BIG DATA IN HEALTHCARE: ELECTRONIC DOCTOR-FREE SYSTEM OF HEALTH MONITORING AND CORRECTION

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Abstract. Big data analytics is a growth area with the potential to provide useful insight in healthcare. E-health based on the use of information and communication technologies including big data analysis provides a unique opportunity for the improvement of life quality and length. The main problem here lies in the development of new, doctor-free methods of health monitoring and correction that are designed for individual use. This article presents the project of personal medical diagnostic system for doctor-free health monitoring with elements of correction on a mobile core.

Introduction. In recent years, the concept of big data has been introduced to the healthcare system as a solution to a variety of healthcare related information system problems as health systems grown increasingly complex and expensive. Estimates suggest that in 2012, healthcare data reached about 500 petabytes. While future estimates suggest that by 2020 healthcare data will equal 25,000 petabytes. Effective integration of such data using data mining and medical informatics may result in lower

costs and improved patient care via well informed decision making [1].

Big data is the intelligence for Electronic Health Records , as it has the ability to connect financial, operational, and clinical analytic systems, and may support evidence-based healthcare. Evidence based healthcare involves the systematic reviewing of previous clinical data in order to provide decision makers with information. Evidence suggests that big data can be used to detect disease. However, big data requires careful data management in order to fulfil the goals of big data analytics [2]. This includes data governance of the data sources, data content, data quality, data consistency, data access and security, user training, and data stewardship. Data related issues can arise without effective management and governance, and these include unreliable, inaccessible, missing, or inaccurate data [3]. Therefore, data management aims to provide authentic, accurate, and reliable data essential for good decision making in healthcare.

Consequently, big data initiatives must consider the various aspects of big data processes such capturing, storing, searching, sharing, and analyzing of data [2,4]. The analysis of data in turn demands adaptation of the general concept of big data processing (see figure 1) in relation to medical information.

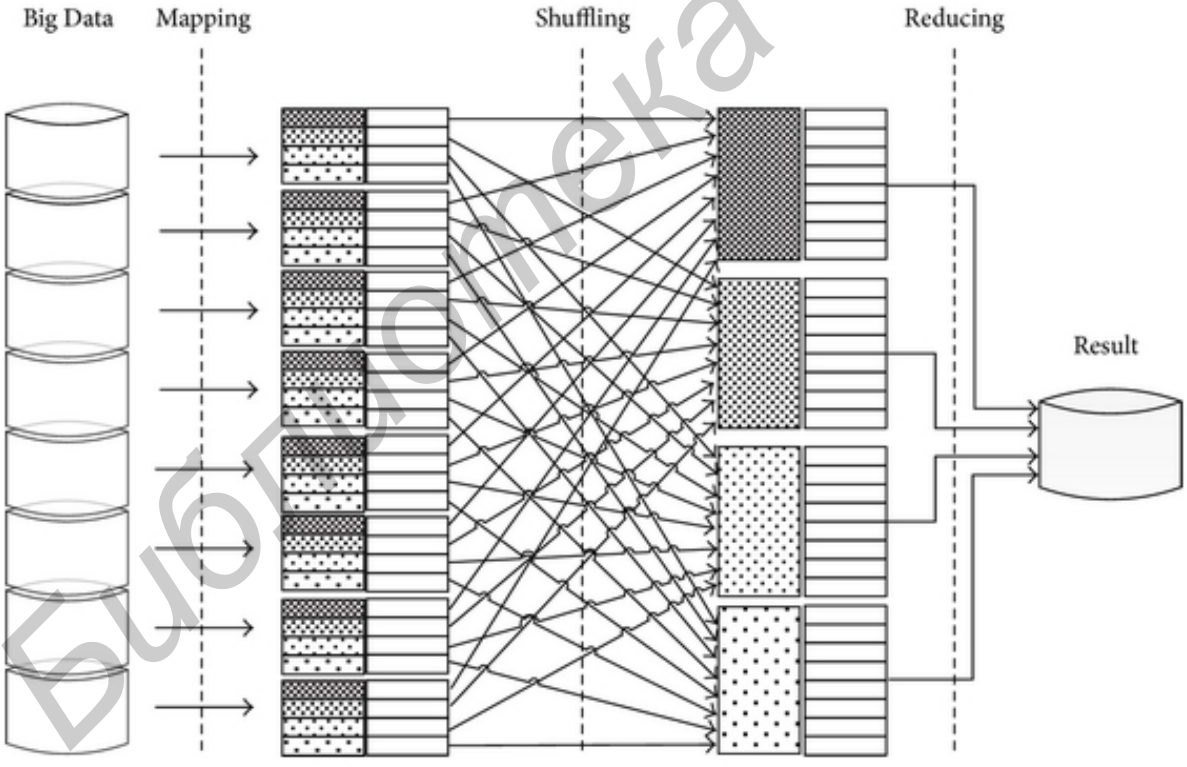

Fig. 1. Big data processing architecture

Big data processing architecture consist of map, shuffle and reduce stages. Semantically, the map and shuffle phases distribute the data, and the reduce phase performs the computation. MapReduce logic, unlike other data frameworks, is not

restricted to just structured datasets. It has an extensive capability to handle unstructured data as well.

Electronic doctor-free system of health monitoring and correction. Today, e-health based on the use of big data analysis provides a unique opportunity for the improvement of life quality and length. The main problem here lies in the development of new, doctor-free methods of health monitoring and correction that are designed for individual use.

The main objective of this article is to present the project of personal medical diagnostic system for doctor-free health monitoring with elements of correction on a mobile core.

See figure 2 for the proposed system of health monitoring and correction.

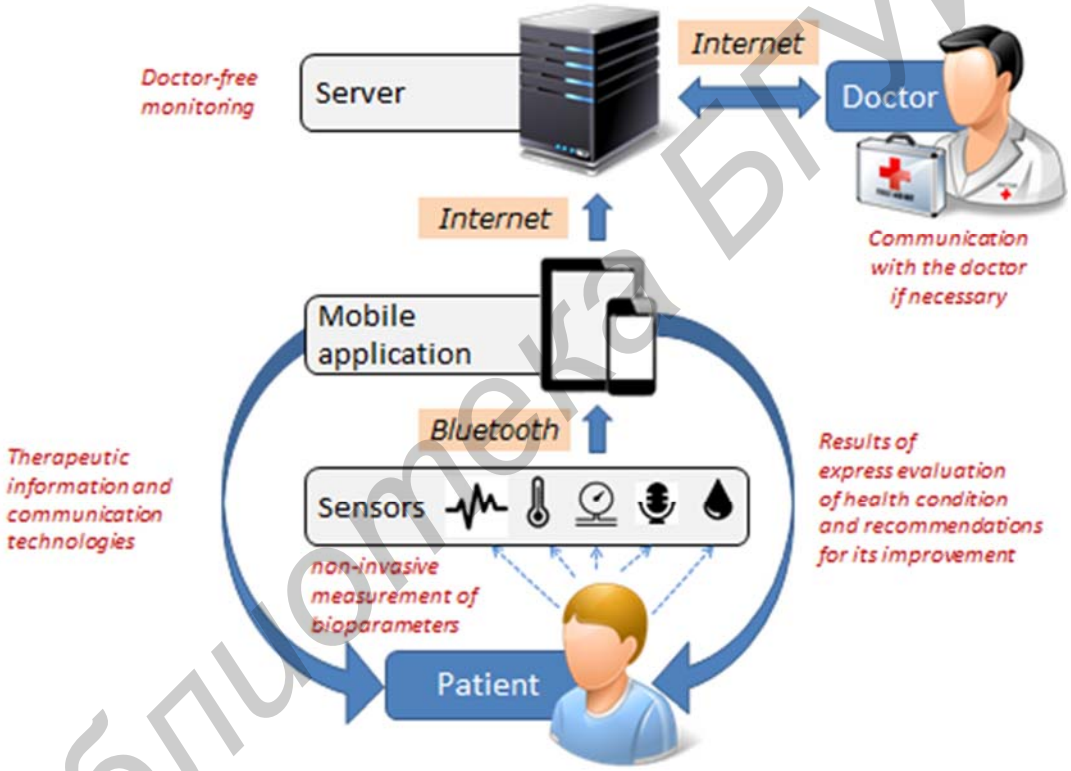

Fig. 2. Electronic doctor-free system of health monitoring and correction

The system provides:

– non-invasive measurement of main parameters of functional human state with the help of well-known biomedical sensors;

– transfer of information to the user's mobile device via Bluetooth;

– express evaluation of health condition with the help of newly developed methods of biomedical signal processing [5-8] that are based on a mobile application and provide an opportunity of user notification when his/her physiological indicators exceed normal limits set individually. A warning signal will allow the patient to take a number of appropriate measures to normalize his/her physiological state and thereby to prevent the development of severe dysfunctions;

– automatic treatment suggestions with the help of specially developed methodology;

– correction of the patient's functional state based on information and communication technologies;

– transfer of information to the server with special software including big data analysis. Processing and storing of the patient's health information for the doctor to be notified if his/her physiological parameters approach critical levels.

One of the most important issues in creating such systems is to choose the parameters to be monitored. Pulsograms, blood parameters, temperatures of the representative body zones, blood pressure, ECG, EEG and speech signals will be used taking into account the necessity of non-invasive registration, simplicity of sensor implementation, informativity and reading speed.

Peripheral pulse signal is one of the most informative physiological signals, which characterize hemodynamic parameters of the cardiovascular system: intravascular pressure, tension in arterial paries, wave processes in the arterial system, blood viscosity and etc. Pulsograms will be registered with the help of optoelectronic diagnostic methods, which will be combined with non-invasive measurement of blood parameters and oxyhemoglobin monitoring.

More than 40% of adult population in Europe and the United States have high blood pressure, and some patients with hypertension become insensitive to the effects of pharmacological agents. Such patients are at the highest risk of suffering from stroke, so their pressure needs to be monitored.

Temperatures, ECG and EEG will be measured as they provide a basis for assessing the general state of a human body and are sufficiently informative for the diagnosis and monitoring of a number of diseases.

Extremely important is a currently developing area of early diagnosis of speech disorders that allows to identify and treat a variety of neurological disorders (dystonia, dysarthria, parkinsonism, circulatory pathologies, cognitive impairments and etc.) in time, which is crucial for healthy ageing. We have carried out a research of this type of diagnostics jointly with medical institutions (National Scientific and Practical Centre of Neurology and Neurosurgery of Belarus). In this regard, the method of speech signal parameter monitoring will receive further development under this project.

It should be noted that the question of choice or improvement of the list of monitored parameters is still open for discussion.

The key issue of the system is an informed choice of methods of biomedical information digital processing.

We have obtained preliminary data, which allow to optimally adapt the method of digital processing to the test object [9-11]. The system will provide for the decomposition of biomedical signals and calculation of diagnostically important parameters describing individual physiological state of the user, as well as the evaluation of the dynamics of change in this state. The results of express assessment will serve as a basis for the generation of automatic recommendations about the user's

state improvement.

The project will develop a methodology of integrated biomedical information processing. It constitutes in the research of changing nature of a number of signals, which describe the state of various systems of human body (e.g., plethysmogram, degree of oxygen in blood, respiration rate), and in the determination of their correlation. This will enable us to build a more accurate mathematical model, which adequately describes the behavior of medical and biological functional systems that will ultimately enhance the accuracy of diagnostics.

Methods (hardware and software) of application of ICT therapeutic potential to the prompt correction of the user's physiological state will be developed in order to improve the efficiency of the system.

In its simplest variant, the system will present the user with: the information about his current state and the dynamics of this state; recommendations of the preventive nature; prompt communication with a physician if necessary.

Currently, therapeutic methods based on the application of information and communication technologies and biofeedback are widely used. In our case, an innovative approach will be applied, associated with the reduction of blood pressure by electrical neurostimulation of baroreceptors located in the carotid artery. In this condition, parasympathetic nervous regulation units that affect the heart, kidneys and blood vessels are activated resulting in a decreased blood pressure.

In this project transmission channel protocols will be developed. Given that the price for a mistake in the transmission of such information is high noiseless coding of the transmitted information will be used. Codes and signals with special properties will be synthesized taking into account specific features of digital signal processing with respect to mobile phone systems, nature of transmitted biomedical signals and code hardware.

High requirements will be imposed to the reliability and accuracy of sensors and easy registration of biomedical signals.

Conclusion. This article presents the project of personal medical diagnostic system for doctor-free health monitoring with elements of correction on a mobile core. The system provides: non-invasive measurement of main parameters of functional human state with the help of well-known biomedical sensors; transfer of information to the user's mobile device via Bluetooth; express evaluation of health condition with the help of methods of biomedical signal processing that are based on a mobile application; correction of the patient's functional state based on information and communication technologies; transfer of information to the server with special software including big data analysis.

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