Information Technology in The Mobile Application of Analysis and Correction of The Diet of Individual Healthy Nutrition

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***Abstract*— This article deals with the problem of developing and implementing a mobile software product for compiling a healthy human nutrition ration using IT technologies. An analysis of existing software applications in this area for desktops; developed functional requirements for a mobile computer system for healthy nutrition, formulated the conceptual foundations of information technology, formalized the general decision-making support algorithm in the preparation and optimization of a healthy diet.**

Keywords*— *healthy nutrition, diet composition, interchangeability, compatibility, it-technologies, expert systems, mobile applications.

I. INTRODUCTION

The fourth industrial revolution, better known as "Industry 4.0", received a new name: "Businessmen and politicians, scientists, scientists and experts in the field of science and technology, science and technology and technology" using digital technologies and technologies of integration of "cyber-physical systems".

Digital data surrounding a person for a long time has been constantly growing in number and quality. A huge array of digital information is an environment in which various real-world events are reflected. A person is capable of recognizing these events, however, only with convenient display and on the foreseeable scale of information. At the same time, the use of digital technology allows us to increase the scale of perceived information in all areas of the operation of large amounts of data.

Over the past two decades of observation, adequate - or rational - nutrition has become an acute public health problem.

One of the priorities (fig.1) of the scientific and technological development of the Russian Federation [1] is the transition to personalized medicine and the organization of healthy nutrition of people through the introduction of advanced digital technologies and platform solutions.

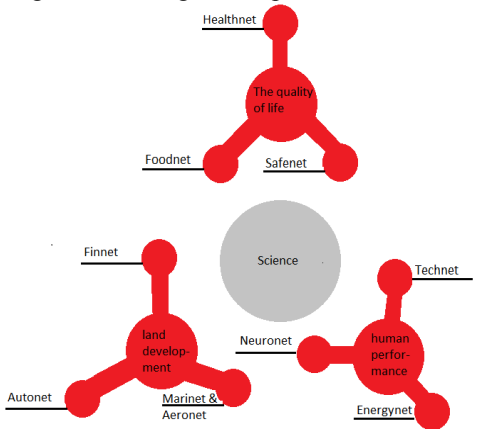

Fig. 1. Priority areas of scientific and technological development [1]

According to the WHO (World Health Organization) [2], a series of diseases is associated with deficiency or excess of certain components in a person's daily diet. Such links can be traced between fluorine and caries, iodine and goiter, necessary fats and diseases of the cardiovascular system, dietary fibers and diseases of the gastrointestinal tract, calcium, fluoride, vitamin D and diseases of the musculoskeletal system, gland, folic acid and anemia.

Currently, a person uses many mobile devices every day, such as smartphones and smart watches, which allows him not only to get access to the worldwide network from almost any location, but also to receive information about his activity - the number of steps taken, the average level palpitations, etc. In a sense, they are independent onboard devices, because people carry them almost all the time, wherever they are. Taking into account the computational capabilities of modern devices, you can use smartphones as an application platform, the purpose of which is to combine dishes to create a healthy diet.

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This paper describes the use of information technology to create people's diets, the result of which can be used to track the health of a software user.

II. Methods and Applications for Computer Optimization of a Healthy Diet

Adequate nutrition means following the basic rules of healthy eating. Over the past two decades of observations, adequate - or rational - nutrition has become an acute public health problem, and some studies have shown that most diseases that currently affect humanity shorten their lifetimes, largely due to uncontrolled diets, which clearly reflected in the study of the European Journal of Epidemiology [3].

Currently, a number of health computer calculators are on the market [4], the principal flaws of which are that they do not take into account the specifics of diseases, body features and mentality; there is no information about Russian food products and dishes, the requirements of Russian legislation on the composition, quality and safety of food products and dishes are not taken into account, and they also do not provide Russian-language interface.

In the course of the development of modern technologies, a number of software products (PPs) have been developed, allowing to calculate the necessary and sufficient human diet, and in some cases provide a list of daily consumption products for maintaining and improving health, based on anthropometric data about a person (gender, age, weight and other). However, in most cases, PP is an application for stationary computers that are not intended for the quick assessment of the user's diet with the necessary number of functions for its compilation and correction. In this regard, for the operative access of the user to the necessary data, the development is required on the basis of existing examples of algorithms and software (application) installed on mobile devices and taking into account the user's characteristics in drawing up the daily diet and goals (for example, maintaining the body, losing weight, and etc.).

For example, DietPlan software is an application for Windows 7 that contains a database of various foods for 100g [5], and also offers menu sets for school canteens for a portion, but this application is not suitable for an ordinary PC user because of the excessive workload and complexity of the menu and interface of the application, as well as the focus on the use in school institutions, as there is no opportunity to provide menus for adults and teenagers.

At the same time, the NutriSurvey app [6] is a visual power diary that user fills during the day. If the user enters their anthropometric parameters such as age, gender, weight, height and desired height, as well as the average level of activity during the day and minute of basic daily activities, NutSurvey displays the total average calorie level that the body should consume during the day (fig. 2).

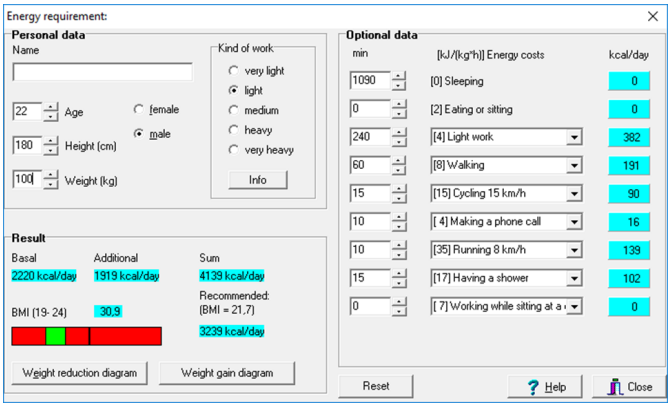

Fig. 2. Calorie Calculation with NutriSurvey

However, this application cannot create a daily menu - the user can enter abstract product data into it, moreover, irrelevant - both by territorial conditions (the database is based on nutrition data in the USA) and by periods (the last update of the application was in 2007 year).

One of the most popular applications for tracking the process of keeping fit and losing weight is MyFitnesspal, a free software product for Android and IOS devices [7]. This application allows you to track calories getting daily due to the "diary" filling tool - data on the number of meals, nutrition time, as well as workouts conducted by the user (fig. 3).

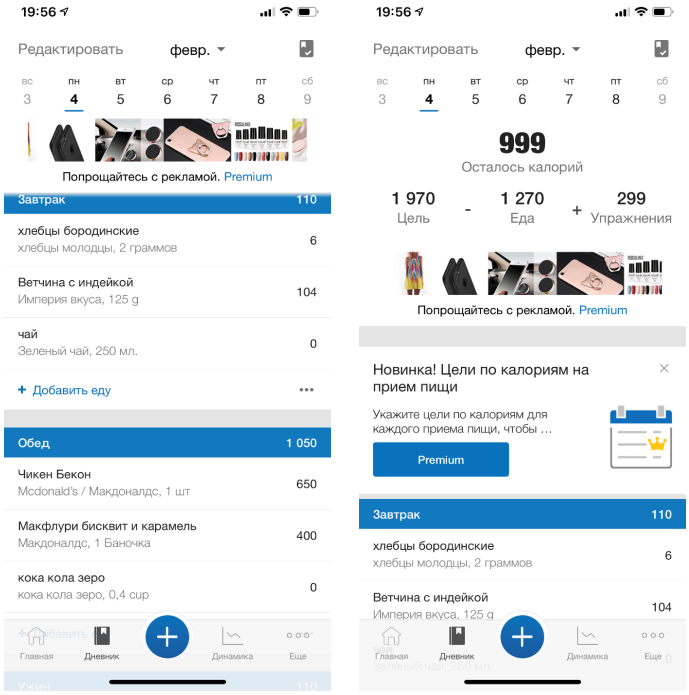

Fig. 3. An example of filling out a nutrition diary and counting calories at the end of the day

After filling in the data on the anthropometric features of the body and the user's activity mode, the application displays the total number of calories that the body should consume for safe and consistent weight loss. In addition, when filling in the information, the user can see the total number of calories left to use until the end of the day. The application has a large set of data on food for various countries, so you can collect data on products that are located in the country of the user, for example, products sold in Russia, which makes the application convenient for use in everyday life. However, this application has the disadvantage of not being able to get a healthy food menu for any age: this application makes predictions on body weight in the next weeks based on the nutritional dynamics that the user makes and cannot give him a nutritional recipe.

Also, a popular application is 8fit [8] - an application that combines a set of workouts, the implementation of which does not require staying in the gym and the proposed diet for breakfast, lunch, light snack and dinner. After filling in the data about the user, his daily routine, the approximate body fat content (both present and desired), the application creates a personal workout plan, which the user should follow to obtain a satisfactory result.

Also, based on your cooking preferences, the frequency of meals per day, as well as allergies to certain foods, the countries whose instructions are shown in fig. 4, the application will create an individual nutrition plan for the user. However, this function is paid and requires monthly payment, which is a drawback of the mobile application for calculating adequate power.

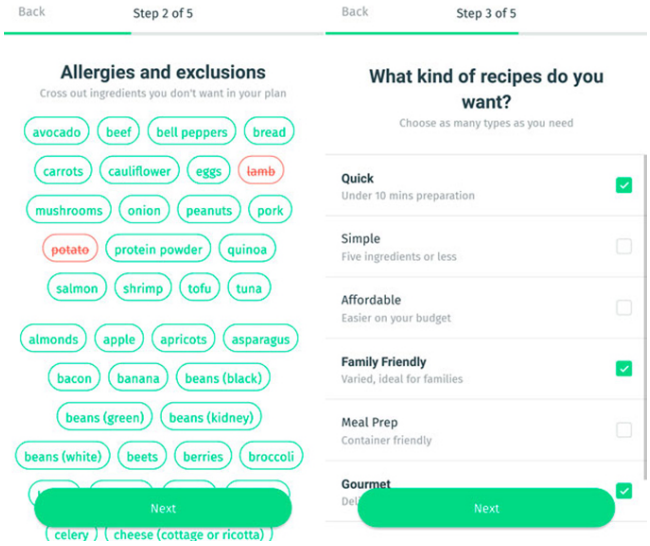

Fig. 4. The page for filling out the features of an individual plan for adequate nutrition of the application 8fit

On the application site you can also see examples of working with the application and the results of individual use. The disadvantage is the lack of Russification both on the website and in the application.

I. General algorithm and mathematical formulation of the task of compiling and optimizing a healthy diet

From the above examples, it follows that now development of a mobile application for an individual user is relevant and, besides the user's anthropometric data, data on his physical and mental activity during the day are needed. This requires a database of food available in the region where the user lives and their biochemical composition, which must be processed and totally supply the required amount of nutrients to the body per day, as well as ensure the compatibility and interchangeability of products in the diet.

In accordance with the theory and practice of adequate human nutrition, the algorithm of the main stages of the preparation, evaluation and structural optimization of the diet of adequate nutrition [9,10] is reduced to the formation of a parametric model in the form of norms of nutrient intake per day, after which an assessment of the state of the body, the amount of adipose and muscle tissue, etc. Based on the data obtained, selection is made of the necessary and desired products in the database, the use of which is adequate for the user and allows approaching the WHO standards.

With each unsuccessful selection and combination of products, the composition and structure of the possible diet should be optimized by selecting interchangeable and compatible products according to the criteria of the minimum deviation from the standard structure of the nutritional and biological value indicators of an adequate diet.

The hierarchy of quadratic criteria of the minimum deviation from the reference structure of a set of indicators of nutritional, biological and / or energy value, presented in a generalized form as an adequacy criterion, is used as the objective function.

$$\sum_{k=1}^{n}\left(B_k^0-\sum_{j=1}^{m}b_{kj}y_j\right)^2\to\min \qquad (1)$$

where y_j - mass fraction (volume) of the j-th product in the diet; b_{kj} is the specific content of the k-th element of the chemical composition of the j-th product; B_k^0 - normative content of the k-th element in the diet; with restrictions:

- by total daily ration V

$$\sum_{j=1}^{m} y_j = V; \qquad (2)$$

- on permissible limits of change in the mass fraction (volume) of the j-th product in the diet

$$y_j^{\min} \le y_j \le y_j^{\max};\ j=\overline{1,m}$$

As criteria or limitations, digestibility, direction of action, compliance with the chemical composition and nutritional value of food to the diet and age needs of the organism, etc. can also be used.

The degree of deviation of the current diet from the model of a particular type of food (children, school, student, adult, heroic, etc.) is assessed by the adequacy functional [11],

which, taking into account the structuring factors into groups of properties has the form:

$$G = \prod_{k=1}^{m_k} \left(1 - z_k^2\right) \cdot \left[\sum_{i=1}^{m} a_i \left(1 - \sqrt{\frac{1}{n} \sum_{j=1}^{n_j} b_{ij} z_{ij}^2} \right) \right] \quad (3)$$

where $z_{ij} = \frac{x_{ij} - x_{ij}^0}{\Delta x_{ij}^0}$ - the relative deviation of the *j*-th factor of the *i*-th group; $x_{ij}, x_{ij}^0, \Delta x_{ij}^0$ - respectively, the actual, reference and tolerance from the norm of the *j*-th parameter in the *i*-th group; a_{ij}, b_{ij} - coefficients of significance of the *i*-th group of factors and the *j*-th factor of the *i*-th group, determined by the methods of expert assessments or by means of a factor experiment; z_k - relative deviation of the *k*-th factor of the critical group, the deviation of which outside the tolerance turns the functional to 0.

The functional changes from 1 with full adequacy of the ration to 0 at the boundary of the allowable area and turns to 0 when any parameter of the critical group is exceeded.

The quality and adequacy of the diet is determined, first of all, by its compliance with the requirements, taking into account the physiological characteristics of the body and the recommended norms of consumption of biochemical elements.

The combination of products with each other is an integral part of the diet, as well as mutual substitution in case of a shortage of any product or necessary nutrients and the need to replace one product with the same, while preserving the main indicators of nutritional and biological value and balance the chemical composition of the diet.

The source of the above, the general algorithm of the software product is presented in fig. 5.

To reduce the required computational power, within the framework of solving this problem, one should use machine learning methods [12-14], which allow to derive a general function, on the basis of which food belonging to one class can be taken as interchangeable with some assumption.

This application requires a database processed to reduce the consumed power of the processor of smartphones; removing correlated features (when part of the chemical composition correlates with each other, resulting in unnecessary information to highlight relative identity) and adding class indices (soups, meat products, etc.) will speed up data processing by the application.

Within the limits of tolerance from the function, two food products satisfy one condition, as a result of which they can be taken interchangeably in the proposed diet.

Also, the one should consider individual nutritional restrictions, such as allergies or other reasons like prohibition of certain foods. Therefore, you should add the ability to delete / block position data from the dataset on the user's device. As a reference constant in the preparation of the diet should take into account the mass / volume of servings and the original food, when eating, changing of which can lead to an increase in processing time and the possibility of irrational and incompatible results, as an example - eating only fish and cereals, drinking milk products.

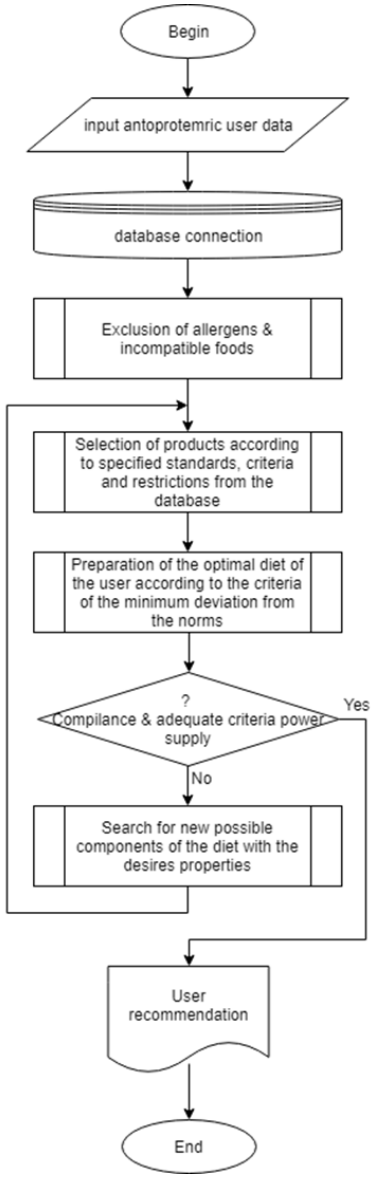

Fig. 5. General compilation and optimization algorithm healthy diet

III. CONCLUSONS

The problem of developing and implementing a mobile software product for creating a diet of healthy adequate human nutrition using IT technologies for mobile use based on modern online calculators and applications is socially important and relevant for ensuring public health.

IT for compiling and optimizing an individual (personalized) daily diet are based on the anthropometric data of the user, the regulatory base of healthy nutrition and indicators of the biochemical composition and properties of the products. Implementation of the software can be carried out through using smart phones running Android / IOS with the minimally required set of software modules. The algorithm of the developed software product describes the recommendatory system for selecting the diet of adequate nutrition and includes the development of necessary database and procedures for the preparation, evaluation and structural optimization of the diet according to the criteria of minimal deviation from the norms of healthy nutrition with possible interchangeability and compatibility of food products.

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