG 2019S. Nesmachnow and L. Hernández Callejo (Eds.): ICSC-CITIES 2018, CCIS 978, pp. 164–178, 2019. https://doi.org/10.1007/978-3-030-12804-3_13.
5. S. L. Kryvyi, S. D. Pogorilyy, M. S. Slinko, MODEL JUSTIFICATION OF GPU-BASED APPLICATIONS, DOI <https://doi.org/10.15407/usim.2018.04.0046>, ISSN 0130-5395, Control systems and computers, 2018, № 4.
6. Kryvyi S. L., Boyko Y. V., Pogorilyy S. D., Boretskyi O. F., Glybovets M. M. Design of Grid Structures on the Basis of Transition Systems with the Substantiation of the Correctness of Their Operation. Cybernetics and Systems Analysis.
7. Kryvyi S.L. 2015. Linear Diophantine constraints and their application. Chernivtsi: “Bukrek” Publishing House.

¹ Oleksandr Riabov

Master's degree student, Data Analyst

² Iulia Khlevna

Doctor of Technical Science, Associate Professor

^{1,2} Taras Shevchenko National University of Kyiv

RECOMMENDATION SYSTEM DESIGN IN PYTHON BY METHODS OF EMOTIONAL ANALYSIS AND MACHINE LEARNING

Abstract. The article is devoted to the design of an algorithm for providing accurate offers to online store customers based on their previous reviews. The article contains modeling methods explanations as well as practical use cases.

Keywords: modeling, emotional analysis, recommendation system, machine learning.

The development of an e-commerce activity is one of the Internet components [1]. This activity is a calling of our time. Simultaneously, these trends transform the user's decision-making process that is influenced by various forms of recommendations. Online marketing personalization is an obvious trend of the last decade [2]. According to McKinsey, 35% of Amazon revenue, and 75% of Netflix revenue comes from recommended products, and this percentage is likely to increase [3]. It is reasonable to form recommendations based on previously provided feedbacks and that is why an accurate algorithm design for product recommendations is an actual challenge.

Classification model is an underlying model for the sentiment detection. The dataset that has been used for the research contains 23 thousand reviews with 10 feature variables such as goods id, category, text, rating etc. Reviews that have 4 or higher rating were marked as positive (True) and reviews that have 2 or lower rating were marked as negative (False). Neutral reviews that are equal to 3 were not included to the research.

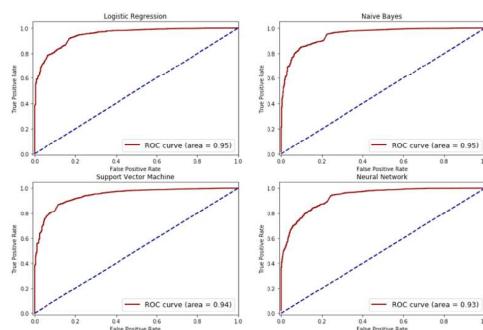


Figure 1 – Classification modeling results

On the other hand, Naïve Bayes takes less computation time and when we have a bigger dataset, this difference might be an important advantage.

The dataset has been divided as training and test samples and been prepared to classification model design using different methods: Logistic Regression, Naïve Bayes, Support Vector Machine and Neural Network. It's been concluded that Naïve Bayes and Logistic Regression show the best results - the area under ROC-curve is equal to 0,95 (Figure 1). Thus, both of them are very effective in sentiment prediction.

The next step is a use of collaborative filtering as a standard method for product recommendations. Pearson correlation has been used to identify customers similar to the current customer in terms of their ratings on the same set of goods. After that, we took their ratings of goods the current customer has not bought yet and then recommended goods with the highest average rating to the user.

The model accuracy evaluation has been conducted by the cross-validation and RMSE as a key indicator (Figure 2). Based on the results it's been concluded that suggested algorithm performs much better than random recommendations and RMSE decreases with the increase of the nearest neighbors number, that is why we recommend running algorithm based on at least 30 connected customers in a graph.

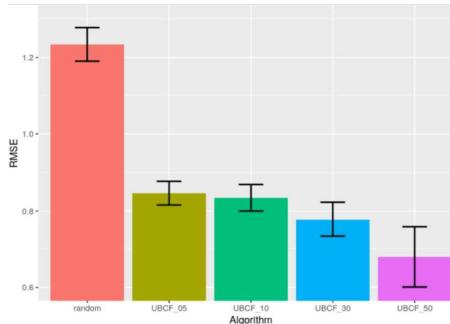


Figure 2 – Model evaluation using RMSE

Provided recommendation system can be implemented to the back-end part of online shops.

References:

1. A. Gupta. Role of e-commerce in today's business//International Journal of Computing and Corporate Research. URL: <https://www.ijccr.com/January2014/10.pdf>
2. M. Balan. Personalize, Summarize or Let them Read? A Study on Online Word of Mouth Strategies and Consumer Decision Process. Inf Syst Front (2020). URL: <https://doi.org/10.1007/s10796-020-09980-9>
3. How retailers can keep up with consumers. URL: <https://www.mckinsey.com/industries/retail/our-insights/how-retailers-can-keep-up-with-consumers#>

¹ Anna Selivanova

Lecturer

² Oleg Pursky

Doctor of science, professor

³ Yurii Yurchenko

Lecturer

⁴ Hanna Samoylenko

Candidate of science, associate professor

⁵ Tatiana Dubovyk

Doctor of science, professor

Kyiv National University of Trade and Economics, Ukraine

AGENT MODELING OF ONLINE STORE ACTIVITIES

The current development of the economy is characterized by a rapid growth of the pace of informatization of economic processes, the expansion of the scale of e-business and, in particular, of retail e-trade on a large scale [1, 2]. Rapid development of e-commerce and online marketing are becoming an attractive alternative to media campaigns because they can be cost effective with a relatively small budget and specifically targeted to user profiles.

The aim of the study is to construct a model, describes in detail the work of an online store. The main task is the construction of a real object model and its functioning dynamics. For this purpose we used AnyLogic computing environment [3].

For fast tracking and responding to changes in the market, and to image dynamics increase the number of customers, it is advisable to use agent-based modeling technologies. The first step in building a model will be to determine the criteria and conditions under which the experiment will begin. A relatively small market with 5,000 people will be considered. To implement the model, each client will be an agent. Since it is determined that the conditional company is new, no one will be interested in the product at first, people's interest will appear under the influence of advertising. After that, the number of successful sales will be affected by the natural increase in customers, which will occur due to the fact that customers who have already bought the product will share information with their friends. The last to the model will be added indicators that can negatively affect the operation of the system, as they will change the conditions under which each purchase will be made.

The block scheme of the online store is very simple, step by step it can be described as follows:

- buyer goes to the website of the online store, looks for the product and sends it to the cart when placing an order;

- client indicates his contact details and method of payment;

- manager contacts the client to confirm the order and clarify contact information, delivery point;

- customer pays for the order at this stage, or does so upon arrival of the goods; the manager of the online store, or another employee, packs the goods and sends it by

courier service (if the customer did not prefer self-pickup);

- customer receives the order and makes the payment if he has not done so before
- after-sales interaction with the buyer (cross-sell, up-sell, advertising and email-marketing).

Potential buyer visits the online store, registers, places the selected order and:

1) the goods are delivered to the warehouse

2) collection of the order in a warehouse

3) change the status of the order in the database to the current state at the time

4) registration of documents to the order (check) and notification to the client about readiness

The process of building an agent model consists of successive steps.

Step 0. Analysis of the initial data.

Step 1. Create a new model.

Step 2. Creating drives.

Step 3. Add a product sales stream.

Step 4. Adding constants.

Step 5. Setting the initial values of drives.

Step 6. Creating dynamic variables.

Step 7. Configure model startup.

Step 8. Launch the model.

Step 9. Add charts.

In this model, the number of potential consumers is not reduced to zero, but is constantly replenished as consumers re-buy products instead of unusable ones. The intensity of product acquisition increases, decreases, and eventually takes on a value depending on the average suitability of the product and the parameters that determine the intensity of this flow. The presence of a product in the withdrawal model means that some part of the population will always remain potential consumers. The most effective option for an online store is one in which the time to collect the order is minimal. Thus, agent-based modeling technology makes it possible to conduct preliminary modeling of any enterprise in e-commerce to ensure the possibility of choosing the optimal market strategy and the required number of consumers of the product with minimal costs for their implementation.

References:

1. G. Schneider, Electronic Commerce, 12th ed., Cengage Learning, Boston, 2016.
2. S. Belew, J. Elad, Starting an Online Business All-in-One for Dummies, 5th ed., For Dummies, New Jersey, 2017.
3. The AnyLogic Company: Official Website of The AnyLogic Company, 2020. URL: <https://www.anylogic.com/features/cloud/>.

¹ Artem Yurchenko

PhD (Pedagogical Sciences), Associate Professor of the Department of Computer Science

² Olena Semenikhina

Dr. (Pedagogical Science), Professor, Chair of the Department of Computer Science

³ Volodymyr Shamonia

PhD (Physical and mathematical Sciences), Associate Professor of the Department of Computer Science

⁴ Yurii Khvorostina

PhD (Physical and mathematical Sciences), Associate Professor of the Department of Mathematics

^{1,2,3,4} *Makarenko Sumy State Pedagogical University, Ukraine*

OPEN EDUCATIONAL RESOURCES IN IT SPHERE

Abstract. The authors provide their quantitative analysis of IT courses on the following educational platforms: Coursera, EdX, Udemy, MIT Open Course Ware, OpenLearn, Intuit, Prometheus, UoPeople, Open Learning Initiative, Open University of Maidan. The authors propose to use open educational resources for organization of independent work within the same Ukrainian courses in Ukrainian realities; for organization of distance learning; for professional development of teachers.

Keywords. MOOC, Online Learning, online courses, online training courses, educational platforms, IT courses.

Due to the great popularity of specialties in the information technologies (IT) field in Ukraine there is a huge expansion of work in the “freelance” format with customers from abroad, with different standards for creating or presenting virtual content. Therefore the analysis of an open educational resources in the IT field on the different educational platforms becomes relevant and would contribute to resolving the contradiction between the demand of Ukrainian society for a competitive IT specialist and the established content, methods, approaches, etc., of the training for such specialists in Ukraine.

By definition, UNESCO's “open educational resources are educational and scientific resources that are openly accessible or licensed, allowing their free use and modification by third parties” [1]. In Ukraine, the term “mass open online courses” or the MOOC is commonly used, which is understood as an open platform, that after the help of the recognized specialist in certain industry provides not only the free access, and online resources but also the social networks for active communication between a large number of students who self-organize their participation according to their own learning goals and prior knowledge and skills [2]. Such course can be positioned as organized by a program, which defines certain terms of study and topics, but at the same time active communication during the course can lead its organizers beyond the chosen problem. Such courses are not accredited and are not intended to guarantee certain learning outcomes, in contrast to open educational resources, which include, in

particular, the acquisition of a certain set of knowledge / skills for testing them internally and / or at the end of a course study in the form of testing or performing certain tasks.

We conducted an analysis of ten open educational resources (ER) (Coursera, EdX, Udemy, MIT OpenCourse Ware, OpenLearn, Intuit, Prometheus, UoPeople, Open Learning Initiative, Open University of Maidan) regarding the availability of courses in the IT industry (analyzed as of March 2020). We conducted a similar analysis for open educational resources in mathematics [3]

Quantitative data on the number of courses in total and the number of courses in the IT industry are shown in Figure 1.

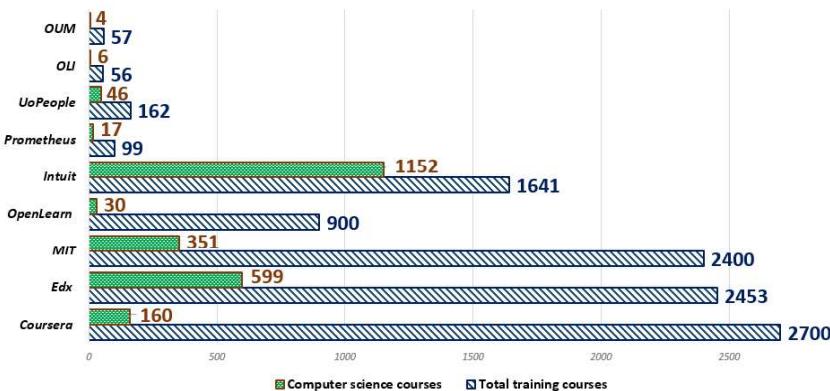


Figure 1. The proportion of computer science courses on various ER

According to fig. 1 analysis, it can be concluded that among well-known educational platforms the most filled with different courses are foreign Coursera, EdX, MIT OpenCourse Ware, OpenLean and Intuit. The number of courses on them exceeds the value of 2.4 thousand, while in the Ukrainian Internet space the most saturated courses platform Prometheus where about 100 courses are located.

Obvious (table 1) is the leadership position of the resource Udemy (in fig. 3 this resource is not displayed for a better visualization of the content of other resources) of the number of courses in general – 82943, and on IT – 35727. According to this resource in the number of IT courses is a platform Intuit, which offers 1152 courses, then go EdX (599 courses) and MIT OpenCourseWare (351 course). At least ten courses on IT-industry offer Open Learning Initiative (6 courses) and OUM (4 courses).

The results of quantitative analysis of the IT open in the IT field give grounds to formulate the following proposals for improvement of professional training of IT industry professionals in Ukraine.

Organization of independent work within the separate courses of training plan specialists can be connected with the passage of a non-commercial course on one of the mentioned platforms. It is worth considering the amount of independent work (the

amount chosen on the open platform of the course should be about the same or smaller). Obtaining a certificate of course on an open platform will be a condition of enrolling actual work.

We also consider it advisable to use the open non-profit ER for organization of remote or correspondence courses within the variation part of the training plan of the specialist.

The level of the teacher's professionalism directly flows to the level of future specialist training, and therefore the successful completion of courses on open platforms should be perceived as a training for teachers. The certificate of completion of the course of 3 or more ECTS credits for a long-term improvement of training and 2 credits ECTS [3] for short-term administration may be counted as a confirmation of advanced training for Teachers of educational institutions.

The analysis conducted by us can encourage teachers to research specific open OR depending on their preferences and educational or scientific tasks. We believe that this will positively affect the quality of teaching copyright courses, the dissemination of copyright techniques and the teacher's professionalism. We also note the possibility and feasibility of distributing copyright techniques in the development of their own courses and promoting them on open platforms.

References:

1. S. Touzé, Open Educational Resources in France: Overview, Perspectives and Recommendations. UNESCO Institute for Information Technologies in Education, 2014.
2. A. McAuley, B. Stewart, G. Siemens, D. Cormier, The MOOC Model for Digital Practice. Created through funding received by the University of Prince Edward Island through the Social Sciences and Humanities Research Council's "Knowledge Synthesis Grants on the Digital Economy", 2010.
3. O.V. Semenikhina, M.G. Drushlyak, Yu.A. Bondarenko, S.M. Kondratiuk, I.M. Ionova. Open Educational Resources as a Trend of Modern Education. Proceedings of 42 International convention on information and communication technology, electronics and microelectronics "MIPRO 2019", Opatija (Croatia), 2019, pp. 779–782.
4. Zakonodavstvo Ukrayny, Regulations on the improvement of qualification and internship of pedagogical and scientific-pedagogical workers of higher educational establishments, 2013. URL: <https://zakon.rada.gov.ua/laws/show/z0488-13>.

¹ **Sergiy Zagorodnyuk**

PhD, associate professor

² **Bohdan Sus**

PhD

³ **Oleksandr Bauzha**

PhD, associate professor

¹⁻³ Taras Shevchenko National University of Kyiv

THE APPLICATION OF NETWORK COMMUNICATION FOR ORGANIZING A LABORATORY WORK

Abstract. This paper describes the developed network infrastructure of remote laboratories and discusses the effective mechanisms of remote sessions and technologies of network administration of laboratory equipment. The developed remote laboratory works and systems of visualization of the measured data, settings of a computer network, process of switching of the laboratory computer equipment and remote supervision are discussed in detail. Developed technical solutions, developed laboratory facilities, engineering and network solutions with a detailed description were analyzed in detail.

Introduction

Computer support of the educational process provides additional opportunities for both the independent activity of the student and for his work in classrooms and laboratories. Handling the network infrastructure and e-learning materials, the student can learn independently from textbooks with interactive examples and demonstrations, perform tests, prepare for scientific research.

A remote lab is a distributed computing environment that allows students to conduct experiments by interacting with real devices, tools, and mechanisms through a customized telecommunications platform. [1, 2].

Today, remote laboratory work is an important topic for the educational community. Laboratory activity is an integral part of the educational process in higher education institutions in the study of natural sciences. By conducting laboratory work the student not only acquires fundamental knowledge but also acquires the necessary skills, which is a requirement for its formation as a competent specialist[3, 4]. In engineering education, practical work is an important addition to theoretical courses. Students come to the laboratories to conduct experiments and evaluate the differences between their observations and predictions according to theoretical courses. The need for physical access to laboratory equipment is not in doubt, but the implementation during quarantine is an urgent and complex problem, which is especially actual for laboratory work in natural sciences[5].

Remote laboratories can be used for academic, industrial and research purposes. Laboratory equipment connected to the Internet provides remote control of the laboratory work process. [6]. In particular, the remote control is supported by telescopes, large-scale installations operating on particle accelerators, devices for

recording ionizing radiation, etc. Distance laboratory work is one of the most important applications of IoT principles to education, especially in physics and other fields for which experiments are a key part of the learning process. The Internet of Things (IoT) is a network of physical devices connected by local and wide area networks, including the Internet. As technology has evolved, the importance of IoT has increased tremendously.

Despite the advantages and disadvantages, every year more and more universities start practicing remote laboratory works. Earlier, they were available in only a few universities that had research teams specializing in Internet technology. Now, many universities offer telecommuting in addition to traditional practice laboratories to present students of other universities the opportunity to operate with laboratory experiments that they would not be able to prepare in their own laboratories and to provide them extra laboratory time.

Students and teachers typically access remote lab work through specialized web applications that allow them to control lab equipment, conduct experiments, and retrieve real measurement data. [7, 8].

Practical implementation

The laboratory work is based on a research setup. This work well demonstrates the implementation of the concept of remote laboratory work for natural and technical sciences. Remote access to devices is implemented using standard interfaces and a computer connected to the Internet.

The exponential method is used for calculation and analysis in this laboratory work. Its essence is the direct registration of the kinetics of photocurrent changes through a semiconductor sample under the influence of the latter on U-shaped pulses of light.

The system architecture of experimental setup consists of three parts.

The first part is designed for the generation of strobe-shaped pulses of light to the samples under investigation.

The second part of the experimental setup consists of a set of samples for measurement controlled by mosfet keys and digital oscilloscope.

Distance learning students can access the laboratory through a specialized authorized website, where each student will receive personal instructions on how to join the remote laboratory of the university and perform laboratory work.

Conclusions

The development of remote laboratories is a promising direction for natural and engineering education, as they provide students with the means to design and conduct experimental research without the need for a physical presence near the laboratory equipment.

The suggested and assembled remote laboratory setups demonstrate that due to the use of standard hardware interfaces and common mechanisms of network infrastructure to create a similar remote laboratory work can any researcher or teacher interested in ensuring that the learning process in higher education continues without

interruption and without significant restrictions on the flexibility and functionality of the laboratory installation.

References:

1. Khazri, Y., Toumi, H., Al Sabri, A., Moussetad, M., Sabir, B., Fahli A.: Remote Control Laboratory Experiments in Physics using LabVIEW. International Jounal of Information Science & Technology –iJIST, 1 (1), 11-16 (2017). ISSN : 2550-5114
2. Teng, M., Considine, H., Nedie, Z., Nafalski, A.: Current and Future Developments in Remote Laboratory NetLab. Int. J. Onl. Eng. 12, 4 (2016). <https://doi.org/10.3991/ijoe.v12i08.6034>.
3. Zapata Rivera, L.F., Larrondo Petrie, M.M.: Models of Collaborative Remote Laboratories and Integration with Learning Environments. Int. J. Onl. Eng. 12, 14 (2016). <https://doi.org/10.3991/ijoe.v12i09.6129>.
4. Khazri, Y., Rouane, M., Fahli, A., Mohamed, M., Khaldouni, A., Naddami, A.: Developing a Remote Practice for Laboratory Experiments on Measuring Instruments. Int. J. Onl. Eng. 10, 12 (2014). <https://doi.org/10.3991/ijoe.v10i5.3833>.
5. Gadzhanov, S., Nafalski, A., Nedic, Z.: Remote Laboratory for Advanced Motion Control Experiments. Int. J. Onl. Eng. 10, 43 (2014). <https://doi.org/10.3991/ijoe.v10i5.3835>.
6. Heradio, R., de la Torre, L., Dormido, S.: Virtual and remote labs in control education: A survey. Annual Reviews in Control. 42, 1–10 (2016). <https://doi.org/10.1016/j.arcontrol.2016.08.001>.
7. Colwell, C., Scanlon, E., Cooper, M.: Using remote laboratories to extend access to science and engineering. Computers & Education. 38, 65–76 (2002). [https://doi.org/10.1016/S0360-1315\(01\)00077-X](https://doi.org/10.1016/S0360-1315(01)00077-X).
8. Bencomo, S.D.: The Role of Interactivity in Control Learning. IFAC Proceedings Volumes. 36, 1–12 (2003). [https://doi.org/10.1016/S1474-6670\(17\)33646-7](https://doi.org/10.1016/S1474-6670(17)33646-7).

¹ Viktoriia Zinchenko

PhD in Pedagogical Sciences, Associate Professor

² Anna Kyrypa

PhD in Pedagogical Sciences, Associate Professor

³ Olena Stepanenko

PhD in Philological Sciences, Associate Professor

¹ Donetsk National University of Economics and Trade named after Mikhail Tugan-Baranovsky

^{2,3} Communal Institution of Higher Education «Dnipro Academy of Continuing Education» of Dnipropetrovsk Regional Council

INFORMATION AND COMMUNICATION TECHNOLOGIES WHILE FORMING NON-PHILOLOGICAL STUDENTS' PROFESSIONAL LANGUAGE AND SPEECH COMPETENCES

Abstract. The research is devoted to analyzing the way of implementation of information and communication technologies in teaching process which could be helpful while forming professional language and speech competences of non-philological students. The tasks of information and communication technologies as well as psychological prerequisites for mastering the knowledge and forming language and speech competences, communication skills and abilities are described.

Keywords: teaching and learning model, information and communication technologies, professional competence, language and speech competence.

In modern conditions of developing and widespread using computer equipment the learning process in higher educational institutions must be arranged with applying information and communication technologies which promotes differentiation and humanization of education, intensive development and realization of students' spiritual and intellectual potential. That is why educational institutions review the approaches for teaching the humanitarian disciplines in a professional direction, as well as search for innovative methods taking into account the development of information and communication technologies. In order to transform the traditional teaching model based on the teacher's explanations, the use of new teaching and learning models connected with information and communication technologies is being actively implemented [1].

The high speech culture is a part of common human culture. Today we observe the heightened interest in the humanitarian disciplines as well as the state language; it is not enough for students to have knowledge acquired at school. Modern students are characterized by a predominantly imaginative perception of the world, so it is necessary to seek and use new opportunities of the human brains to form optimal methods of mastering knowledge. The graduate of higher educational institutions must perfectly know and use the Ukrainian language first of all. Developed language and speech as well as professional language competences encourage mastering the subject, increase working efficiency and influence positively on business relationships. The high speech culture and writing skills for a future professional is not just a reflection of his or her

professionalism, tolerance, good manners and intellectuality. It also determines work culture in all aspects. The search for innovative and effective methods of teaching at the courses in non-philological higher educational institutions determines studying peculiarities of forming language and speech competences of non-philological students with applying modern information and communication technologies. Also, the use of information and communication technologies makes it possible to diversify the work, to make the process of learning the humanitarian disciplines go beyond the teaching audience and to make it continuous, promotes the organization of students' independent work. Sometimes it is due to multimedia resources that students' desire and need to learn the humanitarian disciplines are activated, which significantly affects the learning performance. According to many scientists, the development of individual competences in modern conditions is significantly influenced by the introduction of new information and communication technologies in the educational process [2, 3, 4, 5, 6].

This article reveals psychologists' and pedagogs' views on introducing information and communication technologies into teaching humanitarian disciplines from professional point. It determines fundamental linguo-didactic problems which can be solved by introducing information and communication technologies into the teaching process of humanitarian disciplines.

Psychological and pedagogical conditions for forming professional language and speech competences of non-philological students with applying information and communication technologies are described. Changes in the model and components of teaching professional language with applying information and communication technologies are considered. We agree with the scientists who emphasize such tasks of applying information and communication technologies as forming information and communication culture of future specialists; ensuring the development of students' personal traits and skills, disclosing the creative potential of every student; increasing the efficiency of the educational process; providing creative research activities; intensifying the educational process.

Psychologists include necessary psychological prerequisites for mastering the knowledge and forming language and speech competences, communication skills and abilities. They underline positive attitude to the learning process (interest in the subject, constant attention, and high pace of educational work); processes of direct sensual familiarization with the material (from the language point it includes schematic visualization, interactive learning technologies); thinking process (activation of concrete and abstract, conceptual and artistic thinking, perception, comprehension and understanding of the material); memorizing and storing the information received, the ability to reproduce it performing individual speech abilities. These prerequisites contribute to creating learning motives, encouraging non-philological students to learn linguistic theory and to produce speech activity, ensuring the development of linguistic persona. Their implementation is significantly facilitated by the introduction of information and communication technology training [4, 7].

The use of information and communication technology while studying at the courses of humanitarian disciplines in higher educational institutions of non-philological profile helps to solve the problems of humanization of the educational

process and allows to significantly increase its effectiveness through intensification, differentiation (taking into account students' individual characteristics), effective combination of individual and team activities; prompt interrelation of the source of educational information and the student; timeliness, usefulness, appropriate dosage, availability (understandability) of educational information; adaptation of the rate of its presentation to the rate of assimilation; introduction of innovative teaching methods and tools.

The analysis of approaches to the methodology of teaching at the courses of humanitarian disciplines in higher educational institutions of non-philological orientation shows that there is an objective need to develop a special methodological system of language training for the professional direction of future professionals with applying information and communication technologies, which would contribute to the formation of language and speech skills among students and their professional communication skills.

The prospect of the research can be seen in the further study of the linguo-didactic potential of modern information and communication technologies, a detailed analysis of the peculiarities of applying each tool of specific information and communication technology while the process of teaching different aspects of language by professional direction and forming skills in different types of language activity.

References:

1. Concept of implementation of media education in Ukraine. URL: http://www.ispp.org.ua/news_44.htm. (in Ukrainian).
2. P. V. Sysoyev, Information and communicative technologies in linguistic education. Moscow : The «Librocom» Publ., p. 264, 2013 (in Russian).
3. R. S. Hurevych, “Usage of Internet technologies in the preparation of specialists: aspects of education in networked communities”, Scientific journal of M. P. Drahomanov NPU. Series № 2. Computer-oriented systems of education, vol. 16 (23), pp. 8–12, 2015 (in Ukrainian).
4. H. B. Zakharova, “The use of information technology as an innovative vector of higher education didactics”, Scientific works. Pedagogy, pp. 63–66, 2013 (in Ukrainian).
5. O. V. Semenikhina, New Paradigms in the field of education in the conditions of the transition to the «smart» society. URL: <http://nvd.luguniv.edu.ua/archiv / NN23 / 13sov.pdfs.pdf>. (in Ukrainian).
6. A. Kyrpa, Interactive technologies and gamification in foreign language teaching, European Academy of Science, Bonn, Germany: «EAS», 2019, pp. 75-76.
7. G. F. Ponomaryova, New pedagogical technologies: teaching aids. Kharkiv, p. 282, 2013 (in Ukrainian).

MATHEMATICAL FOUNDATIONS OF INFORMATION TECHNOLOGY

¹ Oleksii Bychkov

Doctor of Technical Science, Head of the Department of Software Systems and Technologies, Associate Professor

² Oleksii Ivanchenko

Candidate of Technical Science, Head of the Personnel Department

³ Kateryna Merkulova

Candidate of Technical Science, Associate Professor of the Department of Software Systems and Technologies, Associate Professor

⁴ Yelyzaveta Zhabska

Assistant of the Department of Software Systems and Technologies

^{1,2,3,4} Taras Shevchenko National University of Kyiv

MATHEMATICAL METHODS FOR INFORMATION TECHNOLOGY OF BIOMETRIC IDENTIFICATION IN CONDITIONS OF INCOMPLETE DATA

Abstract. The purpose of this research is to develop mathematical methods for information technology of biometric identification which will allow to recognize person's face in conditions of incomplete data such as wearing a medical face masks during the pandemic.

Keywords: biometric identification, face recognition, wavelet transform.

Nowadays wearing medical masks caused increasing of the probability of false identification results of recognition systems from 5 to 50%, as the US National Institute of Standards and Technology (NIST) concluded [1].

During the ongoing pandemic researchers focus on quick and effective solutions to develop technologies that handle this problem. This research concentrates on the analysis of the already existing solutions and proposes a mathematical method of face identification for information technology based on wavelet transform under the condition of wearing masks by people. Since there is no database which contains face images with masks, a new database was created. This database contains 820 images of 40 people, whose faces was limited only by top part of the face (forehead, eyes).

First set of experiments was performed with the use of standard Python library `face_recognition`, which allows to recognize and manipulate faces from Python or from the command line with the world's simplest face recognition library. It built using `dlib`'s state-of-the-art face recognition toolkit with deep learning. `dlib` model is a ResNet network with 29 conv layers.

In the second set of experiments FaceNet system was used. It is a system that, given a picture of a face, will extract high-quality features from the face and predict a 128-element vector representation these features, called a face embedding.

Third part of experiments was performed to analyze the efficiency of three popular facial recognition methods: eigenfaces, fisherfaces, and LBPH. Eigenfaces algorithm processes all the training images of all the people as a whole and tries to extract the components which are relevant and useful. Fisherfaces algorithm extracts principal components that differentiate one person from the others, so an individual's

components become more useful over the others. The purpose of LBPH algorithm is to find face local structure by comparing each pixel to the neighboring pixel, forming a list of local binary patterns, that can be converted into a decimal number.

Results of performed experiments are presented on the Figure 1.

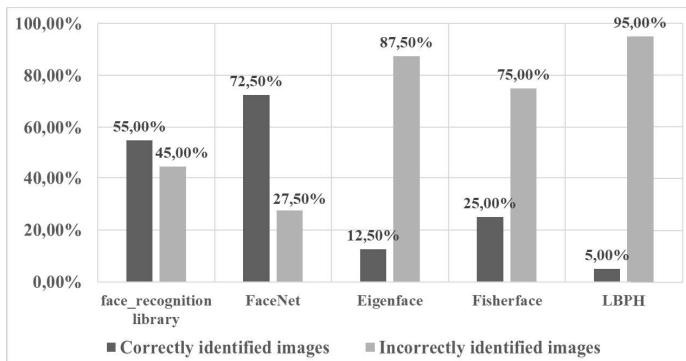


Figure 1 – Results of identification with the use of face_recognition, FaceNet, Eigenfaces, Fisherfaces and LBPH methods on the dataset of masked images

Mathematical methods proposed in this research based on wavelet transform, that provides processing of patterns hidden in the data performing data analysis in general as well as in the detail. To compare the results of the commonly used algorithms with wavelet transform there was developed algorithm with the use of Daubechies wavelets and reverse biorthogonal wavelets.

Daubechies wavelets [2] are the type of basic wavelets, that orthonormal basis defined as:

$$\phi_{r,j,k}(x) = 2^{\frac{j}{2}} \phi_r(2^j x - k), j, k \in Z, \quad (1)$$

where function $\{\phi_r(x - k) | k \in Z\}$, j is the scaling index, k is the displacement index, and r is the filter index.

Reverse biorthogonal wavelets [3] can be described with the following:

$$[\langle \phi(x) | \bar{\phi}(x) \rangle] = I, \quad (2)$$

$$[\langle \psi(x) | \bar{\psi}(x) \rangle] = I. \quad (3)$$

Figure 2 depicts results of the Daubechies wavelet transform and standard deviation calculation on the dataset of masked images.

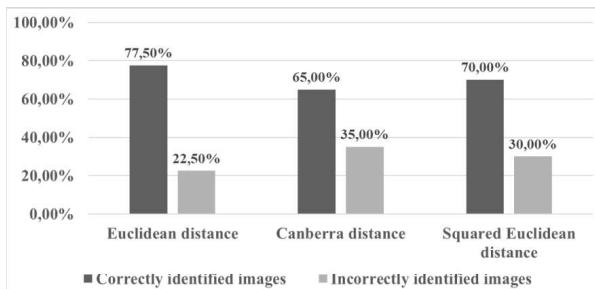


Figure 2 – Results of the Daubechies wavelet transform and standard deviation calculation on the dataset of masked images

Figure 3 depicts results of the reverse biorthogonal wavelet transform and standard deviation calculation.

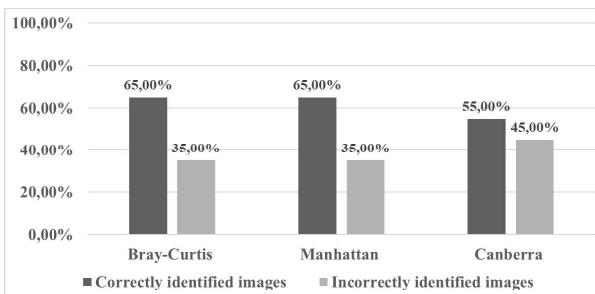


Figure 3 – Results of the reverse biorthogonal wavelet transform and standard deviation calculation on the dataset of masked images

The results of experimentation results analysis indicate that the popular and commonly used methods of face identification do not demonstrate high efficiency results. Proposed mathematical methods for information technology based on wavelet transform improves the face recognition and identification process under the condition of faces covered with mask. Specifically, the most accurate identification rate of 77,5% was obtained with the use of Daubechies wavelets.

References:

1. M. Ngan, P. Grother, K. Hanaoka. National Institute of Standards and Technology Interagency or Internal Report 8311 Natl. Inst. Stand. Technol. Interag. Intern. Rep. 8311 (2020). doi: 10.6028/NIST.IR.8311.
2. I. Daubechies. Ten lectures on wavelets. Society for Industrial and Applied Mathematics, USA, 1992.
3. C. Stolojescu, I. Railean, S. Moga and A. Isar. "Comparison of wavelet families with application to WiMAX traffic forecasting." 12th International Conference on Optimization of Electrical and Electronic Equipment, Basov, 2010, pp. 932-937. doi: 10.1109/OPTIM.2010.5510403.

¹ Hryhorii Hnatienko

PhD

² Artem Rimek

Student

^{1,2} Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

USE OF ALGEBRAIC APPROACH WHEN EVALUATING THE CORRECT SEQUENCE OF THE PRESENT LIST ELEMENTS IN TESTING TASKS

Testing is controversial, debatable, but reliable, powerful, effective and, for some branches of human life, irreplaceable tool. In particular, the testing procedure is fruitfully used in programming, engineering, medicine, psychiatry, and education. Moreover, for example, pedagogical testing simultaneously performs several functions: teaching, diagnostic, evaluative, incentive, developing, educational, etc.

Today there are many opinions about the appropriateness of using tests. On the one hand, tests are viewed as a means of positively improving the educational process towards its technologization, objectivity, and reducing labour intensity. On the other hand, tests are seen as a means of reducing the role of the teacher, and the test results are sometimes considered insufficiently reliable. However, it should be noted that, despite the different attitudes towards this area, testing itself becomes the main form of diagnostics of the level of students' training.

We only note that tests, at least, eliminate the drawbacks of empirical control. After all, a test consists of a number of tasks in a certain area and a standard known to the teacher, that is, a sample of complete and correct performance of the task.

Types of test items. Test items are traditionally divided into two large groups: closed and open. Closed-type tasks are considered in this work, namely: the problem of determining the arrangement of list elements in a certain sequence, that is, determining the order for arranging elements (objects, alternatives, entities), the sequence of actions, operations, the course of processes, the order of calculations, the chain of events, judgments and the like. In this case, respondents are offered a list of concepts, phenomena, dates, words, etc., which they must arrange in a correct sequence. Such test problems arise in various areas, for example:

- Establish the chronological sequence of events;
- Define some logical sequence;
- Formulate a definition from a set of randomly given words;
- Arrange some numbers in ascending or descending order;
- Restore the order of the proof of some theorem;
- Write a sequence of calculations when writing a program code that ensures the determination of the value of a given formula and the like.

Such tasks help to form students' algorithmic thinking, consolidate the relevant knowledge and skills.

Formulation of a task. Consider a formal description of the ordering of items in closed questions during testing. Note that models and methods for determining the competence of respondents based on the axiom of unbiasedness when ranking alternatives were studied, in particular, in the monograph [1].

Let the set of elements of a complete answer $a_i \in A$, $i \in I = \{1, \dots, n\}$ be given; the number of them is equal to n , $n = |A|$. A respondent must build a linear (complete) order for this set, that is, a strict ranking of the given elements of the answer. We will denote the correct order of elements, which is known to the teacher, and for which the respondent receives the maximum score, through R^0 , $R^0 = a_{i_1} \succ a_{i_2} \succ \dots \succ a_{i_n}$, $i_j \in I$, $j \in I$. Thus, the testing procedure can be formalized in the class of ranking problems.

Note that the ability to guess the answer is the main reason for the negative attitude of teachers to the closed form of tasks. To eliminate this deficiency, a correction for guessing test points is even applied. Its essence lies in the fact that the number that can be guessed is subtracted from the total score received by each respondent, in accordance with the provisions of the theory of probability.

Since the number of possible answers to the tasks of ranking elements is equal to $n!$, then at $n = 5$, for example, $n! = 5! = 120$ and the value significantly increases with an increase in the number of elements that need to be ordered. That is, the probability of guessing the correct answer is extremely low. In this regard, the warnings of teachers regarding the possibility of guessing are baseless.

Solution algorithm. When assessing the tasks of ordering a set of given elements, the dichotomous assessment of the task performance is most often used: "Yes" - "No", 0 or 1. Less often, some heuristic assessment rules are used. For example, a correctly completed task is assessed using 3 points, an error at the end of the task is assessed using 2 points, an error in the middle of a task is assessed in 1 point, and an error at the beginning of a task results in a zero value. It should be noted that sometimes in these tasks it is advisable to establish only a dichotomous, that is, a binary assessment. But a large number of test items allow for variations in grades over a wide range.

We will apply algebraic approach, where it is appropriate and justified. That is, the value of the respondent's score $C(R^*)$ will proportionally depend on the distance for the answer provided by him R^* to the correct (or - ideal, reference) answer R^0 , and will symbolically denote the following:

$$C(R^*) = B \cdot (1 - d(R^0, R^*) / d^M),$$

Where B – the maximum possible score for the answer, d^M – the maximum possible distance, that is, the distance from the correct answer to the completely incorrect which is opposite to the ideal one. For example, when the answer $R^0 = a_1 \succ a_2 \succ a_3 \succ a_4$ is correct, then the "worst" answer being farthest from it is $R^* = a_4 \succ a_3 \succ a_2 \succ a_1$.

According to works [1, 2], distances in ordinal (rank) scales, in particular, ranking, are measured using various metrics, in particular:

- Cook's metric for mismatching ranks (places, positions) of list elements

$$d^K(R^0, R^*) = \sum_{i \in I} |r_i^0 - r_i^*|, \quad (1)$$

Where r_i^0 – the rank of the i -th list element in the reference ranking of list elements R^0 , r_i^* – the rank of the i -th list element in the ranking of the elements specified by the respondent;

- Hamming metric

$$d^H(R^0, R^*) = \sum_{i \in I} \sum_{j \in I} |b_{ij}^0 - b_{ij}^*|, \quad (2)$$

Where $b_{ij}^0 = 1$, $i, j \in I$, if and only if there is a relation $a_i \succ a_j$, $i, j \in I$ in the correct answer R^0 ; $b_{ij}^0 = -1$, $i, j \in I$, when the ratio $a_i \prec a_j$, $i, j \in I$ takes place in the correct answer R^0 ; $b_{ij}^0 = 0$, $\forall i, j \in I$; $b_{ij}^* = 1$, $i, j \in I$, if and only if there is a relation $a_i \succ a_j$, $i, j \in I$ in the respondent's answer R^* ; $b_{ij}^* = -1$, $i, j \in I$, when the respondent specified the following order $a_i \prec a_j$, $i, j \in I$; $b_{ij}^* = 0$, $\forall i, j \in I$ in his/her answer R^*

- Euclid's metric

$$d^E(R^0, R^*) = \left(\sum_{i \in I} (r_i^0 - r_i^*)^2 \right)^{1/2}, \quad i \in I;$$

- a vector of preferences, the elements of which are the number of alternatives that precede each alternative in the ranking.

Maximum possible distances between the benchmark and the worst ranking are:

- For the Cook metric of the form (1) $d^{K^M} = n^2 / 2$ - for even ; and for odd ones it is calculated according to the formula $d^{K^M} = (n^2 - 1)/2$;

- For the Hamming metric of the form (2) the maximum distance is $d^{H^M} = n(n-1)/2$.

It should be noted that the respondent's partial answers should also be perceived and fairly evaluated. It is clear that this procedure must be justified and formalized. That is, the approach described in this work can be generalized in the case of incomplete answers when the respondent could not answer for technical reasons, or did not have time to fill out the test, or does not know the full correct answer, but is sure of its fragments, or does not want to give a full ranking of a given set of elements, etc. This situation can be viewed as a case of incomplete rankings.

Conclusions. The paper proposes a new approach to calculating the score for testing using questions that involve compiling a list element. The approach is grounded and formalized; therefore, it can be applied in various subject areas. A positive feature of the proposed approach is the transparency of the rules that are a priori set by the organizers of testing and the absence of situations of uncertainty during the assessment procedure. In addition, the described approach allows for the possibility of further development and improvement.

References:

1. Hnatienko H.M., Snityuk V.E. Expert decision making technologies: Monograph. - M.: LLC "McLaut", 2008. – 444p.
2. Voloshin A.F., Mashchenko S.O. Models and methods of decision-making: a textbook for students of higher educational institutions. - 2nd edition - M.: Publishing and Printing Centre "Kiev University", 2010. - 336 p.

Dmitriy Klyushin

Doctor of Physics and Mathematics, Professor
Taras Shevchenko National University of Kyiv

RANDOMNESS: OLD AND NEW IDEAS

Introduction. Randomness is one of the most important and difficult notions in computer science. The importance of randomness is justified by the fact that we face randomness in the simulation of real processes (physical, chemical etc.), cryptography and many randomized algorithms. Difficulty of randomness lies in the fact that its nature is controversial. Some classics of computer science (e.g. Turing and von Neumann) considered randomness as a purely physical phenomenon. Other mathematicians (von Mises, Kolmogorov etc.) tried to construct a rigorous mathematical theory of randomness. Thus, now there exist two parallel worlds: the world of physicists, engineers, computer scientists and other investigators that work in the field of real random events and the world of pure mathematicians that attend to theoretical issues of randomness (e.g. consistency of axioms, interconnections between different definitions of randomness etc.). We propose a strongly valid mathematical theory of randomness that is easily applicable in practice. We consider three classical approaches to randomness and propose an alternative model.

Frequency approach (von Mises). The model proposed by von Mises uses a concept of an infinite binary sequence x_1, x_2, \dots (collective) that meet the following conditions: 1) if h_n is the relative frequency of units in first n elements of a sequence,

then there is a limit $\lim_{n \rightarrow \infty} h_n(T, A) = \lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n x_k = p$, $0 < p < 1$ (global regularity); 2) every infinite subsequence x_{i_1}, x_{i_2}, \dots drawn from the sequence x_1, x_2, \dots using a rule of acceptable selection has the same limit p (local regularity). A sequence is random by von Mises if it has two properties: 1) every sequence of relative frequencies of units in the collective has the same limit; 2) the relative frequencies are invariant under the procedure of so-called acceptable selection, that is, the choice of a sequence in which the choice of an n -th element does not depend on its value.

Randomness as computational complexity (Kolmogorov). Kolmogorov complexity of a sequence $x = (x_1, x_2, \dots, x_N)$, or is algorithmic entropy, is the length $K(x)$ of its shortest description, constructed using a Turing machine. If there is some additional information y , then we can consider conditional Kolmogorov complexity $K(x|y)$. A sequence is called Bernoullian by Kolmogorov if its complexity is close to $\log_2 C_N^k$, i.e. $K(x|N, k) \approx \log_2 C_N^k$. Also, Kolmogorov introduced the notions of chaotic sequence that satisfies the condition $K(x|N, k) \geq \log_2 C_N^k - m$. Is a set A contains finite number of elements x_1, x_2, \dots, x_N , then the complexity of its element is less or equal to $\log_2 N$. An element x of A is random if its complexity is close to maximal, i.e.

$K(x|A) \approx \log_2 N$. The difference $\log_2 N - K(x|A)$ is a defect of randomness of an element x . An infinite binary sequence $x_1, x_2, \dots, x_n, \dots$ is random by Kolmogorov if for any natural n there is a constant c so that $K(x_1, x_2, \dots, x_n) \geq n - c$.

Randomness as typicality (Martin-Löf). An infinite binary sequence $x_1, x_2, \dots, x_n, \dots$ is called random with respect to uniform measure, if for an arbitrary natural n there is a constant c such that $K(x_1, x_2, \dots, x_n) \geq n - c$. Obviously, a sequence that is random by Martin-Löf is random by von Mises. From the other side, there are sequences that do not satisfy the conditions of Martin-Löf.

Alternative model (Petunin–Klyushin). Consider the trial T having two consequences: A and \bar{A} . Introduce the value x_k such that $x_k = 1$ if under k th repetition of the trial T the consequence A is realized, and 0 otherwise. The sequence of bits x_1, x_2, \dots is called a Bernoullian sequence of order p , $0 \leq p \leq 1$, if $\lim_{n \rightarrow \infty} h_n(T, A) = \lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n x_k = p$, where $h_n(T, A)$ is the frequency of the event A under the n repetition of the trial T .

The main point in our theory is that for correct definition of the concept of random trial we must use an infinite set of series X_1, X_2, \dots . For convenience, let arrange these series as indefinite characteristics matrix $\Theta(T) = \{x_{ij}\}_{i,j=1}^\infty$.

Let $X_i = (x_{i1}, x_{i2}, \dots, x_{in}, \dots)$ be rows and $X_j^* = (x_{1j}, x_{2j}, \dots, x_{nj}, \dots)$ be columns of characteristics matrix $\Theta(T)$. It is easy to see that every row X_n and every column X_n^* of the matrix $\Theta(T)$ generate real numbers α_n and α_n^* from the segment $[0,1]$. Really, put $\alpha_n = 0, x_{n1} x_{n2} \dots x_{nn} \dots$ and $\alpha_n^* = 0, x_{1n} x_{2n} \dots x_{nn} \dots$ and consider these expressions as binary ratios. Denote as M and M^* the sets of numbers α_n and α_n^* , respectively. A trial T is said to be random if: 1) every row X_n and column X_n^* ($n=1, 2, \dots$) of $\Theta(T)$ is a Bernoullian binary sequence of the same order $p \in [0,1]$; 2) sets M and M^* corresponding to rows and columns of $\Theta(T)$, respectively, are everywhere dense in $[0,1]$. A random experiment E consists of infinite series of the random trial T . A random event R_E is an outcome of T inducing the experiment E . The result R can be outcome of a random event A or \bar{A} . A probability $p(E, A)$ of a random event (E, A) is an order $p \in [0,1]$ of a Bernoullian sequence consisting of results of a random trial T generating the random experiment E .

¹ **Igor Kovalenko**

Dr.Sc., Professor of the Department of Software Engineering

² **Yevhen Davydenko**

Ph.D., Associate Professor of the Department of Software Engineering

³ **Alyona Shved**

Ph.D., Associate Professor of the Department of Software Engineering

^{1,2,3} *Petro Mohyla Black Sea National University*

STRUCTURING OF GROUP EXPERT JUDGMENTS FORMED UNDER COMPLEX FORMS OF IGNORANCE

Abstract. The technology for structuring of group expert assessments formed under complex (combined) types of ignorance caused by uncertainty, inaccuracy, inconsistency, conflict (contradiction) and their combinations has been proposed, based on the mathematical apparatus of the theory of evidence and the theory of plausible and paradoxical reasoning. Different quantified measure of uncertainty and conflict in evidence theory has been considered.

Keywords: information technology, decision-making, expert evidence, combination rule, ignorance.

The problem of choosing and making managerial decisions is often solved in the face of an increasing number of external and internal factors that affect the achievement of the goal. In this case a person cannot, at the heuristic level, guarantee synthesis of optimal strategy for decision-making taking into account all the conflicting factors. The situation is aggravated in the presence of various types of ignorance, which are inextricably linked with the processes of formalization and presentation of the existing system of knowledge, and have a direct negative impact on the processes of extraction, analysis, presentation and processing of data and expert knowledge. This, in turn, creates the preconditions for the synthesis of a complex of formalized mathematical models focused on the intellectual support of the processes of preparation and decision-making in conditions of complex forms of ignorance, multi-criteria and risk.

The aim of the work is to present and formalize the main ideas of the technology for structuring expert knowledge, in the context of complex (combined) types of ignorance generated by uncertainty, inaccuracy, inconsistency, conflict, contradiction of expert knowledge. It is based on a systematic approach to the identification of various forms and types of ignorance, and its combinations that creates conditions for reasonable choice and application of methods for expert knowledge analysis.

Let's consider the main ideas of the proposed technology. Let $A = \{A_i | i = \overline{1, n}\}$ be a set of alternatives, on which certain limitations can be imposed: mutually exclusive and / or mutually exhaustive elements, which determines the type of model in frame of which expert evidence will be formed.

Let a group of experts $E = \{E_j | j = \overline{1, t}\}$ have formed profiles of expert preferences $B = \{B_j | j = \overline{1, t}\}$ on the set $A = \{A_i | i = \overline{1, n}\}$. The profile B_j formed by the expert E_j reflects

his preferences regarding all analyzed elements of the set A (depending on the chosen analysis model).

For each expert the same instruction has been presented, which prescribes what they should do with the set A. The instruction contains information about a scale measurement type, within which experts express their preferences, which in turn affects the information received from experts (words, conditional gradations, numbers, rankings, binary relations or other objects of non-numerical nature).

The profile B_j formed by the expert E_j reflects his preferences, expressed within a given scale, with respect to the elements of the set A. The expert himself decides which elements (or selected groups of elements) of the set A will be evaluated. Thus, the profile of preferences B_j formed by E_j may contain: estimates expressed with respect to all elements of the set A; the assessments expressed regarding the preferred elements of the set A; the estimates expressed regarding the selected groups of preferred elements of the set A.

Next, the set of expert assessments $B = \{B_i | i = \overline{1, n}\}$ is fed to the input of the block of ignorance nfi identification, $nfi \in NF$, in this case we are talking about such types of ignorance nfi as uncertainty, inaccuracy, inconsistency, conflict or their combinations that can be simultaneously present in the knowledge system. In the ignorance identification block, a system of identification criteria $C_i = \{c_j^{(i)} | j = \overline{1, z}\}$, $i = \overline{1, p}$, of the analyzed forms of ignorance $NF = \{nfi | i = \overline{1, p}\}$ is formed. On the basis of formed $C_i = \{c_j^{(i)} | j = \overline{1, z}\}$ a system of decision rules $SR_i = \{R_l^{(i)} | l = \overline{1, h}\}$ for nfi identification is developed. For nfi identification it can be used one or combination of features, which allows to unambiguously establish the presence of nfi in the initial data (knowledge) set. The absence of nfi is recognized if for all set of proposed ignorance identification criteria C_i confirmed absence of nfi ($\forall j : c_j^{(i)} \rightarrow \text{absence of } nfi$); the presence of nfi is recognized if there is at least 1 criterion $c_j^{(i)}$ (from a given set C_i) signals the presence of nfi ($\exists j : c_j^{(i)} \rightarrow nfi$).

First, it is necessary to form a set of criteria $C_i = \{c_j^{(i)} | j = \overline{1, z}\}$, which, in turn, are considered as indicators of the presence of ignorance in the analyzed data (knowledge) set.

For identification the above forms of ignorance (and their combinations), it is proposed to use the following features:

1. The structure of expert evidence.

The level of conflict.

Indicators of the quality of the received evidence: level of auto-conflict; the degree of specificity of the generated evidence, etc.

The degree of inconsistency of the formed expert evidence.

Limitations which are imposed on the frame of discernment A.

The next step is to form a system of decision rules $SR_i = \{R_l^{(i)} | l = \overline{1, h}\}$ for analyzed forms of ignorance identification.

Based on the formed decision rules $R_l^{(i)}$, a rule for choosing a method for modeling the above forms of ignorance (and their combinations) can be obtained:

$$B_j \in \begin{cases} P_1, & \text{if } \forall l: R_l^{(i)} \rightarrow \text{absence } nf_i; \\ P_2, & \text{if } \exists l: R_l^{(i)} \rightarrow nf_i; \end{cases}$$

where P_1 indicates that expert evidence are no contradict, have a high (acceptable) quality, and consistent; P_2 indicates that expert evidence have a high (not acceptable) level of conflict.

If $B_j \in P_1$, then it is assumed that the expert evidence are consistent (they are characterized by close evidence, the presence of a low / insignificant level of conflict), and may indicate a high (acceptable) quality of expert evidence.

In this case, evidence combination rules can be used to find the aggregate expert assessments formed in frame of DS or DSm model [1–4]. The algorithm for the complex use of evidence combination rules for aggregation of expert assessments formed in frame of DS model has been proposed.

Let a set of $P = \{P_i | i = \overline{1, k}\}$ potential combination rules be given. It is proposed to choose a rule $P \in P$, $m_{combP} = m_i P m_j$, that minimizes the value of the total uncertainty of the combined bpa 's $\min(T(m_{combP}))$.

Formally, the procedure for choosing a combination rule can be represented as next successive stages. At the first stage, from the set of available combination rules $P = \{P_i | i = \overline{1, k}\}$, a subset $P' \subseteq P$ is selected that satisfies a set of specified criteria $C = \{c_i | i = \overline{1, q}\}$.

The analysis model (DS model, DSm model), information about expert's competence, information about conflicts, degree of interaction and the structure of expert evidence can be considered as criteria for choosing a combination rule. Recommendations for the selection of combination rules based on the analysis of a number of criteria are given in [1, 5]. As a result, the initial set $P = \{P_i | i = \overline{1, k}\}$ will be narrowed down to subset $P' = \{P_i | i = \overline{1, z}\}$, $z \leq k$, that obtained by excluding from the set P , rules that do not satisfy the formed set of criteria

The choosing the combination rule based on the analysis of quantitative characteristics of uncertainty has done on the second stage.

At first, the combination rule $P_l \in P'$ is selected that maximizes the value of measure that reflects the degree of specificity of the combination result $\max(\delta_s(m_i P_l m_j))$, $\delta_s(m_i P_l m_j) \neq 1$.

Next, the combination rule $P_r \in P'$ is selected that minimizes the value of the measure that reflects the degree of contradiction of the combination result $\min(Contr(m_i P_r m_j))$, $Contr(m_i P_r m_j) \neq 0$.

If $P_l \neq P_r$, then a combination rule is selected that satisfies the following condition:

$$P = \begin{cases} P_l, & T(m_i P_l m_j) < T(m_i P_r m_j); \\ P_r, & T(m_i P_l m_j) > T(m_i P_r m_j), \end{cases}$$

where T is a measure of global uncertainty.

If $B_j \in P_2$, then it was revealed that there is inconsistency (conflict) of expert evidence, which indicates the presence of several subgroups of experts with similar

assessments, or the presence of so-called dissident experts (one or more experts with estimates significantly different from those of the main group).

As a result, three tasks arise:

1. Identification and exclusion of conflicting (contradictory) evidence (experts).

Partitioning (clustering) of the original set of expert evidence into homogeneous (with an acceptable level of conflict) subgroups.

Aggregation of conflicting (contradictory) evidence in order to develop a group assessment.

The next step is to determine the nature of the task of expert assessments structuring and the choice of the mathematical formalism for the analysis of expert assessments. If the absence of ignorance type nfi (or its combinations) is confirmed, then the procedure for structuring the set of expert assessments is reduced to solving the problem of finding an aggregated (generalized) expert assessment. If the analysis reveals the presence of nfi (the set of expert assessments is characterized by low consistency, or inconsistency of assessments), then the procedure for structuring the set of expert assessments is reduced to solving the problem of partition the expert group into several subgroups (clusters) of experts with close (agreed, consistent, homogenous) assessments, for their subsequent analysis and search for an aggregated estimate within each of the selected subgroups.

The final stage is the interpretation of the results of structuring and the development of a group solution.

The proposed technology is designed to solve the problem of analysis (ranking, clustering, ranking clusters) of group expert assessments under multi-criteria, multi-alternativeness and complex forms of ignorance (uncertainty, inaccuracy, inconsistency, conflict) in order to synthesis a final (generalized) assessment that takes into account opinions (arguments) of each expert.

References

1. K. K. Annamdas, Evidence based uncertainty models and particles swarm optimization for multiobjective optimization of engineering systems, Ph.D. thesis, University of Miami, Coral Gables, Florida, 2009.
2. A. Shved, I. Kovalenko, Y. Davydenko, Method of detection the consistent subgroups of expert assessments in a group based on measures of dissimilarity in evidence theory, in: N. Shakhovska, M. Medykovskyy (Eds.), Advances in Intelligent Systems and Computing IV, CCSIT 2019, Advances in Intelligent Systems and Computing 1080, Springer, Cham, 2020, pp. 36–53.
2. F. Smarandache, J. Dezert, Representation of DSmT, in: Advances and Applications of DSmT for Information Fusion, volume 1, American Research Press, Rehoboth, 2004, pp. 3–35.
3. F. Smarandache, J. Dezert, Advances and applications of DSmT for information fusion. Collected works, volume 2, American Research Press, Rehoboth, 2006.
4. F. Smarandache, Unification of Fusion Theories (UFT). International Journal of Applied Mathematics and Statistics 2 (2004): 1–14.

¹ Borys Kredentser

Doctor of technical science, professor, professor of the Department of "Construction of telecommunication systems"

² Dmytro Mogylevych

Doctor of technical science, professor, professor of the Department of Information and Telecommunication Networks

³ Iryna Kononova

Candidate of technical sciences, associate professor of the Department of Information and Telecommunication Networks

⁴ Vadym Mohylevych

Student

¹ Military Institute of Telecommunications and Informatization named after Heroes Krut

^{2,3} The Institute of Telecommunication Systems of the National Technical University of Ukraine "Kyiv Polytechnic Institute"

⁴ Taras Shevchenko National University of Kyiv

ANALYTICAL MODEL WITH INTERRUPTION OF SERVICE OF SHORT-TERM OBJECTS WITH TEMPORARY RESERVATION

Abstract. The article presents an analytical model for the maintenance of short-term facilities with temporary redundancy, which are used not continuously, but occasionally. These systems perform tasks that arrive at random times and take some time to complete. Examples of such systems are communication systems as well as various automated control systems. In the developed model, various factors of the real functioning of this class of systems are taken into account.

Keywords: information and communication networks, refusal, failure, readiness index, reliability index.

The article a method is proposed for determining the optimal maintenance frequency and extreme values of the indicators of the systems under consideration: a complex reliability indicator – the coefficient of technical utilization and a cost indicator – the average costs per unit time of the object's stay in a working condition (average unit costs).

The need for maintenance arises at the stage of operation of any technical system. The main purpose of maintenance is to ensure the maximum efficiency from the usage of the system during operation. This goal can be achieved by purposeful intervention in the functioning of the system through a rational choice of the type of maintenance, justification of the optimal timing and content of maintenance. Therefore, the solution to the problem of optimal maintenance, in which the extreme values of the selected indicators are provided, is relevant.

Consider a system with a replenishment reserve of time (system "object-time"), in which an object is represented by one generalized structural element. Let the operating time of an object to failure t_0 be distributed according to an arbitrary law

$F(t) = P\{t_0 < t\}$ with a finite mathematical expectation \bar{t}_0 , and a failure manifests itself at the moment of its occurrence (a system with instant indication of failures).

The system performs tasks arriving at random moment of time, and the time intervals between the times of arrival are distributed exponentially with a parameter γ_f . We will assume that the duration of the task is so short in comparison with the average operating time of the object to failure that it can be practically neglected (short-term system). This means that if an incoming task finds the system in a working state, then it is executed with a probability of one.

Suppose that at the initial moment of time $t = 0$ the object is operational and a scheduled preventive maintenance is assigned at a deterministic time T , which determines the frequency of maintenance. Before the start of service execution, one of two independent events can occur: object failure or task arrival. Let the object fail first. In this case, the restoration of its performance immediately begins, the duration of which is a random variable t_R , distributed according to an exponential law with a parameter μ and a finite mathematical expectation $\bar{t}_R = 1/\gamma_z$. If a task is received during the recovery process, then a delay (delay) in its execution for a time τ_a is allowed, which can be a random variable, exponentially distributed with a parameter γ , or a deterministic value $\tau_a = \text{const}$. If the restoration of the object's operability is completed before the use of the time reserve τ_a (or t_a) that determines the permissible lag time, then the task is executed with probability one, otherwise, at the moment the condition $t_R > \tau_a$ (or $t_R > t_a$) is fulfilled, the system fails (task execution failure).

Let the object fail until the moment T (an event $t_0 > T$ has occurred). Then, at the appointed time T , maintenance starts, the duration of which is exponentially distributed with a parameter Θ . If a task arrives in the process of servicing, then servicing is terminated and the object is transferred to the main (operating) mode in a random time t_z , exponentially distributed with a parameter γ_z . At the same time, the system provides for a permissible time for bringing an object to readiness to perform a task τ_{a1} , which can be a random variable with an exponential distribution law with a parameter γ_1 or a deterministic value $\tau_{a1} = \text{const}$. If $t_z < \tau_{a1}$ (or $t_z < t_{a1}$), then the received task is executed with probability one, after which the object is transferred to the maintenance completion mode. Otherwise (at $t_z > \tau_{a1}$ or $t_z > t_{a1}$) at the moment when the time reserve is used up, the system malfunctioning (refusal to complete the task) occurs.

Thus, the system uses two components of the replenished reserve of time: one component is provided in the system itself (τ_a and τ_{a1} or t_a and t_{a1}), and the other is due to the random nature of the arrival of tasks (the time from the moment of object failure or the start of maintenance to the moment the task is received).

It is necessary to obtain analytical expressions for the service quality indicators: technical usage coefficient $K_u(T)$ and average unit costs $\bar{C}(T)$ (objective functions) and determine the optimal values of the service frequency T^* and T_1^* , at which the

quality indicators take extreme values: the maximum value $K_{uu}(T^*)$ for the technical utilization factor and the minimum value $\bar{C}(T_1^*)$ for the average unit costs.

The studies carried out and the results obtained allow us to draw the following conclusions:

For the same values of the time for performing maintenance and restoring the object's operability $\mu/0=1$, the considered maintenance strategy provides a sufficiently high efficiency of the types of restoration work used, and the value of the technical utilization factor depends significantly on the ratio of parameters $\gamma_z t_{a1}$, γ_f/μ , γ_f/γ_z , that determine the amount of time reserve and the efficiency of its use.

In particular, it can be seen that an increase in the intensity γ_z of the transfer of the object from the maintenance mode to the main mode (with an increase in $\gamma_z t_{a1}$ and $t_{a1} = \text{const}$) by only two times leads to a significant increase in the efficiency of maintenance. This is due to the fact that with an increase in $\gamma_z t_{a1}$ system downtime due to maintenance, they are more and more compensated for by the time reserve existing in the system, while the amount of downtime compensation when restoring the object's operability does not change.

In the case when the value $\lambda T \rightarrow \infty$ (at $\lambda = \text{const}$), in the system, only the restoration of operability after failures is carried out and coefficient of technical usage asymptotically tend to the value of the stationary availability factor of the system K_h in which maintenance is not carried out.

The value of the technical utilization coefficient is also significantly influenced by the failure rate λ of the object under consideration.

References:

1. NSU 2860-94, Reliability of technology Terms and definitions, 1995. URL: http://ksv.do.am/publ/dstu/dstu_2860_94/3-1-0-1102.
2. W. Ahmad, O. Hasan, S. Tahar, Formal reliability and failure analysis of ethernet based communication networks in a smart grid substation, Formal Aspects of Computing, (2020) 71–111. doi: 10.1007/s00165-019-00503-1.
3. D. Mogilevich, I. Kononova, Improved Estimates for the Reliability Indicators of Information and Communication Network Objects with Limited Source Information, Springer Nature Switzerland (2019) 101–117. doi:10.1007/978-3-030-16770-7_5.
4. Hall, P., Jin, Y. and Samaniego, F. J. Nonparametric estimation of component reliability based on failure-time data from systems of varying design, Statistica Sinica (2015) 1313 – 1335. doi: 10.5705/ss.2014.092
5. T. Zin, J. Lin, J.-S. Pan, P. Tin, M. Yokota Reliability Specification of Telecommunication Networks Based on the Failure Influence by Using Evolutional Algorithm, Genetic and Evolutionary Computing, Springer International Publishing Switzerland (2016) 115-126. doi: 10.1007/978-3-319-23207-2_12.

Alexander Makarenko

Doctor of Science, Professor

*Institute of Applied System Analysis at National Technical University Igor Sikorski
Kiev Polytechnic Institute*

CELLULAR AUTOMATA MODELS WITH RIEMANN SURFACES

Abstract. New class of mathematical models for computation theory is considered – namely cellular automata (CA) with branching transition functions. The key point is possible multivaluedness of transition functions. Some cases with complex-value functions had been considered. The case of continuous-valued CA and their finite-valued approximations are discussed.

Keywords: Cellular automata, complex functions, Riemann surfaces, continuous-valued CA, branching, computations

1. Introduction

Typically, classical cellular automatic machines (CA) have a cell assembly structure with a certain set of possible states. The states change at discrete points in time according to certain rules. Up to now, as far as we know, these dynamic rules have been defined using unambiguous transition functions. Recently, there has been a need to investigate CA with multi-valued transition functions [1]. Further study of such new CA (with multivaluedness) depends on examining specific examples of such objects. In this paper, we propose complex-valued cellular automata with a branched (multi-valued) structure with values on the Riemann surface. CA with the location of cells on the Riemann surface are also considered.

2. One-dimensional case

In this paragraph we will illustrate the simplest cases.

2.1 One branching point where branching conditions are not met for any point (e.g. all values during evolution are on the same branch of a function, e.g. on a function $\sqrt{\varphi}$ branch. Then the branching point is the only point, but let the CA values be outside the vicinity of the branching point. This corresponds to the class of unambiguous CA, but with certain generalizations. Namely, in our general case, CA looks like

$$x_i^{n+1} = \varphi(\{x_i^n\}_N; \vec{\alpha}) \quad (1)$$

x_i^n - state value of i cell at n moment of time ($n = 0, 1, 2, \dots$). In the case of classic CA, such as a game of life, the state of the cell is 0 or 1. In our case, the complex function φ , $x_i^n \in M, M \subset C^1$ where M - some subset of the space of complex numbers.

Here we represent the evolution of the values of one cell. Note that just in such case we have essential difference from the classical case. We can assume a whole set of values M , including $\text{card}M = \infty$, when a continuum of values is also allowed. Note that in general case it is possible to consider approximations of a continuum set M using a discrete set $M_K \subset M$ with a finite number K of possible cell values. An interesting task

is the rigorous mathematical study of the applicability of such approximation, as well as the crystallization of the approximation.

2.2 A more complicated case is when the branching point of the transition function appears in the value range for only one cell. A simpler case appears to be implemented for the function $\sqrt{\varphi}$ presumably with no jumps between branches, which requires further research. In this case, the idea of approximation with a finite set of values by branches can also be applied.

However, for arbitrary analytical functions with a large number of branches (or even an infinite number of branches) the problem is more complex. In this case, all studies on the limit behavior of CA remain valid. But, limit behavior must be investigated for a multi-valued case, for which the theory of multi-valued dynamic systems should be involved. Along the way, we will point out another new class of research problems. For traditional cellular automata (including the game of Life) we can set the following problem: according to the well-known rules of CA, to find CA with a complex-valued transition function such that traditional CA is an approximation of complex-valued CA. In this case, it is possible to raise the problem of studying traditional CA. Probably, the function $\sqrt{\varphi}$ can only evolve over two branches independently of each other (without jumping from branch to branch).

This creates a whole new set of problems associated with finding special function φ . The first class of problems is related to the construction related to a specific CA (including traditional ones). Then it is necessary to simplify problem definition and achieve only the proximity of a given CA solution with a certain complex function $\bar{\varphi}$ at a certain time range $[0, T]$. It is also possible to use functions φ with an infinite number of branching points. It is also important to construct a function with given branching points so that these branching points set a fixed behavior of the solution or at least approximate the required behavior of a multi-valued solution on a certain range.

2.3 Set out in pp. 2.1-2.2, it is easy to generalize for other problems as well. Thus, nothing limits the transfer from the case of 1D space with only one branching point in one cell to the case of possible branching points in each cell of the cell space. Everything said above is carried over to the case of 2D, 3D, ..., ND spaces. But it is also possible to generalize the very concept of cellular automata. Thus, it is possible to consider cell automata on Riemann surfaces. A particular problem is the study of the dependence of the dynamics of CA on the topology of the space in which CA is given.

By the way, the transition from CA with a continuum of possible values to approximations of finite sets correlates with the study of continuous dynamical systems with the methods symbolic dynamics in ergodic theory.

Thus in proposed paper we had been introduced new class of cellular automata with presumable multivaluedness. New research problems are proposed.

References:

1. Makarenko A. Multivaluedness in cellular automata with strong anticipation and prospects for computation theory. WSEAS Transactions on Information Science and Applications. 2020. Vol. 17. Pp. 69-79.

¹ Volodymyr Polishchuk

PhD, Associate professor of department of Software Systems

² Mykola Malyar

Doctor of Engineering Science, Professor, Professor of department of cybernetics and applied mathematics

³ Andriy Polishchuk

PhD student of department of cybernetics and applied mathematics

¹⁻³ Uzhhorod National University, Narodna Square, 3, Uzhhorod, 88000, Ukraine

THE TECHNOLOGY FOR DETERMINING THE LEVEL OF PROCESS CONTROL IN COMPLEX SYSTEMS

Abstract. A study of the current problem of developing technology for determining the level of process controllability in complex systems, with different modes of operation was done. In this investigation for the first time was proposed a fuzzy mathematical model based on expert hybrid data, using linguistic and quantitative variables.

Keywords: process controllability, fuzzy set, decision-making, modes of system operation.

Information systems and technologies are increasingly replacing intellectual ones, but the desire to represent the future does not disappear. At the present stage of human development, there is an increasing desire to control the processes in the world. Tools for analyzing massive data sets, today allow you to get new, high-quality knowledge from various information. The amount of data is growing rapidly in all areas, with them there is a need for processing, which is reduced to obtaining knowledge, on the basis of which further decisions are made. Such technologies make life more comfortable, more stable, smarter, and most importantly safer.

Today, decision support systems are increasingly using data mining tools. But most of them are designed to make decisions in the safe mode of operation of systems. For conditions where the system is rapidly changing modes from safe operation, emergency to disaster, most decision support models are not able to adequately assess the situation. Proof of this is the work of the municipality, region, state in the conditions of, for example, a pandemic of coronavirus infection (COVID-19).

Every day, due to various circumstances, extraordinary situations occur that lead to material destruction, threat to health or life. Often through the fault of decision-maker, making the wrong management decisions. Management decisions directly affect the safe state of the system environment. Sometimes decision-maker try to control processes in complex systems without suspecting that process control is very low or non-existent. There are circumstances that do not depend on people. However, there is our desire to know whether we can influence certain processes. There are events that we cannot change, but we must work to anticipate them.

At a time when a complex system is moving from a safe mode of operation to a catastrophe, the situation is changing rapidly, the controllability of processes is

declining, the data influencing decision-making are becoming increasingly vague. Any emergency or catastrophe is the end result of a consistent transition of the normal mode of operation of the system, respectively, in an emergency or catastrophic situation.

Confirmation of the above is illustrated by the following example. The investigation of the plane crash shows what factors and influences accompanied the events of the crash. The conclusion of the causes of the crash indicates whether the accident situation depended on the pilots, the technical condition of the vessel, weather conditions and the possibility of avoiding the accident. The factors of the internal condition of the aircraft, the influence of the external environment, the actions of pilots in an emergency situation and human factors in the management of air traffic are indicated. In other words, the assessment of process controllability in a complex ship piloting system is indicated. And most importantly, the International Civil Aviation Organization is taking clear steps to prevent similar situations in the future.

The above, argues and confirms the relevance of our study on the application of intelligent analysis, systems approach, processing fuzzy data to develop technology to assess the level of process control in complex systems from normal to disaster. The relevance of this study proves the need to understand the controllability of processes in different objects of study and different modes of operation, for sustainable operation of systems, achieving its goals, formalization of such processes, especially in a pandemic COVID-19.

The logic of the study is as follows: if the overall assessment of the system is high, the factors influencing the control processes for the appropriate mode of operation, then we can talk about a high level of process control in the system, and competent management decisions will achieve the goals of the system. ensure the appropriate level of security of the system operation environment.

The logic of the study is as follows: if the overall assessment of the system is high, the factors influencing the control processes for the appropriate mode of operation, then we can talk about a high level of process control in the system, and competent management decisions will achieve the goals of the system. ensure the appropriate level of security of the system operation environment.

Let it be known some object of study that we will consider as a complex poorly structured system S . There are many known system goals and many factors that affect the controllability of complex systems. Also known are the indicators of the system that allow to quantify or qualitatively assess the property of the system. Fuzzy models of system evaluation are built on the basis of known indicators. Within this, it is necessary to assess the controllability of processes in the object of study for quality decision-making depending on the modes C : regular situation, out of the regular mode, critical situation, emergency, accident situation, accident, catastrophic situation, catastrophe.

Suppose we have a set of indicators K , according to which we will assess the level of process control in a complex system S . Indicators can be a whole system of criteria, factors and models, based on which a single aggregate assessment is derived. For example: the level of control of the aircraft is influenced by indicators that depend on the factors of the technical condition of the aircraft, external conditions, human factors and risk-oriented situations; the level of safe financing of innovative projects is

influenced by factors of the microenvironment of the project (strength of the idea), environmental factors (competitors, market, policy), factors of risk management and anticipation, and the main level of project developers.

Formally, we can present a fuzzy model for determining the level of process control in complex systems, taking into account the different modes of operation as follows:

$$A(I; M; C) \rightarrow R(\mu), \quad (1)$$

A – an operator that matches a set of output values R , with input variables $I; M; C$. The input data of the model are: I – expert indicator or quantitative assessment of the level of process control in the system, or a combination thereof; M – taking into account the reasoning of the decision-maker on the scenario of unfolding events; C – system operation mode. At the output of the evaluation model we have: μ – assessment of process control in complex systems taking into account different modes of operation on the basis of which the level is determined R .

As a result of the study, the following results were obtained for the first time:

- ✓ a fuzzy mathematical model for determining the level of process control in complex (weakly structured) systems taking into account different modes of operation, based on expert hybrid data, using linguistic and quantitative variables has been proposed. The estimates of the indicators of a complex system are aggregated in relation to the decision-maker reasoning about the scenario of events. One aggregate estimate of the level of process control in a complex system with respect to different modes of operation is derived. Based on the obtained result, can be determined the level of safe operation of the system to prevent negative consequences or confidence in achieving the goals of the system. All this allows to reveal the uncertainties of expert opinions and data obtained, justifying the degree of decision-making and to draw adequate conclusions, taking into account the different modes of operation;
- ✓ experimental testing of the conducted research in the task of determining the level of process control in the airport management's information systems, with data security threats, taking into account different modes of operation was done. A web application was created for the developed model, with the help of which you can configure models and conduct experimental research for various application tasks.

The rationality of the obtained aggregate estimates, the level of safe state to prevent negative consequences of the system, or the confidence of achieving the goals of the system in different modes of operation, proves the advantages of the developed model. The reliability of the obtained results is ensured by the correct use of intellectual analysis of knowledge, system approach, fuzzy set theory, which is confirmed by research results.

¹ Volodymyr Rusyn

PhD, Assistant Professor of Department of Radio Engineering and Information Security

² Aceng Sambas

Lecturer of Department of Mechanical Engineering

¹ Yury Fedkovych Chernivtsi National University

² Universitas Muhammadiyah Tasikmalaya, Jl. Tamansari No. KM 2,5, Mulyasari, Kec. Tamansari, Tasikmalaya, Jawa Barat, 46196, Indonesia

CIRCUIT REALIZATION OF THE PULSE TRANSFORMATION OF THE ANALOG NONLINEAR SIGNALS BASED ON CHUA'S GENERATOR

Chaotic signals have the following characteristics: sensitive dependence on the initial conditions, unpredictability, similarity to the noise, and difficulty to be deciphered. Therefore, it is especially suitable to be applied to the secure communication field [1-3]. In this paper, the pulse transformation of analog nonlinear signals is presented. Classical Chua's chaotic generator as a main part that generate nonlinear signals was used for demonstrate of this process. Electronic circuit and components with nominal values are presented. MultiSim software environment was selected for analysis and demonstrate of computer modelling results.

The electronic circuit is displayed in Fig. 1, with component values: capacitors C1 = 100 nF, C2 = 10 nF, diodes VD1, VD2 – 1N4148, DA1, DA2 – operational amplifier TL082, powered by a 9 V, VCC1 – +5 V, one transistor VT1 – 2N2222A, inductor L1 = 18 mH, voltage sources V1 = V2 = 9 V, potentiometer R1 = 2 k Ω (1.7 k Ω), resistors R2 = 1 k Ω , R3 = 3.3 k Ω , R4 = 47 k Ω , R5 = 3.3 k Ω , R6 = 1 k Ω , R7 = 5.6 k Ω , R8 = 1 k Ω , R9 = 47 k Ω , R10 = 2.2 k Ω , R11 = R12 = 290 Ω , R13 = 1.2 k Ω .

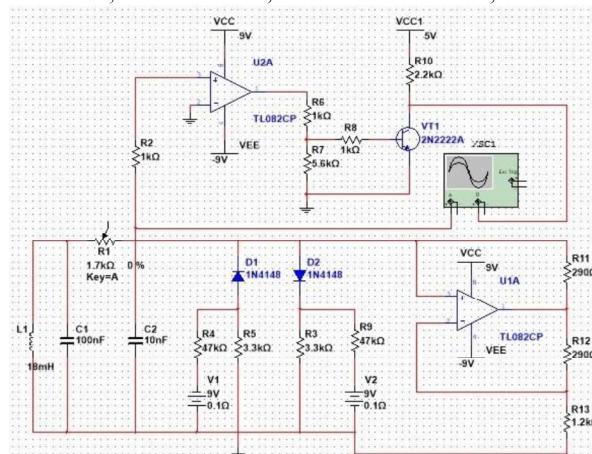


Figure 1 – Circuit realization of the process of pulse transformation

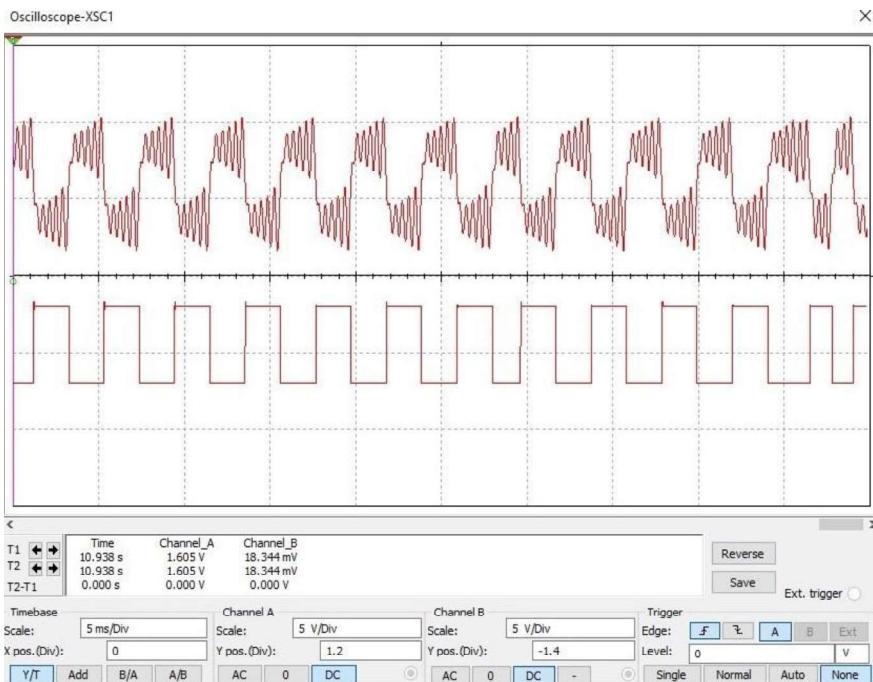


Figure 2 – Time series and pulse transformation

Fig. 2 shows time series and pulse transformation for chaotic coordinate X. The simulation parameters for Fig. 2: U1 = 5 V/div, U2 = 5 V/div, time scale 2 ms/div.

References:

1. Sambas A., Sanjaya WS. M., Mamat M., Putra Prastio R., Azar A.T. (2016) Mathematical modelling of chaotic jerk circuit and its application in secure communication system. Studies in Fuzziness and Soft Computing. Vol. 337, 133-153.
2. Sambas, A., Sanjaya, M. WS, Mamat, M., Diyah, H. (2013) Design and analysis bidirectional chaotic synchronization of rossler circuit and its application for secure communication. Applied Mathematical Sciences, Vol 7(1), 11-21.
3. Rusyn, V., Mohamad, M.A., Purwandari, D., Mamat, M., Titaley, J., Pinontoan, B. (2020) Chaotic and Controlling Regimes of a New Modified Chua's Generator. Journal of Advanced Research in Dynamical & Control Systems, Vol. 12, Issue 02, 556-561.

¹ **Vladimir Semenov**

D. Sc., Professor

² **Yana Vedel**

PhD student

^{1,2} Taras Shevchenko National University of Kyiv

CONVERGENCE OF ADAPTIVE METHODS FOR EQUILIBRIUM PROBLEMS IN HADAMARD SPACES

Abstract. We study and describe two new adaptive two-stage proximal algorithms for the approximate solution of equilibrium problems in Hadamard spaces. For pseudomonotone bifunctions of Lipschitz type, theorems on the weak convergence of sequences generated by the algorithms are proved. A new regularized adaptive extraproximal algorithm is also proposed and studied.

Keywords: Equilibrium problems, Hadamard space, adaptability, convergence, regularization, extraproximal algorithm.

In the talk based on works [1-3], we study and describe two new adaptive two-stage proximal algorithms for the approximate solution of equilibrium problems in Hadamard spaces. The proposed rules for choosing the step size do not calculate the values of the bifunction at additional points and do not require knowledge of the Lipschitz constants of the bifunction. For pseudo-monotone bifunctions of Lipschitz type, theorems on the weak convergence of sequences generated by the algorithms are proved. The proofs are based on the use of Fejer properties of algorithms with respect to the set of solutions to the problem.

A new regularized adaptive extraproximal algorithm is also proposed and studied. To regularize the adaptive scheme, the classical Halpern scheme was used, a version of which for Hadamard spaces was studied in [4].

Let (X, d) be a Hadamard space. For a non-empty convex closed set $C \subseteq X$ and bifunction $F : C \times C \rightarrow \mathbb{R}$ we consider an equilibrium problem:

$$\text{find } x \in C: F(x, y) \geq 0 \quad \forall y \in C. \quad (1)$$

We assume that the following conditions are satisfied:

- $F(x, x) = 0$ for all $x \in C$;
- functions $F(x, \cdot) : C \rightarrow \mathbb{R}$ convex and lower semicontinuous for all $x \in C$;
- functions $F(\cdot, y) : C \rightarrow \mathbb{R}$ are weakly upper semicontinuous for all $y \in C$;

- bifunction $F : C \times C \rightarrow \mathbb{R}$ pseudomonotone, that is for all $x, y \in C$ from $F(x, y) \geq 0$ it follows that $F(y, x) \leq 0$;
- bifunction $F : C \times C \rightarrow \mathbb{R}$ Lipschitz type, that is, there are two constants $a > 0$, $b > 0$ such that for all $x, y, z \in C$

$$F(x, y) \leq F(x, z) + F(z, y) + ad^2(x, z) + bd^2(z, y).$$

We denote set of solutions for (1) by S . In what follows, we will assume that $S \neq \emptyset$.

Let's describe one of the algorithms.

Algorithm 1. Adaptive version of the extraproximal algorithm.

Initialization. Choose element $x_1 \in C$, $\tau \in (0, 1)$, $\lambda_1 \in (0, +\infty)$. Assume $n = 1$.

Step 1. Calculate

$$y_n = \text{prox}_{\lambda_n F(x_n, \cdot)} x_n = \arg \min_{y \in C} (F(x_n, y) + \frac{1}{2\lambda_n} d^2(y, x_n)).$$

If $x_n = y_n$, then stop and $x_n \in S$. Otherwise, go to step 2.

Step 2. Calculate

$$x_{n+1} = \text{prox}_{\lambda_n F(y_n, \cdot)} x_n = \arg \min_{y \in C} (F(y_n, y) + \frac{1}{2\lambda_n} d^2(y, x_n)).$$

Step 3. Calculate

$$\lambda_{n+1} = \begin{cases} \lambda_n, & \text{if } F(x_n, x_{n+1}) - F(x_n, y_n) - F(y_n, x_{n+1}) \leq 0, \\ \min \left\{ \lambda_n, \frac{\tau}{2} \frac{d^2(x_n, y_n) + d^2(x_{n+1}, y_n)}{F(x_n, x_{n+1}) - F(x_n, y_n) - F(y_n, x_{n+1})} \right\}, & \text{otherwise.} \end{cases}$$

Set $n := n + 1$ and go to step 1.

Algorithm 1 converge weakly. To ensure the convergence of the approximating sequences in the metric of the space to the solution of the equilibrium problem (1), we considered algorithm 1, regularized using the Halpern scheme [4], with adaptive choice of the step size.

Algorithm 2.

Initialization. Choose elements $a \in C$, $x_1 \in C$, values $\tau \in (0, 1)$, $\lambda_1 \in (0, +\infty)$ and sequence (α_n) such that $\alpha_n \in (0, 1)$, $\lim_{n \rightarrow \infty} \alpha_n = 0$, $\sum_{n=1}^{\infty} \alpha_n = +\infty$. Set $n = 1$.

Step 1. Calculate

$$y_n = \text{prox}_{\lambda_n F(x_n, \cdot)} x_n.$$

Step 2. Calculate

$$z_n = \text{prox}_{\lambda_n F(y_n, \cdot)} x_n.$$

Step 3. Calculate

$$x_{n+1} = \alpha_n a \oplus (1 - \alpha_n) z_n.$$

Step 4. Calculate

$$\lambda_{n+1} = \begin{cases} \lambda_n, & \text{if } F(x_n, z_n) - F(x_n, y_n) - F(y_n, z_n) \leq 0, \\ \min \left\{ \lambda_n, \frac{\tau}{2} \frac{d^2(x_n, y_n) + d^2(z_n, y_n)}{F(x_n, z_n) - F(x_n, y_n) - F(y_n, z_n)} \right\}, & \text{otherwise.} \end{cases}$$

Set $n := n + 1$ and go to step 1.

We plan to consider more special versions of algorithms for variational inequalities and minimax problems on Hadamard manifolds (for example, on the manifold of symmetric positive definite matrices).

This work was supported by Ministry of Education and Science of Ukraine (project “Mathematical modeling and optimization of dynamical systems for defense, medicine and ecology”, 0219U008403).

References:

1. Y.I. Vedel, G.V. Sandrakov, V.V. Semenov, L.M. Chabak, Convergence of a Two-Stage Proximal Algorithm for the Equilibrium Problem in Hadamard Spaces, Cybernetics and Systems Analysis. 56 (2020) 784–792. doi:10.1007/s10559-020-00299-6.
2. Y.I. Vedel, V.V. Semenov, Adaptive algorithms for equilibrium problems in Hadamard spaces, Dopov. Nac. akad. nauk Ukr. (2020). doi:10.15407/dopovidi2020.08.026.
3. Ya.I. Vedel, S.V. Denisov, V.V. Semenov, Algorithm for variational inequality problem over the set of solutions the equilibrium problems, Journal of Numerical and Applied Mathematics. (2020) No. 1 5–17.
4. M. Bacak, Convex Analysis and Optimization in Hadamard Spaces, De Gruyter, Berlin, 2014.

¹ Valentyn Sobchuk

Doctor Engineering Sciences, Professor of Department of Higher Mathematics

² Yuliya Olimpiyeva

Senior Lecturer of Department of Higher Mathematics

³ Andrii Musienko

Doctor Engineering Sciences, Associate Professor Department of Design Automation for Energy Processes and Systems

⁴ Andrii Sobchuk

graduate student of the Department of Information and Internet Technologies

^{1,2} State University of Telecommunications

³ National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

⁴ Taras Shevchenko National University of Kyiv

ENSURING THE PROPERTIES OF FUNCTIONAL STABILITY OF MANUFACTURING PROCESSES BASED ON THE APPLICATION OF NEURAL NETWORKS

Most of the systems that modern science explores are complex. They form multilevel structures. The functioning of such systems is not described by the usual sum of interactions of their elements. Complex technical systems (CTS) are built to perform certain special tasks. The development of artificial systems leads to the complication of their functioning and the emergence of new properties, such as functional stability. [3-5]. Many modern studies in the field of functional stability of complex technical systems and in the field of artificial intelligence require in-depth analysis of the results and the possibility of their implementation in order to build functionally stable information systems. These information systems use artificial intelligence algorithms to diagnose the state of the system and maintain its functioning in accordance with its main purpose for the required period of time.

Of particular interest for our research are the properties of systems that ensure the possibility of their functioning when internal and external parameters change. The property of functional stability is the ability of the system to adapt to new and not always taken into account situations, to withstand any internal or external influences, while realizing its target function. The main task is to increase functional stability and, as a consequence, reliability through the use of various types of redundancy (functional, algorithmic, technical, topological, and temporary), and organizing it in the form of duplicate or majority structures. One of the methods the reliability theory offers to improve the quality of technical systems functioning is to ensure fault tolerance.

Technological production processes to ensure the achievement of parameters $x(i)$ at each stage require external influences on the production process – $u(i)$ (active effect, energy effect, chemical or other technological impact at each stage).

It is clear that the final quality of the product as well as the intermediate quantity at each stage depend on tight adherence to technology and ensuring control over the necessary parameters at each previous step. Next, we assume that this a priori requirement is met.

Denote:

$A(i)$ – matrix of product quality indicators dependence on $(i + 1)$ -st stage on indicators on i stage, actually matrix of production process;

$C(i)$ – a matrix that determines the structure of influence on the production process $u(i)$.

Then the mathematical model of the technological process, provided by the information systems of the production enterprise, can be written as follows

$$\begin{aligned} x(i+1) &= A(i)x(i) + C(i)u(i), \quad i = 1, 2, \dots, N \\ x(i) &\in \mathbb{R}^n, \quad A(i) \in \mathbb{R}^{n \times n}, \quad C(i) \in \mathbb{R}^{n \times m}, \quad u(i) \in \mathbb{R}^m. \end{aligned} \quad (1)$$

Where $x = (x_1, x_2, \dots, x_n)^T$ – state vector of dimension n , $u = (u_1, \dots, u_m)^T$ – the control vector has dimension m , $A(t)$ – $n \times n$ – matrix, $C(t)$ – $n \times m$ – matrix, $t = 0, 1, \dots, N - 1$. Denote by $I_N = \{0, 1, \dots, N\}$; $x(t, x_0, u)$ system solution, $t \in I_N$ when managing $u(t)$, $t \in I_{N-1}$.

When automating such processes in practice, it is necessary to set certain management tasks that actually describe the design conditions of the control function u , which provides controlled purposeful execution of the process. The main task is to consider the search for the control function u , which ensures the execution of the process, so that the result of the process provides the final production in $x(N)$ products that meet all the quality characteristics required by current standards. If at the end of the process the product has deviations from the specified standard parameters, then such deviations are guaranteed to fall into the set of permissible tolerances, which are defined by the current standards for such products. Mathematically, this means that there is a desired final state x_N and a positive parameter $\varepsilon > 0$ such that

$$\|x(N) - x_N\| < \varepsilon.$$

Let $\bar{x} = (\bar{x}(0), \bar{x}(1), \dots, \bar{x}(N))^T$ — reference process. The reference process guarantees full compliance with the set of parameters $x(k)$, $k = 0, 1, \dots, N$, which should be followed in the ideal execution of the production process at all stages and at each of the links. This is a certain median value, which simultaneously assumes the presence of an a priori set of permissible deviations of the system parameters. The parameter $\varepsilon > 0$ is set, which determines the set of permissible deviations (tolerances) from the reference values.

Definition. If for the data of matrices A , C and vector u there exists a solution $x = \bar{x} + e$ of system (7) such that $\|e\| \leq \varepsilon$, then such a technological process will be called functionally stable.

A valid theorem.

Theorem. Let the condition be fulfilled

$$u^T Qu = 0,$$

where $Q = C^T Z(A^T)C$, $Z(A^T) = E - AA^+$ – projector on a matrix core A^T , A^+ – pseudo-inverted matrix. With

$$\|A^+(Cu - A\bar{x})\| \leq \varepsilon.$$

Then the technological process described by equation (1) is functionally stable.

Ensuring the functional stability of production processes is one of the most important tasks. The implementation of technological processes requires constant

monitoring of product quality with simultaneous diagnostics of units and assemblies of production equipment. To solve this problem, it is proposed to use neural network technologies that will solve this problem.

Mathematically, a neuron is an adder of weights, the only output of which is determined through its inputs and a weight matrix in this way

$$y = f(u), \quad u = \sum_{i=1}^n w_i x_i + w_0 x_0.$$

Where w_i and x_i – respectively, the signals at the inputs of the neuron and the weights of the inputs, function u - induced local field, $f(u)$ – activation function. A neural network (NN) is defined as an interconnected set of neurons. The variety of neural network models is determined by the presence of various activation functions and the topology of their connection and interaction.

Through training, the network acquires the ability to correctly respond not only to training data, but also to process other data from the valid set well. Moreover, this set can be constructed in such a way that the conditions of the theorem are satisfied. That is, the neural network has the ability to generalize. One of the advantages of neural networks is the ability to approximate a given function using an appropriate network architecture. Thus, on the basis of a neural network, an effective model of a dynamic system and a network observer can be built. In studies [1,2] various neural networks (with one hidden layer, multilayer feed forward network, radial basis network, Hopfield network, self-organizing neural network) are used to build various systems for test diagnostics of equipment to ensure functionally stable implementation of technological processes.

This paper investigates the use of numerous classes of neural networks for diagnosing the state of equipment, ensuring the functionally stable functioning of the corresponding technological processes of industrial enterprises. The expediency of using artificial neural networks as an effective toolkit for ensuring the functional stability of production processes has been substantiated.

References:

1. Karpenko M., Sepehri N., Scuese D. Diagnosis of Process vavle Actuator Faults Using a Multilayer Neural Network // Control Engineering Practice. – Vol. 11, 2003, N 11: pp. 1289–1299.
2. Osokowski S. Neural networks for processing information. Finance and Credit, 202: 344p.
3. Sobchuk V. Method of creating a single information space in a production enterprise with a functionally sustainable technological process// Control, navigation and communication system. Academic Journal. pub.6(58), 2019: pp. 84 – 91.
4. Sobchuk V.V. Methodology for the establishment of a single information space in a computerized enterprise with a functionally stable computerized process. Science periodically seeing "Management systems, navigation and communication". Poltava, 2019, 6 (58): pp. 84 – 91.
5. Sobchuk V.V., Barabash O.V., Musinko A.P., Laptv O.A. Analysis of the main approaches and stages of the safety of the power of the functional efficiency and information systems of the enterprise. Sciences of Europe, Praha: Sciences of Europe, 2019. Vol 1, No 42: pp. 41 – 44.

¹ Mykhailo Solomko

PhD, Associate Professor

² Liudmyla Zubyk

PhD, Associate Professor

³ Yaroslav Zubyk

Senior Lecturer

⁴ Anastasiia Ivanytska

PhD, Assistant

^{1,3} National University Water and Environmental Engineering

^{2,4} Taras Shevchenko National University of Kyiv

MODIFIED ALGORITHM FOR TRANSFORMATION OF BOOLEAN FUNCTIONS

Abstract. Classic methods of constructing of logic circuits need to be generalized and optimized that can be implemented by making changes to existing processing algorithms. One of the options for minimizing logical functions is based on the combining sequences of logical operations. The method of image transformations is used to minimize completely and incompletely defined Boolean functions, minimize Boolean functions in different views, minimize Boolean function of the system etc. Attention focusing of potential expansion and modernization of future technical base of computing elements makes our researches relevant.

Keywords: Boolean functions, models for adding of binary codes, optimization methods, codes figurative transformations

Introduction. Basic methods of constructing of logic circuits were described early in various sources [1, 2, 3]. However, they constantly need to be generalized and optimized that can be implemented by making changes to existing processing algorithms. One of the options for minimizing logical functions is based on the combining sequences of logical operations. The method of image transformations is used to: minimize completely and incompletely defined Boolean functions, minimize Boolean functions in different views (DNF, CNF), minimize Boolean function of the system, minimize Boolean functions in Schaeffer, Webb (Pierce) monobases, minimize random Boolean function (algorithm Blake-Poretsky) [4].

Focusing on potential futures expansion and modernization of the technical base of computing elements, research aimed at optimizing algorithms for minimizing logical functions remains relevant.

The purpose of this research is to modify algorithms for minimizing logical functions through image transformations. To achieve this goal, the following tasks were forming:

- generalize the known patterns of minimization of logical functions;
- to improve the algorithm for minimizing logical functions based on the method of image transformations.

Modifying of algorithm trough figurative transformations. The transformation of the Boolean functions using different mathematician methods was

described early in [5, 6, 7]. The process of the minimization of the interval structure is connected with using of the super-gluing logic operation for internal variables. The result of transformation can be acquired with the help of the 2-(n, b)-design system search algorithm in the truth table's structure. The specified algorithm aimed at the automation search for the intervals on the combinatorial systems 2-(n, b)-design with using of the truth table structure and is as a tool for automating the transformations of the logical functions by a method that was described earlier [5, 8, 9, 10].

The algorithm for the recognition of intervals (or combinatorial systems 2-(n, b)-design) and to search for its boundaries is shown on Figure 1 part a. As a part of the general scheme for the transformation of any Boolean function was formed algorithm that shown on Figure 1 part b.

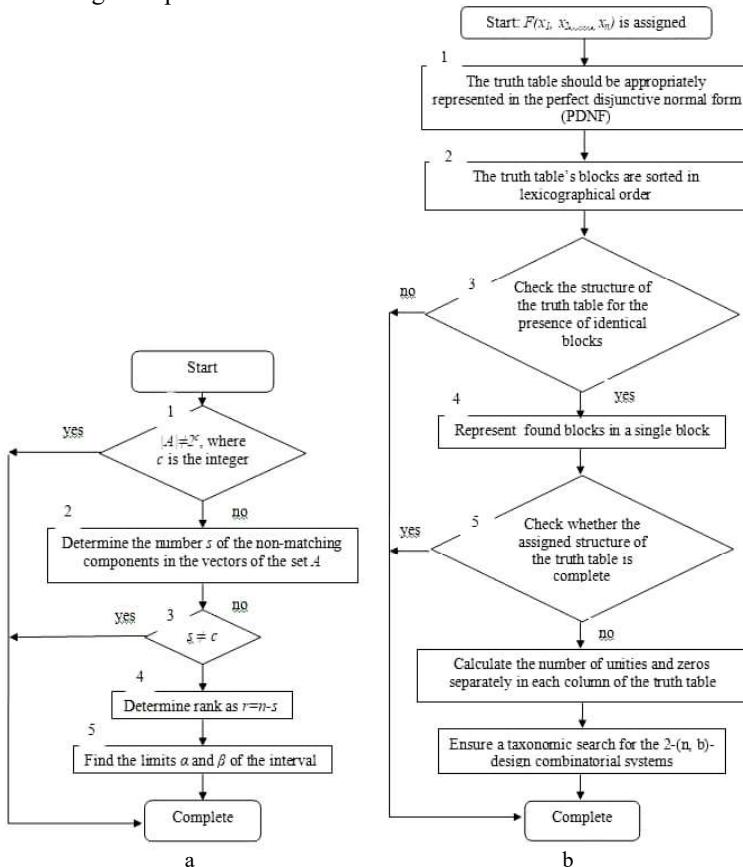


Figure 1 – a. The algorithm for the recognition of intervals (or combinatorial systems 2-(n, b)-design) and searching of it's boundaries; b. The main part of general scheme of Boolean function transformation

Conclusions. The algorithm for transformation Boolean functions using the figurative processing is similar to the procedure of searching for the intervals $I(\alpha, \beta)$ in the Boolean space n .

The high speed of calculus for any of Boolean functions may be achieved by using of algorithm, based on the primary application of the operation of super-gluing the variables within the truth table.

Modified algorithm aims to extension the set of Boolean function representation, that are not always represented by the truth table, and ensuring of productive calculations for different logical functions view.

References:

1. D. A. Pospelov, Logicheskie metody analiza i sinteza shem. Moscow: Energiya, 1974, 368.
2. A. D. Zakrevskiy, Logicheskiy sintez kaskadnyh shem. Moscow: Nauka, 1981, 416.
3. B. E. Rytzar, Metod minimizatsii bulevyh funktsiy. Problemy upravleniya i informatiki, 2, 1997, pp. 100–113.
4. M. Solomko, N. Khomiuk, Y. Ivashchuk, V. Nazaruk, et al, "Implementation of the methods of image transformations for minimizing the Sheffer functions", Eastern-European Journal of Enterprise Technologies. Mathematics and cybernetics – applied aspects. Vol 5/4(107), 2020: 19-34, doi: 10.15587/1729-4061.2020.214899.
5. V. Riznyk, M. Solomko , Y. Sagic, Minimization of conjunctive normal forms of boolean functions by combinatorial method. Technology Audit and Production Reserves, 5 (2 (43)), 2018. pp. 42–55. doi:10.15587/2312-8372.2018.146312
6. J. Huang, Programing implementation of the Quine-McCluskey method for minimization of Boolean expression. arXiv, 2014. URL: <https://arxiv.org/ftp/arxiv/papers/1410/1410.1059.pdf>
7. M. Nosrati, R. Karimi, An Algorithm for Minimizing of Boolean Functions Based on Graph DS. World Applied Programming, 1 (3), 2011, pp. 209–214.
8. K. Y. Kabanian, A. El-Hajj, S. Fakhreddine, W. S. Smari, Computer tool for minimizing logic functions. Computer Applications in Engineering Education, 3 (1), 1995. pp. 55–64. doi: 10.1002/cae.6180030108
9. K. G. Samofalov, A. M. Romlinkevich, V. N. Valuyskiy, V. N., Kanevskiy, et al. Prikladnaya teoriya tsifrovyh avtomatov. Kyiv, 375, 1987. URL: http://stu.scask.ru/book_pta.php?id=62
10. Bonal, D. Karnaugh and Mahoney, Map Methods for Minimizing Boolean Expressions, 2013. URL: <http://davidbonal.com/karnaugh-and-mahoney-map-methods-for-minimizing-boolean-expressions/>

¹ **George Vostrov**

Ph.D., Associate Professor, Department of Applied Mathematics and Information Technologies

² **Andrii Khrinenko**

Ph.D. student

^{1,2} *Odessa National Polytechnic University*

MATHEMATICAL MODELS OF PSEUDORANDOM PROCESSES BEHAVIOR FOR NONLINEAR DYNAMICAL SYSTEMS

Modeling of random and pseudorandom processes in nonlinear dynamical systems based on randomized algorithms of cyclic trajectories of fixed points requires formation of information technologies that would include a wide range of mathematical methods for predicting occurrences of such trajectories and pattern recognition for their behavior that depends on previous states [1]. Algorithms for analyzing such behavior increase the range of approaches that can be used to effectively solve various problems in areas such as modeling of dynamical systems, functional analysis, function theory, cryptography and others.

To analyze above-formulated problem, this paper considers the processes in maps, which are examples of nonlinear dynamical systems. Nonlinear maps of the following classes are considered: "Tent", "Asymmetric tent", "Sawtooth" and multiplicative order map [2]. The choice of these maps allows us to consider and analyze the chaotic processes that are also observed in complex dynamical systems. Despite the simplicity of the above maps, their iterative cycles have properties that confirm the above statements. According to them, the structure of iterative cycles is determined not only by the properties of the maps themselves, but also by the properties of the numbers on which these maps are based and which have a significant impact on the structure and can significantly change it. The presented nonlinear maps allow to divide the set of primes p into a system of classes based on the length of the iterative process for given prime numbers. Note that there are an infinite number of prime numbers for which the length of the period is significantly less than the dimension of the number.

References

1. Crandall R., Pomerance K. Prime numbers: cryptographic and computational aspects. – 2nd edition. – Springer, 2005. – 597 p.
2. Hirsch M., Smale S., Devaney R. Differential equations, dynamical systems, and an introduction to chaos. – Elsevier, 2013. – 423 p.
3. Vostrov, G., Opiata, R. Effective computability of dynamic system structure of prime number formation. ELTECS, 2017. – 244 p.

NETWORK AND INTERNET TECHNOLOGIES

¹**Volodymyr Barannik**

² **Yurii Babenko**

³ **Sergii Shulgin**

⁴ **Maksym Parkhomenko**

^{1,3,4} *Kharkov National University of Radio Electronics*

² *Taras Shevchenko National University of Kyiv*

VIDEO ENCODING TO INCREASE VIDEO AVAILABILITY IN TELECOMMUNICATION SYSTEMS

Abstract. Article shows presence of the imbalance caused by insufficient level of productivity of modern and perspective information communication technologies concerning information intensity of bit streams. It is described how imbalance level reducing can be formed as a result of increasing of information processing technologies efficiency and that JPEG platform is the basic concept for construction of technologies of compression representation. Therefore it is proposed to provide further development of video processing methods using individual components of the JPEG platform for improving the integrity of information in terms of ensuring the required level of its availability.:

Keywords: video image, integrity of information, areas of coherence, local-position coding.

Nowadays the development of information and communication technologies is accelerating as never before. Brand new technological concepts are being created such as quantum computing, 5G generation telecommunications systems, robotic systems, computer vision, intelligent technology, VR / AR applications. On the other hand, such technological breakthrough in the creation of IT concepts, in turn, provides background for the development of information services, increasing their popularity and quality. As a result, the level of imbalance between the capacity of existing and upcoming IT systems and the level of information load is not reduced. Moreover there is an increase in such an imbalance which level reaches 99%.

Reducing the level of imbalance is achieved by increasing the efficiency of information processing technologies [1 - 5]. At the same time, we have to face a contradiction due to the presence of an inversely proportional relationship between the amount of compressed representation of the video frame and the level of its information integrity [1-5]. Thus, increasing the efficiency of video data compression technologies is an urgent research and applied research issue.

Based on the assessment of the shortcomings of the existing methods of reducing the bit volume, it follows that to reduce the time delays for the delivery of the video it is necessary [5]:

1) to organize a reduction of the bit volume (RBV) of the video with a controlled level of visual assessments of based on the identification and approximation of the description of the elements for the areas of coherence;

2) to provide reduction of the bit volume relative to the code description of the characteristics of the areas of coherence should be carried out not only on the basis of reducing statistical redundancy, but also on the basis of reducing structural redundancy.

Accordingly, the purpose of the research in this article is to create a method of reducing the bit size of video frames based on the detection and processing of their areas of coherence.

Achieving the required level of availability of information in terms of maintaining indicators of its integrity is proposed to organize on the basis of ensuring the reliability of the structural components of the relevant objects of interest. To do this, it is proposed to identify the segments of the video frame by the degree of their importance from the standpoint of maintaining the required level of integrity of objects of interest. Identifying segments by component brightness is proposed. This can be explained by the fact that the brightness component carries the main information load among other color components in the color difference model of the video frame. It is proposed to carry out identification for localized areas of the video frame, which are characterized by greater homogeneity of their structural and statistical properties. Therefore, from a methodological point of view, the assessment of the information contribution of the segment should be based on the results of structural and statistical processing of its four microsegments, $S(X)_{i,j}^{(u)}$, $u = \overline{1, 4}$ from the point of preserving the semantic integrity of the video resource. Depending on the informational significance, microsegments $S(X)_{i,j}^{(u)}$ are classified into three types, namely: microsegments with a high level of structural-statistical saturation (SSN) at the syntactic level of the description; microsegments with an average level of SSN; microsegments with low levels of SSN.

References:

1. Ian Richardson, H.264 and MPEG-4 Video Compression: Video Coding for Next-Generation Multimedia / Ian Richardson, pp. 368, 2005.
2. Pratt W. K., Chen W. H., Welch L. R. Slant transform image coding. Proc. Computer Processing in communications. New York: Polytechnic Press, 1969. P. 63-84.
3. Sindeev M., Konushin A., Rother C. Alpha-flow for video matting. Technical Report. 2012. P. 41–46.
4. Barannik, V.V., Ryabukha, Yu.N. and Kulitsa, O.S.: The method for improving security of the remote video information resource on the basis of intellectual processing of video frames in the telecommunication systems. In: Telecommunications and Radio Engineering. Vol. 76. No 9. pp. 785-797. (2017). doi: 10.1615/TelecomRadEng.v76.i9.40.
5. Barannik, V. and Barannik, N. and Ryabukha, Yu. and Barannik, D.: Indirect Steganographic Embedding Method Based On Modifications of The Basis of the Polyadic System. In: 15th IEEE International Conference on Modern Problems of Radio Engineering, Telecommunications and Computer Science (TCSET'2020), pp. 699-702 (2020) DOI: 10.1109/TCSET49122.2020.235522.

Roman Belfer

Postgraduate Student at the Computer Engineering & System Programming Department

Khmelnitsky National University

THE ARCHITECTURE OF THE LAYERED PEER TO PEER NETWORK

To design a blockchain network according to the Proof-of-Activity [1] consensus protocol principles, some clarifications regarding the architecture should be added. The classic blockchain network, for example Bitcoin which uses the Proof-of-Work consensus protocol, is based on the Peer-to-Peer network architecture. In that case, each node is an equal unit in the global system workflow. But, to design the network to handle the PoA protocol, the node's type or parametrization is required. It's necessary to follow the stages of the defined consensus algorithm to select the validator nodes.

Designing a peer to peer blockchain network, which is going to follow the Proof of Activity consensus protocol, requires additional details which is why multiple layers are suggested for handling the different types of parameters of the network. Each layer (or level) contains a subset of the nodes that are grouped by some specific condition. Nevertheless, the network still keeps the properties of the classic P2P network of nodes being equal. We refer to this enhanced clarified architecture by the name Layered Peer-to-Peer (LP2P).

According to the quantity and the quality of its activity in the network, a node may be transferred through the layers, promoting itself and increasing the possibility of being selected as the validator. Note that the location of a node in the network is not static and may change.

If the condition:

$$\text{activityIndex}(\text{node}) \geq \text{index}_1, \quad (1)$$

for node_0K is true, the transformation happens:

$$\text{node}_0K \rightarrow \text{node}_1L+1, \quad (2)$$

If the node located on layer N gets the level of activity, that's at least equal to activity index $N+1$, this node moves to the next layer and becomes a layer $N+1$ node. Nodes will be grouped in layers based on their activity and will be able to participate in selecting nodes for validation roles.



Figure 1 – Multilayered Peer-to-Peer network and layered nodes

The LP2P network architecture becomes the structural pattern for the network designing to follow the Proof-of-Activity protocol and operate as blockchain. The multi layered structure allows to separate responsibilities of the nodes but not to limit the possibilities and opportunities for the separate ones. The following validation algorithm could be applied for different nodes, which belong to specific network layers, with different predefined conditions and parameters. That allows to scale the number of layers depending on input requirements for different number of predicted behaviors.

References:

1. Belfer R. Proof-of-Activity Consensus Protocol Based on a Network's Active Nodes / R. Belfer, A. Kashtalian, A. Nicheporuk, A. Sachenko, G. Markovsky // Proceedings of the 1st International Workshop on Intelligent Information Technologies & Systems of Information Security. - Khmelnytskyi, Ukraine, June 10-12, 2020. - Pp.239-251.
2. Bandara, H. M. N. D; A. P. Jayasumana, "Collaborative Applications over Peer-to-Peer Systems – Challenges and Solutions". Peer-to-Peer Networking and Applications., 2012, pp. 257–276 doi:10.1007/s12083-012-0157-3
3. Steinmetz, Ralf; Wehrle, Klaus, "2. What Is This "Peer-to-Peer" About?". Peer-to-Peer Systems and Applications. Lecture Notes in Computer Science. Springer, Berlin, Heidelberg, pp. 9–16 doi:10.1007/11530657_2

¹ Serhii Buchyk

Doctor of Science, Professor

² Danil Palageychenko

Student

^{1,2} Taras Shevchenko National University of Kyiv

INFORMATION TECHNOLOGIES IN UKRAINIAN JUDICIAL SYSTEM

Abstract. In centure of repid introduction development of the latest technologies in all public spheres, the evaluation of its effectiveness is relevant. Accordingly, it becomes necessary to carry out research on implementation issues, which can only be carried out taking into account the practical achievements of Ukraine and other leading countries in this field. Electronic document has the right to exist, taking into account the implementation of the advances in technologies, and having in mind the need for a thorough assessment of its impact on the judicial system.

Keywords: Electronic document, management, network, information technologies, Ukrainian judicial system.

The development of information technology is an extremely important component of modern society. It is now difficult to find an area in which electronic media is not used (in 2014 the number of Internet users in Ukraine was 280 thousand, and today it is about 22 million [1]).

Innovations are actively introduced into the justice systems of a number of advanced European countries, as the legislation must meet the modern requirements of society. Ukraine, in the context of integration processes, is also trying to introduce electronic document management to ensure the efficiency of the judiciary and the quality of justice in general.

Electronic document is the creation of an appropriate information base on the media for the purpose of realization of conditions for using this system of the appropriate management in the process of performing its functions [2].

Thus, it is possible to distinguish its basic principles of functioning: one time registration of the document; when working with the document is guaranteed its continuity of movement; the document base should be the only one - it makes duplication of documents impossible; search engine is well organized.

The following requirements must be observed when storing electronic documents: the information contained in electronic documents must be available for further use; it must be possible to restore the electronic document in the format in which it was created, sent, received; if available, information should be stored that can establish the origin and purpose of the electronic document, as well as the date and time of its sending and receipt [3].

Every year, the realization of services that can be done through the Internet or using certain online resources is gaining in popularity. Often, you need to create your own electronic signature in order to identify a user or enter personal information. A paper document in its usual traditional form is information certified by a signature and in some cases a seal. However, the historical path of development of the paper document was so rapid that now there is its original new electronic form, which has

become a relevant element in business culture. However, in order to authenticate the document, ie to ensure the veracity of the information contained in it, it is necessary to take certain actions. It is through this that a natural or legal person seeks to verify the validity or authenticity of specific information. Thus, we can distinguish two main functions of electronic signatures in legal practice: (1) the connection between the document and the party who created it is checked; (2) Ensuring that the content of the document has been revised and that it meets certain standards.

Keeping a wealth of information, including the power of personal data, does not exclude the possibility of cyberattacks for the purpose of unauthorized access to it. To prevent this, proper development of the necessary protection of the automated system, as well as of all registers and databases that will be widely used, should be carried out by qualified personnel.

In this regard, the following principles of electronic signature in practice arise: 1) Identity: a person must use the method to identify themselves and indicate their intention. 2) Reliability: the method of identification should be as reliable as appropriate, taking into account the purpose of the message. 3) Consent: the person to whom the signature is given must consent to the use of electronic communication to comply with the signature requirement and the method of identification.

Problems with the transition of introduction of electronic document can arise from various reasons: financial, inadequate preparation to work with the system of electronic document flow of staff, lack of experience, etc. Quarantine has introduced some difficulties in the process of notifying persons and has significantly increased the time of consideration of the case, as quite often people do not have the opportunity to receive a mail (by postal). Therefore, taking into account the recommendations provided by the Council of Judges of Ukraine, including the Supreme Court, Ukrainian citizens started to use an electronic correspondence. Sufficient practice has not yet been established on this issue: there are not many cases, and the issue of admissibility or inadmissibility of electronic evidence has not been considered by the court of cassation. Technically, any citizen registered in the Electronic Court can send a document to the court, and this document will be registered - a more difficult issue is the ambiguous position of the courts on the possibility of using this system and obtaining documents electronically.

Thus, today the preconditions are gradually being created for the courts to work with electronic documents, but the decision on whether to accept them or not is still up to them.

References:

1. Article "E-Justice is a big step forward" from - 19.05.2018 // [Electronic resource] // - Access mode: <https://yaizakon.com.ua/elektronnoe-pravosudie-eto-bolshoj-shag-vpered-sudya-aleksandr-sasevich/>.
2. Regulation on the automated system of court circulation (decision of the Council of Judges of Ukraine No. 30 of November 26, 2010) in the version dated 02.03.2018 // [Official web-portal of the VRU] // - Access: <https://zakon.rada.gov.ua/rada/show/vr030414-10>
3. Вимоги щодо зберігання електронних документів // [Офіційний веб-портал Оболонської районної в місті Києві Державної адміністрації] // - Access mode: <https://obolon.kyivcity.gov.ua/content/vymogy-shchodo-zberigannda-elektronnyh-dokumentiv.html>
4. Стаття «Як отримати електронний підпис у 2019 році», // – Access mode: <https://ursambo.com/ukr/zahyst-yurosib-i-fop/iak-otrymaty-etsp-elektronnyj-tsyfrovyy-pidpys.html>

¹ **A. Cherevativ**

Student

² **S. Paliy**

PhD, Associate Professor of the Information Systems and Technologies Department

^{1,2} Taras Shevchenko National University of Kyiv

THE USE OF ARTIFICIAL INTELLIGENCE IN THE INTERNET OF THINGS SYSTEM

Internet of Things, IoT - is a global infrastructure of information area, which provides advanced services by interconnecting physical real-world objects with centers of control, management, and information processing. Communication is carried out using existing information technologies for the intellectual recognition, administration, tracking, monitoring and positioning.[1]

IoT allows us to look at everyday life from the other side, but only AI allows us to fully unleash the entire huge potential of the IoT system.

According to the Business Insider Intelligence, there will be approximately 55 billion IoT devices by 2025, compared to 9 billion in 2017. It is more than 4 devices per person.

Gartner forecasts that in the nearest future an AI feature will be used in more than 80% of enterprise IoT ventures, up from a mere 10% today.

Companies who can combine applying IoT data and AI in real-time could gain a major business edge, including a 38% boost in profitability by 2035, according to Forbes.

Usually a human has five senses: vision, sound, taste, scent, and touch.

The main problem is that a person has a limited number of sense organs, which is also limited by the distance to the object, which gives us a certain sensation. In other words, we cannot feel what is outside the limits of our perception.

However, an AIoT system can likely have an infinite number of sensors that capture even more complicated data over greater distances. [2]

It is clear that as the number of these devices increases, the amount of data that needs to be processed will also increase like an avalanche. This is where artificial intelligence reveals its potential, providing its learning capabilities for devices connected to the IoT.

These interdependent technologies change the way we interact with our devices all around, thus generating Artificial Intelligence of Things.

There are main sections where we can see the influence of AI on IoT:

- Smart Industry
- Smart Home
- Smart City
- Wearable

Smart Industry is a branch of industry that rely on AIoT technologies from supply-chain sensors to real-time data processing, smart technologies help stop risky market failures and minimize an effect of human's mistakes.

Smart Home is a type of house that is constantly connected with the user, his requests, wishes. Smart homes can use control over various household items to optimize consumption, safety, taking into account the user's characteristics, his wishes

Smart City is a system of interconnected IoT things that makes the life of citizens as comfortable as possible, while improving the efficiency of using natural resources. In smart cities, there is also the possibility of using IoT with AI to improve the quality of life in various aspects by analyzing data that comes in every day.

Wearables are devices that make everyday life easier and allow you to keep a constant record of the state of the body, using AI, they also have the ability to adjust to the human biorhythm to optimize effective work[3]

In general, artificial intelligence training algorithms can be divided into three categories, which are based on the level of human intervention in the process: training under full supervision, training under semi-supervision, training without supervision.

Supervised learning involves a fixed closed set of labels, and only certain selected data are available for processing. This type is only possible for small-scale applications, but cannot be used when working with a scale that covers a wide range of behaviors and contexts demonstrated by a large community of users.

Semi-supervised learning describes an approach in which only part of the data is labeled, which reduces the need for labeled examples, in which case algorithms study the mechanism of recognizing similarities or differences, identifying certain anomalies in the processing of a data set.

Unsupervised learning does not require labeling of data, which provides a much wider range of applications, but a more demanding learning process. Uncontrolled learning methods can be applied to a variable context based on behavioral similarities, but they can potentially lead to behaviors that do not correspond to activities that can be identified as useful for data processing. [4]

Comparing Iot and AIoT we can say that:

IoT: requires hardware that would be connected, while often such a system does not analyze the data collected during the operation of the system, such a system requires minimal human intervention.

AIoT: in addition to everything that a conventional IoT system requires, it also requires the development and implementation of a software product in order to obtain the highest quality data processing, with the aim of further training the system, and the next stage is the maximum reduction in the need to involve a person as a link that controls the learning process of the system [5]

Conclusions: Combining the use of IoT and artificial intelligence significantly expands the functionality of the system by analyzing and processing the collected data. This is a great solution to improve system performance and optimize many processes that would be much more difficult to implement without using AI. This is a breakthrough decision that will change the lives of many people in the nearest future.

References:

1. Carlos Salazar, Keyur Patel, Sunil Patel, P. Scholar. Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges. 2016. [Електронний ресурс] Режим доступу: https://www.researchgate.net/publication/330425585_Internet_of_Things-IOT_Definition_Characteristics_Architecture_Enabling_Technologies_Application_Future_Challenges
2. 2018.[Електронний ресурс] Режим доступу: https://www.sas.com/ru_ru/explore/resources/aiot.html
3. Iman Ghosh. AIoT: When Artificial Intelligence Meets the Internet of Things. 2020. [Електронний ресурс] Режим доступу: <https://www.visualcapitalist.com/aiot-when-ai-meets-iot-technology/>
4. Artur Miguel Arsénio, Hugo Serra, Rui Francisco, Fernando Nabais Internet of Intelligent Things: Bringing Artificial Intelligence into Things and Communication Networks. 2014. [Електронний ресурс] Режим доступу: https://www.researchgate.net/publication/265248986_Internet_of_Intelligent_Things_Bringing_Artificial_Intelligence_into_Things_and_Communication_Networks
5. Dinesh Soundararajan. AIoT: The powerful convergence of AI and the IoT. 2020. [Електронний ресурс] Режим доступу: <https://www.iot-now.com/2020/04/10/102236-aiot-the-powerful-convergence-of-ai-and-the-iot/>
6. Copyright © 2020. All rights reserved

¹ Andriy Dudnik

Doctor of Technical Sciences, Associate Professor of the Department of Network and Internet Technologies

² Mykyta Kobylchuk

Student of the Department of Network and Internet Technologies

³ Daria Pokutnia

Student of the Department of Network and Internet Technologies

^{1,2,3} Taras Shevchenko National University of Kyiv

ANALYSIS OF THE CURRENT STATE OF TECHNOLOGY "SMART HOME"

Abstract. The main task of this article is to analyze the current state of the "Smart Home" system. This paper analyzes the prototype of the system "Smart Home" with the mandatory content of the review of the concept of automation systems, the specifics and main aspects of the implementation of such systems. Theoretical and methodological bases of house automation systems are studied.

Keywords: smart home, Internet of Things, system parameters, methodology.

Today, there are many different systems and protocols designed to provide full automation of houses, houses or apartments. There are more than twenty technologies aimed at creating a so-called "smart home". These include some categories and subcategories, such as video surveillance systems, for ventilation, heating, air conditioning, entertainment, centralized and distributed systems, and so on. The object of research was the so-called "intellectual house". Hi-tech in all its manifestations has firmly taken its place in our lives, and one of its manifestations in everyday life is the smart home system.

One of the main advantages of intelligent buildings is the comfort they provide to their residents. Control of lighting and infrastructure of the house allows you to create different lighting options for the room, any combination, depending on the time of day and mood, at the touch of a button. The climate control system allows you to simultaneously reproduce the conditions of different climatic zones in different rooms. To do this, simply set the desired temperature on the touch control panel.

Another undeniable advantage of a smart home is its security system. Moreover, automation systems are designed to provide protection against any emergency. First, they provide protection against intrusion by CCTV cameras, automation of doors, gates, the role of blinds, burglar alarms. Secondly, there is almost no chance of a fire - the iron, tongs or oven, which are left on, will be turned off in time, and in case of fire or smoke, the fire alarm will go out. The system controls the flow of water, electricity and heat. This is achieved through the most rational use.

The relevance is that the modern market of IT technologies offers interested customers a wide range of so-called "smart" systems. Such systems are designed to automate the home use of a number of tasks without human intervention. As well as providing information to the user about the state of the system and the environment, such as temperature and humidity, the state of the devices.

The challenge was to find and develop effective systems for the comfort and safety of the owners. In the process of work the goal was set - to develop and determine the optimal Smart Home system, to calculate the main methods of studying the parameters of the Smart Home system (Fig. 1).

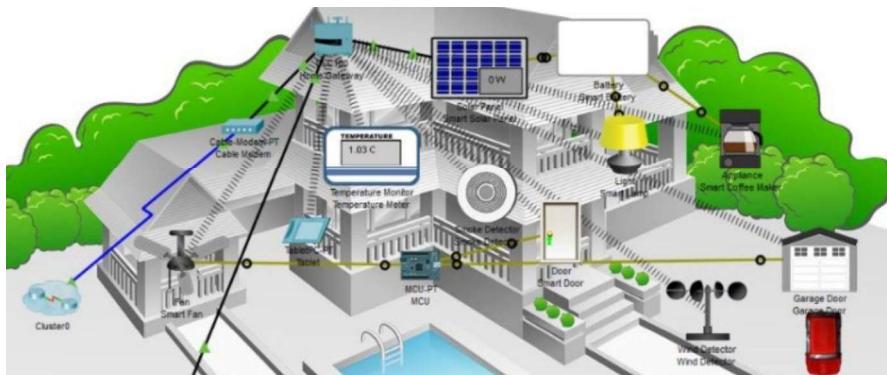


Figure 1 – Smart Home system

Conclusion. Also, today, hundreds or even thousands of different process automation systems have been developed in the world. But they are designed with Western monitoring standards in mind, so they are of little use to middle- or low-income countries without adaptation. Automation also constantly needs some support with the constant involvement of a specialist or developer, as it is quite a complex and lengthy process.

Another problem is that many of our potential users are not sufficiently informed about the purpose of automated systems. Most perceive this not as an opportunity to save resources and, consequently, financial resources, but as an indicator of prestige.

For this reason, manufacturers for many countries, such as Ukraine, do not seek to develop too much the technological level of production of systems, on the contrary, greatly simplifying the technical characteristics, not so much energy efficient as aesthetically attractive.

References:

1. Adriano D. B. et al. Iot-based Integrated Home Security and Monitoring System //Journal of Physics: Conference Series. – IOP Publishing, 2018. – T. 1140. – №. 1. – C. 012006.
2. Amri Y., Setiawan M. A. Improving Smart Home Concept with the Internet of Things Concept Using RaspberryPi and NodeMCU //IOP Conference 64Series: Materials Science and Engineering. – IOP Publishing, 2018. – T. 325. – №. 1. – C. 012021.
3. Ashton K. et al. That ‘internet of things’ thing //RFID journal. – 2009. – T. 22. – №. 7. – С. 97-114.
4. Hardeniya N. et al. Natural Language Processing: Python and NLTK. – Packt Publishing Ltd, 2016.
5. Kenter T., Borisov A., De Rijke M. Siamese cbow: Optimizing word embeddings for sentence representations //arXiv preprint arXiv:1606.04640. – 2016.

6. Kodali R. K., Yerroju S. Energy Efficient Home Automation Using IoT // 2018 International Conference on Communication, Computing and Internet of Things (IC3IoT). – IEEE, 2018. – C. 151-154.
7. Korobov M. Morphological analyzer and generator for Russian and Ukrainian languages //International Conference on Analysis of Images, Social Networks and Texts. – Springer, Cham, 2015. – C. 320-332.
8. Le Q., Mikolov T. Distributed representations of sentences and documents //International conference on machine learning. – 2014. – C. 1188-1196.
9. Lobaccaro G., Carlucci S., Löfström E. A review of systems and technologies for smart homes and smart grids //Energies. – 2016. – T. 9. – №. 5. – C. 348.
10. Meng Y. et al. Securing Consumer IoT in the Smart Home: Architecture, Challenges, and Countermeasures //IEEE Wireless Communications. – 2018. – T. 25. – №. 6. – C. 53-59.
11. Mobile Operating System Market Share Worldwide. – URL: <http://gs.statcounter.com/os-market-share/mobile/worldwide>.
12. Nath R. K., Bajpai R., Thapliyal H. IoT based indoor location detection system for smart home environment //2018 IEEE International Conference on Consumer Electronics (ICCE). – IEEE, 2018. – C. 1-3. 6566
13. Patel V., Shah A. Android Based Smart Home Controlled System Using Raspberry Pi //Journal of Control & Instrumentation. – 2018. – T. 9. – №. 2. – C. 5-11.
14. Perevalov A. et al. Question Embeddings Based on Shannon Entropy Solving intent classification task in goal-oriented dialogue system //Proceedings of the 7th International Conference on Applied Innovations in IT. – 2019.
15. Reina D. G. et al. The role of ad hoc networks in the internet of things: A case scenario for smart environments //Internet of things and inter-cooperative computational technologies for collective intelligence. – Springer, Berlin, Heidelberg, 2013. – C. 89-113.

¹ Myroslava Gladka

Teaching Assistant

² Rostyslav Lisnevskyi

Ph.D., Associate Professor, Docent

³ Mykola Kostikov

Ph.D., Associate Professor, Docent

^{1,2,3} Taras Shevchenko National University of Kyiv

³ National University of Food Technologies

USING THE INTERNET OF THINGS WHEN INTRODUCING CRM SYSTEMS IN THE BANKING SECTOR

Abstract. The Internet of Things (IoT) concept becomes more popular, in particular in the banking sector. Each customer needs special attention and an individual approach to service. Wireless communication between banking objects and the customer's mobile phone reduces the number of customer's actions and improves the protection of operations. Individual algorithms for interaction between customers and banking objects that work within modern customer relationship management (CRM) systems increase the loyalty of customers.

Keywords: Bank, customer, online banking, customer relationship management, Internet of Things, geolocation

1. Introduction

As the banking sector develops, the customers' requirements for its services increase. To attract and retain customers, banks must not only widen the range of services provided but also select which services should be offered to which customers. Introducing Customer relationship management (CRM) systems helps banks to analyze their interaction with each customer individually and to deliver efficient management based on this analysis [1].

One of the main areas of work with customers is using online banking that allows customers to work with their accounts from any point of the globe, given the availability of Internet connection [2]. Virtually all online banking customers use not only their PCs but also smartphones.

Internet of things (IoT) is a technology for wireless connection between devices via the Internet that allows them to exchange information and interact with minimal human intervention [3]. The development and use of IoT in the financial and banking sector for work with customers will allow increasing the quality and speed of service [4, 5].

2. Using the IoT for CRM Systems in Banking

2.1. Devices Interaction when Performing Banking Operations

All customer bank accounts are linked to a mobile phone number, which provides binding the IoT smartphone to the person who is the account user. When connecting to control devices, it is the smartphone that is identified by the personal number and, if necessary, by the password [6].

When a bank customer uses services of ATM, POS terminals, PC, etc., the authentication is possible through using the customer's smartphone geolocation [7]. The customer who uses an additional authentication for banking operations may use his smartphone that will function as a part of IoT and perform this action instead of the customer himself (figure 1).

To perform such actions, it is necessary to meet the next requirements: the customer permits to perform authentication by using a smartphone; the smartphone must have geolocation enabled [8]; the device and the object performing the operations must be within the strictly defined distance [9].

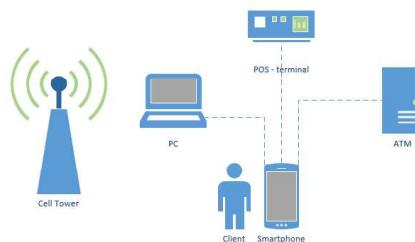


Figure 1 – IoT devices interaction for performing online banking operations

2.2. Determining the Distance for Interaction

We have all the needed conditions to determine the distance between objects: ATMs are installed at stationary positions that clearly define their geolocation; POS terminals have the functionality to determine their location; PCs and other devices are also able to show their location. Thus everything we need is to calculate and indicate the maximum allowable deviation distance between the action object and the customer's smartphone. Let the distance between objects be D . Then the allowable distance will be determined by the formula 1:

$$D \leq |(M \pm \Delta\beta) + (O \pm \Delta\gamma)|, \quad (1)$$

where M is the customer's smartphone location;

β is the accuracy of determining the smartphone location;

O is the location of the object performing banking operations;

γ is the accuracy of determining the location of the object performing banking operations.

It is worth noting that for different objects of interaction, the distance D may be defined individually, as each object has its features for work. Thus it is necessary to define the maximum allowable distance between objects when writing interaction algorithms in a CRM system. We should also consider the possible location error. Each scenario must take into account the features of work with each object (figure 2).

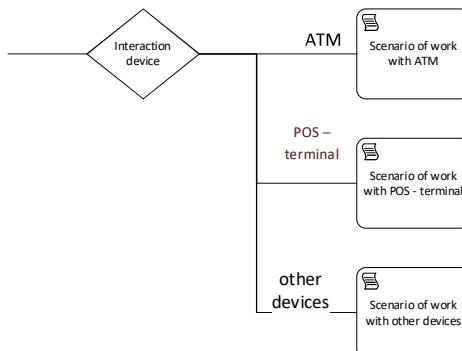


Figure 2 – Choosing a scenario for interaction between customers and objects in a CRM system

Due to using these functions at the device connection layer, a customer doesn't need to go through additional verifications for actions and operations.

2.3. Conclusions

Using modern IoT for work and customer support in banking helps to reduce the time for operations of two-factor authentication while providing an additional protection layer. However, there are some disadvantages. Not all bank customers are using modern smartphones, which is necessary to determine the customer's location accurately. Besides, the smartphone's geolocation must be on at all times for providing the functions needed.

But a smartphone with enabled geolocation can provide an additional access layer when performing operations. At this level, devices will exchange information without further actions by the customer. Additional actions for authorization are required from the customer only in case of lacking the listed conditions.

Introducing IoT in the banking sector of Ukraine will provide [10]:

- reducing human impact on operations;
- increasing protection of banking operations due to additional verification and authentication that are performed at the device level;

- optimizing and minimizing the message traffic of mobile network operators;
- gaining and maintaining leadership in the banking sector through the introduction of global trends in digitalization.

3. Acknowledgments

The paper has been prepared based on data provided by the company Terrasoft which introduces and develops CRM systems in the banking and financial sector.

References:

1. M. Bardicchia, Digital CRM: Strategies and Emerging Trends: Building Customer Relationship in the Digital Era, Independently published, Milan, 2020.
2. O. P. Rishi, A. Sharma, Maximizing Business Performance and Efficiency Through Intelligent Systems, IGI Global, Hershey, PA, 2017.
3. M. Milenkovic, Internet of Things: Concepts and System Design, Springer, New York City, NY, 2020.
4. L. Lazepko, Interview: OTP Bank Digital Transformation of Corporate Banking, 2020. URL: <https://www.creatio.com/node/18139>.
5. IoT-Enabled Banking Services: White Paper, Infosys, Bengaluru, India, 2018. URL: infosys.com/industries/financial-services/white-papers/documents/iot-enabled-banking.pdf.
6. Е. Петрова. Проблемы IoT в банках, 2017. URL: <https://bis-expert.ru/articles/56278>.
7. J. Shin, S. Kancharlapalli, M. Farcasin, E. Chan-Tin, SmartPass: a smarter geolocation-based authentication scheme, in: Security and Communication Networks 2015, Wiley, Hoboken, NJ, 2015, vol. 8, pp. 3927–3938, doi: 10.1002/sec.1311.
8. D. Nield, How Location Tracking Works on Your Phone in 2020, Gizmodo, 2020. URL: <https://gizmodo.com/how-to-turn-off-location-tracking-on-your-phone-1841695041>.
9. P. A. Shary, Models of Topography, in: Q. Zhou, B. Lees, G. Tang (Eds.), Advances in Digital Terrain Analysis, Springer, Berlin, Heidelberg, 2008, pp. 29–57. doi: 10.1007/978-3-540-77800-4_3.
10. В. И. Гербич, Л. А. Нетребчук, Интернет вещей в банковской сфере, in: Актуальные проблемы маркетинга XXI века: матер. Междунар. науч.-практ. конф., Минск, 21–22 марта 2019, Ин-т бизнеса БГУ, Минск, 2019, с. 102–104.

¹ **Hrygorii Hnatienko**

PhD in Physical and Mathematical Sciences, Associate Professor

² **Volodymyr Kudin**

Doctor of Technical Sciences

³ **Oleh Ilarionov**

PhD in Engineering Science, Associate Professor

⁴ **Oksana Vlasenko**

Specialist

^{1,2,3,4} Taras Shevchenko National University of Kyiv

FUZZY DEFINITION OF RELATIVE ESTIMATES OF ALTERNATIVES BASED ON PAIRWISE COMPARISONS USING PSEUDOBASIC MATRICES

A significant number of papers in domestic and foreign sources are devoted to the study and analysis of methods for solving the problem of determining the structure of preferences on set of objects. It is generally accepted that it is difficult to obtain direct consistent information from an expert about the numerical values of the relative estimates of objects.

We will consider one of the most common ways to represent the values of relative estimates in the form of real numbers, taking into account the condition of normalization: $\sum_{i \in I} \rho_i = 1, \rho_i > 0, i \in I$.

But in many real-life cases, the values of the weights are fuzzy. In particular, fuzzy constraints and fuzzy criteria are used in multicriteria problems in different subject areas [1]. System of expert preferences in most cases is an extremely important heuristic when calculating an adequate solution of multicriteria optimization. Therefore, a promising area of research is to determine relative estimates in the form of a function of belonging to a fuzzy set.

It is known that an expert can not accurately determine the weights of alternatives, so for such cases indirect methods are used. In particular, one of the methods of solving the problem of determining the weight of objects by an incomplete metricized multiplicative matrix of pairwise comparisons between the importance of alternatives is described and investigated in [2, 3]:

$$M = (\mu_{ij}), i, j \in I. \quad (1)$$

At the initial stage of this method, a rectangular matrix of size $(n \times N)$, $N = n(n-1)/2$,

$$P = (\pi_{ij}), i \in H = \{1, \dots, N\}, j \in I, \quad (2)$$

is constructed from a matrix of the form (1).

Its elements are determined as follows:

$$\pi_{ij} = \begin{cases} 1, & \text{if } i = (2-n) + \sum_{l=1}^s (n-l), \quad s = 1, \dots, n-1, \\ \mu_{ij}, & \text{if } j = s+i \quad \text{for } i = 1, \dots, n-1, \\ j = s+i - \sum_{l=1}^s (n-l) \quad \text{for } i \geq l \quad \text{or } s \geq 2, \\ 0 & \text{in all other cases.} \end{cases}$$

At the next stage of the method, a brute force is organized, as a result of which all possible combinations of the $(n-1)$ -th line are selected from the matrix (2) and are supplemented by a line of n , length consisting of single elements. The matrix constructed in this way is denoted by $A^{(l)}, l \in \Lambda$; the resulting system of linear algebraic equations is as follows:

$$\begin{aligned} A^{(l)} \rho &= e, \\ \rho_i &> 0, \quad i \in I, \end{aligned} \tag{3}$$

where Λ – set of indices of form (3) systems, for which the matrix $A^{(l)}, l \in \Lambda$, is nondegenerate, e – vector of n length with elements $(0, \dots, 0, 1)^T$, T – transposition sign. The components of the unknown variables (3) vector of are positive.

It is obvious that matrices $A^{(l)}, l \in \Lambda$, in systems of the form (3) are very sparse, so special methods can be applied to them, which allow to simplify the calculations when solving the problem.

Simplification can be achieved by:

- checking the conditions of nondegeneracy of the constraint matrix when replacing one line in the system (3);
- the positive condition of the components of the new solution when replacing one line of constraints (3).

It is easy to see that the number of compatible systems of the form (3), according to Kelly's theorem on the number of undirected trees in the graph [4], is n^{n-2} . With a large number of objects, a large number of systems of equations are incompatible. In particular, for 7 objects the number of compatible systems is 31% of the total number of systems of type (3), for 8 – 22%, for 9 – 16%, for 10 – 11%.

Note that the sequence of calculation of systems of the form (3) can be "organized" in such a way that each successive matrix of the form $A^{(l)}, l \in \Lambda$, differs from the previous one by only one line.

In the case of a significant increase in the speed of calculations the method of pseudobase matrices [5] can be successfully used for solving systems of the form (3). This method consists "natural" checking of the conditions of nondegeneracy of the matrix of constraints type (3) when changing one line, and the connection of the components of the solution vector and the elements of the inverse matrix as a result of such changes. That is,

before the basic calculations, to identify "not promising" in terms of fulfilling the conditions of matrix nondegeneracy constraint, the positiveness of the solution components, and compatibility.

Since the described method of determining the weights in the form of functions of belonging to a fuzzy set is computationally complex, it is proposed to apply the method of pseudobasic matrices, which significantly speeds up the calculation.

Here are the results of a computational experiment for six alternatives.

Given a matrix of pairwise comparisons of the form (1):

1	0,333	8	3	3	7
3	1	9	3	3	9
0,125	0,111	1	0,167	0,2	2
0,333	0,333	6	1	0,333	6
0,333	0,333	5	3	1	6
0,143	0,111	0,5	0,167	0,167	1

A rectangular matrix of the form (2) is constructed:

1	-0,333	0	0	0	0
1	0	-8	0	0	0
1	0	0	-3	0	0
1	0	0	0	-3	0
1	0	0	0	0	-7
0	1	-9	0	0	0
0	1	0	-3	0	0
0	1	0	0	-3	0
0	1	0	0	0	-9
0	0	1	-0,1667	0	0
0	0	1	0	-0,2	0
0	0	1	0	0	-2
0	0	0	1	-0,3333	0
0	0	0	1	0	-6
0	0	0	0	1	-6

The number of combinations in this problem is equal to 3003. And the number of possible compatible systems in this case is 1296.

As a result of the computational experiment, we obtain the frequency of the values of the weights of the alternatives, which is shown in the figures. When aggregating the obtained solutions, we use the method described in the monograph [3] for constructing the function of belonging to a fuzzy set based on the analysis of the frequency of values.

Horizontally, the graphs show the values that each of the coefficients of importance of alternatives acquires, vertically - the frequency of occurrence of these values in the respective ranges.

Several options for interpreting the results can be offered.

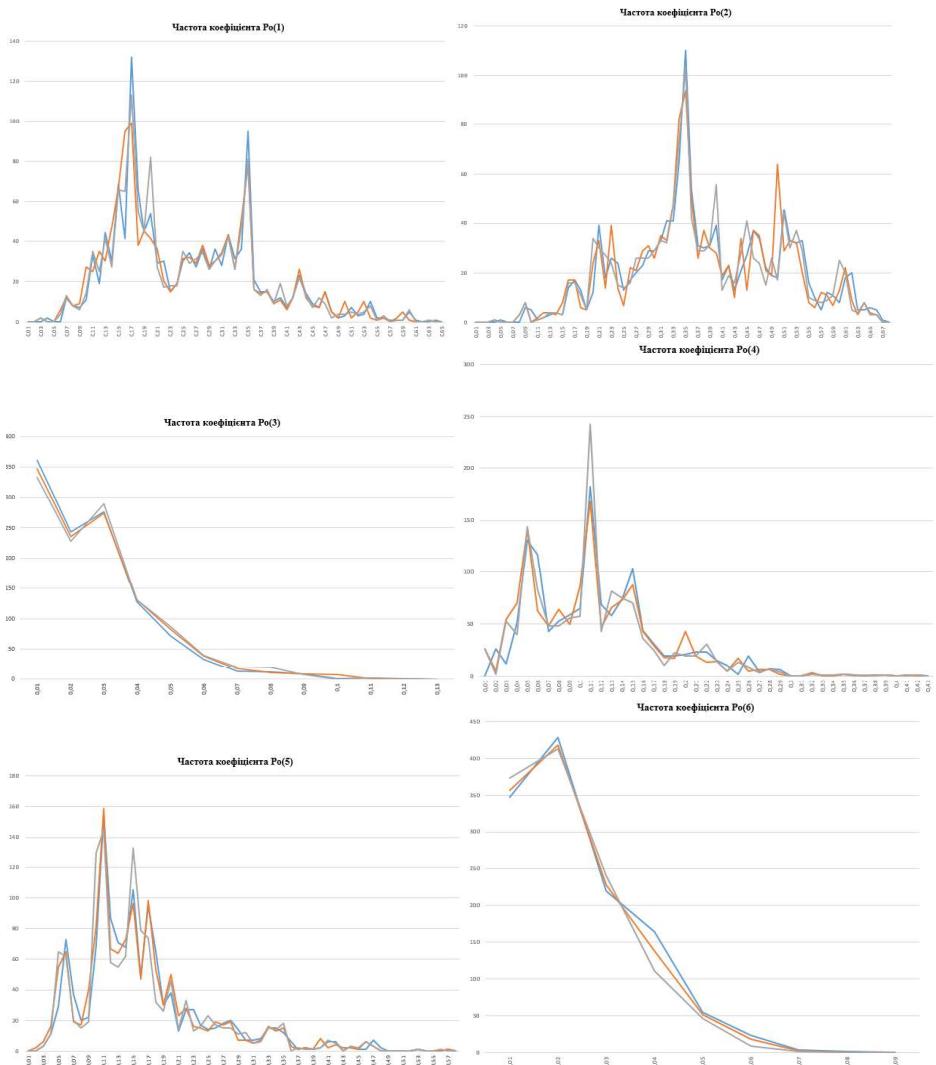
1. Define clusters on the hyperplane $\sum_{i \in I} \rho_i = 1$. The most powerful of the clusters

will contain solutions of the initial problem and it can be used to construct membership functions of the coefficients of importance of alternatives.

2. Determine the clusters on the set of points for each of the n dimensions found

by solving equations of the form (3), and build membership functions on the most powerful clusters on each axis.

3. From the set of obtained frequencies presented in the graphs, select the membership functions of a given type (triangular, trapezoidal, Z-shaped, S-shaped, Gaussian, etc.) and automatically generate logical expressions.



Thus, this paper proposes an approach that allows to find the whole set of possible values of the weights of alternatives, and at the same time to interpret the obtained solutions as a function of belonging to a fuzzy set. In order to increase the efficiency of calculations in this problem, which has great computational complexity, it is proposed to use the method of pseudobasic matrices. In the case of incomplete matrices of pairwise comparisons, this method can be used to calculate fuzzy weights of more than 10 alternatives.

References:

1. Zgurovsky M.Z., Zaichenko Y.P. Models and methods of decision making in fuzzy conditions, Naukova Dumka. K .; 2011.- 275 p.
2. Gnatienko G.N. Setting preferences on a set of criterion functions in multicriteria optimization problems // Proceedings of the Kyiv University. Modeling and optimization of complex systems. - 1990. - Issue. 9. - P. 87–92.
3. Gnatienko G.M. Expert technologies of decision making: monograph / G.M. Gnatienko, V.E. Snytyuk. - K.: Maclaut Ltd., 2008. - 444 p.
4. Boz'oki, S. and Tsyganok, V. (2019). The (logarithmic) least squares optimality of the arithmetic (geometric) mean of weight vectors calculated from all spanning trees for incomplete additive (multiplicative) pairwise comparison matrices. International Journal of General Systems, 48(4):362–381.
5. Kudin V.I., Lyashko S.I., Khritonenko N.V., Yatsenko Y.P. Analysis of properties of a linear system by the method of pseudobasic matrices // Cybernetics and system analysis. - 2007. - N 4. - P. 119–127.

¹ Illia Kondratiuk

Student

² Sophia Vlasiuk

Student

³ Sergiy Paliy

Docent, Associate Professor of the Information Systems and Technologies Department

^{1,2,3}Taras Shevchenko National University of Kyiv

CURRENT PROBLEMS OF INFORMATION SECURITY OF IOT SYSTEMS

The Internet of Things is a system that integrates real things into a virtual network, reducing the need for human involvement in a particular process, or eliminating the need for it completely. Obviously, such a thing not only can't bypass information technologies around the world, but it is the next step in their development, and therefore, we need to identify and realize all current issues of cybersecurity of the Internet of Things.

Any IoT system is a complex technology, which means that its problems have to be considered at several layers. The hierarchy of the Internet of Things architecture [1] looks like this:

Perception layer is the physical level of collecting information about the environment, which means obtaining certain parameters (temperature, humidity, the presence of a certain object, etc.) using different sensors.

Network layer — the level of connection to the network, connection of smart devices to the server, to other devices or to each other. Its task is data processing and transmission.

Application layer — the level that's responsible for providing the user with specialized services of narrow use, so it processes specific tasks (smart home, smart parking, smart subway, etc.)

At every layer, there are a lot of issues that have inherited from already existing network device vulnerabilities, but there are also IoT-only issues. Let's consider each layer separately[2].

Security at the perception layer. At this layer, the threats have more physical character: breakdowns of sensors due to improper interaction with them, power outages, poor exposure to too low or high temperatures. If we are talking not about emergencies, then the important role is played by the accuracy of the data received by the sensors. In the future, IoT technologies can be used in medicine, in the physical or chemical industry, and in other fields which require high accuracy numbers, and therefore all indications must be microscopically accurate. Another problem is the maintenance of elements of the Internet of Things. Although they are scalable, they themselves have a fixed configuration and they rarely receive any internal firmware updates, which will limit possibility of their serviceability. Until these elements become physically universal, their distribution and use will be delayed.

Security at the network layer. Any Internet of Things system is built on basic communication networks, therefore, their problems extend to the system itself. This

includes CIA violations, DoS/DDoS attacks, man-in-the-middle attacks or any attempts of attacking a system with viruses or other malware. But IoT also has a list of specific problems, which worsen the existing issues(so they require more attention) or which are completely new(so no one is prepared for them). If we are talking about the already existing ones, they are usually connected with system overloads. Devices must compile clusters of information from thousands of sources, and then make some conclusions. This amount of work makes them vulnerable to DoS and DDoS attacks, because it's much easier to cause the system overload, and a tiny delay in data transmission can break all the system work. Speaking of IoT-specific problems, we should mention the insecurity of certification[3]. Networks should be made of trusted devices, but, as we said earlier, their amount is extremely big, and certificates for them are being sold for low prices and in large quantities. Any hacker can easily obtain a trusted device and then compromise a network, send corrupted data into them and even take control of them. Therefore, the approach to these issues needs to be reconsidered.

Security at the application layer. These include the vulnerabilities in embedded software, as well as all the security details of each individual application that will be used in the network. Though there is a large amount of devices in an IoT system, inaccurate data of just one of them may affect the operation of other devices. That means, that every single one of them must complete only those tasks, for which it was programmed, and access to the executable code should be limited. Any changes in executable files and programs have to be signed and confirmed by trusted people, and anything connected with device configuration has to be strongly encrypted.

Conclusion. All the actual problems of IoT security will continue to worsen, slowing down the process of these technologies being spread to the broad masses. Further analysis of the obstacles to Internet of things development and the search for a way to eliminate them should be intensified. All mentioned vulnerabilities have to be revised, and we have to take action on them, developing a new way of protecting information, which would specify on this kind of systems.

References:

1. Pallavi Sethi, Smruti R. Sarangi, Internet of Things: Architectures, Protocols, and Applications, 2017. URL - <https://www.hindawi.com/journals/jece/2017/9324035/>
2. Sokolov M.N., Smolianinova K.A., Iakusheva N.A., Problems of IoT security, 2015. URL - <https://cyberleninka.ru/article/n/problemy-bezopasnosti-internet-veschey-obzor/viewer>
3. Oreshkina Daria, Internet of Things Security Reference Architecture, 2017. URL - <https://www.anti-malware.ru/practice/solutions/iot-the-reference-security-architecture-part-1#part5>

¹ Yuliia Kovbas

Student

² Olga Izmailova

PhD, Associate professor

^{1,2} Kyiv National University of Construction and Architecture

SCENARIO FORMATION CONSTRUCTION OF A LOCAL CORPORATE NETWORK OF THE ENTERPRISE

Abstract. Stages of construction of a corporate network of the enterprise, ways of construction of a network, formation of scenarios of construction of a local enterprise network are considered.

Keywords: architecture, local area network, design, client, server, technologies.

With the growing number of enterprises, the problem of designing and creating local enterprise computer networks. This paper proposes a system for forming a scenario for building a local enterprise computer network (LECN)

The purpose of this system is to study the scenario of optimizing the structure of LECN taking into account the situational conditions of a particular subject area of the problem, user requirements based on the application of a set of models of system analysis, system design and multicriteria evaluation [1].

The scenario includes the following steps [2]:

1. Formation of system architecture. For corporate systems, a client/server architecture is recommended, which is mainly based on a template (Fig. 2), where the variables are the number of users and the type of computing resources.

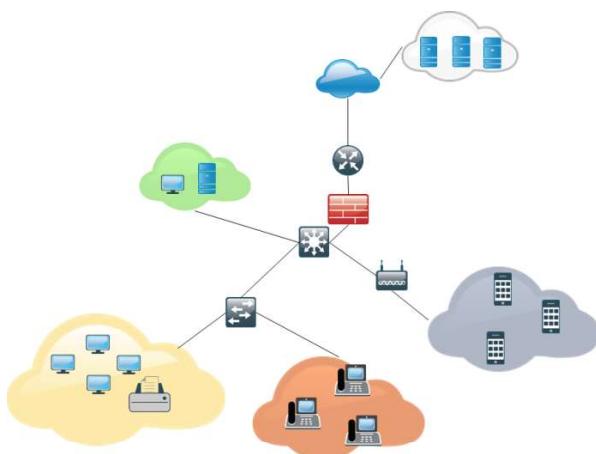


Figure 1: An example of LECN architecture

2. Forming a model of the script in the form of a diagram of precedents (Fig. 3), where the basic precedent is the choice of the necessary software (SW) and hardware (HW).

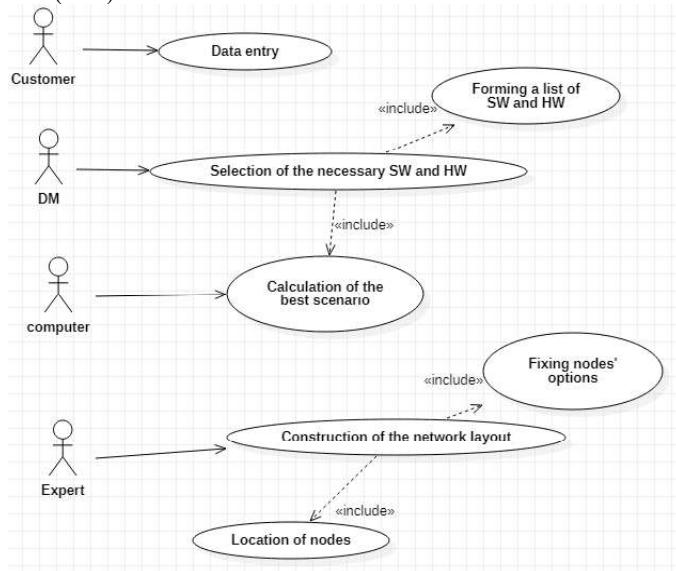


Figure 2: Diagram of system precedents.

The basis of the construction of options for determining the structure of computing resources are the following components:

- Computing resources. The computing resource of the network is a server, but it can be actually a corporate server, which from the company's point of view is HW, or a dedicated place on a remote server (cloud computing), which from the company's point of view is SW A mixed solution - a hybrid calculation - is also possible.
- Corporate database management system. The use of a database depends on the specifics of the company's information activities.
- Electronic document management system. EDMS systems implement a simplification of the company's document management mechanism.
- Services. A service is a web-identified software system with standardized interfaces that can communicate with each other and with third-party applications through messages based on certain protocols.
- Software. Each company has its own specifics, which is determined by the nature of its activities, which in turn determines the software.

Using statistics [3] to find popular solutions, in terms of the functions to be performed by the system, the method of morphological analysis created a possible set of variations (Tab. 1).

Table 1
The result of morphological analysis

Computing resources	OS	Database	EDMS	Services			Software
				General	Security	Fault tolerance	
Cloud computing	Windows	MySQL	Zoho Docs	Proxy	With Backup	General	
Corporate server	Linux	MongoDB	Logical Doc	Log	Without Backup	MacOS - oriented + general	
Hybrid calculation	MacOS	Microsoft SQL Server	SharePoint Online	Proxy + Log		Windows - oriented + general	
		PostgreSQL		None			
		SQL					

Due to the compatibility of couples most appropriate components are the following variations:

- Z1: Windows + Microsoft SQL Server + SharePoint Online + Cloud (Mail + File) + corporate server (Web + Backup + Log) + Proxy + Software (Windows-oriented + general);
- Z2: Linux + MySQL + Logical Doc + Cloud (Mail + File + Web) + Software in general);
- Z3: Linux + MongoDB + Zoho Docs + corporate server (Mail + File + Web + Backup + Log) + Proxy + software (general);
- Z4: MacOS + PostgreSQL + Zoho Docs + Cloud (Mail + File + Web) + corporate server (Backup + Log) + Proxy + Software (MacOS - oriented + general);
- Z5: Linux + PostgreSQL + Zoho Docs + Cloud (Mail + File + Web) + corporate server (Backup + Log) + Proxy + software (general).

4. Scenario choice

Choosing a scenario decision maker (DM) is guided by the following decision-making methods:

- Method of analysis of hierarchies [4], which allows to assess the composition and relative priority of the established evaluation criteria. The basic ones are: performance, scalability, security, manageability, compatibility and cost.
- Method of direct expert evaluation of the values of the criteria for each variant of the structure [5] (Tab. 2)

Table 2

Normalized values of the criteria of each scenario from 1 to 10 points

Scenario	Performance	Scalability	Security	Manageability	Compatibility	Cost
Z1	7	7	3,25	7	10	1
Z2	1	4	10	1	5,5	10
Z3	4	10	1	1	5,5	8,663
Z4	4	1	5,5	7	1	8,697
Z5	10	1	7,75	7	5,5	8,775
Z1	7	7	3,25	7	10	1

- Method of linear convolution of criteria, based on which the utility function of each scenario is determined.

The selected scenario is the basis for further work of ATS formation of the network layout and activity diagram (Fig. 2), which describes the logic of its implementation. When entering data, the customer provides information about:

1. Type of activity of the company,
2. Number of employees,
3. Plan of the room where the network will be deployed,
4. Specifics of information data flows.

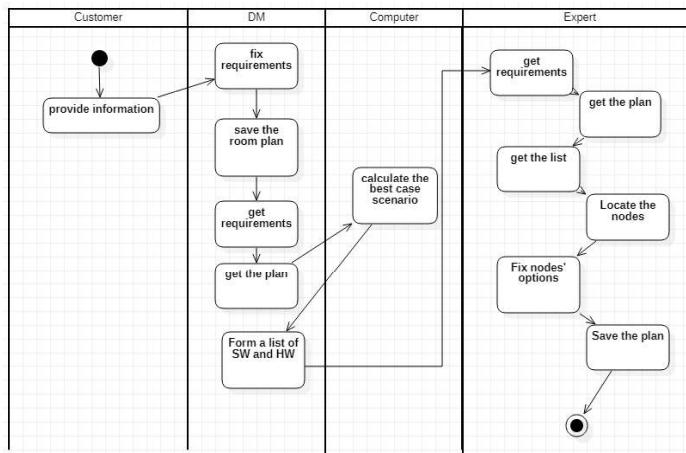


Figure 2: Diagram of activities at the level of precedents.

References:

1. T. Hamdi, Introduction to Operations Research, 6th. ed, Williams Publishing House, 2001.
2. Complete Cisco Handbook, 3rd ed, 2009.
3. Global Business Data Platform URL: <https://www.statista.com/>.
4. B. Bogush, O. Dovidkov, Design of secure information systems and networks, DUICT, 2006.
5. O. Izmailova, G. Krasovska, Approach to building an open database of DSS models for the assessment of investment projects of man-made safety, Management of complex systems development, Kyiv, 2018.

¹ Yuri Kravchenko

Doctor of Technical Sciences, Professor

² Natalia Dakhno

Doctor of Philosophy, Associate Professor

³ Olga Leshchenko

Doctor of Philosophy, Associate Professor

⁴ Anastasiia Tolstokorova

Student

^{1,2,3,4} Taras Shevchenko National University of Kyiv

MACHINE LEARNING ALGORITHMS FOR PREDICTING THE RESULTS OF COVID-19 CORONAVIRUS INFECTION

Abstract. The paper analyzes data collected from around the world on patients with COVID-19. A binary classifier has been developed that considers data on a person's health, symptoms, patient's age, and other properties and determines the patient's disease outcome by assigning it to one of two categories: fatal or not. The work's practical value is to help hospitals and health facilities decide who needs care in the first place when the system is overcrowded and to eliminate delays in providing the necessary care.

Keywords: supervised learning, classification problem, model fitting, feature selection, feature engineering, data normalization, model validation, confusion matrix, logistic regression, Naive Bayes, Decision tree, random forest.

In March 2020, the World Health Organization officially declared the Covid-19 coronavirus a global pandemic. COVID-19 coronavirus disease is an infectious disease caused by the recently discovered coronavirus SARS-CoV-2. By visualizing the development of the disease in other countries where the outbreak has passed, it is possible to build a truly effective behavior strategy that will save lives while minimally harming the economy, if possible, in these circumstances.

In this work, a DSS model was developed to help identify patterns between the characteristics of the patient (sex, age, types of symptoms, and chronic diseases) who contracted COVID-19 and mortality. This study offers a model of artificial intelligence that can provide hospitals and medical facilities with the information they need to address congestion. It will also allow developing a patient sorting strategy to address hospitalization priorities and eliminate delays in providing the necessary care.

Before the study, relevant data were found that meet the criteria for the work [1]. This dataset collects data from more than 920,000 patients from around the world of all ages, with various chronic diseases and symptoms, including men and women.

After obtaining the required data, several algorithms were selected that are most suitable for achieving this goal [2]. In this study, five classification algorithms were selected that had previously proven to be the best in this type of problem. These are the following algorithms [3]: Logistic regression, K -nearest neighbors algorithm, Decision trees, Reference vector method, Naive Bayesian classifier.

To assess the quality of classification models that will solve this problem, the following metrics were chosen [4]: accuracy, precision, recall, f-measure, logarithmic loss (logloss), area under the ROC curve.

The results are shown in Table 1 and Table 2.

Table 1

Classifier model	Accuracy score	Precision score	Recall
Logistic regression	0.85185185185	0.956521739130	0.55
K-nearest neighbors	0.86419753086	0.931034482758	0.675
Decision tree	0.90123456790	1.00	0.8
Method of reference vectors	0.777777777778	0.95652173913	0.55
Naive Bayesian	0.81481481481	0.757575757575	0.625

Table 2

Classifier model	logloss	F-measure	ROC
Logistic regression	0.78	0.22168696855	0.824782324771
K-nearest neighbors	0.58	0.3694783949	0.712064649542
Decision tree	0.89	0.1182328674	0.9
Method of reference vectors	0.47	0.428594828689	0.662064649542
Naive Bayesian	0.68	0.339922231006	0.810758598171

After analyzing each of the algorithms and comparing the results, we can say that in this study, among all the proposed methods of machine learning to solve problems of binary classification, the algorithm of decision-making trees best coped.

The developed classifier and its application in DSS can help hospitals and health facilities decide who needs attention in the first place when the system is overcrowded, as well as eliminate delays in providing the necessary care.

References:

1. B. Xu, B. Gutierrez, S. Mekaru and et al. "Epidemiological data from the COVID-19 outbreak, real-time case information", Scientific Data. 2020 Mar;7(1):106. DOI: 10.1038/s41597-020-0448-0.
2. D. T. Larose, C. D. Larose, "Discovering Knowledge in Data: An Introduction to Data Mining", John Wiley & Sons, 2014. ISBN: 978-0-470-90874-7.
3. T.M. Mitchell, "Machine Learning", 1997.
4. Y. Sasaki, "The truth of the F-measure", School of Computer Science, University of Manchester, 2007.

¹Ruslan Kucherenko

master

²Olha Kravchenko

Ph.D., Associate Professor of Information Systems and Technologies

^{1,2}Taras Shevchenko National University of Kyiv

IoT SOLUTIONS SYSTEM FOR CLIMATE CONTROL PROCESS OF MAKING CHEESE

Abstract: The problem of industrial application of IoT of things is considered. A system of IoT solutions for climate control of the cheese-making process at a dairy plant is being developed. The structural scheme of the climate control system is proposed, which includes hardware and means of communication. Sensor data is transmitted to the data processing system.

Keywords: IoT solution, climate control system, production technology, block diagram, information technology

The aim of the research is the process of designing and practical implementation of the IoT solution system for climate control of the dairy production process on the example of the cheese ripening chamber.

The object of the study is industrial systems that contain industrial climate control of the process of making dairy products: the manufacture of hard cheeses [5]. Following the reviewed information sources, it was found that the development of IoT solutions in dairy production is poorly represented [2-4]. Given the visible advantages, it was decided to choose for the development of climate control system cheese ripening chamber Wi-Fi module ESP8266-01. The Arduino Nano V3 board and various sensors are used, which provides automatic climate control. The main requirements for the system of IoT solutions for climate control of the cheese-making process are ease of implementation, availability of hardware and software technologies, and price.

In the operation of the climate control system for cheese storage chambers, there is a comparison of defined and current values. According to the results, a signal is given to activate the required process. An indication is used to display all active processes.

Following this goal, we describe the algorithm of the climate control system for cheese storage chambers.

1. Display of nominal values of temperature and humidity depending on the type of cheese. According to the norms of DSTU 6003:2008, raw materials are stored indoors at temperatures from minus 4 to 6 °C and relative humidity - from 80% to 90% [5].

2. Get indicators that characterize the environment. The main ones are temperature and humidity. Additionally, the CO₂ concentration in the air and illuminance are read.

3. Compare nominal and real values. According to the result, give a signal to perform the processes: heating, cooling, humidification, dehumidification, ventilation, lighting control.

Structure diagram for automated climate control of image storage cameras in [1].

According to the described algorithm, the device should consist of an Arduino microcontroller, light sensor, temperature sensor, humidity sensor, CO₂ level sensor, relay set control system, WI-FI module [6-10].

The strength of the IoT solution system for climate control of the dairy production process is its structure. Due to the branched structure, the program simultaneously receives and processes data from light, pressure, and humidity sensors.

The disadvantage of this software is the initial stage of implementation of the system, which will require additional funds for the purchase of sensors and installation of the communication network as hardware for the IoT solution for climate control of dairy products, but it will pay off during operation.

In the future, this system allows you to add modules for the analysis of manufactured products or storage system.

Threats that will have negative consequences for the system of IoT solutions for

- climate control of the dairy production process can be considered insufficient funding;
- staff training costs;
- the need to introduce a specialist to the plant staff who will be responsible for maintaining the software product.

The developed software product takes into account the advantages of analogs on the market, but has a cheaper cost and has the advantages of ease of use required for cheese production.

It is planned to implement the system for production.

References:

1. Kravchenko O. V., Kucherenko R. Y., Danchenko E.B., Besedina S.V. Розробка системи iot рішень для клімат контролю процесу виготовлення молочної продукції// Sciences of Europe, Vol 2, No 51. Praha, Czech Republic. 2020. Pp. 69-75.
2. Perera C., Chi H. L. M. A survey on internet of things from industrial market perspective // IEEE Access. – Volume 2, 2014, pp. 1660–1679.
3. Debasish Mondal, The Internet of Thing (IOT) and Industrial Automation: a future perspective// World Journal of Modelling and Simulation (2019) [Electronic resource] - Resource access mode: <https://cutt.ly/JgDW30c>
4. Shopan Dey, Ayon Roy and Sandip Das. Home Automation Using Internet of Thing// IRJET (2016), 2(3) pp. 1965-1970,
5. ДСТУ 6003:2008 Сири тверді. URL: <https://cutt.ly/8gDWVOD>
6. Arduino nano v3 datasheet URL: <https://cutt.ly/4t2cjeu>
7. GY-302 datasheet URL: <https://cutt.ly/Qt2czHG>
8. AM2320 datasheet URL: <https://cutt.ly/Dt2cQq5>
9. MQ-135 datasheet URL: <https://cutt.ly/Zt2cR1L>
10. ESP8266-01 datasheet URL: <https://cutt.ly/9gSxH1y>

¹ V.Kudin

Doctor of Technical Sciences, Associate Professor

² A.Onyshchenko

Doctor of Economic Sciences, Associate Professor

³ Oleh Ilarionov

PhD in Engineering Science, Associate Professor

^{1,2,3} Taras Shevchenko National University of Kyiv

MODELING OF DYNAMIC ECOLOGICAL-ECONOMIC INTERACTION

The emergence and intensification of global environmental problems and the growing destabilization of the climate prove the need to change the established economic paradigm of development. It is becoming increasingly clear that the traditional model of economic growth, which ignores the importance of natural factors, cannot prevent the aggravation of global environmental problems, including further climate change; it has exhausted itself in the current historical period of civilization. Thus, there is a need to build a concept of balanced interaction of economic and environmental spheres.

Balance implies mutual coherence of the system of proportions of production at the macro and micro levels. It characterizes the degree of proportionality, i.e. the degree of conformity of production, needs, and environmental standards. More progressive proportions make it possible to achieve a higher level of balance.

The balance of the economy as a form of systematic interconnection of production and consumption implies the correspondence of the volume and structure of output of products and services to the volume and structure of social needs in kind and value, in time and space, in qualitative and quantitative characteristics.

In [1] it is proposed to consider the costs of meeting the emission limits of greenhouse gases in the structure of the main production industries in the form of a balance ecological and economic model:

$$\begin{cases} x_1 = A_{11}x_1 + A_{12}x_2 + Cy_2 + y_1, \\ x_2 = A_{21}x_1 + A_{22}x_2 - y_2, \end{cases} \quad (1)$$

The first equation of the proposed model reflects the economic balance – the distribution of gross industrial output for production consumption of primary and secondary production, final consumption of primary production and costs associated with the implementation of environmental obligations.

An important step in the study of ecological and economic interaction is to preserve the structural balance of the model in terms of its directed transition from one state to another. The balance of the economy as a form of systematic interconnection of production and consumption implies the correspondence of the volume and structure of products and services produced to the volume and structure of social needs in kind and value, in time and space, qualitative and quantitative characteristics. The transition to a high organization and efficiency economy leads to the achievement of a comprehensive dynamic balance of production and ecology, as this is a necessary prerequisite for proportional, deficit-free development of ecological and economic system, optimal functioning of all its structural subsystems. Without a stable balance of economic development, which requires the entire correspondence between the volume and structure of production and the volume and structure of needs, the optimal proportions of all reproduction processes, it is impossible to achieve planned environmental parameters, rational use, gradual intensification of economic development.

Successful solution of the process of interaction between ecology and economy is possible under the conditions of using the mathematical apparatus as an effective tool for formalizing the abstract field, i.e. mathematical modeling.

According to model (1), the original output vector $x = (x_1, x_2) = (\underbrace{x_{11}, x_{12}, \dots, x_{1p}}_{x_1}, \underbrace{x_{2p+1}, x_{2p+2}, \dots, x_{2p+q}}_{x_2})$ can be interpreted as follows:

The components of the sub-vectors respectively form the resulting interaction of the components of the output of useful products of the main $x_1 = (\underbrace{x_{11}, x_{12}, \dots, x_{1p}}_{x_1})$ and components of the auxiliary production of the “output” of pollutants $x_2 = (\underbrace{x_{2p+1}, x_{2p+2}, \dots, x_{2p+q}}_{x_2})$ among themselves, i.e. the lower level of interaction.

Together, the components of the vector (x_1, x_2) form an aggregate interaction of sub-vectors, i.e. x . This vector will determine the resulting gradient of “exit” of the ecological and economic system. It is easy to see that changes in the ecological and economic model will cause a change in the vector of output – the exit of the system and vice versa.

The issue of determining the priority of development of economic and environmental components can be determined by the involvement of experts – specialists in this field. That is, to form the coefficients of decomposition of vector x by vectors x_1, x_2 . The decision to give them a specific meaning can be made considering a system of criteria. In such conditions, the construction of the vector of advantages

according to the system of criteria is solved with the involvement of a group of experts (methods of expert evaluation [2]).

On the other hand, the result of the work of the team of experts (application of expert evaluation methods) also provides a mechanism for the formation of weights for the system of criteria, i.e. their priority. What for the specified model (1) forms the direction of the main development and improvement of the model. A separate (inverse), important task is to make targeted changes in the model, which will “fill” the content of the strategy of changes in the technological elements of the model, to achieve the set of development indicators. This is the task of building a given mainstream of development (directed change) of the ecological and economic model [3]. The complexity of the task increases with the need to consider the limitations in the system for conducting such organizational “innovations”.

Thus, there is a pressing issue of constructing mathematical algorithms and their application to the balance ecological and economic models of type (1) in order to work out ways to transfer the system from one state to another by given economic and environmental criteria.

References:

1. Onyshchenko A.M. Methodology of mathematical modeling of economic and ecological interaction in terms of implementation of the Kyoto Protocol / I.M. Onishchenko. Lyashenko, AM Onishchenko // Economic Cybernetics. - 2011. - 64-6 (70-72) - P. 17-26.
2. H. Hnatienko, V. Snytyuk. Expert decision-making technologies. K.; Ltd. “McLaut”, - 2008.-144 p.
3. V. Kudin, A. Onyshchenko, I. Onyshchenko. Algorithmizing the methods of basis matrices in the study of balance intersectoral ecological and economic models. Eastern-European Journal of Enterprise Technologies. ISSN 1729-3774, 3/4(99)2019, p. 45–55 DOI: 10.15587/1729-4061.2019.170516

¹ **Olga Leshchenko**

PhD in Technical Sciences, Associate Professor

² **Natalia Dakhno**

PhD in Technical Sciences, Associate Professor

³ **Oksana Herasymenko**

PhD in Technical Sciences, Associate Professor

⁴ **Vladislav Lavrinovich**

student Department of Networking and Internet Technologies

¹⁻⁴ Taras Shevchenko National University of Kyiv

APPLICATION PECULIARITIES OF GRADIENT DESCENT ALGORITHMS IN NEURAL NETWORKS

The steepest descent method (gradient descent) is a method of numerical optimization to find the minimum or maximum of a function by moving in the direction of the gradient or anti-gradient. It has the easiest implementation compared to other methods of optimization, has a fairly weak convergence conditions, but very low speed (linear). The gradient step is very often used in other methods, such as Fletcher-Reeves.

The gradient descent method is used in various machine learning algorithms where we need to find the extremum of the function - neural networks, SVM, k-means, regression.

In neural networks, the gradient descent method with some modifications is very widely used for perceptron training and is also known as error backpropagation.

The problem is that for neural network training, it is necessary to change the weights in order to minimize the average loss at the output (use optimization algorithms on the loss function to reduce loss as quickly as possible). In other words, in order to formally make one step on the gradient, it is necessary to submit all data to the input sequentially, calculate the error for each value and calculate the required weight correction, and after submitting all data calculate the value in the adjustment of each coefficient (gradient sum) and correct the coefficients for this step, which takes a lot of operations to perform[1].

For instance, for linear regression, the loss function will be defined as

$$S(\theta) = \sum_{i=0}^n (y_i - \hat{y}_j)^2$$

where θ is a free regression parameter. By definition, a gradient is a vector of the following form:

$$\nabla f = \frac{\partial f}{\partial x_1} e_1 + \dots + \frac{\partial f}{\partial x_n} e_n$$

and $\frac{\partial f}{\partial x_n} e_n$ is a partial derivative.

Let us define the point a , around which the function is defined and differentiated. Then the vector of the antigradient will indicate the direction in which the function will fall the fastest. From this we can determine that in a certain point $b = a - a\nabla f(a)$ for

some small a , the value of the function will be less than or equal to the value of the function at point a . Based on the afore mentioned concepts, we can derive a formula for determining the unknown parameters:

$$\theta_j = \theta_j - \alpha \frac{\partial S(\theta)}{\partial \theta_j}$$

where α is a step of the method. From here we can derive a formula for calculating free regression parameters:

$$\frac{\partial S(\theta)}{\partial \theta_j} = \frac{\partial}{\partial \theta_j} (y - \sum_{i=0}^p \theta_i x_i)^2 = -2(y - \sum_{i=0}^p \theta_i x_i) x_j$$

Let us rewrite the formula for a sample of n elements:

$$\theta_j = \theta_j + \alpha \sum_{i=0}^n (y^{(i)} - \hat{y}^{(i)}) x_j^{(i)}$$

In other words, for v iterations and n elements for each j it is necessary to repeat the above algorithm v times.

The requirement of simultaneity means that the derivative must be calculated with the old θ values, i.e. we should not initially calculate the first parameter, then the second, etc., because after changing the first parameter, the individual derivative will also change its value.

Suppose we have a three-dimensional figure, and if we calculate the parameters one by one, then this process can be described as movement in coordinates (one coordinate at a time) instead of movement along the vector. This variant of the algorithm is called batch gradient descent. The number of iterations also means that the parameters will be adjusted until the previous and given values of the function become equal. In practice, such equality is impossible to achieve and the criterion ε , is introduced, which characterizes the convergence threshold, i.e. if the difference between the previous and current function is less than or equal to ε iterations cease.

There is another version of the algorithm - stochastic gradient descent. Let's compare the formulas of stochastic and batch gradient descent in the pseudocode of iterations:

Batch: for i in train_set: {

$$\theta_j = \theta_j + \alpha \sum_{i=0}^n (y^{(i)} - \hat{y}^{(i)}) x_j^{(i)}$$

}

Stochastic: for i in train_set: {

$$\theta_j = \theta_j + \alpha (y^{(i)} - \hat{y}^{(i)}) x_j^{(i)}$$

}

Although the formulas are similar, there is a significant difference between the algorithms: batch gradient descent calculates the step using the entire set of input parameters, and stochastic uses only one element per step.

The disadvantage of the batch algorithm is that when passing through the curved flat valley, the method performance is very slow, because the steps become very small [2]. However, the stochastic algorithm does not follow the exact direction of anti-gradient but deviates each time in random direction, although it almost always reaches an extreme.

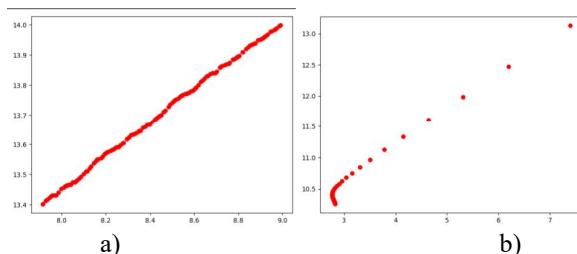


Figure 1. Comparison of stochastic (a) and batch (b) descents for 200 elements

As we can see in Fig.1 b) batch descent falls into the the curved valley, so the steps along it become very small, however, sooner or later the batch descent will reach the minimum. Therefore, there is no noticeable difference between algorithms in the sample of 200 elements, but if you increase the sample to 2000 elements, the stochastic descent shows much higher efficiency.

There is also a third type of algorithm: mini-batch. Unlike the batch and stochastic algorithms, the mini-batch algorithm uses not one or all values, but a number of values, such as 100 random ones. This algorithm is more often used in practice, because it is more efficient than the batch algorithm, and less random than stochastic descent [3].

Thus, the batch algorithm is well suited for strictly convex functions, stochastic works better with functions that have a large number of local minima (random values allow to come out of curved valleys), stochastic algorithm is generally faster, because it does not use the entire sample, although it performs more steps. The mini-batch method allows you to vectorize the stochastic algorithm, which speeds up execution and increases accuracy.

References:

1. A. El Mouatasim (2018). Implementation of reduced gradient with bisection algorithms for non-convex optimization problem via stochastic perturbation. *Journal of NumericalAlgorithms*, 78(1):41 - 62.
2. Y. Yao, L. Rosasco, and A. Caponnetto. On early stopping in gradient descent learning. *Constructive Approximation*, 26(2):289–315, 2007
- 3.Cotter,A,Shamir,O.,Sridharan, K.,“Better mini-batch algorithms via accelerated gradient methods,” *Advances in Neural Information Processing Systems*,2011,pp.1647-1655.

¹ Yehor Myroshnychenko

Master degree Student of Information Systems and Technologies.

² Sergiy Palij

PhD, Associate Professor of Information Systems and Technologies.

^{1,2} Taras Shevchenko National University of Kyiv

ROAD TRAFFIC OPTIMIZATION BY IOT

Abstract. The article discusses the principles of monitoring road traffic. The basis of the traffic monitoring system is visual observers and sensors of traffic parameters. Existing systems and their traffic sensors show unsatisfactory results. In order to optimize road traffic in cities, it was decided to develop a microprocessor-based system for determining the traffic intensity. The basis is Hall sensors and the Arduino Pro Mini microprocessor controller.

Keywords: vehicle traffic monitoring, traffic optimization, IoT.

Purpose and objectives. Given the growing rate of increase in traffic, the issue of traffic monitoring is relevant for effective assessment of problematic sections of the route, obtaining operational traffic information, traffic management in cities, regulating the duration of traffic lights and timely activation of information signs. The purpose of this work is to develop a zonal controller that could perform all these functions. The task is to develop such a block so that it consists of a minimum number of functional units and provides accurate information about the condition of the road.

Object and subject of research. The object of research is the basis of information systems for traffic monitoring - visual observers and sensors of traffic parameters. The efficiency of the entire information system largely depends on their functionality and reliability of data. Modern road traffic control systems are based on zonal controllers (ZC), which consist of sensors to obtain primary information about the movement of vehicles and a microprocessor unit for data processing [1]. The subject of the study is the simplification of the design of the ZC while improving their characteristics.

Scientific novelty. Optical and ultrasonic sensors, magnetic gates, video surveillance systems are most often used in ZC [2]. Existing traffic sensors of foreign production show unsatisfactory results in the conditions of intensive traffic of vehicles (vehicles), parking of vehicles in the lane, visual overlap of vehicles of the traffic sensor and when moving vehicles between lanes. This leads to a premature transition of the ZC to the functional state of "congestion", and a significant reduction in the informativeness of the system. I proposed the implementation of the ZC, which eliminates all the above shortcomings.

Research results. To find the optimal solution for recording the movement of

cars, the currently existing traffic control systems [3,4] are analyzed, which use different physical effects and appropriate sensors to collect primary information. Analysis of existing monitoring systems shows that the weak point of such systems are the sensors / methods by which motion is detected. Therefore, the main task in creating a new traffic control system is to choose an effective method of recording traffic

means. Below we will consider the method based on the Hall effect and show the possibility of its application in traffic monitoring systems. Each vehicle has metal elements in its body and, when moving, it will in one way or another affect the Earth's magnetic field [5]. To record this change, we use magnetic field sensors. The data read by the sensors during the perturbation of the magnetic field is processed by a microcontroller with a pre-loaded program (in our case, the microcontroller performs the functions of determining the speed and direction of movement). The system includes the following components and blocks:

- two sensors - Hall sensors for removing primary information;
- data processing unit, consisting of a reading unit and a calculation unit;
- the reading unit, implements the reading of information from the Hall sensors with a certain reading step t_s .
- computing unit, that implements the algorithm of the system, performing the necessary speed calculations movement on the basis of information received from the reading unit;
- the data visualization unit implements the user interface of the system with the visualization of the monitoring results.

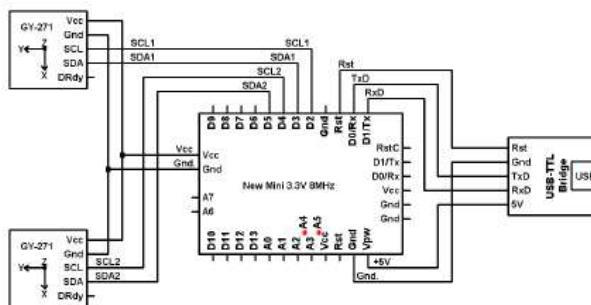


Figure 1 - Schematic of the electrical principle of the zonal controller

Research methods and tools. To test the efficiency of the above method of measuring the intensity of movement, a model of the experimental stand was designed. Magnetic field sensors were installed at a distance of 10 cm from each other. To emulate the movement of the vehicle, at a height of 2-3 cm from the sensors moved a piece of steel, oriented perpendicular to the direction of movement. The piece of steel was chosen as an object that to some extent resembles the front / rear axle of the car.

Conclusions:

1. The existing traffic control systems are analyzed.
2. The analysis of physical methods of control of movement of motor transport is carried out.
3. The analysis of methods of information processing and traffic monitoring is carried out.
4. To register the movement of vehicles, it is proposed to use sensitive magnetic field sensors - digital compasses.
5. Developed a project of a microprocessor system with magnetic sensors to record the movement of vehicles.

References:

1. Ju R. S. Transportation quarterly / Eno Foundation for ... v.41 [Електронний ресурс] / R. S. Ju, A. R. Cook, T. H. Maze // Westport, Conn. : The Foundation. – 1987. – Режим доступу до ресурсу: <https://goo.su/2scr>.
2. Ahmed S. A. Urban freeway traffic management technology [Електронний ресурс] / Ahmed // Journal of Transportation Engineering / Volume 112 Issue 4 – Режим доступу до ресурсу: <https://goo.su/2scs>.
3. Jovanis P. P. Coordination of Actuated Arterial Traffic Signal Systems [Електронний ресурс] / P. P. Jovanis, J. A. Gregor // Journal of Transportation Engineering / Volume 112 Issue 4. – 1986. – Режим доступу до ресурсу: <https://goo.su/2SCS>.
4. Monitoring avtomobilnyih dorog [Електронний ресурс] // ONIL SAPR GIS. – 2012. – Режим доступу до ресурсу: <https://goo.su/2sCu>.
5. Sistemyi dorozhnogo monitoringa. Intellektualnaya transportnaya sistema [Електронний ресурс] // MK Grupp. – 2015. – Режим доступу до ресурсу: <https://goo.su/2scV>.
6. Datchyky mahnitnoho polia. Novi zastosuvannia i tekhnolohii vymiriuvannia rukhu i strumu [Електронний ресурс] // Ecworld. – 2017. – Режим доступу до ресурсу: <https://goo.su/2SCY>.
7. ARDUINO VY'MIRYuYeMO MAGNITNE POLE ZEMLI MAGNITOMETROM HMC5883L [Електронний ресурс] // Mikrotik KPI – Режим доступу до ресурсу: <https://goo.su/2SCZ>.
8. Sbor i obrabotka dannyih IoT. Stoit li vnedryat i kak eto sdelat effektivno [Електронний ресурс] // DIS Group. – 2018. – Режим доступу до ресурсу: <https://goo.su/2Sd0>.
9. Biloschitsky A. A. Optimizatsiya dorozhnogo trafika s ispolzovaniem sredstv IoT [Електронний ресурс] / A. A. Biloschitsky, Y. M. Myroshnychenko // «Molodiy vcheniy» # 5 (81). – 2020. – Режим доступу до ресурсу: <https://goo.su/2Sd2>.

¹Volodymyr Nakonechnyi

Doctor of Technical Sciences, Professor at the Department of Cyber Security and Information Protection, Faculty of Information Technologies

²Oleksandr Pliushch

Candidate of Technical Sciences, Docent at the Department of Mobile and Videoinformation Technologies

³Andrii Bielikov

Student

^{1,3} Taras Shevchenko National University of Kyiv

² State University of Telecommunications, Kyiv, Ukraine

DEVELOPMENT AND ANALYSIS OF ALGORITHMS FOR RECOGNIZING MOVING OBJECTS IN THE DATA STREAM

Abstract. The problem of detecting the movement of objects in a video stream is relevant for the development of systems based on computer vision. Computer vision is a new scientific direction of robotics and artificial intelligence, associated with image processing and the selection of real-world objects. This direction is closely related to such areas as computer vision, image processing, analysis and pattern recognition.

Keywords: motion recognition, algorithm, stream, frame, image.

Introduction:

With an ever-expanding scope of information systems and computer technologies, the task of processing video images in the video stream occurs quite often.

Today, there are a lot of works that overviewed recognition of objects and multimedia data by such scientists as D. Forsyth, A. Yuriev, V. Pratt, J. Furman, etc. The authors of these works mainly provided a theoretical basis for the algorithms for motion detector and object tracking [1]. They mathematically described the principles of their operations as well. Therefore, it became necessary to develop a program that would automatically track objects along the entire "field of view" of the camera.

The problem of identifying moving objects and methods of its solution:

The task of detecting the movement of an object was first implemented in motion sensors. Motion sensor is a special device that tracks the movement of some objects. This term is most often understood as an electronic infrared sensor that detects the presence and movement of a person, switching the power supply of electrical appliances (most often, lighting). The principle of operation of motion sensors is based on tracking the level of infrared radiation in the sensor's field of view. When a person (or other massive object with a temperature higher than the background temperature) appears, the voltage rises at the output of the pyroelectric sensor. Typically, motion sensors are used in two cases: either for automatic control of lighting devices, or for burglar alarms [2].

Nowadays several algorithms have been developed to solve the problem of detecting moving objects in two-dimensional images. Most of them are based on

separating the foreground from the background of the image. Background subtraction methods make a pixel-by-pixel comparison of the current frame with the model and associates pixels with the foreground or background.

The main problem that arises when processing data from a video stream is the speed of the algorithms. It is necessary to have time to process the current frame before the next one is received. The idea of the algorithm is to compare the location of all objects in the "field of view" of the web-camera on two adjacent frames, and determine which of them has changed its position. In other words, you need to identify and recognize a moved object.

Object recognition theory develops the theoretical foundations and methods for classifying and identifying objects, phenomena, processes, signals, situations and other objects characterized by a finite set of certain properties and attributes. Such tasks have to be solved quite often. Example is crossing a street at traffic signals. Recognizing the color of the traffic light and knowledge of the traffic rules allow you to make the right decision about crossing the street at the moment [3].

There are two main directions in object recognition that can be distinguished. First one is the knowledge of properties of recognition. Second one is their explanation and modeling, as well as the development of the theory and methods of constructing devices designed to solve individual problems in applied problems.

Typically tasks such as tracking and detecting motion can be complicated by foreign objects in the frame and obstacles. Typical tasks of computer vision are [4]:

- Recognition (the task of determining a specific characteristic object, feature or activity containing video data).
- Motion understanding (a sequence of images is analyzed to find an estimate of the velocities of each image point).
- Scene reconstruction (reproduction of a three-dimensional model of a circuit with two or more images).
- Image restoration (removing noise, sharpening motion blur, etc.).

During the research, a webcam was used to receive a continuous stream of video data. To analyze an image from a webcam, it was split into frames. A frame is a picture in .jpg format, which is a snapshot from a video stream.

References:

1. Zellner A., Ando T. Bayesian and Non-Bayesian Analysis of the Seemingly Unrelated Regression Model with Student-t Errors, and its Application for Forecasting. International Journal of Forecasting, 2010. P. 413-434.
2. T. Bouwmans and E. H. Zahzah. Robust pca via principal component pursuit: A review for a comparative evaluation in video surveillance. Computer Vision and Image Understanding, 2014.
3. C. Guyon, T. Bouwmans, and E.H. Zahzah. Robust principal component analysis for background subtraction: Systematic evaluation and comparative analysis, 2014.
4. Zoran Zivkovic. Improved adaptive gaussian mixture model for background subtraction. In Pattern Recognition, ICPR 2004, IEEE Proceedings of the 17th International Conference, P. 28–31.

¹ **Kateryna Nemchenko**

Bachelor degree Student of Information Systems and Technologies

² **Sergiy Paliy**

PhD, Associate Professor of Information Systems and Technologies

^{1,2} Taras Shevchenko National University of Kyiv

STATEMENT OF THE TASK OF BUILDING AN ADAPTIVE SYSTEM OF ENERGY-EFFICIENT LIGHTING FOR ADMINISTRATIVE BUILDINGS BASED ON THE INTERNET OF THINGS

Abstract. The relevance of developing adaptive lighting systems based on the Internet of Things has been described. The requirements for the system's capabilities have been formulated.

Keywords: Internet of Things, lightning, administrative buildings.

Every year, the use of systems based on the Internet of Things (IoT) is becoming more common in various industries. The use of such systems for controlling technological processes in modern office premises, buildings, and structures provides them unique advantages, which positively affect the level of competitiveness. IoT is widely applied for automating business processes, managing the operation of climate systems, controlling object security, and accessing premises and data in Information Systems. An example of IoT such systems is a system for controlling the lighting of administrative buildings.

The advantages of developing and using a smart lighting system are the improvement of energy efficiency and reducing energy costs; the possibility of centralized and individual devices management; monitoring the state of the lighting system; creating comfortable working conditions; managing system with a smartphone; ensuring security for people in the building.

It is proposed to develop an adaptive system for energy-efficient lighting of administrative buildings using the Internet of Things technology.

For the convenience of users, the system should provide the ability to control each lamp individually or to control the formed group of lamps simultaneously. The process of controlling indoor lighting can be simplified by creating basic scenarios for typical situations that do not require configuration, as well as the ability to create personalized scenarios depending on the user's needs.

For optimal IoT operation, the system must be equipped with light sources that allow you to change the color temperature of lighting, brightness, and color of light. Small changes, such as increasing or decreasing the brightness or setting warmer or colder lighting, as in Figure 1, will contribute to better creativity of employees, or will help direct their attention, focus, and thus increase their performance [1, 2].

The lighting system must interact with the security system and amplify alerts through color lighting and distinct scenarios that signal a dangerous situation.



Figure 1 – Different light temperatures in the Herstedlund school

Such a system implementation will increase the level of energy efficiency, reduce energy consumption, and create a controlled, comfortable production environment. The introduction of scenarios based on the use of presence sensors and light level sensors, in the absence of people, allows you to either completely turn off the lights or illuminate the room with lower brightness, taking into account the brightness of daylight, if the room has windows [3, 4].

While implementing an IoT system for lighting control potential problems should be taken into account. *Examples of such issues* are cyber threats to the system or insufficient digital competence of personnel.

Conclusions. The feasibility of the development lies in the fact that the use of the Internet of Things (IoT) system for administrative buildings such as lighting control systems will optimize business processes, conditions for their implementation, reduce energy and financial costs. In particular, the implementation of such a system will expand the capabilities of devices management and help to improve processes by analyzing the data obtained while monitoring the usage of premises and devices. Moreover, it will have a positive impact on the employees' performance and reduce energy consumption.

References:

1. Effect of Light Color Temperature on Human Concentration and Creativity. URL: <https://pubmed.ncbi.nlm.nih.gov/26098084/>
2. School invests in ‘concentration’ lighting. URL: <https://www.luxreview.com/2019/03/08/schools-invests-in-concentration-lighting/>
3. Saving Energy with Internet of Things. URL: <https://www.schoolofthefuture.sg/saving-energy-with-internet-of-things>
4. Creating Smarter Schools: Benefits and Applications of IoT in Education. URL: <https://www.igor-tech.com/news-and-insights/articles/creating-smarter-schools-benefits-and-applications-of-iot-in-education>

¹Peter Nikolyuk

Doctor of physics and mathematics sciences, professor of computer sciences and information technologies department, professor

²Tatiana Neskorodieva

PhD, associate professor of computer science and information technologies department

³Eugen Fedorov

Doctor of technical science, associate professor, professor of department robotics and specialized computer systems

⁴Esta Chioma

Student of computer sciences and information technologies department

^{1,2,4} Vasil' Stus Donetsk National University

³Cherkasy State Technological University

INTELLECTUAL ALGORITHM IMPLEMENTATION FOR MEGACITY TRAFFIC MANAGEMENT

Abstract. This investigation is aimed solving traffic problem in a big city. Laying of an optimal route for each vehicle in metropolis has been performed. As a result of application of urban traffic regulation an optimal regime of vehicle movement is achieved.

Keywords: urban traffic, optimal route, A^{*}-algorithm, multigraph, java program

The research represents technology that implements an optimal route for each vehicle in a large city [1]. As a criterion of an optimality, time travel vehicle on the pointed route is selected. Let us call this criterion as t-optimal one.

Transport network of any city is presented as a weighted oriented graph [2]. The laying of t-optimal route in such graph is based on: 1). fixing vehicles that cross each intersection; 2). control of all traffic lines between intersections and as a result, the optimal route is selected; 3) use of A^{*}-algorithm.

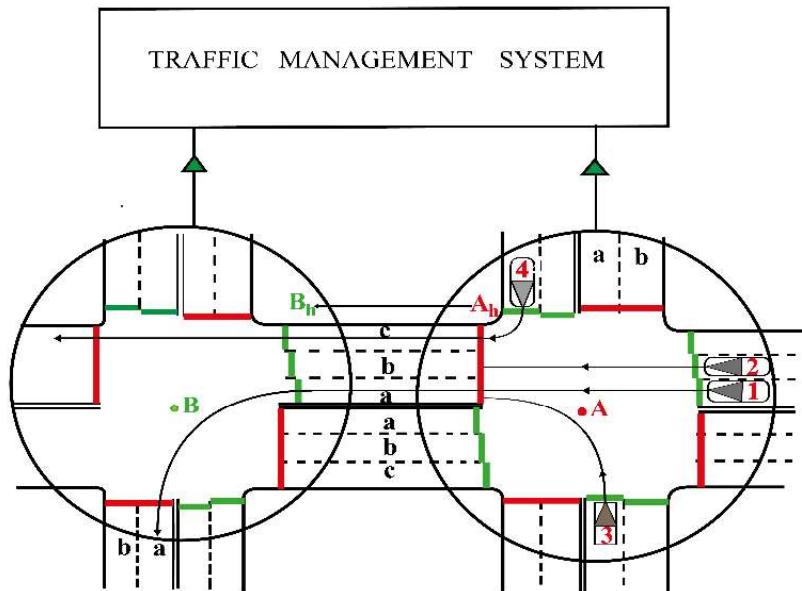
Thus, the entire transport network of the city is controlled by an intelligent traffic management system. By plotting the optimal route in the graph, we can technically perform a procedure for regulating vehicle flows due to a dynamic interaction in real time between a traffic management system (TMS) and each vehicle that has set its position (Fig. 1).

The TMS transmits to each driver a voice commands concerning a route to a destination declared by each driver as with ordinal GPS navigation. The peculiarity consists in the fact that program puts the t-optimal route, but not geometrically optimal (g-optimal) one as modern GPS navigation does. Because of g-optimal routes traffic jams in cities take place. In a case of applying a criterion of t-optimality, there is an opportunity not only to improve a travel through individual intersection, but also to organize optimal routes for all vehicles in the metropolis, taking into account a traffic situation at each particular time moment.

The proposed technology focuses not only on laying t-optimal routes but also is extremely dynamic working with

renewable data. The integrated effect of the intelligent regulation leads to a new quality – synchronization of traffic flows, and consequently, to the disappearance of the traffic jams. An ultimate goal of the study is the algorithm that allows synchronizing the flows of vehicles, optimally using all city transport routes and accompanying each vehicle to the final destination in a shortest possible time. With this approach traffic jams in cities will not occur in general!

Figure 1 – Two adjacent cross-shaped intersections – A and B – and vehicles that enter



the lane between these intersections are shown. The red stripes are input sensors. Output sensors are represented as adjacent green stripes.

References:

1. D. Boguto, V. Volynets, P. K. Nikolyuk, P.P. Nikolyuk, Automated system management of vehicle movement in city, Bulletin of Kharkiv University, series “Mathematical Modeling. Information Technology. Automated Control Systems” is.35, pp. 3-9, (2017).
2. D. Boguto, V. Komarov, P.K. Nikolyuk, P.P. Nikolyuk, Intellectual urban transport traffic management algorithm, Bulletin of Kharkiv University, series “Mathematical Modeling. Information Technology. Automated Control Systems” is.38, pp. 4-13, (2018).

¹Vadym Paiuk

Postgraduate Student at the Computer Engineering & System Programming Department

²Olena Heidarova

Candidate of Economical Sciences (PhD), Associate Professor at the Economic & Management Department

^{1,2} Khmelnytskyi National University

DETECTING SOFTWARE MALICIOUS IMPLANT BASED ON ANOMALIES RESEARCH ON LOCAL AREA NETWORKS

The development of information technology in various fields continues to be accompanied by a relentless desire of attackers to benefit from shortcomings in their protection. The most relevant for the benefit from the point of view of attackers are organizations and enterprises in which information technology operates. There are many ways to penetrate the local computer networks of enterprises (organizations) for the purpose of unauthorized access to information in them. One way for attackers to access information resources of enterprises (organizations) is to use undocumented capabilities in software and hardware of personal computers and peripherals, which allow for covert unauthorized access to system resources, usually through a local network. A program implant is a secretly implemented program that poses a threat to the information contained in a computer [1]. The main purpose of implant of software is to provide unauthorized access to confidential information.

As an object of study we will consider program implant of software used in local computer networks of enterprises (organizations).

Program implant software bookmarks can take part in the creation of botnets, the implementation of Trojans, and so on. Therefore, the problem of detecting malicious software, in particular, undocumented software bookmarks, remains relevant.

One of the tasks that needs to be solved is to develop models of program implant software in local computer networks.

Consider the types of threats from program implant that can be implemented in the local network. Their analysis is related to the security requirements of computer systems on the network: confidentiality, integrity, availability and authenticity.

Implant in program models in LAN computers: 1) the model of "interception"; 2) the "observer" model; 3) the model of "compromise"; 4) model "distortion or initiator of errors"; 5) model "garbage collection".

Research of implant in program by professional specialists in cybersecurity allows to establish their presence on the following grounds: the presence of software modules that do not meet the purpose of the process; the presence of operating system objects that are opened by the process that do not meet the purpose of the process; high intensity of input-output operations from a certain process; a high percentage of CPU or internal memory usage from a particular process; the similarity of the file name to the file name related to the operating system; the executable file of the operating system process is not placed in the conventional directory; the process related to the operating

system is performed on behalf of the local user; the code execution protection system in the data area, which is enabled for all processes, is disabled for the considered process; for a process related to the operating system, other directories are involved, different from what should be for such a process; there is no digital signature in the executable files of the software; high network activity of the process, which must work locally; etc. However, to improve the effectiveness of implant in program detection, tools are needed to establish the existence of implant in program without the intervention of a network administrator who may not handle some of the features for various reasons. Program implant can use masking tools in the system, which complicates their detection.

A distributed multilevel detection system was used for experiments [2]. implant in program were developed as part of each of the typical botnets. Then, the purpose of the experiments was to test the application of the method of botnet detection, the work of the classifier in the structure of the distributed system and determine the dependence of the percentage of detected botnet nodes on their representation by vectors containing program implant. The experiment was performed for the classifier without adding copies of the created botnets and with them, ie the test was performed without training the classifier on the created samples and with the preliminary assignment of samples by class. The duration of monitoring of the computer of the local network was 350 hours for each instance of the botnet of each of the two classifiers. The attack from the nodes of the botnet was not carried out. Bot network nodes worked only in the mode of computer control and support of the bot network structure through sent messages. Thus, for the distribute system components, the objects of study were launched in the computer processes and, accordingly, the construction of vectors on them. To conduct the experiment, botnets were selected that use the strategy of obtaining full control in the computer by activating their components implant in program. To perform the experiment by means of API monitoring in the com, vectors were obtained, which were alternately processed by the component classifier.

Implant in program of software used on local computer networks can cause significant harm to personal computer users, and especially to companies that operate computer networks and use specialized software.

Models of Implant in program software allow to include them in detection means after the corresponding formalization. The application of the developed models of implant in program in the distribute system [2] made it possible to improve the efficiency of detection of botnets of which they were part.

References:

1. DSTU 3396.2-97 Zaxy'st informaciyi. Texnichnyj zaxy'st informaciyi. Terminy' ta vy'znamennya [DSTU 3396.2-97 Information protection. Technical protection of information. Terms and definitions]
2. Nicheporuk A. Detecting Software Malicious Implant Based on Anomalies Research on Local Area Networks / A. Nicheporuk, V. Paiuk, B. Savenko, O. Savenko, O. Geidarova // Proceedings of the 1st International Workshop on Intelligent Information Technologies & Systems of Information Security. - Khmelnytskyi, Ukraine, June 10-12, 2020. - Pp.196-207.

¹ **Roman Ponomarenko**

PhP in Physics and Mathematics, assistant

² **Roman Tkachenko**

Student

^{1,2} Taras Shevchenko National University of Kyiv

METHOD OF PROCESSING COMPLEX OBJECTS BASED ON OBJECT-ORIENTED PROXY SYSTEM

A new method of processing objects of complex object-oriented systems is proposed based on objects' proxying technology.

Object proxying technology is designed to mediate access between the object and its environment [1]. It provides the use of a special Proxy object to wrap the proxied object and further intercept actions on it, to delegate the organization of access to it and its behavior Proxy-object.

Proxying technology is widely used in the design of browser applications and solutions (frameworks).

The syntax for using the Proxy object proxying class [2–4] (JavaScript programming language):

```
let proxy = new Proxy (target, handler);
```

The target parameter is an object (the object can also be a function, an array of objects, or a Proxy object) to be proxied, and the handler parameter is a wrapper function that specifies the behavior for the proxied target object.

The main idea of using the Proxy class is to create special "traps", each of which allows you to intercept the execution of internal methods (low-level methods that describe most actions on the object) over the original object, substituting each of their behavior. The internal methods include (the full list is given in [2, 3]):

- [[Get]] - read property;
- [[Set]] - record property;
- [[Delete]] - delete the property (call the delete operator);
- [[Call]] - call the object method;
- [[Construct]] - call the new operator, etc.

Accordingly, by extending the configuration of the Proxy object in the handle parameter, you can "set traps" for basic actions on the object, but subject to certain restrictions on their implementation.

The paper proposes a new method of processing objects of complex object-oriented systems based on the application of object-proxying technology. A library has been developed that organizes the transmission of messages by objects to basic Proxy-objects for further analysis of the received information. The purpose of this development is to simplify the processing of complex objects, tracking their condition at any time, to capture memory leaks.

Based on the developed method, is offered an algorithm for counting the number of duplications of objects of a complex system. The proposed algorithm also can be used for efficient and quick check objects for uniqueness under conditions of complex inhomogeneous system structure.

In fig. 1 presents a complex system with a heterogeneous structure of relationships between objects. Dotted arrows indicate the properties of objects (connections such as aggregation), solid arrows - the direction of transmission of messages by objects.

When using the proposed method, to successfully verify the uniqueness of a particular object in the system, it is sufficient to generate a request "up" to the appropriate Proxy with the appropriate message. Accordingly, the object Obj4 (Fig. 1), being non-unique, will generate a message twice. Proxy-object is enough to count the number of non-unique objects based on the received messages (without using the operations of direct analysis and comparison of system objects).

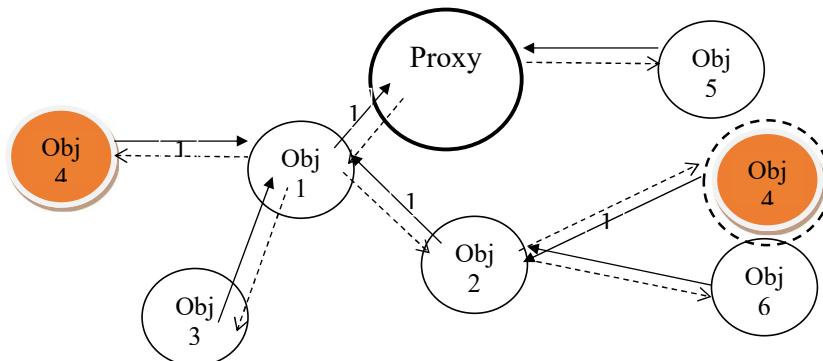


Figure 1 - Example of a complex system based on Proxy-objects

References:

1. Van Cutsem T. and Miller MS Trustworthy Proxies. In: Castagna G. (eds) ECOOP 2013 - Object-Oriented Programming. ECOOP 2013. Lecture Notes in Computer Science. Springer, Berlin, Heidelberg, 2013, vol. 7920, pp.154-178. doi: 10.1007 / 978-3-642-39038-8_7.
2. Proxy and Reflect. The Modern JavaScript Tutorial. Available: <<https://learn.javascript.ru/proxy>>.
3. Proxy. MDSN web docs. Available: <https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Proxy>.
4. Ferguson R. and Cirkel K. Working with Proxies. In: JavaScript Recipes. Apress, Berkeley, CA., 2017, pp.277-280. doi: 10.1007 / 978-1-4302-6107-0_16.

¹**Dmytro Sakharov**

MA in programming technologies of IoT

²**Olga Kravchenko**

Associate Professor at the Department of informational systems and technologies

^{1,2}*Taras Shevchenko National University of Kyiv*

IoT SEISMOLOGICAL SITUATION MONITORING SYSTEM DEVELOPMENT WITH ONE OF THE REGIONS OF UKRAINE AS AN EXAMPLE

Keywords: IoT, earthquake, early-warning system, MQTT.

Over the past few years, IoT has become one of the most important technologies of the 21st century. Nowadays it is possible to connect household items - kitchen appliances, machines, thermostats to the Internet to let the communication between people and things (devices) to be seamless.

With low-cost cloud computing, big data, analytics and mobile technology, physical devices can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor and regulate every interaction between connected things. The physical world corresponds to the digital world, and they tightly cooperate[1].

An earthquake is an accidental natural disaster that damages property and sometimes causes human deaths. We cannot stop or fight against earthquakes, but we could be notified in advance. Currently, there are numerous approaches that can be used to detect small earthquakes and vibrations. Precautions could be made before major oscillations occur inside the earth surface. Lifes can be saved by warning people in advance.

Significant seismic processes exist in western Ukraine, particularly in Zakarpatska oblast, where there have been earthquakes occurred with an intensity of 6-7 points on Richter scale. The epicenters of these earthquakes were in the areas of Svalyava, Dovhy, Teredasva, Mukachevo, Uzhhorod[2]. Therefore, the Zakarpatska oblast can serve as an example of the region for the creation of a system for monitoring seismic activity.

The most common type of data driven IoT system that reports a natural disaster is a tsunami detection system. Early warning of a disaster helps prevent many lost lives and reduces economic and material damage. Sensors are installed in coastal regions and transmit data to a remote data center. Such data centers perform data aggregation and operational procedure for detecting destructive events. Methods include GIS (geographic information system) for capturing, storing, analyzing and sending notifications.

In a seismic monitoring system, seismographs should be placed in the form of a grid covering the area of potential earthquake occurrence. The distance between the sensors will depend on the measurement accuracy of each sensor. The location in the form of a grid will allow to use the method of triangulation to determine the hypocenter of the earthquake. The implementation of the sensor is a moderately powerful

microcontroller, with GSM or satellite communication module. Two accelerometers can be used to measure seismic events i.e. to measure longitudinal and transverse acceleration. The design of the sensor must comply with standard of operation of the device outdoors with the influence of any atmospheric factors in temperate and cold macroclimatic areas.

The communication protocol between the sensors and the processing center is MQTT - a standardized, lightweight protocol that distinguish all devices as publishers and subscribers [3]. The publishers are sensors, the subscribers is a processing and analysis center and an smartphone or a web app for results representation.

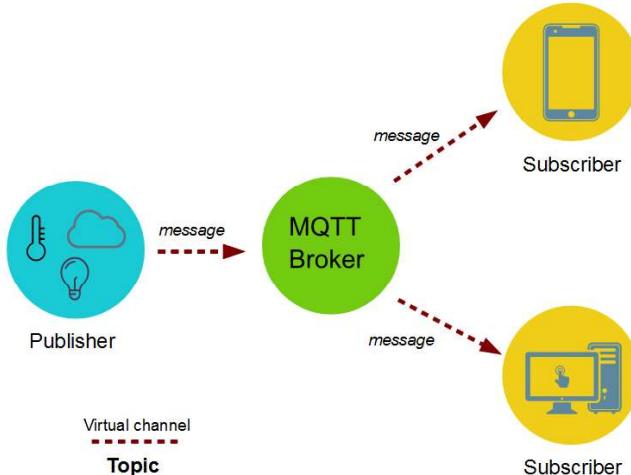


Figure 1 – протокол MQTT [4]

As of today, there is no earthquake early warning system in Ukraine. But with increasing seismic activity in some regions of our country, the implementation of such systems may become necessary to prevent deaths and significant economic and material damage.

References:

1. Oracle, What is the Internet of Things, 2019. URL: <http://bit.ly/2qadArR>
2. Kyiv Institute of Geophysics, Seismic activity of Ukraine, 2019. URL: [http://bit.ly/2qadArR](#)
3. Mqtt.org, MQTT Protocol, 2019. URL: <http://mqtt.org/>
4. F. Azzola, MQTT Protocol Tutorial: Technical description, 2019. URL: <http://bit.ly/2Y9iSQL>

¹ **Tatyana Selivorstova**

Candidate of technical sciences, Associate Professor

² **Serhii Kyrychenko**

Master's degree, specialty 122 "computer science"

³ **Volodymyr Brodskyi**

Master's degree, specialty 122 "computer science"

⁴ **Nataliia Tarkovska**

Master's degree, specialty 122 "computer science"

¹⁻⁴ *The National Metallurgical Academy of Ukraine*

²⁻⁴ *EPAM Dnipro*

RESEARCH OF APPLICATION METRICS DEPLOYED IN MONOLITHIC AND MICROSERVICE ARCHITECTURES

The rapid growth in the number of complex and extensive web-applications has led to the introduction of the latest communication technologies within the project. The monolithic architecture is logically replaced by microservices [1]. In this regard, the task of determining the technical and technological features of this technology becomes relevant.

It is known that the monolithic architecture involves the process of developing the application as a whole. Any changes, even the smallest ones, require significant restructuring and deployment of the entire application. Over time, it becomes increasingly difficult to maintain a clear and understandable modular structure, as changes in the logic of one module tend to affect the code of other modules. Unlike a monolithic architecture, a microservice architecture is an approach to building a server application as a set of almost unrelated services (Figure 1). Services are developed and deployed separately and independently of each other [2]. A separate process is required to run each service. Communication between processes is implemented using HTTP / HTTPS, WebSockets or some other protocols (Figure 2).

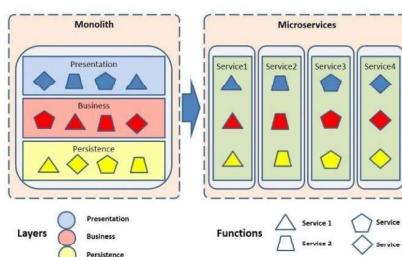


Figure 5 – The typical transition from a monolith to microservices [3]

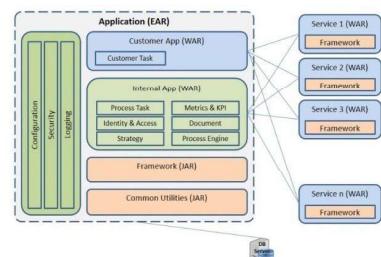


Figure 2 – Microservices landscape for the refactored monolith [3]

Implementation of microservice architecture involves the use of a stack of information technology and related software (Figure 3, [4]). In particular, one of the

options for deploying the Kubernetes cluster requires the use of Minikube, Kubectl, Docker. Minikube implements the local launch of a single-node Kubernetes cluster on a virtual or physical machine. Kubectl is a command line tool for managing Kubernetes clusters. Docker is a container runtime.

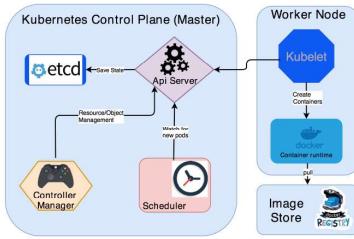


Figure 3 –Kubernetes architecture

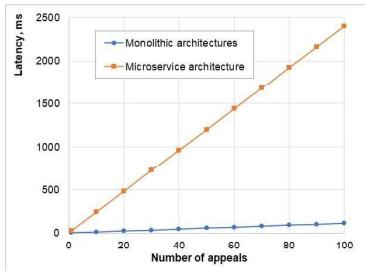


Figure 4 – Response time to the request

To test the technical and architectural parameters of the considered implementations, the application was deployed [5] on a virtual machine AWS EC2 – monolithic architecture and Kubernetes cluster on AWS EKS – microservice architecture. Consider the example of deploying a Kubernetes cluster on a Linux machine.

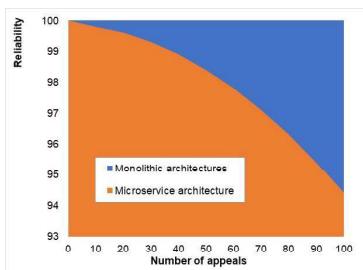


Figure 5 – Reliability

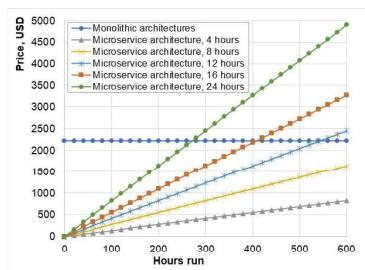


Figure 6 – Price scaling

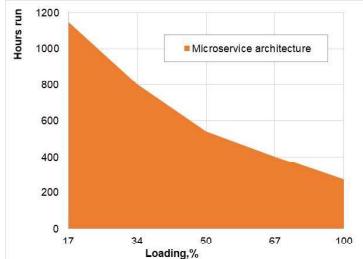


Figure 7 – Time for which the cost of operating microservice architecture becomes more expensive than operating monolithic

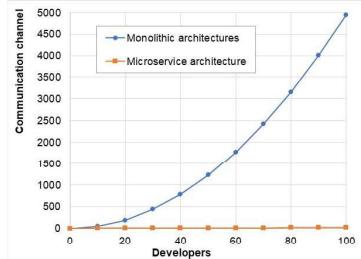


Figure 8 – Dependence of the number of communication links depending on the number of project participants

As part of the study, studies were conducted on the following characteristics [5, 6]:

- 1) Speed of response to a request (Figure 4);
- 2) Reliability (Figure 5);
- 3) Scaling (Figure 6, 7);
- 4) Team communication (Figure 8).

We investigated the configuration of the microservice and monolithic application architecture. We concluded that the microservice architecture has much greater fault tolerance and flexibility compared to the monolithic architecture. Applications deployed in a microservice architecture are much easier to scale and update than applications deployed in a monolithic architecture. Application developers with a microservice architecture communicate much more efficiently in smaller teams compared to the large teams required to develop applications with a monolithic architecture.

However, the monolithic application deployment architecture is simpler and great for deploying an application with unallocated workloads. Monolithic architecture responds much faster to requests and has fewer moving parts. Therefore, it may be easier to administer and maintain applications with monolithic architecture.

References:

1. Deploy to Kubernetes. Docker Documentation. Retrieved 1 November 2020, from <https://docs.docker.com/get-started/kube-deploy/>.
2. Kubernetes Certified Administration. Retrieved 2 November 2020, from <https://github.com/walidshaari/Kubernetes-Certified-Administrator>.
3. John, S. (2020). A Transition From Monolith to Microservices – DZone Microservices. dzone.com. Retrieved 1 November 2020, from <https://dzone.com/articles/a-transition-from-monolith-to-microservices>.
4. Abdelghani, R. (2019). Building and deploying a spring boot application to kubernetes. Medium. Retrieved 1 November 2020, from <https://medium.com/faun/building-and-deploying-a-spring-boot-application-to-kubernetes-12da35d1e2fc>.
5. WalidShaari/Kubernetes-Certified-Administrator. GitHub. Retrieved 1 September 2020, from <https://github.com/walidshaari/Kubernetes-Certified-Administrator>.
6. Kainz, A., Smith, T., & Fiskeaux, C. (2020). Microservices vs. Monoliths: An Operational Comparison – The New Stack. The New Stack. Retrieved 1 September 2020, from <https://thenewstack.io/microservices-vs-monoliths-an-operational-comparison/>.

¹ Oleksandr Turovsky

Candidate of Technical Sciences, Associate Professor

² Valerii Kozlovskyi

Doctor of Technical Sciences, Professor

³ Yurii Balaniuk

Candidate of Technical Sciences, Associate Professor

⁴ Yuliia Boiko

Candidate of Technical Sciences, Associate Professor

¹ State University of Telecommunications

^{2,3} National Aviation University

⁴ Taras Shevchenko National University of Kyiv

MINIMIZATION OF PHASE ERROR DISPERSION IN CLOSED TYPE PHASE SYNCHRONIZATION SYSTEMS IN CARRIER FREQUENCY TRACKING MODE

Phase synchronization systems are widely implemented in various radio engineering devices of communication, radar and control technology, as well as in the device of accurate magnetic recording. It should be noted that the dynamics of the synchronization system, as an automatic control system, is directly related to the level of its astatism. That is, increasing the level of astatism of the synchronization system to the second and higher orders while ensuring a sufficient level of its speed is one of the ways to ensure the efficient operation of the system as a whole [1]. Research of the construction scheme of a closed synchronization system, composed of a combination of logic devices, in the direction of assessing the possibility of increasing the order of astatism of the system, reducing the variance of constant and transient errors in the process of carrier frequency tracking in the presence of noise in the communication channel. the problem to which this work is devoted.

Due to the fact that it is practically impossible to create an absolutely invariant system, in practice selective absolutely invariant systems are used, which allow to provide zero constant error under certain types of external influences.

In fact, the condition of selective absolute invariance is to require the equality of zero of the first few error rates of the system or, in other words, to require a certain order of astatism of the system [2].

On the other hand, ensuring a minimum phase filtering error is realized by automatically adjusting the specified process due to the presence in the control circuit of the feedback synchronization system. The specified feedback is a proportional controller, the task of which is to increase the accuracy of control commands, ie to increase the astatism of the control system of the carrier frequency synchronization scheme.

A characteristic feature of astatism is the presence of the structural scheme of the system K integrating links [1].

The order of astatism of a closed system in relation to the control effect is equal to the number of integrating links included in the feedback circuit between the points of application of this influence (input) and the error measurement point (output) and does

not depend on the number of integrating links included in the direct signal conversion circuit between these points [1].

In this case, as shown in [3], the choice of system parameters must be made under the condition of compromise adjustment.

A similar situation arises in the closed synchronization systems (CSS) of a higher order, the approach of the filter in a closed loop to the integrating second order also worsens the transition process [2].

In addition, as follows from the relations and conclusions given in [4], for CSS, by switching from PIF to IF it is possible to reduce the permanent error, but it is not possible to eliminate it completely, and at $r = 2$ the system remains inoperable .

Obviously, the further development of the process of minimizing the phase error requires solving problems to change the scheme of construction of the synchronization system. One of the ways to solve this is the synthesis of combined synchronization systems in the direction of the introduction of open communication. This issue is sufficiently covered in the works [5].

The research was carried out in relation to the variant of the scheme of construction of the system of phase synchronization of the closed type at tracking of the carrier frequency in the conditions of presence of noise in the communication channel offered in article. It is shown that taking into account the additive Gaussian noise and instability of generators, the desire to minimize the phase error variance in the class of closed synchronization systems causes a deterioration of the system dynamics and does not increase the order of astigmatism. A further direction of research is to work on the synthesis of broken communication in combined synchronization systems against the background of additive Gaussian noise, taking into account the phase instability of the generators.

References:

1. Voronov A.A. Theory of automatic control. Ch. 1, 2. - M.: Energiya, 1986, 1987.
2. Misrihaiov M.Sh. Invariant control of multidimensional systems. Moscow: Energotomizdat, 2003. 236 p.
3. Kanatchikov A.A., Kulikov G.V. Research of possibilities of construction of system of clock synchronization on the basis of the autocorrelation demodulator for reception of signals with the minimum frequency manipulation, Scientific herald of MSTU GA. Series Radiophysics and Radio Engineering. 2010. № 152. P.11-15.
4. Oleksandr Turovsky, Yurii Khlaponin, Muhi-Aldin Hassan Mohamed et al, "Combined system of phase synchronization with increased order of astigmatism in frequency monitoring mode", CEUR Workshop Proceedings, 2020, Vol-2616, Session. 1, pp. 53–62. <http://ceur-ws.org/Vol-2616/paper5.pdf>
5. Turovsky O.L. Estimation of the possibilities of the combined synchronization system with open-link to minimize the dispersion of the phase error when tracking the carrier frequency under the conditions of the influence of additive noise. Technology audit and production reserves. 2020. Vol 3, No 4, pp. 16-22,. DOI: 10.15587/2312-8372.2020.210242.

¹ **Solomiia Tymoshchuk**

Bachelor degree Student of Information Systems and Technologies

² **Roman Ponomarenko**

Candidate of Physical and Mathematical Sciences, Assistant Professor of the Department of Information Systems and Technology.

^{1,2} Taras Shevchenko National University of Kyiv

THE RESEARCH AND DEVELOPMENT OF THE SOFTWARE TO SUPPORT THE EDUCATIONAL PROCESS IN HIGHER EDUCATION INSTITUTIONS

Abstract. The learning process management system has been developed using the cross-platform Java programming language in the Netbeans environment with a connection to the XAMPP web server. The efficiency of this system and the advantages of its use for teachers were investigated in order to speed up the learning process and its better organization in educational institutions with a large number of students.

Keywords: software, managing education system, web application.

With the increase in the number of students in the universities every year, there is a problem of convenient organization of data about students, their grades and the list of disciplines. That is why the question was raised about the development of a convenient learning management system for teachers with a special interface and database connection. The ability to adjust the data at any time according to changes in real time is another advantage of the system, which will significantly reduce time spent on the organizational processes.

This will allow the teacher's ability to directly access the graphical interface of the system and, if necessary, the database in which the information is stored. Such architectural decisions were made on the basis of an open-layer architecture of a multilevel model.[1]

Previously, in these systems, such users could not directly access the database, which slowed down the learning process and required more staff. The developed system solves this problem and during the work process the teacher does not need to apply to such bodies of the educational process as the dean's office or senior management, because all the information can be obtained directly in the system.

The aim of the work is to create an effective software system for managing the educational process in educational institutions, which will be a very effective multifunctional mechanism, in order to rationally use resources and improve the work of teachers and students in general.

The implementation of this system were possible only due to use of the Xampp multi-platform web server and the phpMyAdmin web application to administer the MySQL database.

Figure 1 shows the system's ability to adapt to each teacher who has their own username and password in advance. To add grades to the system, the teacher only needs to choose the discipline taught by the teacher and the student from the list. In Figure 1, you can also see that when entering data, the user ensures the confidentiality of information by transferring data automatically to the database table.

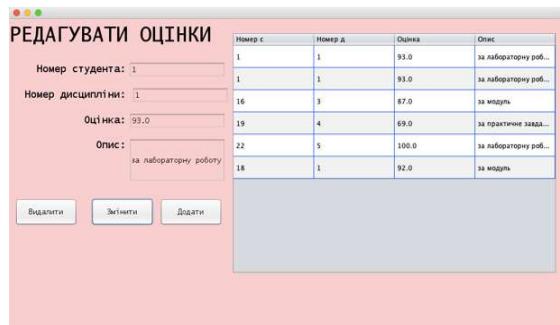


Figure 1 – Page of adding marks

Then, by connecting to the Xampp web server and the phpMyAdmin web application, that are extremely easy to install and low in memory, the teacher will be able to see the interface for accessing student data, their grades for the subject and the number of exact hours, dedicated to the particular subject.

Below in Figure 2 you can see how it looks like in the phpMyAdmin web application (i.e. in the database table):

Figure 2 – The view of structure of the database with the table names

Conclusions. The implementation of this system is very successful, because it simplifies the learning process and saves time for the teachers and staff in educational institutions. The development of software systems of this type guarantees the improvement of education in educational institutions as a whole, by solving organizational problems in this way.

References:

1. S. Ershov, R. Ponomarenko, The Architecture of the Software System of the Hierarchical Fuzzy Inference, National Academy of Sciences of Ukraine, Institute of Software Systems, 2018, pp. 99-108.
2. Modern Java Tools, The Software Engineering, Paradigms, Technologies. URL: https://stud.com.ua/164909/informatika/suchasni_zasobi_java
3. The Content Management and Content Processing in the Intelligent Learning Systems. URL: <http://www.setlab.net/?view=dissertation-1-2>

Authors

- | | | |
|---|--|---|
| <p>Abduramanov Z. 13
 Andrushchenko Y. 65
 Antonevych M. 17
 Astakhov A. 21
 Babenko Y. 323
 Bakhtina A. 260
 Balaniuk Y. 378
 Barannik V. 323
 Bauzha O. 53, 281
 Belfer R. 325
 Bezlutska O. 247
 Bielikov A. 363
 Bila T. 126
 Bobicev V. 29
 Boiko A. 139
 Boiko Y. 378
 Bokan V. 121
 Bondar T. 25
 Bondarenko B. 40
 Bondarenko M. 86
 Braïlovskyi M. 107
 Brodskyi V. 375
 Buchyk S. 65, 68, 99, 110, 327
 Buhriv A. 227
 Buhyl B. 115
 Bura Y. 124
 Burmistenko O. 126
 Bychkov O. 289
 Bystrov A. 77
 Cherevatov A. 329
 Chioma E. 367
 Dakhno N. 357, 350
 Davydenko Y. 297
 Dehtiarova Y. 191
 Derevianchenko O. 27
 Didyk A. 17
 Dolgikh S. 128
 Domanetska I. 251
 Dubovyk T. 276
 Dudnik A. 332
 Dulich O. 57
 Dvoretska S. 131
 Dvoretskyi M. 131, 139
 Fedorchenko I. 135
 Fedorov E. 36, 367
 Fedusenko O. 251</p> | <p>Fesenko A. 79
 Gamotska S. 194
 Gladka M. 335
 Glavchey M. 29
 Gnatyuk S. 79
 Gradinari O. 253
 Harko I. 262
 Heidarova O. 369
 Herasymenko O. 357
 Hlavcheva Y. 29
 Hnatiienko H. 25, 292, 339
 Horban D. 227
 Horban H. 131, 139
 Horbas I. 256
 Ilarionov O. 21, 33, 251, 354, 339
 Ivanchenko O. 289
 Ivanov I. 200
 Ivanytska A. 317
 Izmailova O. 346
 Kadomskyi K. 31
 Kambur M. 197
 Kandyba I. 139
 Kanishcheva O. 29
 Kashtalian A. 71
 Kazantsev A. 92
 Kerdun N. 231
 Kharchenko A. 135
 Khlevna I. 124, 150, 274
 Khlevnyi A. 121, 143, 172
 Khrinenko A. 320
 Khvorostina Y. 278
 Kiktev N. 145
 Klimenkova N. 229
 Klochko V. 83
 Klyushin D. 295
 Kobylchuk M. 332
 Kolesnikova K. 172, 181
 Kolomiiets A. 212, 237
 Koltsov D. 74
 Kondrashov K. 174
 Kondratuk I. 344
 Kondruk N. 148
 Kononova I. 301
 Kopp A. 163
 Kostikov M. 335
 Kostiv O. 115</p> | <p>Kotov M. 113
 Koval B. 143, 150
 Kovalenko A. 200
 Kovalenko I. 297
 Kovbas Y. 346
 Kozlovskyi V. 378
 Krasnovidov S. 49
 Krasovska H. 33
 Kravchenko O. 352, 373
 Kravchenko Y. 350
 Kredentser B. 301
 Kucherenko R. 352
 Kucherova H. 42
 Kudin V. 339, 354
 Kulko A. 110
 Kuzminova K. 153
 Kyrychenko S. 375
 Latysheva T. 202
 Lavrinovich V. 357
 Lendiel T. 145
 Leshchenko A. 247
 Leshchenko O. 350, 357
 Linder Y. 153
 Lisnevskyi R. 335
 Loik O. 204
 Los V. 42
 Lub P. 204
 Lukova-Chuiko N. 77, 79, 83, 95
 Makarenko A. 304
 Makhachashvili R. 260
 Makhachashvili R. 264
 Malyar M. 306
 Merkulova K. 289
 Mezentseva O. 157, 161, 165, 184
 Mikhieiev V. 157
 Minaeva J. 159
 Mironova V. 262
 Mogylevych D. 301
 Mohylevych V. 301
 Morozov V. 191, 200, 206, 208, 239,
 Morze N. 264, 266
 Mudra A. 161
 Mulesa O. 128</p> |
|---|--|---|

- Musienko A. 314
 Myroshnychenko Y. 360
 Nakonechnyi V. 86, 88, 113, 363
 Naumenko A. 212
 Nazarchuk I. 33
 Nemchenko K. 365
 Neskorodieva T. 36, 367
 Nezdoliy Y. 131
 Nicheporuk A. 92, 105
 Nikolaiev A. 27
 Nikolyuk P. 367
 Oberemok I. 214
 Oberemok N. 214
 Ocheretin D. 42
 Olinyuk A. 135
 Olimpiyeva Y. 314
 Onyshchenko A. 354
 Orlovskyi D. 163
 Osypenko V. 145
 Paiuk V. 369
 Palageychenko D. 327
 Paliy S. 329, 344, 360, 365
 Papirna H. 79
 Parkhomenko I. 74, 107
 Parkhomenko M. 323
 Patsyuk M. 233
 Paziak A. 247
 Petrychko M. 170
 Pliushch O. 363
 Pokutnia D. 332
 Polishchuk A. 306
 Polishchuk V. 306
 Ponomarenko R. 270, 371, 380
 Ponomarov S. 95
 Proskurin M. 208
 Provotar A. 272
 Pursky O. 276
 Pyroh M. 262
 Raichuk I. 217
 Revenchuk I. 53
 Riabov O. 274
 Rimek A. 292
 Rudenko A. 225
 Rudenko V. 165
 Rusyn V. 97, 309
 Sakharov D. 373
 Saman M. 135
 Sambas A. 97, 309
 Samoilenco M. 272
 Samokhvalov Y. 40
 Samonenko A. 221
 Samoylenko H. 276
 Savchenko R. 51
 Savenko B. 105
 Savenko O. 92
 Sazonov A. 223
 Seidametova Z. 13
 Selivanova A. 276
 Selivorstova T. 375
 Semenikhina O. 278
 Semenist I. 260
 Semenov V. 311
 Semerikov S. 42
 Shabatskaya S. 143
 Shamonia V. 278
 Sharkadi M. 46
 Sharybura A. 204
 Shelest T. 168, 225
 Shestak Y. 110
 Shpur O. 115
 Shtovba S. 170
 Shulgın S. 323
 Shved A. 99, 297
 Slipachuk L. 102
 Smishchenko D. 202
 Snytyuk V. 17
 Sobchuk A. 314
 Sobchuk V. 314
 Solodovnyk V. 113
 Solomko M. 317
 Soroka P. 49, 51, 194
 Statsenko D. 126
 Statsenko V. 126
 Stepanenko A. 135
 Stepanenko O. 284
 Steshenko G. 227, 241
 Stetsiuk M. 105
 Strutynska O. 266
 Suprun O. 229
 Sus B. 53, 281
 Symonychenko A. 68
 Symonychenko Y. 68
 Taborovskiy A. 172
 Tarkovska N. 375
 Tereshchenkova O. 174
 Timinsky A. 231, 233
 Timrova Y. 227
 Tkachenko R. 371
 Tmienova N. 57
 Toliupa S. 102, 107, 110, 113
 Tolstokorova A. 350
 Tregubenko I. 59
 Triska M. 204
 Tsykun V. 121
 Tukalo S. 115
 Turowsky O. 378
 Tymoshchuk S. 380
 Valieva N. 13
 Vavilenkova A. 178
 Vedel Y. 311
 Veres M. 153, 272
 Vlasenko O. 251, 339
 Vlasiuk S. 344
 Voitenko I. 88
 Vostrov G. 320
 Yakymenko D. 59
 Yas V. 237
 Yefremov H. 181
 Yehorchenkov O. 186, 197, 221
 Yehorchenkova N. 223
 Yeremieieva V. 168
 Yeshchenkov V. 184
 Yurchenko A. 278
 Yurchenko Y. 276
 Yurzhenko A. 247
 Zagorodnyuk S. 281
 Zhabska Y. 289
 Zharikova A. 239
 Zhovtukhin D. 186
 Zhurakovskiy B. 107
 Zinchenko V. 284
 Zubets D. 241
 Zubyk L. 317
 Zubyk Y. 317

PARTNERS OF THE CONFERENCE

AM INTEGRATOR



AM INTEGRATOR LLC is one of the leading TOP 3 IT operators in Ukraine, being a supplier and integrator of a wide range of solutions in the field of modern IT infrastructure, cloud systems, multimedia solutions, engineering infrastructure, business applications and complex business security systems for medium and large enterprises, and also for the public sector.

<https://amintegrator.com>

GlobalLogic

GlobalLogic®

GlobalLogic is a digital product engineering company. They integrate experience design and complex engineering to help our clients imagine what's possible and accelerate their transition into tomorrow's digital businesses.

For nearly 20 years, GlobalLogic has partnered with businesses across every major industry to make amazing products and connect the dots between people, products, and business opportunities. Now, in an increasingly digital world, they place the consumer at the center of every interaction. The company show businesses how they can better engage their consumers, innovate within predictable budgets, and bring the next generation of digital products and services to market in the shortest possible time.

GlobalLogic Company Facts At-A-Glance

- Founded in 2000
- Global Headquarters in Silicon Valley (San Jose, California)
- 16,000+ Employees in 14 countries
- 300+ Amazing Active clients
- 70+ Private label customer labs
- 27 Product Engineering centers
- 9 sales offices
- 3 Method Design Studios (San Jose, New York, London)
- 200+ UX/UI designers and developers
- Privately owned and funded by CPP Investment Board and Partners Group.

<https://www.globallogic.com/>

Skyglyph



Skyglyph is a dynamic start-up consisting of creative and industry savvy aerial survey enthusiasts based in Sofia, Bulgaria encompassing an established business network in North America, Eastern Europe, and Southeast Asia.

Skyglyph renowned specialization is the development of cloud-based software and industrial surveillance solutions that transform drones into concise instruments for deployment in a wide range of business use cases.

Skyglyph's cloud-based platform simplifies the scouting process and management of flight control, asset mapping, site monitoring, data transfer and visual result interpretation. We excel in the professional interpretation of images via the generation of comprehensive analytical and recommended actions reports that can be applied to a variety of survey use case requirements.

Our solutions are designed to bridge the gap between drone technologies and user requirements that deliver the master results that you expect.

Skyglyph eliminates the gap between the technical aspects of aerial surveying and the “plug and play” needs of its users. The results are simple and concise while at the same time providing an intrinsically valuable asset for site analysis.

<https://skyglyph.com/>
Telegram: Skyglyph

S&T Ukraine



S&T Ukraine was established in 1993 and today they are a leading Ukrainian integrator of telecommunication and corporate information systems, provider of IT services.

S&T Ukraine is a company of the S&T AG corporation. With approximately 4,300 employees, S&T AG is the leading provider of comprehensive consulting, outsourcing, systems integration and IT services in Central and Eastern Europe as well as in the German speaking region. The S&T AG operates in more than 25 countries. S&T's core business focuses on the consulting, development, implementation and operation of IT solutions, processes and systems.

The company's business areas:

- IT Infrastructure
- Networks
- Information Security
- IT Services
- Specialized Solutions

S&T Ukraine became the first company in Ukraine to meet all Cisco requirements for Cisco Gold Certified Partner status (2003). The company has successfully recertified for this status in 2019, sixteenth straight time. S&T Ukraine also became the first company in Ukraine to receive all new Cisco Advanced Specializations (2008) and all new Cisco Advanced Architecture Specializations (2013). The company provides technical support in 24x7x365 mode within the framework of partnership with Cisco.

The Quality Management System of S&T Ukraine is certified against the ISO 9001-2015 International Standard.

S&T AG serves companies along the entire IT value chain in the fields of manufacturing, commerce, telecommunications, public services, financial services as well as energy and utility companies. They have completed hundreds of complex projects for customers that are leading Ukrainian companies in financial, telecommunication, manufacturing, retail and utility industries.

Наукове видання

Інформаційні технології та взаємодії (сателітна): Матеріали конференції, 04 грудня 2020 р., Київ, Україна

Information Technology and Interactions (Satellite): Conference Proceedings, December 04, 2020, Kyiv, Ukraine

В авторській редакції

Редактор: Снитюк В.С.

Верстка: Гамоцька С.Л.

Обкладинка: Дубницька А.С.

Підп. до друку 18.12.2020 р. Формат 60x84¹/16.
Папір офсетний. Друк офс. Гарнітура Times New Roman
Умовн. друк. арк. 24,8. Обл.-вид. арк. 23,8

Видавництво «Стилос»
04070, Київ-70, Контрактова пл. 7
Свідоцтво Держкомінформу України
(серія ДК №150 від 16.08.2000 р.)
Тел. (044) 467-51-89