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TABLE OF CONTENTS

1st International Scientific-Practical Conference:
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SOFTWARE-TECHNICAL COMPLEX FOR THE DEVELOPMENT AND MAINTENANCE OF AUTOMATIC CONTROL SYSTEMS OF TECHNOLOGICAL PROCESSES

Bakirova L.R.[1], Huseynov S.N.[2]

[1]ASOIU, head of the department "Instrument Engineering". (Azerbaijan)

[2]"Control measuring devices and automation" LLC, deputy head of Automatic Control Systems and IT. (Azerbaijan)

E-mail: [1]lala_bekirova@mail.ru; [2]mp-717@mail.ru

ABSTRACT

Development of simulation and physical models of hardware and software testing based on the prerequisites for the creation of automatic control systems taking into account the technological processes in the oil and gas industry is considered in the paper. Theoretical and physical bases of software-technical complexes of the created model of the corresponding system within the conditions of security, operativeness, etc., with the implementation of real functions of technological processes have been presented.

Keywords: simulator, sensor, PLC, SCADA, interface, physical model, automatic control, technical complex

Creation of modern automatic control systems for technological processes (hereinafter - ACS) is not only replacing analog regulators with digital ones, but also application of such functions as process visualization, self-diagnosis, archiving and so on. All these ensure high quality ACS control of technological processes. In order to achieve such high quality, modern controllers - PLC (Programmable Logic Controller - programmable logical controller) and high-performance algorithms [4] are used.

The use of modern high-performance algorithms has the following advantages:

- Optimum maintenance of regulators;
- Increasing production rates;
- Improvement of production quality;
- Raw and energy saving;
- Increasing service life of equipment.

Currently, there are SCADA systems with sufficient equipment and software packages for technological processes to create modern ACS [1].

Modern SCADA systems have the following features:

- Collection of information about technological processes
- Operator interface security
- Historical chronology of processes
- Direct automatic control of required volume

As seen from the functions of the SCADA system, the instrument is optimum enough to create ACS for technological processes. However, the disadvantage of this system is that it does not have opportunities to test and maintain high-quality algorithms. These are the algorithms that control the parameters of technological processes, start performance mechanisms, and eliminate accidents. When creating ACS for technological processes, it is dangerous to apply them to technological processes directly. Because of any erroneousness that may result in a written algorithm and equipment selection, dangerous accidents can occur. In addition, regulatory bodies play an important role in technological processes. Optimization of their regulatory cycles leads to the saving of raw materials and energy resources and improving quality in technological processes [3]. Such optimization can be by simulated by simulation complexes, so the efficiency of regulating processes can be increased [1]. For this reason, these ACSs should be simulated in a laboratory setting and tested through simulation complexes.

The goal is to create such simulation complexes. In these simulation complexes, both simulation equipment and simulation software packages should be created [2]. Modifying these software packages, they can be used in the oil and gas industry as well as in other technological processes, depending on the type of technological process.

In order to simulate technological processes, it is first necessary to determine what signals exist between the actual sensors, performance mechanisms and the ACS. These types of signals are:

- 4-20mA analog input signal;
- 4-20mA analog output signal;
- Discrete input signal (24VDC, 36VDC, 48VDC, 110VAC, 220VAC);

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

4

GULUSTAN
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- Discrete output signals (relay or transistor type).

These signals need to be ensured when creating an object simulator.

Figure 1 shows a simple structural scheme of ACS.
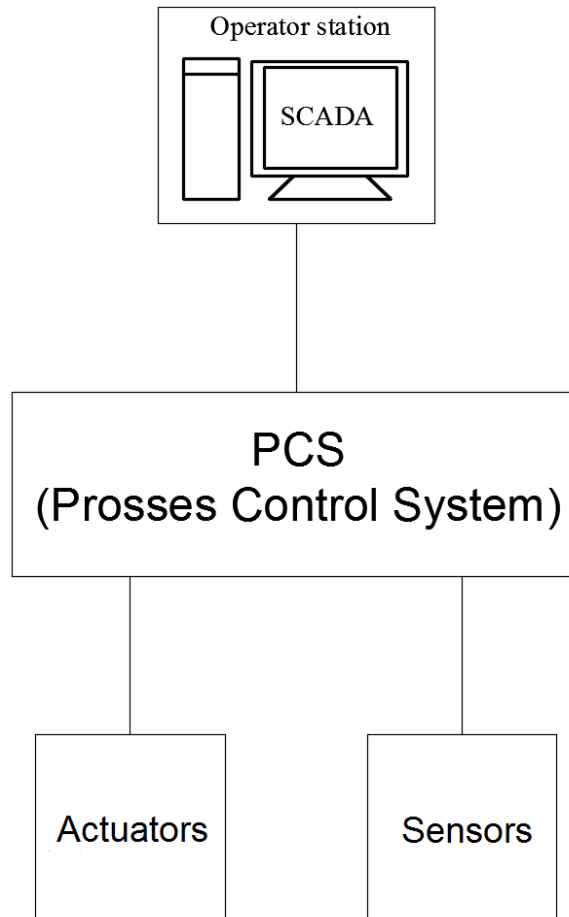
Figure 1. Structural scheme of ACS

In the structural scheme, PCS (Prosses Control System) is an Automated Control System in a modern PLC base. Performance mechanisms and sensors are field equipment installed in real technological processes. Operator station reflects mnemoschemes of technological processes, sensor diagnostics, and chronology of failures and accidents. It also enables to modify crash and signal thresholds as required. Here it is possible to simulate the signals that need to be controlled by using an object simulator that can replace the performance mechanisms and sensors with the signals of the field equipment.

1st International Scientific-Practical Conference:
Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

GULUSTAN
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5

Figure 2 shows the structural scheme of an object simulator connection to ACS.

Figure 2. Structural scheme of an object simulator connection to ACS

The following methods can be used to simulate field equipment signals for an object simulator:

- Using tumblers to simulate discrete input signals;
- Using LED light diodes to simulate discrete output signals;
- Using potentiometers to simulate analog signals.

Thus, using simulation signals, ACS can be tested, maintained, and diagnosed.

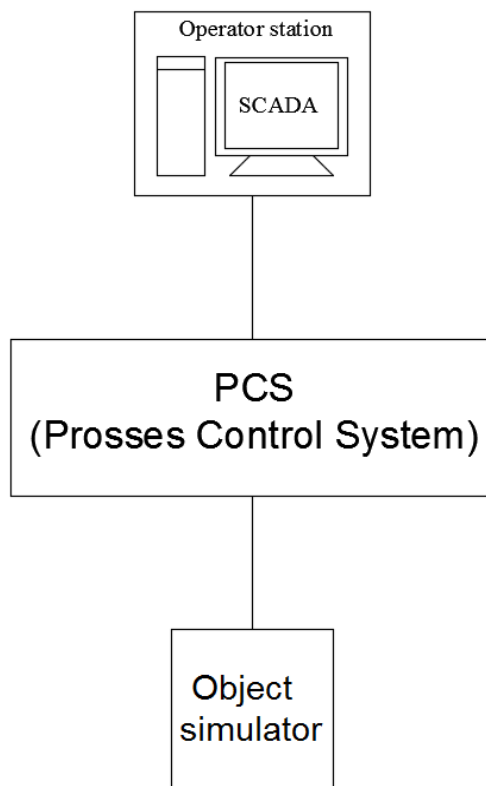This type of ACS, which is tested in a laboratory setting with an object simulator, can be used and more feasible in measuring, controlling processes according to the real object.

Thus, with that object simulation, all ACS modes, signalling thresholds, and accidents are fully analyzed. Such object simulators can be used to simulate technological processes that consist of relatively simple algorithms. However, it is important to take additional measures and improve functionality to simulate complex processes.

So, when the tumbler and potentiometers are required, in simulating them correctly some difficulties may occur if they do not provide a signal to the simulated ACS. Thus, as the parameters of complex technological processes can change instantly, such signals cannot be reacted quickly with a tumbler or potentiometer. In this regard, for simulation of technological processes, which consists of relatively complex algorithms, it is required to take into account the external, internal and random factors affecting processes along with the functional capabilities of simulators.

It is necessary to use dynamic object simulators on the basis of microcontroller to solve other problems mentioned during the creation of simulation models of complex processes.

Figure 3 shows the structure of an object simulator connection which is on the microcontroller base to the ACS.

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

6

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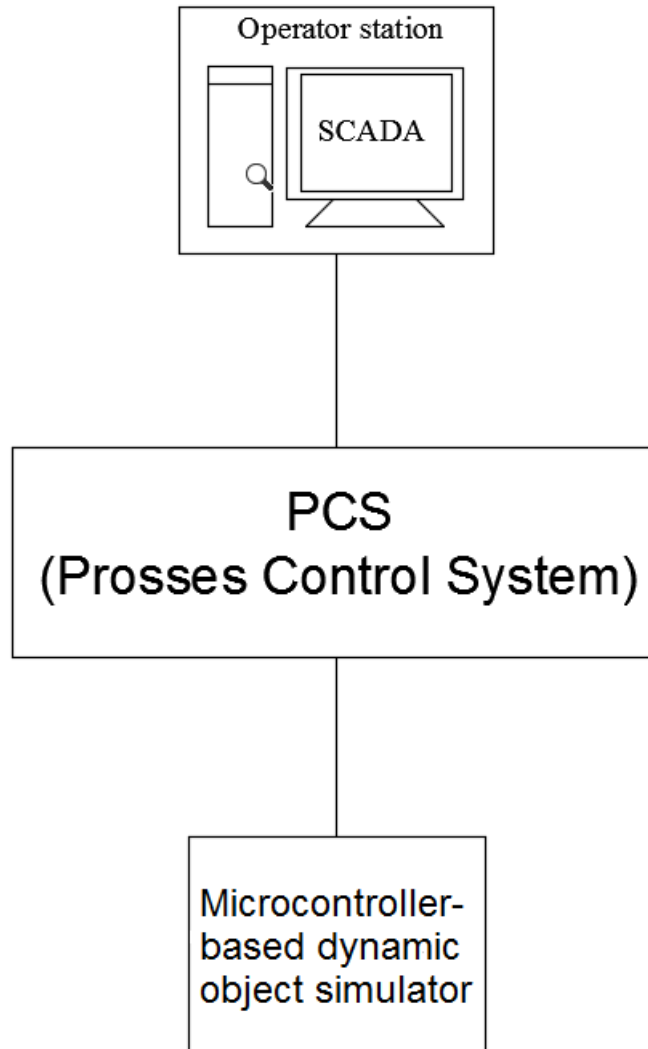BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

Figure 3. Structural scheme of an object simulator connection on the microcontroller base to ACS

The simulation of field equipment signals is performed electronically in the dynamic object simulator. Such simulation signals are used as follows:

- Entering discrete input signals into ACS via an optical separator;
- Entering discrete output signals from ACS into the microcontroller via optical separator;
- Entering analog input signals from microcontrollers into ACS via DAC;
- Entering analog output signals from ACS to microcontroller via ADC.

This time, in order to solve one of the major problems we face it is necessary to use microcontrollers having more input-outputs and compatible intermediate modules to simulate large signals.

The structural scheme of the computer-based functional model of the dynamic object imitator is presented in Figure 4.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

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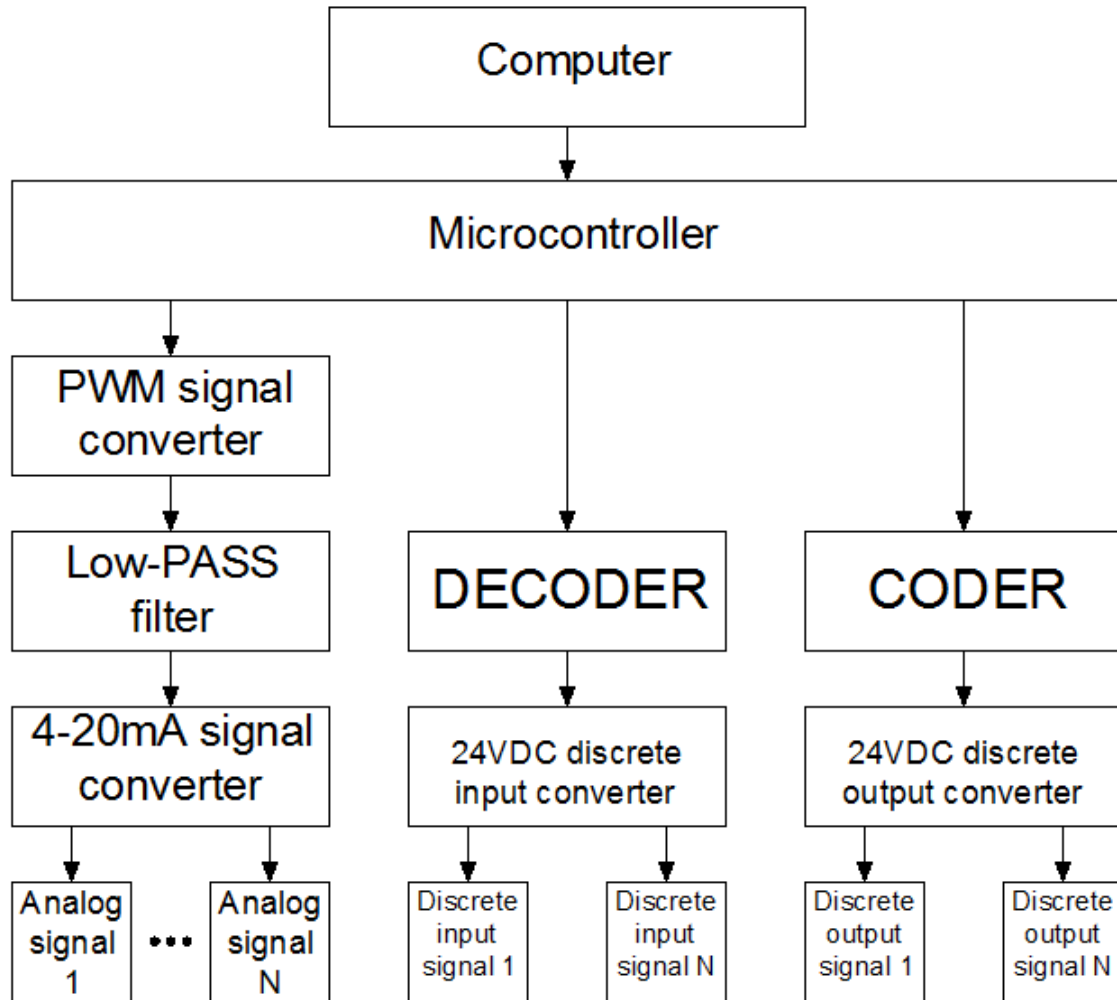BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

7

Figure 4. Structural scheme of a computer-based functional model of a dynamic object simulator

Here the PWM signal converter is used based on the commands obtained from the microcontroller. The output of the PWM signal converter is passed through a low frequency filter, and an analog signal is obtained. Since the output signals of modern sensors are 4-20mA, the same analogue signal becomes a 4-20mA unified signal. So we simulate the analogue signal for modern PLCs. In order to simulate discrete inputs and outputs, decipherers and decryptors are used. As a rule, they also become a specific signal level for PLCs.

In order to implement the given functional model and increase the number of channels, the solution can be considered as follows:
1) Using modern integrated microcircuits which enable to increase discrete input and output signals. For example, as such an integrated circuit it is advisable to use a PCA9555 microcircuit with a 16-channel input and output operating by I2C interface.
2) Using PWM (pulse-width modulation) to increase analog input signals. For this purpose, it is possible to use a 12-bit, 16-channel PCA9685 PWM microcircuit with the I2C interface.

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

8

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CONCLUSİON

It is possible to simulate any technological process that operates with each complex algorithm via a dynamic simulator based on a microcontroller. For this, there is need to consider external, internal and random factors that affect processes, along with the functional capabilities of imitators, for simulating technological processes involving complex algorithms.
Depending on the technological process, the appropriate algorithm simulates the ACS by sending those signals to the microcontroller, by downloading the corresponding algorithm. As a result, safe, optimum and high-quality operation of ACS is achieved which is used in technological processes.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

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9

APPLICATION OF INTELLIGENT TECHNOLOGIES IN MODERN PILOTAGE-NAVIGATION COMPLEXES

Ismailov Ismail[1], Agamaliyeva Jeyran[2]

[1,2] Department of Aerospace Information Systems, National Aviation Academy Azerbaijan,

E-mail: [1]ismayil.maa@gmail.com, [2]ada_avia@yahoo.com

SUMMARY

When a flight's condition changes dynamically, one of the external ways of problems is to create intelligent airborne information systems that support decision-making. The main component of the next-generation airborne equipment is communication programs required for access to such systems. The article builds on-site complexes of intelligent development technologies, uses real-time parallel computing algorithms, expert systems, unhealthy logic and neuroscience users.

Keywords: pilotage-navigation complexes, parallel computing algorithms, intelligent technology airborne complexes, artificial neural networks, fuzzy logic, expert system.

At first, for intellectual analysis, it is necessary to establish an object model. Data modeling is based on the object model and algorithms that investigate regularities between them. These algorithms select the optimal parameters to construct a model of intelligent data analysis as a result of finite iteration calculations. Choosing the right algorithm for solving specific issues is a very complicated process. So as two different algorithms applied to the same problem may produce different results. Therefore, it is difficult to compare these algorithms. It follows that, some of them are based on decision trees, some are based on artificial neural networks or fuzzy logic and etc.

Arrangement of crew work on aircraft is defined by the following conditions:
- ✓ Increasing the amount of analysis and controlled parameters;
- ✓ Limited time for decision-making;
- ✓ Increasing in traffic intensity;
- ✓ Increasing the physiological burden of the crew;;
- ✓ Ddifficult structure of airborne information systems of modern aircraft, etc.

Pilot-navigation complex, which is the main component of airborne equipment, is designed to solve the following types of issues:

- ✓ Calculation, correction, visualization of the current coordinators' of the aircraft;
- ✓ Measurement, rotation and visualization of aircraft navigation parameters;
- ✓ Formal Formation of information on flight access to critical modes;
- ✓ Signals that make up the plane's trajectory flight...?
- ✓ Organization of signals for automatic control systems;
- ✓ Organization of stable movement of aircraft in different modes.

Pilot-navigation complexes used in modern aircraft include integrated airborne equipment, built based on universal computing systems and performing sequential navigation information. Mathematical-software of the present integrated complexes allows complex processing of information from various transmitters and measuring systems. Depending on the source of access, certain types of information can be corrected or processed by certain mathematic-statistical calculations to ensure the autonomy, reliability, and durability of the navigation complex. All of this contributes to the provision of aircraft with intelligent airborne navigation systems.

If we look at the tendency of airborne equipment developed over the years, we can see that the analysis and decision-making of flight situations in airborne intelligent systems only could be carried out on modern aircraft by expert databases and expert systems. In this regard, it is expected that in the future, the airborne equipment will be intellectual with control and control over the psycho-physiological status of the crew.

Modern airborne equipment uses multi-processor computing systems and multi-level complex processing algorithms. The next generation of airborne equipment is intended to use parallel computing systems (neural scientists) and appropriate real-time parallel computing algorithms and neural-network technologies. The main areas of intelligent information systems that will form the basis of the latest generation of airborne equipment are:

• Development of neural network algorithms for information processing;

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

- Development of genetic algorithms;
- Establishing systems for implementing knowledge-based methods;
- Development of algorithm for processing fuzzy information and fuzzy results;
- Creation of multifunctional systems for parallel search and processing of information.

It is intended to use neural network algorithms in airborne information systems in difficult conditions where all the factors that occur during management. Because in such conditions logical algorithms and calculations become more difficult and it is not possible to determine the legitimacy according to the conditions of the problem. Neuroscience algorithms work in decision block for an emergency and difficult situation. An example of the application of genetic algorithms is the selection of the optimum route, and the search for resources to ensure the rational use of resources. These types of issues arise when solving problems when working on a mechanism for accessing semantic networks.

Knowledge-based systems use other logical and object-oriented models based on expert knowledge. Knowledge-based systems include:

- Rules-based systems;
- Semantic networks of different origin and models based systems in frames;
- Systems that provide automatic proof of theorems;
- Automatic hypothesis-based systems;
- Reflection-based systems with similar instructions;
- Objective results.

The use o fuzzy information and fuzzy results processing techniques are used to automate complex and difficult processes. To apply fuzzy methods, intelligent systems must have knowledge of processes that are adequately described by fuzzy terms.

The basic principle of multidisciplinary systems is that the individual parts of the program (they are called agents) are independent decision making. They are able to build different relationships among themselves and create a dialogue with the user.

The intelligent systems that support decision-making are thus comprised of the following intelligent modules that interact with each other:

- Database and knowledge base;
- Decision Maker;
- Knowledge collection and enhancement modules;
- The users' communication modules;
- Forecast and problem situations modeling modules;
- External objects communication modules.

Before using İntelligent İnformation Technology in airborne information systems, it is important to consider the nature of the problem area. The reasons for this are:

- ✓ The complex structure of communication with subsystems included in the management system;
- ✓ Many situations that may occur in the system during operation;
- ✓ Failure of mathematical apparatus to determine system reaction and current state in complex situations;
- ✓ Simultaneous access to various types of information in the short-term decision-making process;
- ✓ There is a time limit when using traditional methods for collecting, processing and transmitting information during management;
- ✓ Am Lack of skilled specialists to apply a possible alternative solution in the uncertainty situation and etc.
- ✓ Lack of an experienced expert to apply a possible alternative solution in the uncertainty situation

One of the reasons for the mentioned problems is that the information they provide first is not valuable. To be more precise, inputs do not overlap and cannot be processed by the intended methods. Other reasons include the large space of solutions, poor quality information, various heuristic considerations, and the dynamics of data and knowledge changes.

Considering the above, Figure 1 gives an overview of the intelligent airborne information systems that support decision-making.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

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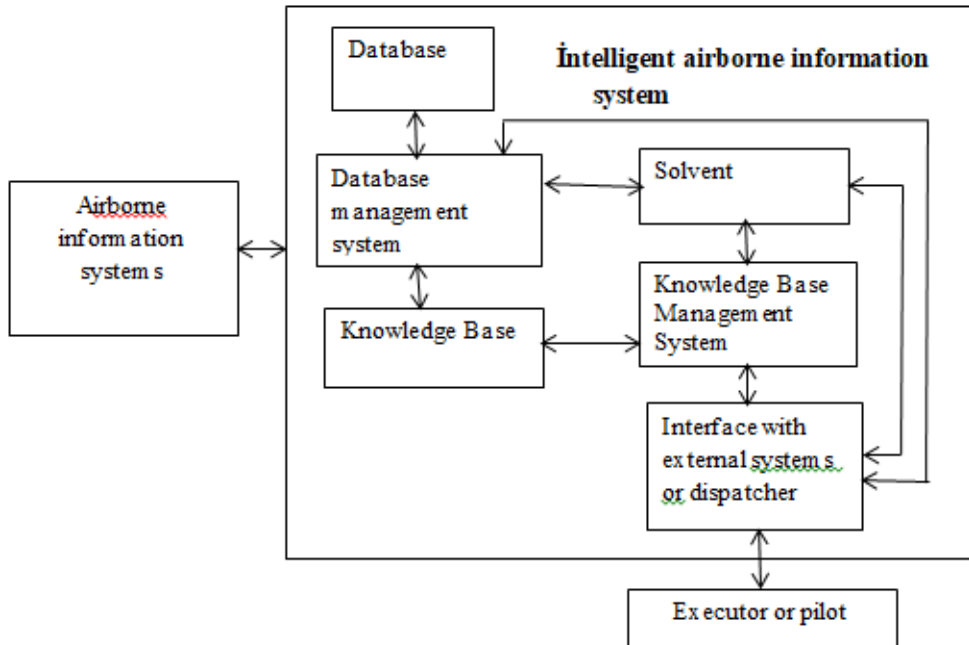BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

11

Figure 1. Structure of intellectual airborne information system supporting decision-making

The knowledge base is a complex system and consists of several subsystems that interact with the expert knowledge system. The general structure of the knowledge base is shown in Figure 2.
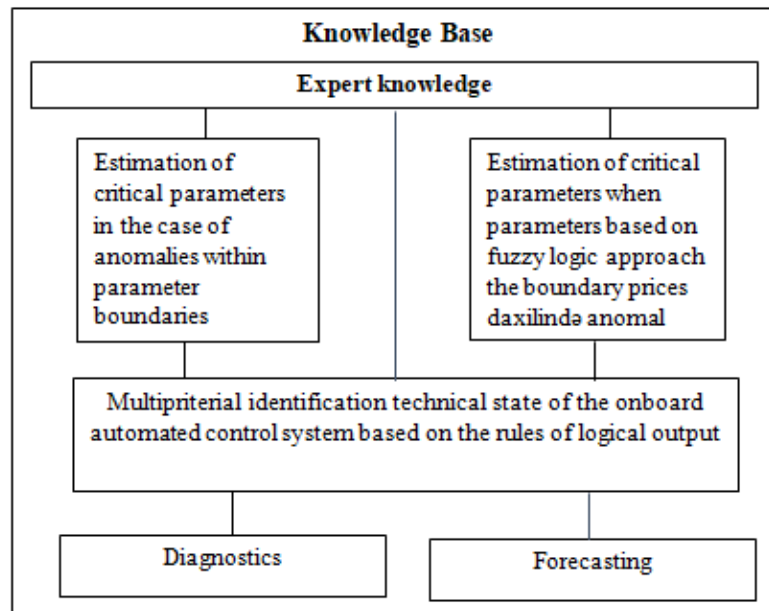

Figure 2. General structure of knowledge base

The subsystems included in the knowledge base serve to identify the optimal solution to diagnostics and prognosis based on the experience and knowledge of highly qualified professionals in a variety of ways under uncertainty.
When it is impossible accurately determined the cause and location of the refusal during parametric control, probabilistic

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

GULUSTAN

12

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or fuzzy assessments are made, which leads to the modeling of fuzzy issues. At this time can be used as a mathematical device, Bayesian networks, Mamdam function, etc.

The above-mentioned approach to the creation of an intelligent system is important in obtaining realistic results together, with the algorithms used to solve the diagnosis and prediction issues. It should be note that the development of a mechanism of interaction between external and internal systems also requires sufficiently complex mathematical and logical operations. Proper and optimal selection of information communication controls the state of the system as a whole, including each individual component, and at the same time contributes to updating the knowledge base.

RESULT

The proposed intelligent airborne information system provides a more precise univocal solution with various algorithms based on modern information technologies. In turn this will cause the estimating of the technical condition of individual units, reducing of the defects detecting resources, increasing the airborne equipment reliability. Depending on the application area, each module in the proposed model can be subdivided into sub-modules and can be used for both theoretical and research support for decision support systems.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

GULUSTAN
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13

THE IMPLEMENTATION OF MANUFACTURING AGENT'S CONCEPT FOR FLEXIBLE PRODUCTION SYSTEMS

Nevliudov Igor[1], Tsymbal Oleksandr[2], Bronnikov Artem[3]

[1]CITAM Dept., Kharkiv National University of Radio Electronics, Ukraine.

[2]CITAM Dept., Kharkiv National University of Radio Electronics, Ukraine.

[3]CITAM Dept., Kharkiv National University of Radio Electronics, Ukraine.

E-Mail: [1]igor.nevliudov@nure.ua; [2]oleksandr.tsymbal@nure.ua; [3]artem.bronnikov@nure.ua

ABSTRACT

The proposed report provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. There is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation.
Keywords: decision-making, manufacturing agent, robotics, flexibility, integrated system.

INTRODUCTION

The research, development and application of flexible integrated systems (FIS) is one of features of humanity entrance to the post-industrial stage of development. Application of FIS must provide the quick and low-cost transition to the new production types output, especially for conditions of low-series production. The efficiency of FIS is determined by optimal organization of technological equipment usage, supplied by robotized and transport systems, delivering bars, details and instruments, making the required service and check of technological processes.

The mass use of FIS becomes effective only then, if with the society demand for their application, the level and culture of production reach the certain quality level. Commercially viable development, introduction and exploitation of FIS's and robots are still quite expensive and not possible and every factory in any country. Recent Fukushima nuclear power station disaster, also earlier accident on oil platform in Mexico Gulf have shown, that even the most developed countries have level of robotics, which doesn't correspond the modern current needs of technical tools application in dangerous human conditions.

From the moment of Chernobyl disaster time in some aspects robotics haven't moved forward and the absence of required technical and informational supplement again lead to human resources using during quite simple tasks execution (investigation, transport operations, cleaning of territory with radioactive dirty) [1]. Therefore, the level of technical, technological and informational supplement of modern FIRS is in-corresponding to public challenges and asks for increased attention from theorists and practices. The mentioned makes researches in this field one of most perspective in modern science and technologies.

The analysis of FIS Applications

Flexible integrated manufacturing systems (FIMS) are considered as the method of production organization, which supplies the total control of production process and assumes the incorporation of NPC-machines and other technological equipment by local computer network to unite the threads for details processing or assembling, application of cutting instruments, other supplement and corresponding information streams [3].

The analyzes of FIMS shows, that the robot's AI is mainly implemented by computer system, which controls the robot manipulator's movements or his mobile platform. The AI of robots is based on highly developed sensor system, which includes the technical vision systems of different types, sensors of tactile type, meters of distance, gyroscopes, compasses, sensors of color etc. In addition, apart from the recognition of scenes and tactile sensoring speech recognition and natural speak processing have important role for FIMS intellectualization [5, 6].

The integrated automated manufacturing must include the in-built artificial intelligence tools, which supply the optimization of whole FIMS taking in account the overall cost of operations and resources. In this condition the manufacturing ACS have to supply the solving for the next problems: [6]:

- optimal application of instruments and equipment;

1-ci Beynəlxalq Elmi-Praktik Konfrans:
 Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

14

GULUSTAN
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- minimization for details displacement and for billet storage level;
- minimization for machines and robots downtime;
- maximization for rate and output volume of production;
- minimization for production costs by materials and tools flows checkout;
- Computation of safe transition paths for systems of robots and interacting robocars with supplement.

The industrial robots need such AI-tools, which give possibility for self-education on base of collected data's on machines timeouts and declining of their characteristics, for response to emergency situations (tool breakage, outside objects appearance in workspace) and for required adaptation on manufacturing system functioning. Robot's, able for self-education and estimation of surrounding workspace can become the assistants of human in manufacturing sphere, which doesn't replaces him, but enriches by functions and simplifies the works with instruments, materials and informational flows.

The tendencies analyzes for FIMS development shows the rising complexity of modern manufacturing as for stand-alone work cell as for workshop or factory. For such conditions the role of automated control systems, which applies the AI-methods and are able with sensor systems to get information on state of manufacturing systems, to analyze it and to make decision on functioning of factory. From other hand, the part of manufacturing decisions at every workplace, which becomes the function of supplement equipment: robocars, industrial robots, and other technological and supplement systems?

Therefore, the problem of development and introduction of tools for intellectual decision-making support at different levels of manufacturing control and for particular units of FIMS is still actual.

Implementations of strategies' planning systems for robotics

The functionality of most of information systems (IS) has purposeful manner. The typical act of such functioning is a decision of planning task by need purpose achievement from fixed initial situation. The result of problem solving can be expressed as plan – the partially ordered sequence of actions. Such plan is similar to scenario, for which vertexes are connected by relations of type "purpose – sub-purpose", "purpose-action", "action-result" etc. Any way in such scenario, which leads from current state to one of vertex purposes defines the plan of actions [7].

The action's plan search task rises then informational system meet non-standard situation, for which there is no known action's set that reaches the purpose. All the tasks of action's plan construction can be divided into 2 typed, corresponding to different models: planning for space of states (SS-problem) and planning for space of tasks (PR-problem) [1].

For the first case the set of situations is given. Their descriptions include the states of surrounding world (workspace) and of Informational system (IS) with corresponding parameters. Situations are combined to generalized states and actions of IC or workspace changes lead to state's changes, actual for current moment of time. Among the generalized states – the initial (usually one) and final (purpose). SS-problem decision is in the search of path form initial state to one of the final.

For the space of tasks planning situation is slightly different. The workspace is created by introduction of relationships like «whole – part», «task – sub-task», «common – partial» etc. Therefore, the task space maps the decomposition of tasks to sub-tasks (purpose – to sub-purposes). PR-problem is in the search of initial task decomposition to sub-tasks, that leads to the tasks with available solutions.

Source [2] contains the classification of methods, used for solving SS- and PR-problems.

1. Planning on states. Presentation of tasks for the space of states includes the following descriptions: states, sets of operators, influences to transition between states and purpose states. States can be described by symbols, one- and two-dimensional arrays, trees, lists etc. Operators transform object form one state to other. Sometimes they have the production view: $A \rightarrow B$, meaning the transformation from state *A* to state *B*.

The space of states can be set by graph with vertexes of states, arcs of operators. If some arc is directed from vertex n_i to vertex n_j, then n_i is son, and n_j - father vertex. The sequence of vertexes $n_{i1}, n_{i2}, \ldots, n_{ik}$ for which every son vertex for vertex n_{ij-1} is a path *k* from vertex n_{i1} to vertex n_{ik}.

Therefore, the task to solve problem $\langle A, B \rangle$ in planning be states can be presented as search task on graph from *A* to *B*.

2. Planning on tasks. Such method is effective for hierarchy structure of problem-solving. Planning search for tasks space is in the sequent reduction of initial task to more and simpler up to reaching the elementary tasks. The partially ordered set of such tasks combines the solution of initial task. The partition of task to alternative sets of subtasks can be easily presented as AND/OR graph. In such graph any vertex (apart from end) has conjunction (of type AND) and disjunction (of type OR) vertexes. For particular case, if AND-vertexes are absent, there is graph of state's space. The end vertexes are finite (corresponded to elementary tasks) or not effective (deadlocks). The initial vertex (the origin of graph AND/OR) is initial task. The purpose of search for graph AND/OR is to shoe, that the initial vertex has connection to solutions. The

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

15

solutions are final vertexes (of type AND) for which all the son vertexes can be solved and all OR-vertexes with at least one solved son vertex. The example of implementation if planning method of General Problem Solver – GPS.

3. Planning with help of logical inference. It assumes the description of states as Well-Formed Formulas (WFF) for certain logical computation, operator's description as WFF or translation of WFF to others. The presentation of operators as WFF lets to create the deductive planning methods, the presentation of operators as translation rules – to create the planning methods with elements of deductive inference.

Manufacturing agents and proposals on it's applications

For case of FIMS adaptivity is a possibility to keep manufacturing system workability for case of functioning condition changes, caused by external (other FIMS, transport system, energy supplement, ventilation system etc.) and internal (work of processing units, NPC-units, transport system, personal activity etc.) sources.

For such conditions FIMS must adapt to the current conditions and change the schedule (plan) for whole system functioning or fro some parts, providing the adaptation of functioning strategy.

The technological process of mechanical processing and assembling must be provided in one or several workshops with processing centers, NPC-machines, industrial and transport robots, storages and the transport system, connecting the technological equipment and the automated storehouse.

The lacks of production process organization for the mentioned mechanical and assembling workshops are:

- the fixed mode of transport system work and insufficient level of automation with limited application of industrial robots;
- the manual loading for NPC-machines;
- the absence of automatized tools to avoid the emergency or non-standard production situations.

To overcome the mentioned lacks there are proposed:

- to introduce the mobile assembling-transport robot to the equipment of flexible integrated systems and workshops (Fig. 2.);
- to develop the mathematical and algorithmic supplement, the software for the mentioned robot.
- The mobile assembling-transport robot must correspond to the following requirements:
- free movement in range of workshops out of technological equipment units workspace;
- robot supplies the devivery of billets and other materials to the workspace of processing centers and NPC-machines;
- robot supplies the devivery of needed instruments or equipment on regular or irregular calls;
- robot supplies the execution of selected assembling operations;
- robot supplies the monitoring for technological and other equipment of workshop;
- robot checks the functionality of technological equipment.
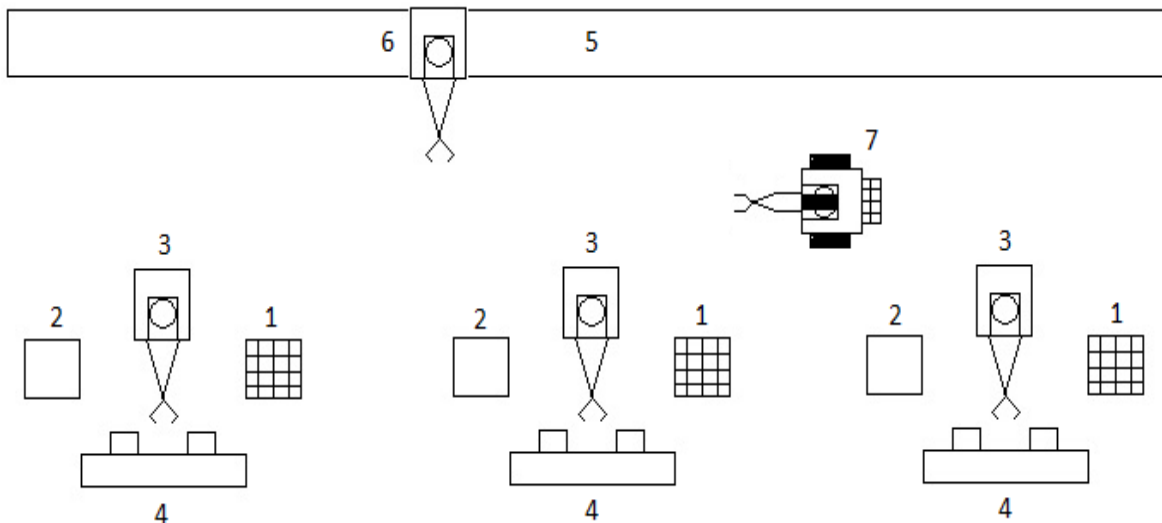
Figure 1 – The structure of flexible automated sector

(1, 2 – input and output storages, 3 – industrial robot, 4 – NPC-machine,
5 – transport system, 6 – transport robot, 7 – intellectual assembling-transport robot)

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

16

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

To supply its functionality the assembling-transport robot must correspond to the following construction demands:
- the presence of mobile platform chassis;
- the presence of manipulator (or of several manipulators);
- the presence of cargo block to transport billets, details, instruments and equipment;
- the presence of communication system;
- the presence of control system with computer on-board;
- the presence of sensor system for chassis and manipulator.

The assembling-transport robot must be selected on base of existing models of transport robots and manipulators.

The particular element of control system for mobile assembling-transport robot is decision-making support system (DMSS). As to dynamics of robot's workspace DMSS must supply the problem-solving for transition tasks of assembling-transport robot to particular workspaces, to schedule the loading-uploading operation for technological equipment, instruments and supplement, to plan some assembling operations. The dynamic nature of assembling-transport robot workspace, determined by particular production system, defined the demands of functioning strategies adaptivity, which must supply the increase stability and productivity of flexible manufacturing systems.

CONCLUSION

The proposed work provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. In particular, there is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation. As an example of manufacturing agent's concept practical implementation the functioning of industrial and transport robots is proposed. Robots, unlike the logical agents, are the real material objects of physical world and, actually, the physical agents. Because of that, robots are supplied by different execution tools of manipulation type, by sensor systems to measure the workspace parameters. Some robots are mobile and able to move on workspace. The real robots act in conditions when the workspace is only partially determined, stochastic, dynamic and continuous. For the most of real cases, the robot's workspace is multi-agent and sequential.

Therefore, the speed and quality of functioning strategies planning for FIMS is defined by selection of methods of data search for intellectual robotized system. The strategies planning correspond to the multi-stage decision-making models. The functioning strategies planning for FIMS can be described by a number of states and tasks with fuzzy and probabilistic methods application. During development of functioning strategies planning systems of FIMS the subject of essential attention is simulation of robot's and surrounding objects workspace. The systems of strategies planning can be practically implemented as action planning systems and correspond to the concept of manufacturing agent.

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1st International Scientific-Practical Conference:
Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

17

CYBERSECURITY ISSUES IN THE INTERNET OF THINGS

[1]Pohasii S.S., [2]Milevskyi S.V., [3]Milevskyi S.V

[1]Department of Cybersecurity and Information Technologies, Kharkiv National University of Economics
(S.Kuznets KhNUE), Kharkiv, Ukraine,

[2]Department of Cybersecurity and Information Technologies, Kharkiv National University of Economics
(S. Kuznets KhNUE), Kharkiv, Ukraine,

[3]Department of Cybersecurity and Information Technologies, Kharkiv National University of Economics
(S. Kuznets KhNUE), Kharkiv, Ukraine,

E-mail: [1]spogasiy1978@gmail.com; [2]Stanislav.Milevskiy@hneu.net; [3]Oleksandr.Milov@hneu.net

ABSTRACT

The article discusses the main problems associated with cybersecurity on the Internet of things, on the example of their implementation in the technology of "smart house". The advantages and disadvantages of modern data transmission technologies are considered. The shortcomings of data exchange protocols and the main directions for solving these problems are indicated.

Keywords — internet of things, smart house, data transmission technology, messaging protocols, cybersecurity.

INTRODUCTION

Today, smart houses are one of the most promising areas in the field of Internet of Things (IoT), the prospects for this segment of the device market Zion Market Research estimates at $ 53.45 billion by 2022 [1]. The development and application of artificial intelligence in commercial projects and the use of voice assistants Apple HomePod, Google Home and Amazon Echo are becoming more common.

Despite the rapid growth of the consumer market of smart devices from early adopters, the full-fledged success of this field depends on how quickly developers can solve the main problems and provide users with ready-made solutions:

- A more convenient interface (and compatibility of devices with each other).
- Affordable price.
- Data security.
- Convenient interface

Smart houses are a relatively new area in which there are no established usability or quality requirements.

With the increase in the number of smart house users, the industry is gathering more and more information to understand how you can improve customization and provide a more affordable out-of-the-box design. Although the creators of smart assistants (smart / voice / home assistants) are not directly involved in device development, they can affect many decisions by creating UX / CX standards, a list of technical requirements (latency, performance, interaction protocols) [2].

Problems review

One of the main problems of implementing a smart house from a security point of view is the choice of data transmission technology. There are several basic data transfer technologies: Z-Wave / Zigbee / Bluetooth / Wi-Fi.

Zigbee became standardized in 2003, developers claim compatibility with other brands, products, manufacturers and the Zigbee version. The advantages include: interaction - most other Zigbee products will work with each other; scale - a large selection of products, which includes many Powerhouse brands, such as Philips, Lutron, Samsung, etc .; the price – it is not expensive, given that their technology is not proprietary (thus, it does not control the premium price); range - all devices that are always on act as a repeater. The main disadvantage is the interaction of most brands work with each other, but because of the many, many manufacturers who produce real Zigbee radio, it is difficult to know which ones meet the standards of alliances.

Z-Wave technology was adopted in the United States in 2001, in 2005 a group of manufacturers came together to form the Z-Wave Alliance, regardless of manufacturer, brand, product, year of product creation or version of Z-Wave software, all Z-Wave products will interact with each other. The advantages of Z-Wave include: interaction - the selected Z-Wave product must be certified; scale - Z-Wave works with more than 1500 products; no interference with Wifi bands, Z-wave operates on a separate radio frequency wave; range - can grow depending on the number of devices that are on the

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

18

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

network. Cons of Z-Wave: the price may be much more than WiFi, but there are no special advantages; moving to another country - Z-Wave devices are programmed with the radio frequency of their intended countries, if you go to a country that does not support the frequency the device is programmed for, it will not work.

Bluetooth and Bluetooth Low Energy (LE) was launched in 1994 by Ericsson and is now managed by the Bluetooth Special Interest Group. Bluetooth Low Energy (BLE) was developed in 2011. Pluses of Bluetooth LE: power consumption - long battery life; price - Bluetooth has been around for a long time and is a standard recognized by many, it should be able to offer quality products at a lower price; compatible and centralized hub - no need for a dedicated HUB, since devices can directly connect to the home router. The disadvantages include: potential problems with interference - Bluetooth operates at 2.4 GHz, it is also susceptible to interference; the scale – it has recently entered the Home Automation industry and, therefore, does not have so many options available to the consumer, in addition, many HUBs do not support Bluetooth LE at this time; range - limited by the general range, physical obstacles.

WiFi for home automation has a number of advantages: the price is the ability to get a lot of offers on smartphones with WiFi support; scale - there are many offers of smart devices with WiFi support. The problems can be attributed to - problems with interference WiFi works at 2.4 GHz, as well as susceptible to interference. Energy intensity - Smart house battery products consume a lot of power.

The problem of affordable prices.

Many households will be prepared to automate trivial household tasks if the price of the final product is available in accordance with the purchasing power of households. Most consumers choose lamps at the initial stage due to the simplicity of the settings and the user-friendly interface, then they add a thermostat to control the temperature or a smart camera. If there is a desire to improve the setting and add a voice assistant and a monitor, the price tag can vary from $ 50 to $ 480. Therefore, manufacturers' priority is to solve the problem of accessibility of a smart house for more people [3].

The problem of data security.

With the advent of smart devices, hackers can hack data from devices, both in the cloud and on a physical device. Therefore, the problem of data security and confidentiality remains fundamental in the field of technology.

The "Security Analysis of Emerging Smart house Applications" study breaks vulnerabilities into 2 categories:

1) excessive privileges;

2) insecure messaging.

Excessive privileges are a security breach when a mobile application gains access / rights to operations that it does not really need for a work. When malware (malware) gain unrestricted access to SMS APIs or logs, it can lead to leakage of personal information (PII), including PIN codes or passwords.

One of the main methods of preventing such scenarios is coding, aggregation and anonymization of data [4].

By working together, device manufacturers, the mobile application certification center and the users themselves can reduce the risk of data being discredited. One of the main factors of competition between manufacturers is the security of user data - starting from the design stage and the system design of the product, apply the latest data protection solutions to thorough testing for potential security problems. One weak link will be enough to discredit user privacy [1].

The problem of unprotected messaging.

IoT devices use different communication and messaging protocols at different levels. When developing an IoT device, the choice of protocol depends largely on the type, level and function that the device must perform. MQTT, XMPP, DDS, AMQP and CoAP are several widely used communication protocols for the IoT application layer.

MQTT is a machine-to-machine (M2M) protocol. This is a publish and subscribe based messaging protocol used to transfer device data to servers. The main purpose of the MQTT is the remote control of IoT devices. It is mainly used when it is necessary to monitor or manage a huge network of small devices via the Internet, that is, parking sensors, underwater lines, the power grid, etc.

XMPP (Extensible Messaging and Presence Protocol) was originally developed as a messaging protocol known as Jabber. It uses XML format for messaging. The main feature of this protocol is its addressing mechanism. It identifies devices / nodes in an IoT network using an address known as Jabber ID (JID). JID follows the standard - name@domain.com. This addressing mechanism allows two nodes to exchange information no matter how far the nodes are on the network.

XMPP messages are usually transmitted over a basic TCP connection. It uses the polling mechanism to determine the destination of the message. XMPP is implemented using a client-server architecture. The client starts the XML stream by sending the opening <stream> tag. The server then responds with an XML stream back to the client. Because XMPP is an open protocol, anyone can have their own XMPP server on their network without the need for an Internet connection.

DDS is also based on the publish-subscription model. DDS connects devices directly, unlike MQTT, which connects them to the server. This is why DDS is faster than MQTT. Apparently, it can deliver millions of messages to several different recipients in a matter of seconds, since it eliminates communication with the server. DDS can be used to provide communication between devices over the data bus. This ensures detailed service quality and reliability.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

Enhanced Message Queuing Protocol (AMQP) is an application-level, open layer protocol for sending transactional messages between servers. As a message-oriented middleware, it can process thousands of trusted transactions in a queue. AMQP is designed not to lose messages, since messages can be transmitted using TCP or UDP. Using TCP provides a reliable point-to-point connection. In addition, endpoints must acknowledge the acceptance of each message. The standard also describes an additional transaction mode with a formal multi-phase commit sequence. Based on its origins in the banking industry, AMQP focuses on tracking messages and ensuring that every message is delivered to its destination, regardless of failures or reloads.

All of the above protocols are uniquely applicable to different working scenarios. Any protocol can be selected manually based on their pros and cons for developing IoT applications. The main factors to consider when choosing any of them for application is the quality of service, security and reliability required for your application [5].

Japan's Trend Micro Cybersecurity Firm has published a report on the security status of IoT. The company found that two of the leading machine-to-machine protocol (M2M) have internal design problems and are often deployed in an insecure manner.

According to Trend Micro's "Fragility of Industrial IoT Data Trunk" report, problems are related to two popular M2M protocols (MQTT) and (CoAP) with a simple keyword search, attackers were able to detect unprotected IoT servers and intermediaries.

CONCLUSION

These protocols have not been designed with security in mind, but are found in an ever wider range of critical environments and use cases. This represents a serious cybersecurity risk. Hackers with even modest resources can exploit these design flaws and vulnerabilities for reconnaissance, lateral movement, hidden data theft, and "denial of service" attacks [6]. To overcome these and other current problems, many companies are looking for specialists with knowledge of Firmware (on the device), Software (on the cloud side). However, the availability of such specialists in the market is significantly limited. This leads to an excessive increase in the cost of their work. Thus, the search for universal solutions in the field of security of the Internet of Things is one of the most pressing problems at the present stage of cyber technologies development.

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

20 GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

INNOVATIVE MECHANISMS FOR THE DEVELOPMENT OF A MARKET FOR ENVIRONMENTAL GOODS AND SERVICES

[1]Belyaeva Elena, [2]Panaseikina Veronika

[1]Candidate of Economic Sciences, assistant professor, Kuban State University, Department of Management and Psychology. (Russia)

[2]Candidate of Economic Sciences, assistant professor, Kuban State University, Department of Management and Psychology. (Russia)

Email: [1]helenla@mail.ru, [2]vspjuly@mail.ru

ABSTRACT

The article is devoted to the main trends and mechanisms of green market development. The main challenges of greening regional and federal markets of goods and services are considered. The contribution of innovative development to the solution of environmental problems is revealed.

Keywords: green economy, green markets, markets for environmental goods and services, green technologies

Currently, the market development for environmental goods and services is being comprehensively researched by representatives of various sciences, such as economics, law, geography and regional economy, sociology, etc. Scientific interest in innovative mechanisms, as well as in opportunities to transform Russian economy under the influence of global trends in environmental management has increased after the Russian Federation has adopted the BRICs Declaration on compliance with green economy and as the UN General Assembly's "2030 Agenda for Sustainable Development" with its 17 goals, including "Industry, Innovation, and Infrastructure" and "Responsible consumption and production" as well.

Environmental development of the Russian Federation involves environmental protection and innovative development; is based on the RF Constitution together with principles and rules of international law, international treaties of the Russian Federation, federal constitutional laws, federal laws, laws of subjects of the Russian Federation, and documents of long-term strategic planning.

These documents include The national security strategy of the Russian Federation up to 2020 [1], the Concept of long-term socio-economic development of Russia up to 2020 [2], the Foreign Policy Concept of the Russian Federation [3], the Strategy of the Arctic zone of the Russian Federation development and national security system for the period up to 2020 [4], the Water Strategy of the Russian Federation for the period up to 2020 [5], the Strategy of sustainable development of rural areas of the Russian Federation for the period up to 2030. [6], the Strategy of hunting sector development of the Russian Federation for the period up to 2030 [7], the Transport Strategy of the Russian Federation, the Strategy of tourism development of the Russian Federation for the period up to 2020, the Strategy for the conservation of rare and endangered species of animals, plants and fungi in the Russian Federation for the period up to 2030, The Strategy of Development of Insurance Activity in the Russian Federation up to 2020, the Strategy of innovative development of the Russian Federation for the period up to 2020, the Strategy of social and economic development of federal districts.

The Concept of long-term socio-economic development of Russia up to 2020 defines the purpose of environmental policy, which is to significantly improve quality of natural environment and eco-conditions of human life, to create a balanced environmentally-oriented model of economic development and environmentally competitive industries. To successfully implement the programme of ecological development is the most important contribution of Russia to global biosphere preservation and maintenance of the global environmental equilibrium. The Concept sets out the main directions of environmental protection.

- Production ecology (gradual reduction of environmental impact of anthropogenic sources). The main elements of this trend should be a new system regulating permissible impact on the environment to reject individual permits for each enterprise and establish standards and plans for gradual pollution reduction to levels corresponding to the best environmentally safe world technologies; to develop waste management industry, and to expand renewable energy sources. Introducing new technologies should be facilitated by tax policy measures, according to which environmentally friendly and energy-saving technologies will be provided with appropriate benefits for corporate income tax, land tax, property tax, as well as various deductions for personal income taxes. Thus, economic incentives will be created to upgrade production and appropriate technologies used by citizens. This is to reduce specific environmental impact by three to seven times depending on the industry.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

- Human ecology (creation of a sustainable and comfortable environment for population to live, work and rest). This direction includes eliminating accumulated pollution, restoring eroded, cluttered areas, ensuring effective sanitation, managing household waste, promoting healthy lifestyles. It is necessary to develop special sustainable health and safety standards for human environment in order to carry out specialized monitoring. To implement this direction by 2020 means to reduce the number of cities with high and very high pollution levels by five times at least; to reduce the number of residents living in adverse environmental conditions by four times at least.

- Ecological business (creation of an effective environmental economy). This sector can include a competitive business in the field of general and special engineering, environmental consulting. Here, the government is to set rules of environmental audit, requirements for process development. In addition, it provides conditions for large-scale implementation of environmental management and increases the transparency of industrial enterprises in terms of their environmental impact and measures taken to reduce the negative impact. Besides, the state is responsible for monitoring the dynamics of environmental economic performance.

The target progress indicators in this direction are the market growth of environmental development, goods and services by five times and the expansion of employment from 30,000 to 300,000 jobs.

- Natural environment ecology (natural environment preservation and protection). This direction should be targeted at regional differences reduction among specially protected natural areas, a more effective and safer bio-productivity of natural systems, and species diversity restoration. Ensuring environmental efficiency of the economy is not only specific for business and economic policy, but also conceptual for innovative economic development, closely related to improving resource consumption efficiency. An increase in technological and environmental efficiency of the economy by 2020 is expected to result in reducing environmental impact by 2 - 2.5 times, which will allow to reach current figures of nature conservation in developed European countries.

Another essential document determining long-term trends and expected results of social and economic development in the Russian Federation and its subjects is the Forecast of long-term social and economic development of the Russian Federation for the period up to 2030. According to Section 8 "Environmental Protection. Economic development of resource potential" there are indicators of the RF environmental development providing for certain achievements in the following areas: emissions from stationary sources for different pollutants, cities with high and very high levels of air pollution, wastes of all hazard classes, fixed capital expenditures aimed at environmental protection and rational use of natural resources, and greenhouse gas emissions.

There is no consensus in the modern economic literature on the term "environmental service". However, the closest meaning reflecting the essence of environmental services as services of a special kind has the following definition: environmental services are activities carried out by various organizations (institutions) on a commercial, contractual or gratuitous basis to implement environmental compliance for third-party facilities.

In foreign businesses, environmental activities and services (market for ecological services) include the following:
- enterprises engaged in biodiversity conservation;
- pollution prevention enterprises (producing equipment, tools and control means for environmental protection, etc.);
- enterprises with nature-saving technologies (waste processing, producing goods with eco-labelling);
- enterprises engaged in landscaping;
- enterprises engaged in the information eco-business [8].

Worldwide, various ways of stimulating environmental technologies are used. They are environmental regulations, rules, legislation, subsidies to reduce emissions, tax incentives, and pollution rights. Experience has shown that direct control measures are the least effective way to stimulate.

In addition, a number of national scientific and technological programmes are being greened. Japan, Germany, Holland, Italy, Canada, France, Great Britain, and Norway are developing national schemes focused on ecologically important technologies. For example, in Japan, The Research Institute of Innovative Technology for the Earth (RITE) funded by the public and private sector was established in 1990. Its main activities are related to global warming and alternative energy sources. In Germany, a Program of Environmental Technology was developed by the Ministry of Research and Technology. In the Netherlands, the Technology Transfer Organization (TNO) is the largest Research & Technology Organization (RTO), in which environmental technologies amounts to 10 per cent of its activities. In Italy, the Fund for Technological Innovation (FTI) has been established, 5 per cent of which are used for developing eco-technology. Canada has introduced the Technology for Environmental Solutions Initiative (TESI). In many countries, environmental technologies are integrated into existing science and technology programmes and initiatives.

In developed countries, environmental engineering and technology is one of the most profitable industries causing the environmental market to boom. In the mid-1990s, over 40 per cent of the global market for environmental products and services were held by the United States [14]. American enterprises produce cleaning equipment and environmentally friendly consumer goods, such as organic foods, harmless paints, etc. Manufacturing such products is considered to be prestigious and profitable, and enterprises thereby create their own advertising and a favorable market recognition. Environmental product settings affect the enterprise's competitiveness in the global market.

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

GULUSTAN
22
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

Due to enhancement of environmental legislation in almost all countries, there will be an increase in environmental engineering and technology industry. This process has already begun throughout the Western world.

The development of the market for eco-innovations is significantly influenced by the EU directives, in particular, requirements to the content of sulfur dioxide, nitrogen oxides and dust in the flue gases emitted by thermal power plants. They make manufacturers develop devices for monitoring trace pollutants. Western European companies engaged in environmental business are successfully using current trends in environmental policy to increase their profits.

While in the 1970s and 1980s, companies mainly strove to neutralize possible consequences of environmental damage, in the 1990s, the emphasis was placed on eliminating causes of environmental violations. Taking preventive measures, rather than neutralizing the pollution effects, is considered by experts a more reliable means of addressing environmental problems.

It is possible to note the main alternatives in the ecological market:

1) Improving existing products by adapting them to new environmental requirements. Many operating companies are expanding their business by fitting manufactured goods or production methods to new market needs. In the 1990-ies, it was popular for companies to review the environmental impact of their products throughout their entire lifecycle, from their production to disposal after disuse ("from cradle to grave" approach).

2) Designing fundamentally new products and even setting up specialized companies for this purpose. The need to address environmental problems and fierce market competition offer exciting possibilities for development, production and marketing of entirely new products instead of environmentally hazardous ones. At the same time, sustainable development gives the best prospects for companies. In some cases, enterprises create new products from waste materials.

3) Investing foreign funds. In some cases, a rapid market development for environmental goods and services leads to companies unwilling to launch new products that may become obsolete before their distribution starts generating a profit. To reduce the risk, companies are trying to attract foreign investors, especially from countries with a developed market for environmental goods and services. Apart from risk sharing, foreign direct investments offer opportunities to acquire new technologies and expand marketing outlets.

4) Providing environmental services as information, consulting, or expert assistance to solve environmental problems, to provide training for environmental specialists, etc. Some other new service areas include technical advice, environmental assessment and audit, waste and recycling management, transportation, retailing, green advertising and marketing.

Certain challenges of market development for environmental services are the following:

- global environmental crisis caused by industrial production development and an increased anthropogenic impact on the biosphere;
- current contradictions (often very sharp) between global and local benefits [9].

Innovative development has greatly contributed to coping with environmental challenges. Thus, technological production upgrade has created respective technical and other conditions for greening industries. Areas affecting environment, both directly and indirectly, can be divided into:

1) technological innovations leading to an increase in production efficiency, expansion of the product range and higher quality of manufactured goods and services or applied techniques, a succession of equipment models and generations, technological structures and processes aimed at linking economic development with the requirements of environmental protection;

2) resource economy (as a key type of technological innovations) associated with introducing resource-saving technologies that not only reduce the extraction extent of various types of natural resources, but also ensure a more complete and integrated usage. Consequently, this can ease the environmental burden from mining and processing industries [10];

3) environmental innovations;

4) tools needed for ecological and innovative activity, incentives for development of ecological services market, eco-production and technologies, etc.;

5) innovative management, legal and other solutions to improve the efficiency of natural resources utilization, along with enhancement or at least maintenance of natural environmental quality;

6) long-term development of the market for environmental pollution rights based on practices in other countries that have enforced such mechanisms within environmental management, as well as on international experience in this area (in particular, the economic mechanisms under the Kyoto Protocol). This will enable to subsequently transfer know-hows to the national level.

To sum up, currently, environmental services market has great prospects for future development. Thus, along with the main types of environmental services (environmental audit, environmental insurance, environmental management and waste disposal), there appear other activities, such as emission trading. The latter direction is a completely new international market, where product demand is more than significant.

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24

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TELEMETRY APPROACH BY CANSAT DESIGN

Elek, Muhammet İkbal[1], Aliew, Fuad[2]

[1]Electronic Engineering Department, Gebze Technical University, Turkey.

[2]Electronic Engineering Department, Gebze Technical University, Turkey.

E-mail: [1]mielek@gtu.edu.tr; [2]aliew@gtu.edu.tr

ABSTRACT

This paper provides an overview for Cansat, auto-gyro and telemetry design. The cansat is developed with an auto-gyro descent system. Additionally, cansat includes a camera and its stabilization system. It is launched by the help of a model solid fuel rocket with a pyrotechnical detachment system.
Keywords: Cansat, Auto-gyro, Telemetry

Concept
Cansat project is based on an idea that provides students to improve their skills on a multidisciplinary satellite mission. Cansat is typically launched to an altitude of 1 km. This flight usually takes around 2.5 minutes. Auto-gyro is used to slow down the descent to 10-15 m/s. A container is used to protect the payload from the stresses inside the model rocket. Payload is the main satellite which includes sensors and microprocessor.

Cansat launcher
Cansat launcher can be a model rocket, UAV's, helicopters or basically anything that can reach the designated altitude and can carry around 500 grams. For testing a UAV is a more dependable and inexpensive way. We mostly used UAV's and model rockets with parachutes and pyrotechnical detachment systems because of them being the most secure solutions.

Structure
Structure includes container and payload. For general structure we have used carbonfiber rods and 3D printed ABS.

Container
Container is Cansat's outer shell that is 30.5 cm long cylinder with a diameter of 12.5 cm including parachute and parachute opening system. It protects the payload from hazards inside and outside the launcher. This subsystem includes a spherical parachute to slow it down to 15-20 m/s and detachment mechanism for payload and container. Cansat's outer shell is a 30.5 cm long cylinder with a diameter of 12.5 cm including parachute and parachute opening system.
Parachute made from Ripstop Nylon that has 11 cm diameters.It has a small hole in the middle to balance stabilization and increase friction with air. While Cansat is in the descending state, the air flow through the holes in the parachute section prevents the payload from tumbling. In addition, the spill-hole at the top of the parachute helps us to avoid tumbling and allows the payload to stabilize.
The concept of release mechanism system is that when the container and the science payload start to fall, the airflow cavities direct the air towards the middle of the main parachute creating higher pressure inside. Then that pressure is used to bust the cut paper open deploying the smaller parachute. Which in turn deploys the main parachute.

Payload
The payload is the main part of the Cansat. It transmits telemetry, which includes sensors to track altitude using air pressure, external temperature, battery voltage, GPS position, pitch and roll and auto-gyro/ passive helicopter recovery blade spin rate. Due to the low power consumption and efficient design in optimized conditions, we choose single rotor with airfoil for the auto-gyro system.
Payload consist of ABS 3D printed discs connecting with carbon fiber epoxy rods. It is attached to the container with three ring release mechanism that is operated by servo motor. The Payload is powered with 8.4 Batteries are connected as parallel.In this way, we can obtain double battery life. Many components are connected to regulator to supply current efficiently. Switch is located on an accesible place.
A camera is placed on a rotatable part within the camera hub in payload.This rotatable part is where the rotational stabilization occures and it is connected to the lower servo via a slipring to ensure that the wires don't get winded up when the servo turns.

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Flight Software

C++ language is used as programming language. Visual Basic, Arduino IDE, XCTU DIE are used as development environments. Necessary raw data is received from various sensors and sent to MCU. Through telemetry, the data packages are sent to the ground station via XBEE radios. Electronic circuits are designed on breadboard. Each sensor is tested individually with Arduino and Serial Monitor and telemetry data is sent with XBee Radio Module to computer.

If any complication occurs which ends with system reset during the flight, here is the method for the recovery: Every data is going to be saved to SD card during the flight, and state data is going to be changed with every milestone check. If any reset occurs, the system will start over and go to the last saved state, then continue the flow from that state.

Indentations and Equations
Auto-Gyro Descent Speed Calculations

$$\sigma = \frac{BladeArea}{DiscArea} = \frac{NRc}{\pi R^2} \tag{1}$$

$$C_L = \sigma \left(\frac{Re}{R}\right)^3 \pi \left(\frac{\theta}{3} + \sqrt{\left(\frac{\theta}{3}\right)^2 + \frac{C_d}{4\pi}}\right) \tag{2}$$

$$W = mg \tag{3}$$

N − Number of Blade
R − Blade Radius
c − Chord
θ − Angle of Attack
C_d − Drag Coeffience
V − Descent Speed
C_l − Lift Coeffience
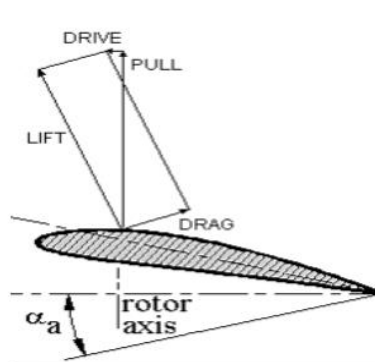
Rc/R = 0.97
R = 0.17975 meters
m = 0.420 kg
c = 0.27 meters
Cd = 0.012
ρ = 1.16
g = .80665
N = 2

$$C_L = 0.095 * 0.0973 * \pi \left(\frac{\theta}{3} + \sqrt{\left(\frac{3}{3}\right)^2 + \frac{0.012}{4\pi}}\right) = 0.548477 \tag{[2]}$$

According to blades angle of attack,radius and count of blades coeffcient lift is: $C_L = 0.548477$

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26 GULUSTAN
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1. The coefficient lift is calculated according to the shape and length of the wing.
2. The coefficient is found in the KwBl equation.
3. Kz0 is calculated using KwBl. 4. Vsink (Descent Rate) and rotational speed are calculated with the calculated values. [1]

$FR = 0.420\ kg\ .9.80665\ m/s2 = 4.12\ N$ Rotor Force
$\rho = 1.16\ kg/m3$ Air density
$tBl = 0.027\ m$ Blade Chord
$rR = 0.18$ Rotor Radius
$nGl = 5$ Airfoil lift-drag ratio
$\epsilon Bl = -5o = -0{,}087266\ rad$ Mean Blade incidence angle
$CABl0 = 0.548477$ Lift Coefficient at 3o angle of attack
$KwRi \approx 0.86$

$Kz0 = 0.418642$
$KwBl = 0.133336$

With these data we estimate a sink rate of:

$Vsink \approx 10.649\ m/s$
$FR \approx 4.12\ N\ nR \approx 2215\ rpm$

The rotor rotational speed is: $nR \approx 2215$ rpm

A) Payload Landing Calculations with Parachute

$$S = \frac{2mg}{\rho\ CDV^2}$$ **Parachute Size**   (4)

$$Dia = \sqrt{\frac{4\ S}{\pi}}$$ **Diameter For Parachute**   (5)

According to the average air temperature in Texas, air density was determined :

     $\boldsymbol{\rho = 1.16\ kg/m3}$

Weight of container and science payload:

     $\boldsymbol{Mass = 0{,}5\ kg}$

Estimated drag coefficient:

     $\boldsymbol{Cd = 1{,}5\ (for\ elliptical\ parachute)}$

     $\boldsymbol{g = 9{,}80665\ m/s2}$

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27

$$V = 15 \; m/s$$

The radius calculated according to descent speed:

$$Rtotal = 0.12 \; m \; Rhole = 0.03 \; m$$

The parachute radius for this parachute is $0.09 \; m.$

B) Container Landing Calculations with Parachute
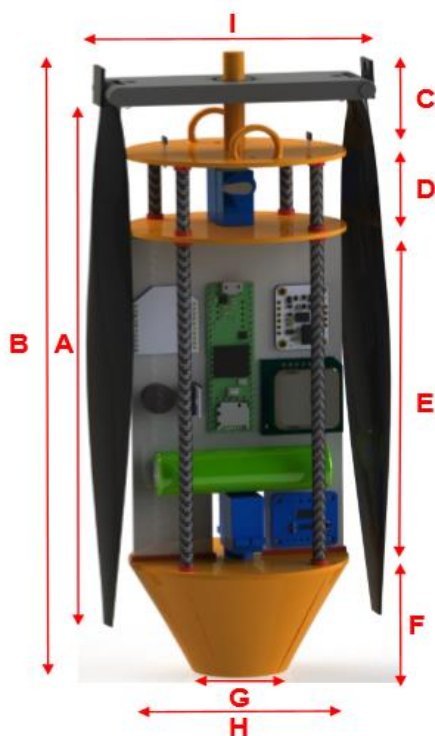
Figure 1. Payload Dimensions

Weight of container:

Mass = 0.08 kg

$$W = mg = 0.08 \; kg * 9.80665 \frac{m}{s^2} = 0.784 \; N$$
$$S = \pi r^2 = 0.0250 \; m^2$$

$$V = \sqrt{\frac{2mg}{\rho \; Cd \; S}} = 6.00 \; m/s$$

C*ontainer descent speed is* **6 m/s**

Figures and Tables
General Dimensions of the Container

Letter	Dimension
A	180 mm
B	254.6 mm
C	50 mm
D	30.6 mm
E	139 mm
F	45 mm
G	36 mm
H	82.5 mm
I	100.16 mm

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

GULUSTAN
28
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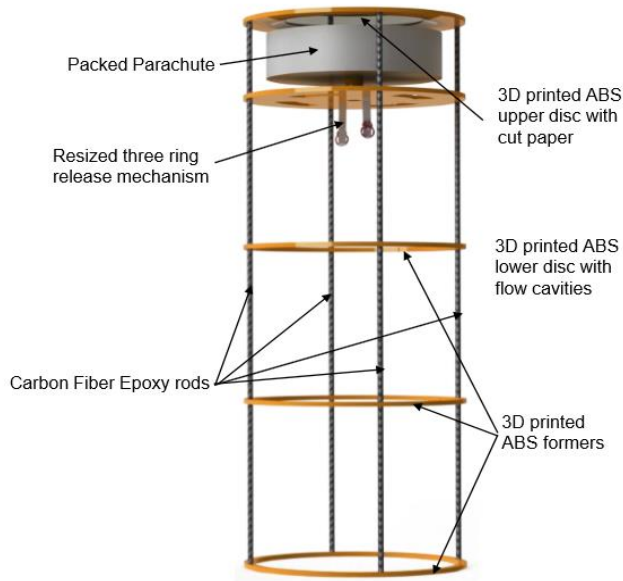
Figure 2. Container

Conclusion

The CanSat program provides students to get hands-on experience in a space-related project. It is a great opportunity for the students to get experience from conceptual design, through integration and test, the actual operation of the system. One of the major advantages of the CanSat is that students can be a part of a multidisciplinary project. Thus, it simulates the real-life job experiences and students can actually see the field that they want to work by working on it.

GTU-SAT Team (2018-2019)
Muhammet İkbal ELEK (Team Leader)
Fuad ALIEW (Faculty Advisor)
Eda Nur Hepgül
Muhammed Altuntaş
Nida Korsan
Şeyma Kurt
Ömer Emre Polat
Doğan Can Cirit
Taha Kavlak
Berkay Öncü

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29

SATCOM ON THE MOVE TERMINAL IN KA-BAND

Atahan Chağkan Chakirer, Sedat Nazlibilek

Email: 1accakirer@aselsan.com.tr; snazlibilek@baskent.edu.tr

ABSTRACT

The aim of this study is to implement a Satcom-on-the-Move Terminal in Ka-Band for military use by minimizing the mechanical and electromechanical structure on military vehicles. The terminal is planned to be used on TURKSAT communications satellite. It will utilize the telemetric and tele-control signals and will track the Ka-Band transponder of the satellite. The content of this study covers the design of the mechatronics terminal including the control system, mission computer, receiving telemetry signals.
Keywords: Satellite, antennas, telemetry and control, tracking, communications, Ka-Band.

INTRODUCTION

Satcom-on-the-Move (SOTM) terminals are designed to be used as the transportation vehicles are on move over fields, air, and sea. The communication requirement of the terminals generally is that when the vehicles are moving at a speed of up to 100 km/h. The communication link will not be lost in all kinds of conditions. The beam of the communication link at Ka-Band is relatively narrow compared to the other satellite frequency bands such as X-Band and Ku-Band, hence the communication is badly affected by the movement of the vehicles. The system depends on the small angular motions of the antenna and the measurements of the signal powers in both azimuth and elevation. A typical application is shown in Figure 1.
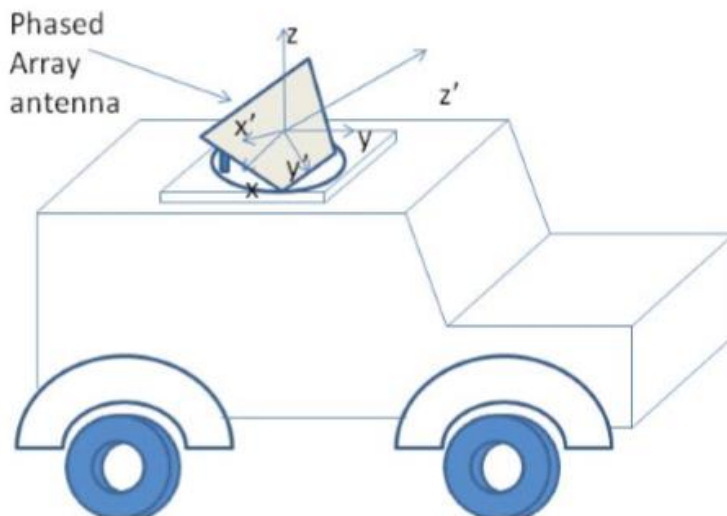
Figure.1 Typical Satcom on the Move (SOTM) application.

Mainly, the following tools are used for motion and position control of the terminal systems. Gyroscope, magnetometer, accelerator meter and position determination systems are widely used for this purpose. We mostly concentrate on the position control and tracking problem in this study. In our study, an open-loop system block will provide pointing information based on the data collected from the motion of the vehicle by the gyroscope to the closed loop control system. The reasons for preference of SOTM terminals are as follows. They have a low profile antenna designs. They prevent the discontinuities on the communication link because of movement of the gun turrets. They have small integrated parts. They don't emit high level of radiations that the personnel expose. They provide discontinuous communications for the vehicles

especially used for emergency purposes. They provide a good communication among the vehicles on vehicle trains moving as a caravan on roads or seas. A conceptual scheme is shown in Figure 2.
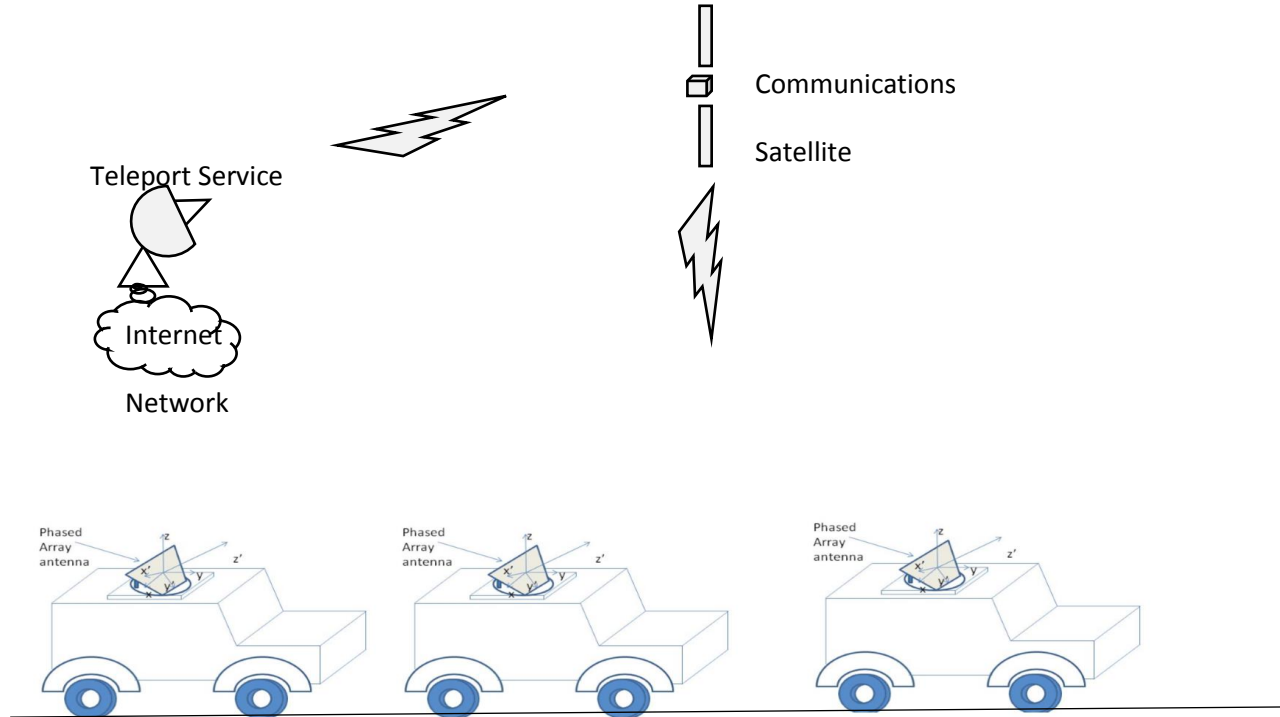
Figure 2 The conceptual representation of SOTM usage in a convoy operation.

SYSTEM DESIGN

2. External Interface
SOTM System Higner Level Components
The higher level components of a SOTM terminal system is composed of five main units. These are system Control Unit, Signal Processing Unit, Antenna Unit, Vehicle External Interface, and Satellite Interface. A general block diagram of the SOTM is given in Figure 3.

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31

Core Terminal

SOTM SYSTEM

System Control Unit

Signal Processing Unit

Anten

Vehicle External Interface

Satellite interface

Jointing Kit

External Interface

System Control Unit

Signal Processing Unit

Antenn

Satellite interface

Figure 3 General block diagram of the SOTM terminal system.

2.1.1. System Control Unit

The system control unit can provide the following functions. The selection of transmitter is done. GPS data and the antenna tracking data is stored within it. Communication interface is provided on it. Mechanical control and power control is done. The IMU data is processed and system control is satisfied. The information from signal processing unit is transferred to the other units.

2.1.2. Signal Processing Unit

The signal processing unit has the following functions. It satisfies the electronic information transfer between the control computer and the antenna. It receives the signals from the antenna. It filters the signals. It transfers the signals received from the antenna to control computer. It transfers the signals from the control computer to satellite interface.

2.3 Antenna Unit

The antenna unit is used for propagating and receiving the signals of Ka-band transponder and the telemetry and telecontrol signals as well. Antenna unit also covers the subsystems for radio frequency (RF) and intermediate frequency (IF) conversions. It includes antenna control mechanisms as well as the stability unit to stabilize vibrations of the antenna itself.

It cannot always be guaranteed the accuracy of the pointing to the satellite by already available tracking mechanisms. Therefore, two ways are followed to eliminate the pointing error and to hold the transmit power under the determined limits. The first one is to reduce upling power and the other is to increase the modem power by keeping the transmit power constant. There are two kinds of antennas for SOTM terminas. They are parabolic antennas and flat antennas (Fig.4).

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

GULUSTAN
32
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH
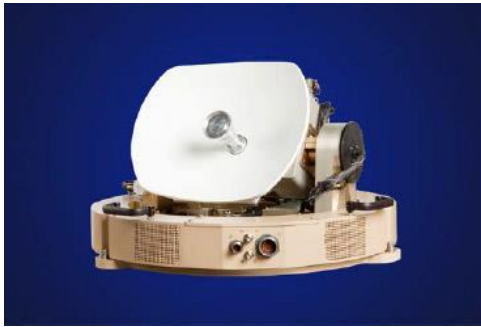
(a)
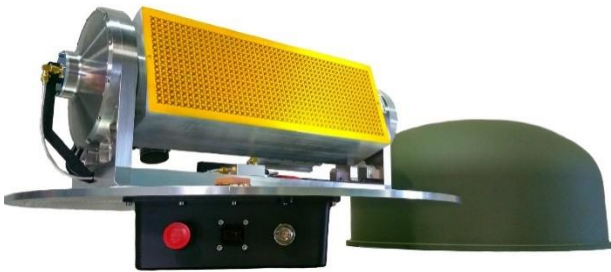
(b)

Figure 4. Two types of antennas used for SOTM terminals; (a) parabolic antenna, (b) flat antenna.
Specifications of the two types of antennas are given in Table 1. The differences may be seen from this table. As seen, the performances of both antennas are somehow similar, although their technologies may have some differences.

Table 1. The specifications of the parabolic and flat antennas

	Flat antenna	Parabolic antenna
Antenna Tx gain	28 dBi	30.5 dBi
Antenna Rx gain	27 dBi	29.5 dBi
Tx frequency band	7.9-8.4 GHz	7.9-8.4 GHz
Rx frequency band	7.25-7.75 GHz	7.25-7.75 GHz
Polarization	Circular interchangeable (right hand or left hand)	
EIRP	>45 dBw (SSPA 100 w)	>46 dBw (SSPA 100 w)
G/T	7 dB/°K	7 dB/°K
Intermediate frequency	L band	L band
Data rate	Up to 2 Mbps	Up to 2 Mbps
Radome dimensions (high x diameter)	223 x 1114 mm	486 x 961 mm

2.1.4. Vehicle External Interface

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GULUSTAN
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33

The functions of the vehicle external interface are as follows. It consists of mechanical and electromechanical units. It includes all types of devices such as modem, GPS, sensors, consol, power and mechanical units. It gives the possibility of seeing the transmission flow by means of Web consol and connection interfaces. It also provides the organization of network management system.

2.2. SOTM System Details
SOTM Terminal has a very detailed structure containing the following systems such as Siytem Control Unit, Terminal Controller, Data distribution Module, Consol server, Power Supply Unit Ethernet Switches, Data Storage Unit, Signal Processing Unit, Antenna RX Adaptor, Antenna TX Adaptor, Signal Converter, RX Connector, RX Adaptor, RX and TX Modem Adaptor, Antenna Switches, Antenna, Receiver and Transmitter Modules, Antenna Control Unit, Motion Sensor, Stabilization Sensor, Mechanical Stopper, IMU, Frequency Converter, Signal Detector, Inertial Position Sensor, Vehicle External Interface, Modem, GPS, NMS, Web Consol, Power Unit, Satellite Interface, Uplink Interface, Downlink Interface, Multi Connection Control System.

3. Examples

Some available examples on SOTM terminals are given in the following. The first example is Alico Systems DST – SOTM Terminal for which the specifications are given in Table 2. This terminal is an X-Band terminal. It is used for military purposes.

Tablo 2 Alico Systems DST – SOTM Terminal

Antenna Specifications	Interface Specifications

• SATCOM On the Move Operation
• Voice, data and streaming video capable
• Full Duplex Data Rate Performance
  — Receive 256 to 1024 Kbps
  — Transmit 512 to 1536 Kbps
• All electronic phased array beam steering
  — Autonomous operation
  — Built-in beam pointing and satellite tracking capability at 100 Hz
• Full Hemispheric Coverage
  — Elevation 0^0 (horizon) to 90^0 (zenith)
  — Azimuth 0^0 to 360^0 Continuous
• Power
  — 700 W
  — 115 VAC or 28 VDC
• Weight
  — 150 lbs
	• Frequency
	  — X-band Receive 7250 to 7700 MHz
	  — X-band Transmit 7975 to 8400 MHz
	• Satellite Constellation Options
	  — WGS (US DoD)
	  — XTAR (US Loral)
	  — SpainSat (Spain)
	  — Skynet (UK Paradigm)
	• Compatible IP Modems
	  — L3 MPM-1000/2000
	  — iDirect e850mp
	  — ViaSat Linkway
	  — Hughes
	  — Others, to be specified
	• Modem interface
	  — L-band 950-1450 MHz
	  — Modem agnostic

The second example the terminal of General Dynamics - SOTM Terminal. The specifications of this terminal is given in Table 3. This terminal is a dual-band terminal and operates both at X-Band and Ku-Band.

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

34

GULUSTAN
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Table 3 General Dynamics - SOTM TERMİNAL

SPECIFICATIONS (Radome Not Included)	Ku	X
Frequency - Receive	10.95 to 12.75GHz	7.25 to 7.75 GHz
Frequency - Transmit	13.75 to 14.5 GHZ	7.9 to 8.4 GHz
Model Number	M17-17A Ku	M17-17A X
Aperture Size	17 inches	
Pedestal	2 Axis Az/El	
SSPB P1dB	25 Watts	25 Watts
G/T Typ at Midband (30° El, 23°C)	11.7 dB/K	7.0 dB/K
EIRP Typ Midband and P1 dB	46.3 dBW	41.7 dBW
Beamwidth, 3 dB, Rx/Tx	4.0°/3.4°	6.3°/5.8°
Sidelobes, Tx	FCC VMES Compliant	MIL-STD-188-164A
Polarization	Linear H/V or V/H Remote Selectable	Circular, RH/LH or LH/RH, Remotely Selectable
Transmit Cross Polarization within Tracking Accuracy	30 dB Typ, 26 dB Min	N/A
Axial Ratio within Tracking Accuracy, Rx/Tx	N/A	<1.2 dB
Azimuth Travel	360 deg	
Elevation Travel (Full Performance)	0° (horizon) to +80°	
Elevation Travel (Total)	0° (horizon) to +95°	
Polarization Travel	360° Continuous	N/A
Tracking Performance	FCC VMES Compliant	< 0.20° – 99% of the time during Churchville B conditions (El angle < 80°)
Satellite Acquisition Time	< 5 sec hot, <5 min cold start	
Height	19.45 inches (from mounting surface) 2.25 inches Max below mounting surface (Connector Interface)	
Diameter	22.2 inches swept volume	
Diameter (Footprint at Base)	15.2 inches	
Weight	< 85 lbs	
Operating Temperature	-40°C to +49°C	
L Band IF Tx/Rx Range	950 to 1700 MHz	950 to 1450 MHz
Supply Voltage	28 VDC per MIL-STD-1275E*	
Power	350 Watts Continuous, 800 Watts Peak (theoretical)	

*Steady state, transient, rev pol, EMC and ESD.

Proposed System

In this study, the proposed system is a Ka-Band SOTM terminal. There are few terminals used in this band. However, studies on the Ka-Band SOTM terminals are still going on. In our study we think about parabolic antenna type Ka-Band terminal. The reason why we prefer this type of system is that parabolic antenna type system has somehow better performance than the flat antenna type system.

Results and Discussion
The results on the study will be given later when we complete the testes.

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36 GULUSTAN
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TECHNOLOGY DRIVES THE EVOLUTION OF MEETING CULTURE

[1]Farid Agayev, [2]Rasim Rahimov

[1,2]Faculty of Information Technologies and Control, Azerbaijan State Oil and Industry University. (Azerbaijan),

E-mail: [2]rasim.rahimov@gmail.com

ABSTRACT

Many of us remember the days when meeting room technology was nothing more than an overhead projector for displaying transparencies. That is a far cry from today's technology, which enables meeting participants to manage a baffling variety of content sources and devices. The purpose to explores this technological evolution and focuses on how meeting room technology is moving into a new phase where access to modern meeting room technology solution is paramount.
Keywords: Collaborative Meeting Spaces, Modern Meeting Room Technology, Meeting Room Design Concept, Meeting Room Equipment

INTRODUCTION

From a historical and sociological point of view, choosing the most appropriate places to convene has had, and continues to be part of, its own evolutionary process. Cavemen had their caves, romans politicized in forums, various tribes had their own versions of strategically and logistically apt gathering points to discuss trade, etc., and the post-industrialization period coined the term to which we still commonly refer to as the meeting room.

Towards the end of the last century, meetings mainly took place in one location. People would sit around a table, exchange information and present ideas. In the world of business, this would typically be done in an executive's office or a specially designated conference hall. In the past, managers would meet separately, while nowadays businesses are moving from this top-down directing approach to a more inclusive, collaborative workforce that engages all employees and aligns them with the organization's aims.

This change is impacting how companies design their workspaces, and, consequently, the meeting room itself is evolving. The days of giant desks, corner offices and over-sized suits with suspenders have drawn to a close and new factors are emerging that need to be considered when planning meetings and the latter's locations.

As Earth's population is growing like billy-o, it's not surprising for statistics to show that a staggering 55 million meetings take place every single day, and approx. 37% of work time is spent at these corporate get-togethers. Not all of the latter, however, are physical.

To meet the demands of this expansion, technological advancements over the last 25 years have triggered enormous changes. Global businesses have deployed video conferencing and telepresence technology to enable visual communications as well as to facilitate external collaboration.

Although virtual meetings, supported by various types of gadgetry, have made it much easier for people scattered around the planet to meet without a room, this has not resulted in a decline of the need for physical meeting rooms. Quite the opposite in fact. We've entered a Millennial-driven "people-centric era", which means internal face-to-face meetings remain a definite must in any company.

The Evolution of the Meeting

Since the beginning of social civilization, people have held meetings in some form or another. One could argue the first "meetings" were held around a campfire, discussing a tribes' plans for the next season and where they would move. Over time, as humans settled and formed cities, these meetings moved into a room. The technological revolution of the past 60 years however, has had a drastic impact on how humans meet and interact inside and outside of these rooms.

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GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

37
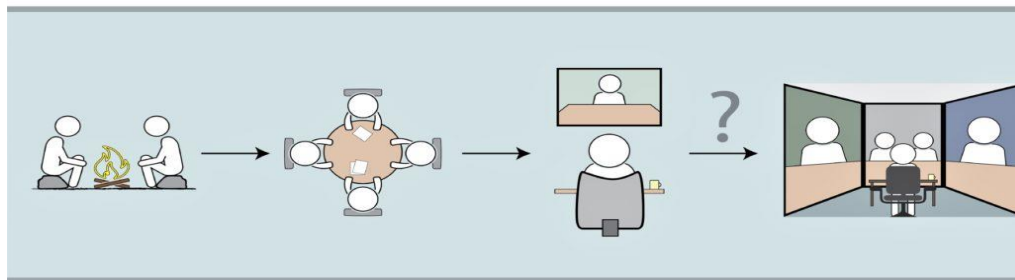
From the past to the future

Generally, we can consider below stages of the meeting room technology evaluation

Analog Meeting Room
Some of us can remember the glory days when a meeting presenter would walk to the front of the room, grab a piece of chalk or dry-erase marker, and proceed to make unintelligible scribbles that would have contained vast wisdom had we been able to decipher them.

The Early Evolution of Meeting Room Technology

In those days of the Analog Meeting, the tools of the trade were simple: chalkboards, flip charts, overhead projectors and dry erase boards among the most popular. To prepare for a presentation frequently meant printing and handing out a packet of documents and then realizing that you had left out something important.

Digital Meeting Room
The arrival of the laptop computer in the 1990's ushered in a new era of collaboration. The mainstay of the conference room during this period was the combination of a laptop, a projector, and a deck of PowerPoint slides. Again, many of us have fond memories of this combination, and of enduring such frustrations as not being able to get the image to focus, not knowing the function key combination to transfer the image from the laptop to the projector, and trying to recover from the sudden burnout of the projector's bulb.

The Later Evolution of Meeting Room Technology: Meetings Go Digital

Despite all the frustrations, this era did help establish a new type of collaboration where meeting participants could evaluate and modify content as they discussed it. Content in meetings became more fluid, more flexible. And PowerPoint was crowned the King of Content.

Multimedia meeting
Over the many years of delivering PowerPoint presentations via a laptop and projector, meeting presenters and attendees increasingly wanted to leverage more types of content: A clip from a DVD. Real-time stock reports. Broadcast audio and

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

38

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

video. Files from the corporate network. Meetings were evolving beyond PowerPoint and into a new age where content was rich and diverse.

The Meeting of Today: Fueled by Multimedia

This evolution from Laptop + PowerPoint to a wide variety of content sources represented the final step in the transition from digital meetings to multimedia meetings. The differences are outlined below

	Digital meeting	Multimedia meeting
Content	PowerPoint slides and other Office documents	Office documents, PDFs, video clips, audio clips, web-based content, broadcast audio & video
Devices & other content sources	Laptop	Networked PCs, web-based storage apps (e.g. Dropbox), laptops, tablets, smartphones, USB drives, DVDs, Blu-Rays, CD-ROMs
Room technology	PCs, overhead projectors, speakerphones, video conferencing systems	LCD Display, networked room PCs, dedicated presentation systems , speakers, speakerphones, video conferencing systems, document cameras, user interfaces (control panels & keypads), VCRs, AV controllers
Expectations	Technology is a nice benefit as long as I can get it to work	Technology is a necessity and it must work

Modern Meeting Room Tech To Consider
No matter how much we sometimes wish we could replace meeting rooms, they are often the best place to get a fair amount of work done. Even in a digital era, face-to-face meetings are still extremely valuable, and that means it's worth it to invest in modern conference room technology and meeting room design that can make your time spent together with your team more effortless and seamless than ever before. The design or re-design of your meeting and conference rooms and use of technology is important to the success of your employees as well as meetings with business guests and clients.
How many times have you been in a meeting room and everyone is waiting to get started, only to be held up by some critical piece of technology that isn't working correctly? Multiply those minutes (or hours) by the number of people in the room, and you can see why it's so important to make sure that you have the best setup you can possibly get: When you consider the cost of time, you simply can't afford not to.
The right meeting room technology enables the seamless connection between all these parties. To get the most out of your collaborative efforts and maximize your efficiency, there are a few key pieces of meeting room audio visual technology critical to success. You have three choices when it comes to connectivity:
• Wired
• Wireless
• A combination of wired and wireless.
Both wired and wireless connectivity have their pros and cons, and ultimately it will come down to a matter of personal preference.

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

Many people prefer wireless connectivity simply because it eliminates the clutter of cords, but table inserts however can discretely hide wired connectivity that would provide a typically higher-quality and more stable presentation experience. Connected table boxes can also include electrical outlets for charging or a wired connection for plug and play. If you want to be able to screen share without plugging in, a wireless connectivity solution may be the right choice for you.

We can consider the several main components, which need to bring your workplace into the modern day.

Displays

The first thing people notice when walking into a meeting and conference room is the display. This is the "visual" part of conference room audio visual, and it is one of your main collaboration tools. The display enables you to see colleagues in other locations, view presentations, and screen share from laptops, tablets and smartphones.

Single displays are a go-to choice for many small conference rooms. Dual displays are a popular option, especially for companies that are heavy video-call users. These dual, or even tri, displays allow screen sharing and video conferencing to share the spotlight.

When on a video call with a single display you will likely have picture in picture view capability. This means you get to choose between seeing the content that is being shared or the other people on the video call (also called the far side) in the large view. Content is often chosen for the large-screen since it typically drives the meeting's conversation. Whichever is not in the large view is shown in a small square at the bottom of the screen. Since content is usually in the large view, people on the call are shown in a small frame. In a conference room, this can reduce one of the main benefits of video conferencing- seeing people!

Dual displays offer a solution to the picture in picture view. Meeting attendees see both the content being presented and the other video participants, each on their own full-screen. Instead of choosing between content and people, you can see both clearly. This solution helps collaboration by enabling the team to see nuances like facial expressions during the presentation.

Interactive Whiteboard

If you host brainstorming sessions in your office or work with people that are visual learners (around 65% of people), an interactive whiteboard can be a valuable tool to add to your system of meeting and conference room equipment. Interactive displays allow you to write directly on the board in various colors, annotating over web pages or documents.

In addition, video conferencing platforms enable users to whiteboard while on the call and share to other participants in real-time or after the conference has completed. This can be helpful if your employees present over video conferencing and can create a more engaging experience for the others on the call.

Audio or Video Conferencing

The next choice in meeting and conference room technology is whether you need audio conferencing, video conferencing, or both.

Video conferencing has taken center stage in the meeting room. Most platforms provide Outlook and Google integrations for easy meeting scheduling. Push to join is also becoming a more readily available option.

As video calls become more mainstream, organizations are on calls with clients, partners, and off-site employees. These external participants may be calling in from a different video conferencing platform. Fortunately, most video conferencing technologies can handle these situations offering easy dial in instructions for those working with different systems.

Scaling web conferencing is a big trend. Audio is the second piece of the meeting room communication. While some companies are comfortable going all-in with video calls, others still want the option for audio conferencing. It's common for companies to have both audio and video conferencing technology in a single room, just let your AV partner know in the design process so they can include the functionality in your design.

Microphones & Speakers

Microphones and speakers are an important addition to conference room audio visual. These can be either in-ceiling, on-table, or a sound bar mounted below the display (sound bars can be an appropriate solution for smaller spaces).

Based on how you intend to use the room and the features of the space, your audio visual integration partner can select the right mix of microphones and speakers.

The choice of microphones and speakers will have a significant impact on the overall conferencing experience. The right set-up can reduce echo, feedback and other noises heard by conference participants.

Lighting Control System

Controlled lighting allows you to create the perfect setting. An integrated system, along with motorized shades and draperies, enables you to adjust the aesthetics to your liking. Instead of merely turning on / off various lights in the meeting room, the system can work together in any combination to offer preset sequences or prearranged schedules. You can

1-ci Beynəlxalq Elmi-Praktik Konfrans:
Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

40

GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

program scenes for scenarios.

Almost no other area is used as diversely as meeting rooms, the spectrum ranging from prestigious customer meetings and multimedia presentations to creative get-togethers and brainstorming. Each situation demands different lighting conditions.

Intelligent lighting solutions enable light to be optimized according to aesthetic and functional factors, including lighting intensity, light colour and the flexible combination of direct and indirect light components.

Meeting rooms need careful attention because the range of activities spans from one-to-one talks via presentation to big conferences. At the same time, the interior and lighting design communicate the company culture internally and externally.

A flexible lighting scheme with efficient control systems supports the various uses of the meeting room. Ceiling luminaires provide efficient background lighting and lighting for more demanding tasks.

Spotlighting and wall washers light up details or walls and create variation. An easy to operate control panel should contain various light settings to support activities such as e.g. note-taking, presentations or conversations.

Dimmable (brightness changeable) lighting should be preferred in meeting and conference rooms. Thus, you can reduce the brightness of light while presentation. In this way, you can draw attention to speaker and you provide enough lighting for the participants to take notes. You can switch off all lights for video presentations, which will increase the visibility of the screen and attract attention.

A good presentation light is needed to see the presenter's face well. This light would need to be synchronized with screen-based presentations or videos.

Since there are many events in meeting rooms from face to face interviews by presentations to large conferences, it is very important to gather attention in this areas. On the other hand, the design and the lighting of this areas reflects the company culture to guests by different way.

Automated Shades or Motorized Window Treatment

With motorized shading control solutions, you can easily raise the shades to add sunlight, or lower them to reduce heat buildup and add instant privacy. Shades can be preset to automatically open and close during a specific time a year, effectively controlling sunlight to decrease energy requirements. Or if you prefer, you can simply push a button to adjust them when you want, achieving the greatest beauty and efficiency in each room at all times. You can control glare and heat while increasing comfort for those attending meetings and presentations.

Surveillance

If your room is staged for video calls it will need to be equipped with a camera. This can range from a small camera in a huddle room to something more sophisticated in larger spaces. Depending on your huddle room furniture configuration, you might consider a camera with a 180 degree viewing angle. You can also note that the nature of huddle rooms are small collaboration spaces. Therefore, the table and chairs are often pushed close to the display and camera. If the camera's viewing angle is too narrow then those sitting closest to the display will be left out of the field of view.

The Importance of Modern Meeting Room Technology

Technology has been one of the biggest driving forces behind change in our society. It is evident when looking back throughout history and when looking ahead to the future. From the health field to the design world, and into people's everyday lives, evolving technology has made a huge impact: one way or another. It changes the way we learn, communicate, work, and play. There is less face-to-face interaction and more face-to-screen conversations today. Anyone who walks down a busy street and counts how many people are looking at their smartphones could attest to this.

This face-to-screen aspect has a significant impact on how we design spaces. We can notice a trend across all project types, particularly workplace and education. There is a want/need for specific technology to allow for some form of virtual meetings. Video conferences, instant messaging, screen sharing, and note transfers are just a few non-traditional meeting options technologies now brings to the table. Like anything else, there will always be advantages and disadvantages to these digital meetings:

Pros

• Saves time and money on travel. Between traveling costs, mileage, and possibly even hotels, a simple long-distance meeting can rack up big bucks and take hours. Technology allows businesses and schools to put that money toward something else on the list because they saved money on travel.

• Your geographical range can expand. It is a lot simpler to meet with someone across the world if you just tap in via video conferences. Even if there is a 12-hour time difference. One less reason to hold back on expansions for your business.

• Everyone can feel connected. Whether it is connecting long-distance employees/clients to a project more directly or allowing a sick student to conference into class instead of missing a lesson, using technology has a way of bringing people together to make them feel included.

• Meetings can happen more frequently. Due to the costs of travelling, meetings would often be more sporadic and for longer periods. Now, you can hold a standing weekly hour-long meeting with individuals all around the world rather than traveling to one meeting every six.

Cons

• Can be hard to read the people on the other end. Not everyone is set up with capabilities to video conference in. This makes it impossible to read body language and make direct eye contact.

• It is expensive! It isn't a secret that high-tech comes with a high price tag.

• There can always be glitches that come along with technology. Jumping on an important conference call 20 minutes late because your conferencing system was having a technical problem can be frustrating.

In the past, there have been many design solutions to attempt to overcome these cons, and bring us back to the human interaction that started with that first meeting around a campfire. Several companies have developed possible solutions that were specifically designed to counter-act the inherent disconnect of looking at someone on a screen rather than physically sitting across the table from them. These "telepresence" rooms often try to recreate an in-person meeting room, through a variety of visual gimmicks such as curved tables or half of a table with a screen at the end, but these often fall flat. Furthermore, with fixed furniture, there is not much of an option to use this room for anything other than virtual meetings.

With the development of larger, thinner, and higher resolution display screens, we are approaching a time that has often been the subject of science fiction movies: wall surfaces become virtual displays, 360-degree virtual reality cameras recreating any location, holograms, etc. It does not seem like such a far-fetched idea now that you could have multiple people meeting in a "virtual" conference room, looking at the person on a screen as if they are sitting next to you. The flexibility of not being tied to a specific piece of furniture or specific set of technology frees the end user to use this room in a multiple of ways.

The biggest hurdle to this is going to be the cost and continuous development always spitting out the next "big thing". However, designing around an idea rather than a specific product could help alleviate some concerns, so new technology could be swapped into an existing room without a complete redesign. There is no perfect answer at this point to making the virtual meeting as effective as those first "meetings" around a campfire from the human perspective, but change is coming. And with each new development, we step incrementally closer to achieving that goal.

CONCLUSION

History tells us that meeting locations tend to change, evolve. So do we. And the places we meet in are predominantly determined by that very fact. It can therefore be concluded that the future of meeting rooms doesn't lie in the design of the room itself, like where to fit the bean bag, pool table or VR helmet to ensure employee productivity and customer satisfaction, nor does it rely solely on high-tech communication or spontaneous trips to the local coffee shop – the future is in people and the way we organize ourselves. And meeting rooms are sure to follow.

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

GULUSTAN

42

BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

METROLOGICAL ASSURANCE OF PRODUCT QUALITY

Dadashova Kamala

Docent, PhD in Economy. UNEC (Azerbaijan State Economic University)

Email: kamala.dadasheva.74@mail.ru

ABSTRACT

Purpose of the study: Development of progressive and perspective methods based on serious scientific and technical basis for re-establishing product quality assurance at the modern requirements.
Methodology of the study: Comprehensive approach, comparative analysis.
The results of the research: Determine the mechanisms for improving the quality of products' metrology in a new format.
Keywords: metrology, assurance, quality, product, perspective

INTRODUCTION

METROLOGY - the science of measurements, methods, and means of ensuring their unity and how to achieve the required accuracy. There is not a single field of practical human activity where one could do without the quantitative estimates obtained as a result of measurements [1].
A man is born, does not yet has a name, but we become aware of it, height, weight, temperature - already in the first minutes of life he has to deal with a ruler, weights, a thermometer. Every morning, leaving the house, we estimate the temperature of the air outside and put on a hat or a fur hat, coat if necessary, or a fur coat. We paint our entire day by the hour and try to fulfill this plan, periodically glancing at the clock. Standing in front of a puddle and deciding whether to jump over it or bypass it, we measure the length of the pool and its capabilities. This is the measurement finding the ratio between the measured value (length of the puddle) and the "unit" of this magnitude (possible jump length)...
Modern metrology as a scientific discipline has survived the stage of infancy, when she described her own and foreign units of measurement, the stage of her youth, when she was called the science of measurements, brought to the standards, matured and became a section of powerful physics, mastered mathematical methods and led instrumentation, which provides us with measuring instruments of objective assessment of the surrounding world. Academician A.P. Alexandrov wrote: "Metrology is an urgent need of our time -it determines the possibility of establishing the fundamental basis of physical worldview, the well-being of the working people depends on it to the least extent. "At present, theoretical metrology is distinguished, which deals with general theoretical measurement problems, historical metrology, which is taught in the Historical and Archival Institute, legal metrology, covering complexes of interrelated common rules, requirements and norms, as well as other issues that need regulation and control by the state, and, finally, applied metrology, dealing with the practical application of met odes and measuring instruments [2].
Metrology is becoming increasingly important in improving production efficiency, technical level, and product quality. Therefore, the development of metrology, improvement of the activities of the metrology organization and services should be given the closest attention by the heads of industrial enterprises, scientific production associations, and research institutes.
Solving the issues of metrological assurance gives the most significant effect and it requires the lowest cost when carried out at the initial stages of creating new types of products, developing and mastering technological processes, organization of production.

Methodological study of bases of metrological supply

Achieving high-quality products and ensuring the accuracy and interchangeability of parts or assembly units is impossible without metrological support of production.
Under the metrological assurance (MO) refers to the establishment and use scientific and organizational foundations, technical means, rules, and standards necessary to achieve unity and the required accuracy of the measurement. The main trend in the development of MO is the transition from the previously existing relatively narrow task of ensuring the unity and required accuracy of measurements to a fundamentally new responsibility of ensuring the quality of measurements.
Measurement quality is a broader concept than measurement accuracy. It characterizes a set of SR properties that ensure that measurement results obtained within the prescribed period with the required accuracy (size of permissible errors), reliability, correctness, convergence, and reproducibility. The concept of "metrological assurance" is applied, as a rule,

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GULUSTAN
BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

43

concerning measurements (testing, control) as a whole. At the same time they allow the use of the term "metrological support of the technological process (production, organizations) ", implying in this case, the MO measurements (testing or control) in this process, production, organization. The object of the MO is all stages of the life cycle (LC) of a product (product) or service, the processes of creating and changing the state of products from the formulation of the fundamental requirements for it before the end of operation or consumption. So, at the stage of product development to achieve high product quality, the choice of controlled parameters, standards of accuracy, tolerances, and means of measurement, control, and testing performed. Metrological expertise of design and technological documentation is also carried out.

When developing MOs, it is necessary to use a systematic approach, the essence of which is to consider this provision as a set of interrelated processes united by one goal to achieve the required quality of measurements.

These processes are [3]:

• establishment of a rational range of measured parameters and optimal

standards for measurement accuracy in product quality control and management processes;

• feasibility study and selection of MI, testing and control and the establishment of their rational nomenclature;

• standardization, unification, and aggregation of the used instrumentation technology;

• development, implementation and certification of modern measurement techniques, testing and control (MVI);

• verification, metrological certification, and calibration of instrumentation and test equipment (CRO) used in the enterprise;

• control over the production, condition, use and repair of the CRO, as well as compliance with metrological rules and regulations in the enterprise;

• participation in the development and implementation of enterprise standards;

• implementation of international, state and industry standards, as well as other regulatory documents of the State Standard;

• Metrological examination of projects of regulatory, design and technological documentation;

• analysis of the state of measurements, development on its basis and implementation of measures to improve the MO;

• training of employees of relevant services and departments of the enterprise to performance of instrumentation operations.

Metrological support has four bases: scientific, organizational, regulatory, and technical. Certain aspects of MF considered in the recommendation.

MI 2500-98 on metrological support of small enterprises. Development and

MO events assigned to metrological services (MC).

Metrological Service is a service created in accordance with the law for performance of work on ensuring the uniformity of measurements and implementation metrological control and supervision.

Normative-legal basis of metrology

The law enshrines the basic principles of metrology. One of the main moments of measurement is the dimension of the measurements measured in the result.

Longitudinal unicellular and weight loss measurements installed rocks with superficial reliability, otherwise, in Zakone beef.

Definition of justification, how to measure weight, standards of the grandfathers, accreditation на право поверки средств измерений, лицензирование на изготовление (repair, sale, rental) Quantity of measurements, calibration certificate. Excited definition of corresponding terminology in International Organization Legislative Metrology (MOIM) [4].

The law establishes that the state governed by the deed the United States of America is implementing the United Nations Federations on Standardization and Metrology and defines its objectives, objectives, competence, responsibility, and competency.

The law determines that the Russian Federation is supposed to apply the United States of America, the United States of America General conference on the meram and allot, recommended by MOES.

RESULT

Metrological certification of measuring means is one of the areas of activity of field bodies to ensure unity of measurements.

Currently, metrological certification is a thorough investigation of standard and non-standard measuring instruments and the standard patterns and properties of substances and materials.

In this area, there are some measurements that have been called non-standard nomenclature.

Unified requirements for the metrological assurance of their development, preparation, and exploitation have been

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Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

identified to ensure consistency and coherence of measurements carried out with the help of non-standard measuring instruments. Metrological Guidelines for their exploitation are also applicable to serialized samples that will affect the metrological characteristics.

All three conditions must be met to achieve the accuracy of the measurements and the required uniformity, the availability of scientific and organizational bases, rules and norms, technical means, and the creation and implementation of metrological support as a whole.

A complex plan for metrological assurance of production preparation based on the analysis carried out. The development of such a plan is appropriate only when the new product is put into production, as well as in the serial production of commodities, during the preparation of the product or the metrological supervision of the metrological control. It is desirable to include measures to improve the technical level of the plan measurements, supply of products with highly productive measuring instruments and measures to ensure the logistics of the enterprise metrological service.

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GULUSTAN
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45

INTERACTIVE METHODS OF ACTIVITIES IN TEACHING FOREIGN LANGUAGES

[1]Valiyeva Vasila, [2]Piriyeva Leyla

[1,2]Head teachers, Azerbaijan State Agrarian University

Email: [1]valiyeva.vasila@gmail.com, [2]night_lp@ mail.ru

XÜLASƏ

Məqalədə innovativ metod olan interaktiv metodun öyrənənlərin şəxsi xüsusiyyətlərinin nəzərə alınmasından bəhs edir. Bu metod müəllimin köməyiləöyrənənlərcün təqdim olunan mətn,audio və video materialların kombinasiyasıdır.
Müəllim informasiya texnologiyalarından istifadə edərək real heyati problemlərdən qaynaqlanan bilikləri əldə etməyə çalışır.Bu nitq vərdişlərinin və xüsusiyyətlərinin formalaşmasına müsbət təsir edir.
Açar sözlər: interaktiv metod, xarici dillərin tədrisi, təcrübədən keçirtmək,müzakirə, qrup halında

РЕЗЮМЕ

В статье рассказывается об индивидуальных характеристиках лиц, изучающих интерактивный метод как один из видов инновативных методов. Этот метод представляет собой комбинацию текстовых, аудио и видео материалов для студентов, работающих под руководством преподавателя. Преподаватель, использующий информационные технологии старается получить знания о реальных жизненных проблемах. Это оказывает положительное влияние на формирование положительных навыков особенностей.
Ключевые слова: интерактивный метод, обучение иностранного языка, испытать, обсуждение, групповая.

INTRODUCTION

Teaching process is mainly based on two activities. They are imparting knowledge and acquiring knowledge. In the first case teacher sends information and the learners receive it. The innovative methods also deal with this process and their aim is to evaluate the activities of a teacher and learners using new ways and methods of teaching including new technical means of teaching. As we know that methodological approach in teaching foreign languages may be divided into three groups. They are Passive methods, Active methods and also interactive methods. If we speak here in the first place about the passive methods, it should be noted that in Passive methods a teacher is in the centre of teaching. He plays active role but the learners are passive. Control can be carried out by the way of questions, individual and control work, tests etc. It may be useful when it is used by an experienced teacher. Secondly, in Active methods learners are also active. Their role and activity is equal in the process of interaction. Learners may ask questions; express their ideas with a teacher. The last but it is in the first nowadays interactive method or approach is a modernized form of active methods. The most of teachers usually understand or mean cooperative action during the lesson. But here attention should be focused on inner action too. The learners should have inner motivation which involves them into active work or active participation at the lesson. In interactive method teacher's role is to direct learners activity to getting the aim of the lesson which include interactive exercises and tasks. Below some types of interactive methods are given:

BRAINSTORMING

It is technique for generating new ideas on a topic. These methods stimulate creative activity of the learners in solving problems and express their ideas freckly. Various variants of solving the problem are usually given here. In brainstorming quantity of utterances is important but not the quality. Teacher should listen to all utterances and not criticize them. Instead of this he inspires the learners to give as many variants of solving the problem as he (or she) can. Lacks of criticism create favorable conditions for the learners to express the ideas freely and these of course motivate them. At the end of brainstorming activity all the expressed utterances are written and then analyzed.

DISCUSSION

This type of interactive method requires studying teaching material on the theme before starting discussion. After having learnt the lexica-grammatical material on the theme the learners may start discussion. This method helps the learners consistently and logically express their ideas by presenting grounds for their utterances. Here the learners work in small groups and this improves their activity because every member of the group may express his/her ideas and takes part in

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

the discussion. The forms of organizing group work are the following:
a) a theme is selected (chosen);
b)learners must have learnt the chosen problem;
c)groups are formed;
d)teacher gives instruction and announces the time;
e) controls the activity of learners and if it is needed, helps and stimulated them.
f)at the end of the discussion one representative of each group makes presentation.

CLUSTER

The next innovative method is cluster. It is one of widely used methods in teaching a foreign language now. It can be used in all stages of teaching English to both young and aged learners. In presenting new words a teacher writes a new word on the blackboard. And then learners tell the words that can be used together with the given word. For ex.:   Then teacher gives a task to make up word combinations with the word "book": my book, a good book, an interesting book, a nice book, etc. This method involves all the learners into active work and forms of motivation. It can be effectively used in improving monologic speech habits and skills.

CONCLUSION

Role playing is also one of the activity used in teaching innovative methods. They are made to improve the efficiency of teaching. Role playing involves the learners into active work by positively influencing on their inner activity. This creates favorable conditions for cooperative work. Such atmosphere creates their motivation, personal potentials of inner activity and helps to form practical skills and habits. During the role playing such skills as creativity, getting out of the difficult situations, resourcefulness, self managing is formed and improved. Role playing has not only educational aim, but also has social aims because some life situations are modeled here for teaching. When a teacher uses role playing method in teaching the foreign language he/she should follow the below given instructions:

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47

BENCHMARK FUZZY TIME-SERIES FORECASTING USING FUZZY RECURRENT NEURAL NETWORK

[1]Gardashova Latafat, [2]Hasanli Narmin, [3]Akhmadov Shamil

[1]Applied mathematics, [2]Robot and robotic systems, [3]Computer science

[1,2]Azerbaijan State Oil and Industry University. (Azerbaijan)

[3]Azerbaijan -French Universityi (UFAZ). (Azerbaijan)

E-mail: [1]latsham@yandex.ru, [2]narmin.mammadova@gmail.com, [3]shamilahmadov@yandex.ru

ABSTRACT

The paper considers the application of neural-networks for long term electric energy consumption forecasting and sunspot predicting problems on the basis of fuzzy recurrent neural network trained by a genetic algorithm based technique. The results, obtained by fuzzy recurrent neural network are compared with electric consumption forecasting results of Turkey, using artificial neural networks up to year 2002 and also the problem of sunspot series forecasting are compared with the results based on several forecasting models. Experimental results on Fuzzy time- series Forecasting Using Fuzzy Recurrent Neural Network (FRNN) show that , FRNN is an effective and efficient tool for forecasting complex long-term time series.

INTRODUCTION

The development of efficient algorithms, based on optimization techniques, for learning the weights and architecture of recurrent neural network have received much interest. We propose a fuzzy recurrent neural network (FRNN) based on time series forecasting method [1,2] use for solving forecasting problems in which the data can be presented as perceptions and described by crisp numbers. The FRNN demonstrates more adequate forecasting results. Recurrent links in FRNN also allow for simplification of the overall network structure (size) and forecasting procedure. Genetic algorithm-based procedure is used for training the FRNN. The effectiveness of the proposed fuzzy time series forecasting method is tested on the benchmark examples.
The main advantage of using fuzzy approach is to apply human expertise throughout the forecasting procedure. This type of time series significantly differs from traditional time series and the methods of the latter are not applicable in this case.
Using benchmark tests show that the forecasting error of this method is significantly smaller than that of existing fuzzy time series approaches [3,4].

2. Structure and Parameters of Fuzzy Recurrent Neural Network
We propose a FNN with 2 hidden layer, n input and one output nodes which can express the relationships[1-2]:

$$\hat{y}_{t+1} = \hat{F}_{NN}(y_t, y_{t-1},..., y_{t-n+1}) , \qquad (1)$$

where an estimate $\hat{F}_{NN}$ for F is constructed from a large class of fuzzy neural network based mappings. In its turn $\hat{F}_{NN}$ is determined by fuzzy weights of neuron connections, fuzzy biases, and neuron activation functions.
The structure of the fuzzy recurrent neural network for the realization of (1) is presented in figure 1[1-2]. The box elements represent memory cells that store values of activation of neurons at previous time step, which is a feedback to the input at the next time step.
In general, the network may have virtually any number of layers. We number the layers successively from 0 (the first or input layer) to L (last or output layer). The neuron in the first (layer 0) layer is only distributing the input signal without modifying the values.

$$z^0(t) = x^0(t) \qquad (2)$$

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

48

GULUSTAN
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Layer 0 (input)   Layer 1 (hidden)   - - - - -   Layer L (output)
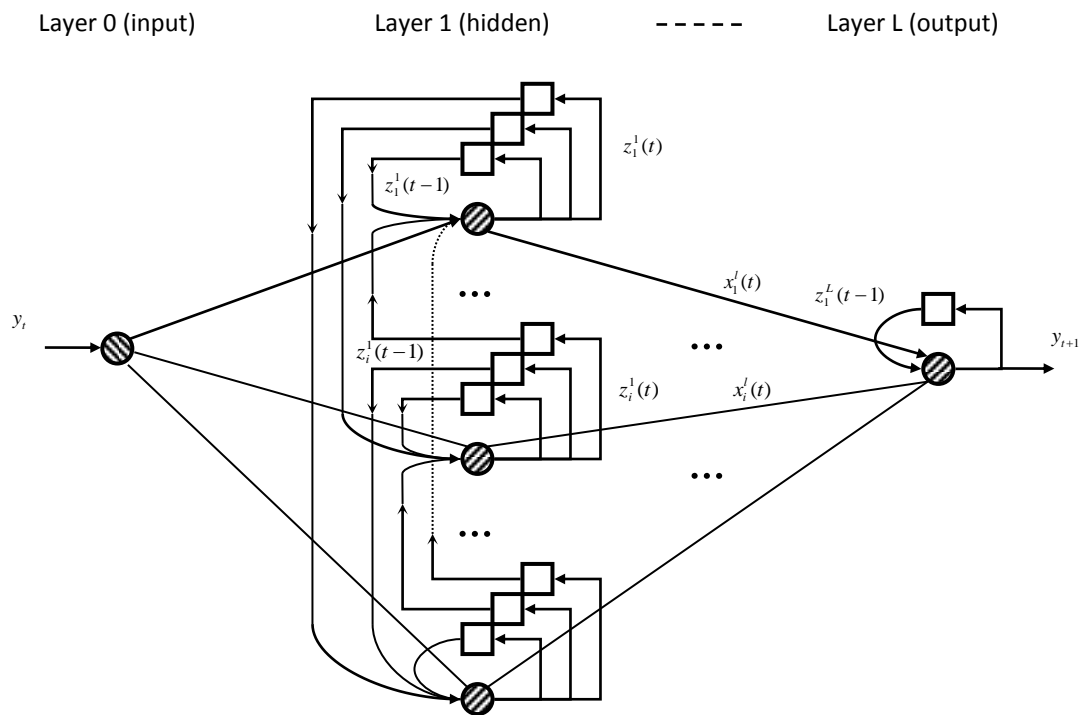
Figure 1 The structure of a simple FRNN

The neurons in the layers 1 to layer L are dynamic and compute their output signals as follows[1-2]:

$$z_i^l(t) = F\left(\theta_i^l + \sum_j x_j^l(t)w_{ij}^l + \sum_j z_j^l(t-1)v_{ij}^l \right), \qquad (3)$$

where $x_j^l(t)$ is j-th fuzzy input to the neuron i at layer l at the time step t, $z_i^l(t)$ is the computed output signal of the neuron at the time step t, w_{ij} is the fuzzy weight of the connection to neuron i from neuron j located at the previous layer, θ_i is the fuzzy bias of neuron i, and $z_j^l(t-1)$ is the activation of neuron j at the time step (t-1), v_{ij} is the recurrent connection weight to neuron i from neuron j at the same layer.

Note that regarding the considered time series forecasting problem, the FRNN input $x^0(t)$ will represent the time series element y_t and the FRNN output z^L will represent the time series element y_{t+1}.

3.Benchmark time –series
3.1 Electricity forecasting

The offered approach's squared error (MSE=2.83, number of input neurons =1, number of output neurons= 1, number of neurons in hidden layer=2) is smaller than the result given in [3](MSE=3.4280). Here mean squared error is calculated by the following formula:

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$$MSE = \left(100 \cdot \sum_{i=1}^{4} \frac{\left| {}^y real_i - {}^y focast_i \right|}{{}^y focast_i} \right) / 4$$

A fragment of real and forecasting values are given Table 1 .

Table 1

	year	real	forecasting	MSE
Learning samples	1991	50295,7		
	1992	54613,1		
	1993	60406,3	60406,3	
	1994	61420,3	61420,3	
	1995	67092,3	67092,3	
	1996	74326,8	74326,8	
	1997	81884,9	81884,9	
	1998	87704,6	87704,6	
Test samples	1999	**91201,9**	**96380,44**	5,37%
	2000	**98295,7**	**97936,16**	0,37%
	2001	**97070**	**96266,04**	0,84%
	2002	**102800**	**98134,77**	4,75%
				2,83%

Graphically real and desired values are given in figure 2.

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GULUSTAN

50

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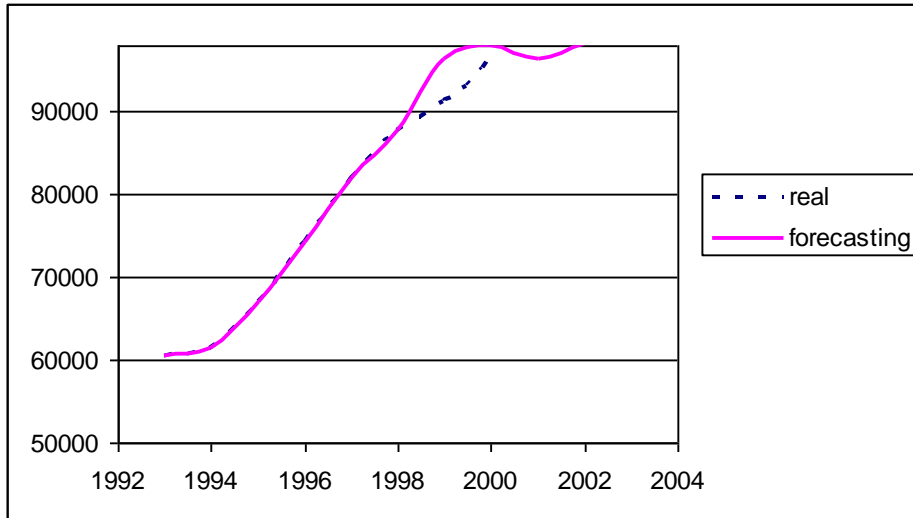
Figure 2 Electricity consumption(real and desired values)

3.2 Sunspot forecasting

The sunspots data have been widely acknowledged as a benchmark in time series forecasting. The conventional forecasting models include linear autoregressive (AR) [5], threshold autoregressive (TAR) [6], and bilinear model [7] Recently ANN have been utilized using the conventional back-propagation algorithm [5,8], connectionist models [9], and pruning algorithms [10-12]. A hybrid forecasting models based on hierarchical fuzzy clustering and linear regression was presented by Geva[13].

The most common partitioning of the data set is the one used in figure 3. The known part of the set (TR) was presumed from years 1700 to 1920 and two unknown predictions sets were used. The first (PR1) was from 1921 to 1955 (figure 4) and the second (PR2) from 1956 to 1979(figure 5).

Figure 3 Traned data set

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51
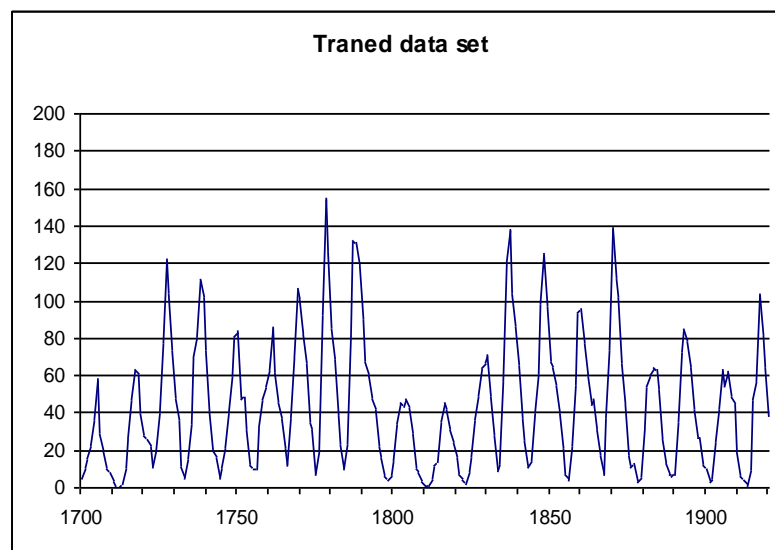
The forecasting performance of the developed models was measured with the normalized mean squared error(NMSE) estimated in the unknown part of the set, as it enables a direct performance comparison between various models. The forecasting results of the previously mentioned models are summarized in table [13]. The performance of the final evolved models were evaluated using the normalized mean squared error(NMSE) which is defined as

$$\text{NMSE} = \frac{\sum_t (y_t - \hat{y}_t)^2}{\sum_t (y_t - \overline{y}_t)^2}$$

where y_t, $\hat{y}_t$, $\overline{y}_t$ correspond to the time series, its prediction and its mean, respectively.

Result of simulation for 1921-1955 years is represented in table 2.

Table 2 (1921-1955 years) Result of simulation

year	actual	Rnn	|act-rnn|	|act-avr|	
1921	26,1	27,19396	1,19674	723,61	
1922	14,2	11,40235	7,826853	1505,44	
1923	5,8	0	33,64	2227,84	
1924	16,7	14,80708	3,583139	1317,69	
1925	44,3	48,13004	14,66923	75,69	
1926	63,9	67,43455	12,49302	118,81	
1927	69	72,01616	9,097207	256	
1928	77,8	79,49392	2,869371	615,04	
1929	64,9	68,41648	12,36566	141,61	
1930	35,7	38,78006	9,48677	299,29	
1931	21,2	20,92003	0,078385	1011,24	
1932	11,1	6,970295	17,05446	1755,61	
1933	5,7	0	32,49	2237,29	
1934	8,7	3,405842	28,02811	1962,49	
1935	36,1	39,07596	8,856349	285,61	
1936	79,7	81,01111	1,719022	712,89	
1937	114,4	101,7932	158,9326	3769,96	
1938	109,6	100,2044	88,27639	3203,56	
1939	88,8	88,36031	0,19333	1281,64	

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1940	67,8	71,04283	10,51597	219,04	
1941	47,5	51,61267	16,91407	30,25	
1942	30,6	32,73587	4,561949	501,76	
1943	16,3	14,33226	3,871997	1346,89	
1944	9,6	4,767006	23,35783	1883,56	
1945	33,2	35,72056	6,353231	392,04	
1946	92,6	91,18102	2,013498	1568,16	
1947	151,6	110,0452	1726,803	9721,96	
1948	136,3	107,4664	831,3737	6938,89	
1949	134,7	107,1322	759,981	6674,89	
1950	83,9	84,55594	0,430251	954,81	
1951	69,4	72,42197	9,13233	268,96	
1952	31,5	33,91554	5,83485	462,25	
1953	13,9	11,00148	8,401404	1528,81	
1954	4,4	0	19,36	2361,96	**PR1**
1955	38	41,2225	10,38453	225	**NMSE**
average	53	Sum	3882,146	58580,54	**0,06627**
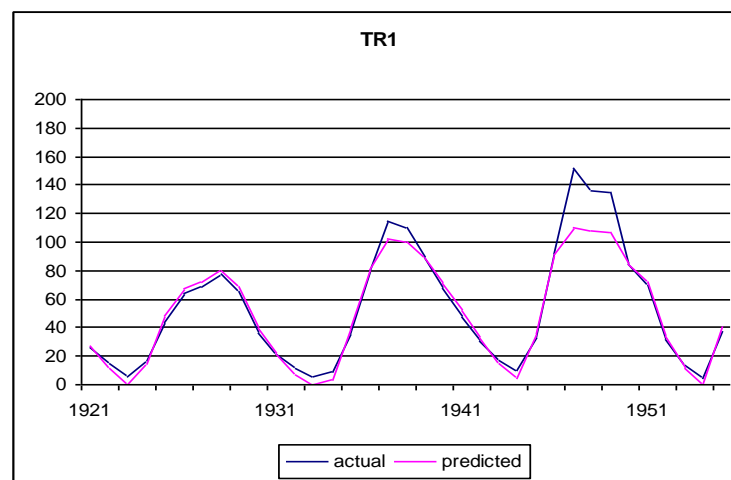
Figure 4 (1921-1955 years) Result of simulation

Result of simulation for 1956-1979 years is represented in table 3.

Table 3 (1956-1979 years) Result of simulation

year	actual	Rnn	|act-rnn|	|act-avr|	
1956	141,7	108,3	1115,562	3905,729	
1957	190,2	114,6305	5710,743	12320,08	
1958	184,8	114,1598	4990,032	11150,48	
1959	159	111,2259	2282,36	6367,375	
1960	112,3	101,1911	123,4074	1095,334	
1961	53,9	58,31981	19,53471	640,3009	
1962	37,6	40,88794	10,81058	1730,907	
1963	27,9	29,42478	2,324953	2632,118	
1964	10,2	5,687563	20,36209	4761,575	
1965	15,1	12,61035	6,198371	4109,344	
1966	47	50,9682	15,74665	1037,108	
1967	93,8	92,10796	2,862998	213,0384	
1968	105,9	98,72698	51,45226	712,6675	
1969	105,5	98,58579	47,80627	691,4709	
1970	104,5	98,16189	40,17168	639,8792	
1971	66,6	70,06824	12,02871	158,865	
1972	68,9	71,93486	9,210394	106,1759	
1973	38	41,4027	11,57836	1697,783	
1974	34,5	37,29852	7,831741	1998,463	
1975	15,5	13,24453	5,087152	4058,221	
1976	12,6	9,105646	12,21051	4436,115	
1977	27,5	28,8667	1,867869	2673,321	
1978	92,5	91,10152	1,955738	176,7792	PR2
1979	155,4	110,6061	2006,496	5805,805	NMSE
average	79,20417	sum	16507,64	73118,93	0,225764

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54

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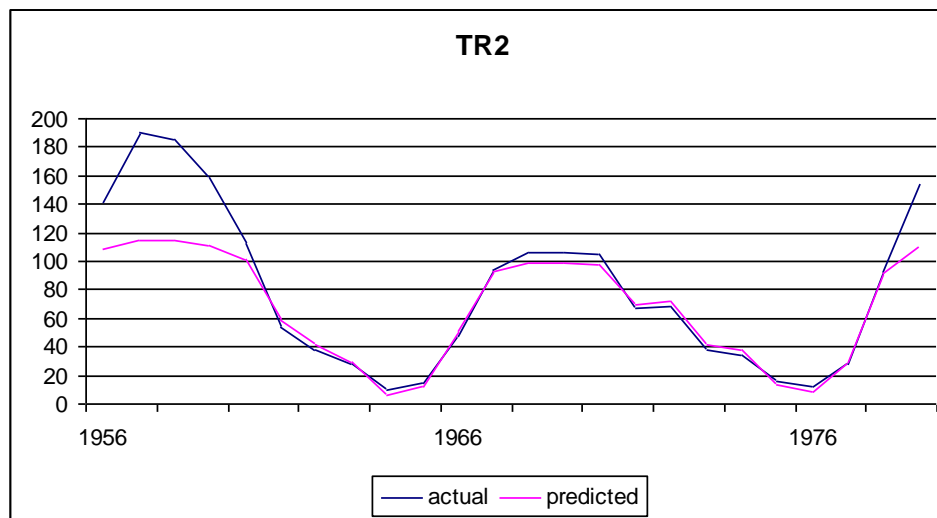
Figure 5 (1956-1979 years) Result of simulation

The offered approach's mean   squared error (NMSE=0,066272, input neurons =1, output neurons= 1, hidden layer neurons=7.Parameters of GA: Size of population:100,Number of best parent genomes to save: 10,Probability of crossover: 0,5,Probability of mutation: 0,05) is smaller than the NMSE in [3](NMSE=0.077)

CONCLUSION

Experimental result on Fuzzy time- series Forecasting Using Fuzzy Recurrent Neural Network (FRNN) show that, FRNN is a good forecasting tool for forecasting electric energy consumption and sunspot problem.

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56

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

62

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Vilnius Gediminas Technical University, Associate professor. Phd in Social Sciences (Management)
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Vilnius Gediminas Technical University. Vice-dean for Scientific Research
Vilma (Kovertaite) Musankoviene
e-Learning Technology Centre. Kaunas University of Technology. PHD
Laura Uturyte
Vilnius Gediminas Technical University (VGTU). Head of Project Manager at PI Gintarine Akademy. PhD in Economy.
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Wroclaw Medical University, Public Health Department, Health Sciences Faculty, Adjunct Professor of Gerontology Unit. PhD MD.
Tadeusz Trocikowski
European Institute for Eastern Studies. PhD in Management Sciences.
_____
Qatar

Mohammed Elgammal
Qatar University. Assistant Professor in Finance. PhD in Finance
_____
Romania

Camelia Florela Voinea
University of Bucharest, Faculty of Political Science, Department of Political Science, International Relations and Security Studies. PhD in Political Sciences.

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1-ci Beynəlxalq Elmi-Praktik Konfrans:
 Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

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Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

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 Müasir Informasiya, Ölçmə və Idarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

68

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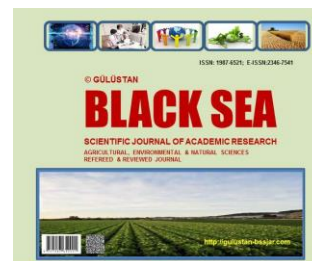
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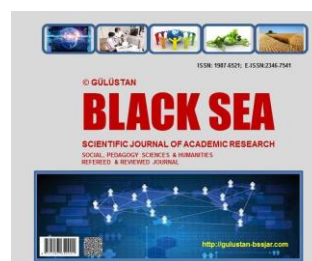
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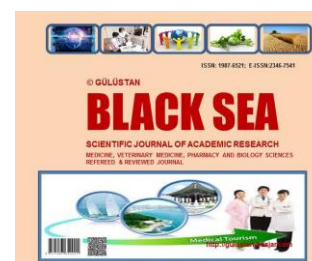
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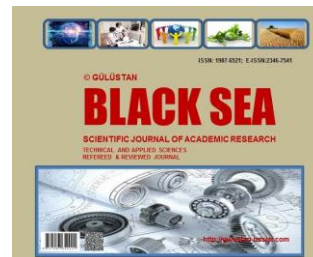
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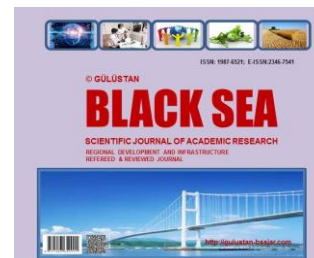
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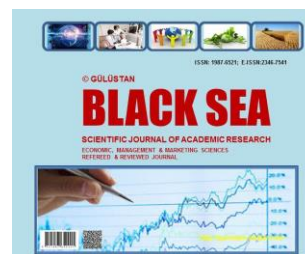
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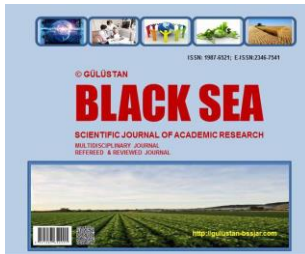Political Problems of International Systems and Global Development

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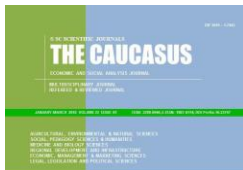
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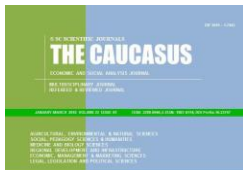
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MULTIDISCIPLINARY JOURNAL

CONFERENCE NEWSLETTER

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Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

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