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Conference Paper *in* Advances in Intelligent Systems and Computing · August 2018

DOI: 10.1007/978-3-319-67349-3_14

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Intelligent Internet Technology for Personalized Health-Saving Support

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Abstract. Multifactorial nature of human health and need in personifying the approach to each person leads to the fact that full implementation of healthy life style (HLS) technologies is possible only on the basis of artificial intelligence technologies, widely implemented in the preventive medicine via modern Internet technologies. Modern computer systems allow considering simultaneously big data of separate factors in health assessing and selecting of individualized recommendations for personal HLS. This article presents a concept and a structure of intelligent Internet technology for personalized health-saving support, which allow assessing health and preparing individual optimal recommendations for HLS.

Keywords: Health, health-saving, big data, healthy life style, Internet technology, preventive medicine, personalized medicine.

1 Introduction

Medical and demographic situation in many countries is one of the main obstacles for an effective socio-economic development. Human health has a multifactorial nature and, so it is necessary to personalize the approach to each patient, a full implementation of health-saving (HS) technologies is possible with active using of modern information technologies in the preventive medicine only.

At the assessment of health status and the selection of individualized recommendations, the modern computer systems allow simultaneous considering many individual factors, which gives people many opportunities in learning [1,2], choosing a healthy lifestyle (HLS) and personal HS [3,4]. Many such systems are available in clinical medicine. IBM Watson is the most famous. In the preventive medicine and HS they are significantly less applied and usually solve particular problems. Usually, a limited amount of data is used to diagnose separate health indicators. So, Internet service Mhealth [5] makes a conclusion about the general state of health and age-related changes based on data on physical activity during the day. Pulse data are widely used to assess stress and overall health [6]. When considering such services, it is worth re

Z. Hu et al. (eds.), *Advances in Artificial Systems for Medicine and Education*,
Advances in Intelligent Systems and Computing 658, DOI 10.1007/978-3-319-67349-3_14

membering about the differences between mHealth and fitness/wellness, however in modern Internet services their convergence is observed [7]. Most fully the main factors of HS: nutrition, physical activity, sleep, fitness - are presented in the Health Box [8].

There is no service integrating diagnostics and prevention of health and chronic diseases, diagnostics of biological age and prevention of age-related changes for a wide range of users. The advantage of our system is a systems approach and an attempt to take into account all the significant factors impacting health.

The literature tells that the HS technology may add 10-15 additional years of active healthy life [9]. The assessments conducted in many countries show that the increase of the life expectancy for one year may cause an increase in the country's gross domestic product for about 4% [10].

This article explores scientific and technical solutions and a new intelligent Internet technology for personalized support of health-saving processes, based on the analysis of big data of health and its key factors. Today our system is at the experimental testing stage. This article objective is to describe the basic principles, approaches and underlying methods, as well as the overall architecture of the system.

2 Concept and Structure of Intelligent Internet Technology for Personalized Health-Saving Support

2.1. Principles of Personalized Health-Saving Support

The main methodological principle of the proposed health-saving technology concept is *method of objectives management*.

The method is based on the control over the information environment, which means the quality control over the information objects (in our case - every person), i.e. help in the objectives formulation, development of the effective methods and the target reaching, information support and training for personal practical application of the proposed methods and technologies.

The key principle is *personification,* i.e. an individual approach to each person, considering his/her gender, age, habits and form of activity, together with data records about the person's genetic, psycho-physiological and medical characteristics, i.e. "health portrait".

Other important principles include:

The *principle of completeness* is understood as an intention to maximal recording of all the most significant processes affecting the human health; it is implemented in the N-dimensional "Control space of personal health".

The *principle of systematization* is a requirement to be based on the bio-psycho-socio-mental concept of health, i.e. to cover the whole health-important living environment.

The *principle of open evolutionary development and the principle of optimal balance between conservatism and revolutionary character* are associated with the scale

of the system, the permanent opening of new knowledge about health and methods for its correction.

This principle requires flexible, open, modular system design that allows a qualitative and quantitative developing, supplementing the bases with new information and the system with new algorithms and methods, connecting new external services to the system, while adhering to good conservatism for the proven methods preservation.

The *principle of standardization* stipulates that the existing standards of preventive medicine should be used (on the analogy of medical treatment standards).

There should also be developed new standards of new personalized prevention programs and information technologies for evaluation the efficiency of the means and methods of health improvement, personalized optimization and support of health programs application, monitoring of the obtained results and effects.

The *principle of health-saving motivation and psychological support* determines the interest of people, its attraction and retention in the HS sphere.

2.2. Cognitive Methods for Health-Saving Data Processing

The effective support of health-saving processes needs using big data of health and its key factors. We proposed and developed processing methods of the structured and unstructured (textual) medical data, enabling to obtain new knowledge about the effect of various factors on the health status from various data. The obtained knowledge is used to develop personal recommendations for health-savings and a healthy lifestyle. The most significant methods are given below.

The method for intelligent medical data and text processing is intended for:

- taking out the names of diseases, organs, body systems and body parts, medicinal prescriptions, patient data (age, gender etc.), severity of the disease etc. from the medicinal texts. The data taking out from medicinal texts is based on the Relational-situational method of search and text analysis [11, 12];
- revealing the correlation of a person's health status with the characteristics of his life style and other health-saving factors on the basis of machine learning. To do this we used such methods of intelligent data analysis as methods of classification, search for associations, forecasting, including neural networks;
- classifying the individuals and health-saving technologies by the selected characteristics to choose the classes and forms of HS-effects optimal for a certain person, for example, to solve the tasks of identifying the groups of people with a high risk of certain diseases and selecting for them optimal prevention schedules., Clustering and classification methods were used to solve these problems;
- assessing the severity of adverse health changes under the influence of risk factors affecting the person, and assessing the favorable health changes under the influence of beneficial factors which the person received after using the health-saving technologies.

The method of extraction data about the psychological and motivational health-saving characteristics, about the standards of application and the effectiveness of health-saving technologies from Internet is based on the sentiment analysis, psycholinguistics and is intended for:

- revealing the opinions of social media users concerning the efficiency of various health-saving technologies;
- assessing the health status of the Internet user by his messages;
- revealing the psychological and motivational characteristics of health-saving from the social media messages.

The method of the integrated health passport renewal is intended for the automated filling out the human health passport with data from various sources: social networks; case records; statistical databases; information provided directly by the patient etc.

To carry out the experimental studies of the developed methods, we created a test data set containing:

1) clinical data set, consisting of real patients case records of one of Russian clinics. The data set includes more than 1000 case records containing examinations data, medical history and results of additional studies (tomography, radiography, skin tests) in text form (conclusions) and the lab results (urinalysis, blood tests, microflora cultures) in a semi-structured form.
2) statistical data set, consisting the health status of the population of Russia and the world in conjunction with socio-economic indicators, potentially affecting the health of the population. It contains data of the Russian State Statistics Service on the diseases of the Russian population and the socio-economic situation in general and by regions, the World Bank's data on the health of the population and the socio-economic situation of all countries (262 countries). The data were collected for the past 15 years.
3) collections of scientific medicinal articles in Russian and English (about 2,1 million articles). These collections include the most authoritative sources of medical information, including PubMed publications and synopsis of theses. It is available at http://health.isa.ru/.
4) collection of websites materials about health, containing data on healthy life style and health support (about 30000 pages).
5) collection of social media messages, i.e. from blogs, forums, social networks, where real users discuss their health problems and which provide the opportunity to receive consultations from doctors in the Question-and-Answer form (about 10000 messages).

The total size of the test data array is more than 3 million of data sources with a volume of more than 3 GB.

2.3. Architecture of Internet Technology for Personalized Health-Saving Support

In general the intelligent Internet technology for personalized health-saving support is intended for:

- development of recommendations on the selection of optimal personalized health-saving technology (or a set of technologies) which provides maximum improvement of the health status of the person, considering its individual characteristics, preferences and capabilities;
- Internet support of personal decisions of the person at choosing health-saving technologies on the basis of his health passport.

The architecture of System of Health-Saving (SHS) that implements this technology is shown in the Fig. 1. All main SHS modules and services are located on the server side of the system and are the framework that may be extended with new modules and services and modify the existing ones. The framework modules and services are combined into functional blocks: block of client applications; block of analysis and development of recommendations; health passport; block of data obtaining and entering in the health passport; database and knowledge base.

Client Applications. Client applications are series of services that made on external applications that the SHS user interacts with: service of cognitive visualization of user's state, services of user's data input, services of recommendations output for the user. These are the basic services. Each client application may extend its functionality.

Module for Data Getting and Entering to the Integrated Health Passport. The main purpose of this module is to collect data about the system user from various sources and to enter them to the health passport. The sources of information are: the client himself (manual or automated data input from test-questionnaires, distance testing systems, mHealth devices); case records stored in the databases of medicinal information systems (MIS) of healthcare facilities; social networks and forums etc.

Health-Saving Services and Modules. The following main modules and services are included in this block: service for health problems estimation; sub-block of modules for making the recommendations on personalized health-saving; module of intellectual processing of medicinal data and texts; module of data extraction from the Internet and its structuring; module of estimation of health-saving technologies efficiency.

Databases and Knowledge Bases. They included in the system contain a variety of data necessary for implementation the functions of all SHS blocks: data on the health

characteristics of patients and their health determinants; official standards and standards for the values of characteristics and factors; structured information on health-saving obtained from scientific texts and medicinal recommendations; description of the most effective health-saving means and methods etc.

A special role is played by a database containing the information on the health characteristics of certain patients and its health determinants: database of *integrated health passports*.

The term "integrated" emphasizes the importance of recording not only health characteristics but also health determinants in the health passport, which makes the difference between this passport and traditional health passports used in the medical and preventive sphere.

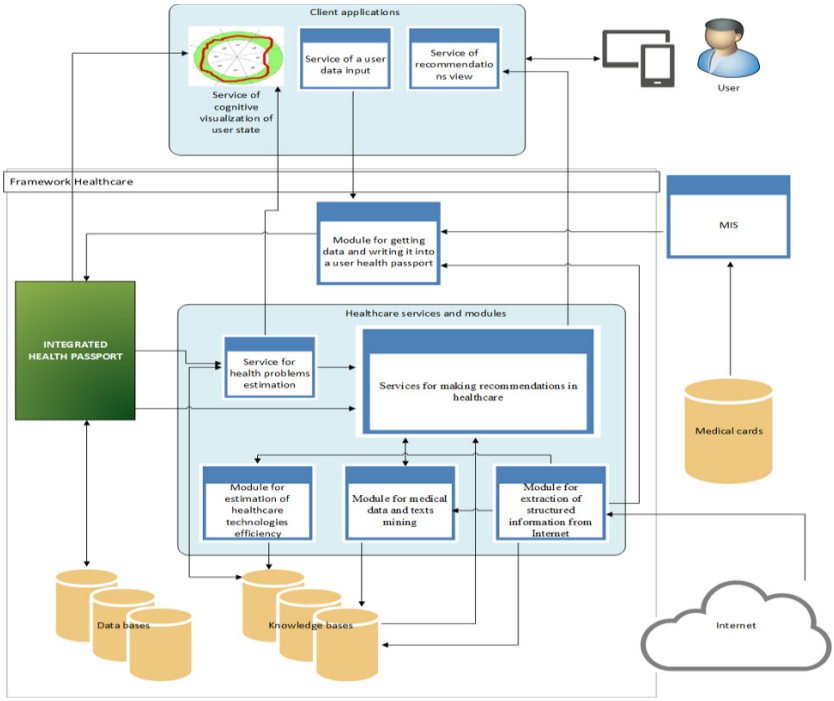

Fig. 1. The architecture of system of health-saving (SHS).

Service for Health-saving Recommendations. The final practical result of the Internet system for personalized health-saving is a personal user page that allows him to assess his health state and to obtain optimal personal recommendations.

The service of cognitive visualization allows you to visualize the user's state and to highlight graphically the problem areas in general and depending on the tasks that the user wants to solve with health-saving method.

This service allows the user to assess his state and its dynamics during the implementation of health-saving programs.

It is also used at the output of data of the user's state monitoring, visualization of recommendation fragments, presentation of environmental characteristics and lifestyle.

To visualize the entered data about the user's state, the service receives data from the health certificate on the server.

The assessment of problem health zones is done by a separate module-service on the server.

To obtain this information, the client application sends a request to the server. The service for the problem zones evaluation receives data about the user's state from the health certificate, sends them to the knowledge base and sends the response from the knowledge base to the client application. The service for assessment of the problem body zones includes assessment of nutrition, physical and mental performance, psycho-emotional status and stress level and biological age factors (Fig. 2).

The module for the development of recommendations in the health-saving sphere is based on the diagnosis of problem health zones and includes several individualized personalized medical and preventive recommendations, and some general provisions on healthy lifestyle, prevention of age-related diseases and dispensary follow-up monitoring.

The basis for the recommendations is the information obtained from a personalized health passport, including those of the previous diseases and family history, test data and recommendations specific to each of the diagnostic and optimization modules and algorithms for adapting those recommendations to the personal user's characteristics.

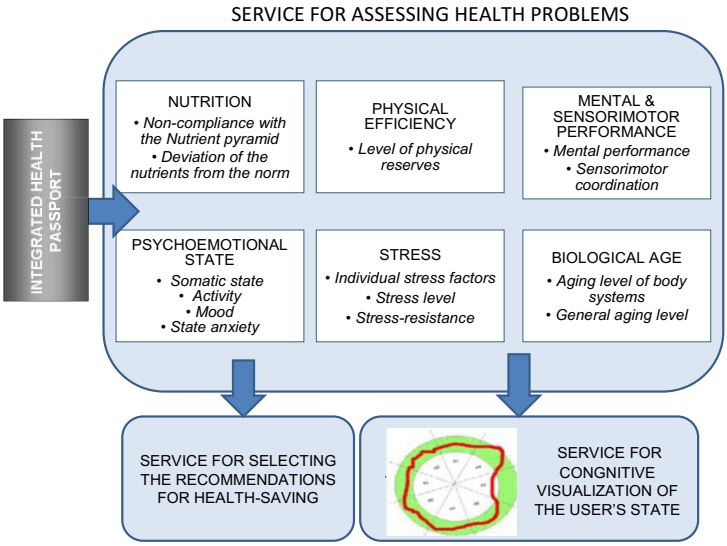

Fig. 2. Structure of service for health problem zones assessment.

3 Conclusion

The developed intelligent Internet technology for personalized health-saving support allows obtaining of a novel systemic result - a new, effective technology with no direct analogues in Russia and in the world, which makes it possible to give a reliable information on modern health-saving technologies to each person, to implement additional motivation to a healthy lifestyle and personal information support in solving the problem of optimizing the spectrum and methods of these technologies, considering personal characteristics and preferences of a person.

The expected results of this technology are: improving the quality of life, improving the demographic indicators, increasing the social activity of population, eliminating the risk of depopulation, ensuring social progress and sustainable economic development of the country as the basis for the well-being of every person, a healthy society developing.

Acknowledgment

This work was financially supported by the Ministry of Education and Science of the Russian Federation. Grant No. 14.607.21.0123 (Unique Project Identifier RFMEFI60715X0123).

References

1. Walid Mestadi, Khalid Nafil, Raja Touahni, Rochdi Messoussi,"Knowledge Representation by Analogy for the Design of Learning and Assessment Strategies", International Journal of Modern Education and Computer Science(IJMECS), Vol.9, No.6, pp.9-16, 2017.DOI: 10.5815/ijmecs.2017.06.02
2. Zoran Kotevski, Ivana Tasevska,"Evaluating the Potentials of Educational Systems to Advance Implementing Multimedia Technologies", International Journal of Modern Education and Computer Science(IJMECS), Vol.9, No.1, pp.26-35, 2017.DOI: 10.5815/ijmecs.2017.01.03
3. Takizawa, K., Takesako, K., Kawamura, M., Sakamaki, T.: Development of medical communication support system "health life passport". Stud Health Technol Inform 192, 1027 (2013).
4. Hsieh, S.H., Hsieh, S.L., Cheng, P.H., Lai F.: E–Health and health-saving enterprise information system leveraging service oriented architecture. Telemedicine and e–Health 18 (3), 205–212 (2012).
5. https://www.gero.com/mhealth
6. https://welltory.com/ru/
7. http://wellnessproposals.com/
8. https://www.underarmour.com/en-ru/healthbox
9. Khaw, K-T, Wareham, N, Bingham, S, Welch, A, Luben, R. et al.: Combined Impact of Health Behaviours and Mortality in Men and Women: The EPIC-Norfolk Prospective Population Study. PLoS Med 5(1), e12 (2008).

10. Bloom, D. E., Canning, D., Sevilla, J.:.The Effect of Health on Economic Growth: Theory and Evidence. NBER Working Paper № 8587. November 2001.
11. Osipov, G.S., Smirnov I.V., Tikhomirov I.A.: Relational-situational method for text search and analysis and its applications. Scientific and Technical Information Processing 37(6), 432-437 (2010).
12. Shelmanov, A.O., Smirnov, I.V., Vishneva, E.A.: Information extraction from clinical texts in Russian. Computational Linguistics and Intellectual Technologies: Papers from the Annual International Conference "Dialogue" 14 (21), 537-549 (2015).