Feasibility of telemedicine and Internet of things concepts application in the RF Arctic zone

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Abstract. Concepts of telemedicine and Internet of things (IoT) are steadily developing and becoming important issues for today's society. Possibility of (I) patients electronic cards storage, (II) remote consultations with specialists, (III) continuous monitoring of vital indicators makes information technologies (IT) a driver of health care environment development. Furthermore, modern IT make today's health care more qualitative and accessible for population. This investigation is intended to affirm feasibility of telemedicine and Internet of things concepts application in the RF Arctic zone aiming to reduce disease and accident risks. Investigation results may be used as a basis for designing and implementation of IT-solutions in regard of remote monitoring of patient's biometrics.

1. Introduction

Currently, the IoT and multi-media technologies constitute a part of health care owing to telemedicine and other modern approaches like value-based medicine, person-centered medicine, P4 medicine which are intended to improve quality of health care services and to add patents self-sufficiency and credibility [1]. Telemedicine is understood as medical services provided with the use of interactive audio-visual and information communications. This concept includes health care, diagnostics, treatment services provision and medical data transmission [2]. At the same time various modern technologies like artificial intellect and the IoT which may use sensors capable to (I) perform monitoring of patients condition and activities, (II) study their behavior patterns and (III) acquire contextual knowledge, make it possible to maintain continuous and highly-technological patient-specialist cooperation.

Furthermore, wide spread of mobile gadgets, considerable Internet coverage, cloud technologies and the IoT formed a new segment of gadgets — “Wearable IoT (WIoT)”. Modern WIoT are transforming the health are sector. Owing to sensors and portable devices today's health care institutions obtain access to personalized information about patient's health, namely: vital signs, physical activity, behavior and other critical parameters affecting the quality of everyday life [3].

All these technologies are intended to considerably improve quality of life, moreover, they are critically important for monitoring of health of population residing or working in remote areas and/or hard climatic conditions. The RF Arctic zone may be referred to such classification; therefore, integrated development thereof becomes a vital task [4].
This article is addressing potentials of various IT technologies whose purpose consists in organizing continuous tracking of biometric indicators of those who live or work in remote and/or severe climatic conditions of the RF Arctic zone aiming to decrease illness and accident risks.

2. Review of literature

The Internet of things became one of key technologies in the sphere of health care. Use of the IoT in health care sector allows to fundamentally changing approach to getting medical aid because medical institutions get an opportunity to remotely connect patients, to process examination results and to compile exact and by maximum personalized diagnosis. Owing to this technology the medical sector gets opportunity for continuous measurement of heart rate, blood pressure and glucose level. Furthermore, modern gadgets incorporating the potentials of the IoT, predictive analytics and big data analysis enable the user to warn him about abrupt variation of vital functions or call ambulance in critical situation.

It became possible to create a low-cost technology of medical sounding — communication and analytical tool capable to perform on-line patient's health monitoring. The IoT networks enable active and continuous on-line interacting between patients, hospitals and doctors; moreover, in order to ensure safe data transmission from the source to the destination point aiming to provide continuous monitoring it is possible to implement specialized architecture on the basis of the said technology.

Researchers propose various technologies enabling the IoT integrating into health care sector. For instance, UbiPILL “A Medicine Dose Controller of Ubiquitous Home Environment” — domestic wireless sensor network improving quality of life and ensuring safety, information and comfort. Investigations also describe the use of RFID technology – a medicine management system. RFID was used for the purpose of medicine management system development; at that, medicine tracking may be performed (including emergency and normal health care) either with or without RFID marking. HF-mark is assigned to the user and using RFID-reader together with camera and web-system to track the user [5].

There are also investigations about self-regulated system of wireless environment monitoring. Large-scale checking of integrated monitoring system in emergency medical aid department is proposed. Integrated monitoring of patients which is generating patients electronic data is supplemented by the possibility of (I) predictive analysis and (II) timely notification of medical personnel.

Some of researchers are trying to integrate portable gadgets and systems into the IoT scenario in order to retrieve better services in the sphere of digital health care. Smart phone-based tele-monitoring system for chronic disease management was presented. Remote monitoring became possible owing to various bio-medical devices which are measuring and transmitting measured data via Bluetooth or ZigBee to the gadget which is controlling them (PC, iTV) [6]. Gathered information may be stored in the gadget or transmitted to data acquisition center which is providing complete monitoring both for specialists and for the patients. Such medical center may be accessed via Internet from mobile gadget or PC. Combination of IOT and RFID is also playing crucial role in (I) object detection and (II) personal identification which may be used by a person for remote monitoring.

3. Results

Organization of continuous biometric monitoring of person residing or working in remote and/or severe climatic zones aiming to reduce risks of disease or accidents is currently a crucial and top-priority task. This task is mostly important for areas like Arctic (if to consider ongoing top-priority research projects in Russia); it may be solved by a combination of Telemedicine and the IoT technologies [7]. Integration thereof enables the user to receive high-quality medical aid irrespective of patient and doctor location.

Telemedicine may be in a broad sense defined as employment of telecommunication technologies for the purpose of medical services and information provision. Although this definition provides for
medical purpose-oriented usage of telephone, fax and remote training, telemedicine is being more frequently used in capacity of electronic clinical consultation.

Telemedicine constitutes an integrated set of technologies and potentials of clinical adaptation thereof. Decisive aspect of telemedicine is electronic signals usage for information transmission. Telemedicine systems may be characterized by (I) the type of information they are transmitting (e.g. X-ray patterns or clinical data) and (II) tools used to transmit it. Many medical practice spheres have potential demands for software applications. Image transmission is an integral part of radiology and pathology.

There are a lot of medical data transmission and utilization methods (table 1).

| Purpose                | Mode                                      | Type of information            | Typical adaptation                      |
|------------------------|-------------------------------------------|---------------------------------|----------------------------------------|
| Diagnostics or         | On-line mode, one-way or two-way video    | Voice, sound, video in          | Tele psychiatry, mental health, remote  |
| therapeutist           | communication                             | on-line mode, images, texts,   | surgery and examinations                |
| consultation           |                                          | documents                       |                                        |
| Diagnostics or         | Photography or video with telephone      | Voice, sound, text              | Dermatology, cardiology,               |
| therapeutist           | contact in on-line mode                   |                                 | otolaryngology                         |
| consultation           |                                          |                                 |                                        |

Use of telemedicine technology is one of components intended to facilitate implementation of Value-Based Medicine (VBM) concept which is aimed at:

- objective value (improvement of quality and/or length of life);
- employment of best standards and practices for service system establishment;
- continuous assessment of costs and monitoring of cost efficiency;
- acquisition of data for analysis and improvement of medical institution activities;
- medical services orientation towards vitally important patients’ health indicators associated with quantitative characteristics [8].

Telemedicine systems are understood as a set of medical information services implemented by means of technological stack (software-hardware package) and maintaining fundamental processes of medical services provision. Within IT sphere these services already became important directions for investigation because they are intended to facilitate services quality improvement. Services are playing crucial role in (I) emerging of new forms of cooperation and communication in the sphere of services, and (II) new concepts automatization, standardization and integration for the clients.

Analysis of available telemedicine technologies and services shows that currently there are no solutions enabling simultaneous tracking client’s blood pressure, heart rate and body temperature. Scarcely found solutions of this kind are only those which are oriented to B2C market. These solutions are intended mostly for independent sportsmen and researchers this is why it is important to elaborate comprehensive solution oriented to B2B market and organization of interaction employee-employer-medical center. Such approach will be essential during organization of research expeditions and servicing of centers located in remote areas with severe climate. Main stake holders may be represented by (I) company-employer (it may be either research institute or company involved in remote area investigation), (II) employees working in these areas and (III) medical centers implementing medical services for company-employer.

It is proposed to supply the employee with special garment equipped by in-built wireless blood pressure, heart rate and temperature sensors. Further, it is proposed to elaborate a mobile or web-application which could be used either by employee (to track own health indicators) or by his
employer (commercial or state-backed organization) or by medical center personnel contracted by the employer for medical consultations provision.

From the viewpoint of advantages provided by this technology to each stake holder we can point out the following ones:

- Any employee will be capable to (I) track medicines taking schedule, (II) view consultation or attendance records, (III) track sensor indications and (IV) receive notifications about vital parameter variations, health risks etc.
- The employer will be capable to track (I) personnel examination schedules, (II) personnel health indicators, (III) current costs associated with medical services provision etc.
- Medical center specialists will be capable to receive data about (I) current patient condition on-line, (II) their chronic diseases, (III) medical history, (IV) earlier references etc. Besides, the doctor will be capable to address the patient via chat uploaded in the same application.

Key requirements which should be taken into account in the course of implementation:

- Possibility to track urgent health indicators like blood pressure, heart rate and temperature;
- Ease of wearing and resistance to extreme climatic conditions;
- Possibility to perform data analysis by means of cloud-based platform;
- Friendly graphic interface which could enable all the users to easily and promptly retrieve all necessary information.

Prototypes of such wearable gadgets and applications are shown in figures 1–4.

![Figure 1. CAD-model of wearable gadget.](image)
Figure 2. Physical prototype of the gadget.

Figure 3. Page of application digital-prototype.
4. Conclusion
This scientific-innovative idea is practically implementable since there are all necessary technologies and technical facilities to do it. In order to implement this idea we propose to use already available components and to assemble them in one integrated solution. Currently, there are a lot of various types of software:

- wireless sensors indicating blood pressure, heart rate and body temperature;
- cloud-based IoT platforms capable to perform data acquisition using various protocols;
- IDE enabling development of mobile and web-applications.

Further promotion of this idea consists in improving this scientific-educational and innovative-technological infrastructure which is intended to ensure complete cycle of medical translation researches. This will allow integrating medical centers into international scientific community and creating a system of continuous interdisciplinary post-graduate training of scientists and medical specialists. This will also allow eliminating informational inaccessibility of medical specialists working in the RF Arctic areas by creating new opportunities to acquire experience accumulated by their colleagues working in leading medical centers.

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