

# Smartphone Base Personal Health Monitoring In Inaccessible Areas

Maxim Yatskovskiy  
FRUCT MD LLC  
St-Petersburg, Russia  
maximus@fruct.org

**Abstract—** The paper describes the experience of using affordable and mass telecommunication and medical technologies in a pilot project to remote monitoring of the health parameters of employees and their families who live at a long distant weather station in the Trans-Baikal Region of the Russian Federation. The main task of the project was to test the possibility of using such accessible technologies in extreme environmental conditions. The project runs from October 2017 to October 2018.

## I. INTRODUCTION

On the territory of the Russian Federation there is a large number of weather stations, where apart from automatic equipment work people who service this equipment and perform part of the observations manually. Some of these stations are located in long distant with bad transport accessibility. Especially in winter season, ground communication with the weather station is difficult. And in situation of problems with the health of its residents, it is necessary to use expensive medical transport aviation. In some cases, due to weather conditions, the use of aviation is impossible and this increases the threat to the health of employees. Therefore, the main medical goal of this project was preventive health monitoring, so as early as possible to identify suspicions of emerging health problems. And then take all the necessary actions in the period of favorable weather conditions.

The location of the meteorological station is more than 500 kilometers to the east of Lake Baikal and more than 4600 km. From Moscow. In total, 4 adults and one child were monitored. For this 6 sets of equipment were used. One set was spare item. The duration of the project is one year, with such a condition that it covers all climatic periods in this place. The project is carried out by the state organizations of the Arctic and Antarctic Research Institute and the All-Russian Center for Disaster Medicine "Zaschita" and a private company BIOCOR, which organized the project. If the success of this approach is confirmed in health control, the project is planned to expand into other territories and increase the number of weather stations participating in it next year.

## II. STRUCTURE OF THE SOLUTION

The technical solution consists of a set of medical devices [1], a personal smartphone, and a internet router connected to a local network, where weather instruments and a videoconferencing system are connected. Part of the system's devices transmitted data automatically to the smartphone

during the measurements. The data from the other part of the devices were manually entered into the smartphone in the form of numerical values.

The following medical devices were used in the system:

- Heart rate sensor for long-term data collection. Has a Bluetooth interface.
- Blood pressure meter with the function of calculating additional parameters of cardio vascular system. Has a Bluetooth interface.
- Pulse oximeter. Has a Bluetooth interface.
- Continuous measurement thermometer. Has a Bluetooth interface.
- Electrocardiograph. It is connected to the audio connector of the smartphone.
- Glucometer. Manual entry of values.
- Measurer of hemoglobin and cholesterol level. Manual entry of values.
- Test strip for the analysis of urine characteristics. Manual input of values, photographing.

As a smartphone, Huawei Honor 6 was used. All devices with a data interface were preconfigured to work with a particular smartphone and labeled to avoid errors in identifying the testimony from a particular person. All smartphones were pre-configured to work with an Internet router. This approach simplified the installation of the sets of equipment on site, when for the communication it was only necessary to connect the Ethernet cable to the local network of the weather station.

Internet access was organized using satellite communications with an asymmetric data channel.

As a software platform for data collection and analysis, we use the cloud-based MDDCloud system developed by us at FRUCT MD. Mobile applications for smartphones have also been developed by us and modified to meet the needs of this project. The cloud platform was created to organize any mass services of mHealth area [2] and was not elaborated specially for this project. The measurements were accumulated in individual smartphones and transmitted to the cloud platform at the time of satellite communications. Additional computers and servers for the accumulation and processing of medical data at the weather station were not be used.

The system used allows automatic collection of measurement data from medical devices. Enter the values manually. Remind the user of the necessary actions based on the schedule compiled by the doctor. To make questioning of the patient on the basis of questionnaires which the doctor has made.

Installation of the whole system was carried out by the employee of the "Zaschita" organization who a visit to the station from Moscow with all equipment. At this point, there was a primary training of users.

### III. THE METHODOLOGY OF THE ORGANIZATION OF MONITORING OF PATIENTS

Based on the methodology of project management, the categories of participants were identified:

- 1) Patients - a family of workers at a weather station;
- 2) Employee coordinator in the dispatch center in Moscow;
- 3) The doctor is the coordinator, who directly works with patients.
- 4) Doctors of the regional state clinic, where patients are hospitalized in case of serious problems.

A permanent multi-level screening of patients' health was organized, conducted according to the method developed by BIOCOR. Combined series of long-term observations of the psychophysiological state of people using the heart rate sensor and situational measurements of blood pressure, electrocardiograms, plethysmogram and measurement of biochemical parameters of blood and urine. In a number of cases, in the first case for the child, a long term continuous monitoring of the temperature was carried out. Long term monitoring of the psychophysiological state in this case made it possible to identify markers that could potentially have a deterioration in their health. And after that, use other methods of diagnosis, based on which you can decide on emergency or scheduled consultation with a doctor.

In addition to medical supervision, the overall emotional background of the weather station workers was additionally monitored and investigated.

Independent research and measurements on a schedule or on reminders of a smartphone alternated with video and conferencing sessions between the weather station staff and the doctor coordinator. Training of the meteorological station staff with the rules of work of the system was carried out by videoconferencing. In addition, the instruction cards for the use of each device included in the kit have been prepared.

### IV. TECHNOLOGICAL PROBLEMS

During the project, several problems were identified. Some of them concern the methodology of the project. The other part deals with the technical support and the immediate functions and features of the operation of our system.

Some of the problems did not concern the system directly, but they influenced the success of the project, they include:

- 1) The degradation of the capacity of the batteries of wearable devices and the reduction of their working time. Due to the fact that the temperature in the winter on the street can reach -50 degrees Celsius and lithium-ion batteries with repeated exposure to such temperatures significantly reduce their capacity.
- 2) Problems with the stability of satellite communications. Due to the fact that the satellite is not always present within the limits of the antenna's visibility. The second problem is the inability to ensure a stable antenna position in strong winds and unfavorable meteorological conditions.

Problems concerning the system itself

- 1) Difficult for users to the application of the smartphone. It is necessary to simplify the interface and add a game component to it.
- 2) The problem of correct input of values when entered is manually. It is necessary to change all devices to automatic data transfer models.
- 3) The need for aggregation in the system not only of patient data, but also the results of their previous requests for medical care to other government clinics

### VII. CONCLUSION

At now, the project is approaching the stage of completion and evaluation of the results. Based on these results, the composition and functions of the system will be finalized. But already at the moment it can be argued that the mass technology of health control can be used to work in difficult conditions in remote areas. After the completion of the improvements taking into account the experience gained..

### REFERENCES

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