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IFAC-PapersOnLine 48-4 (2015) 312–317

Wireless Health Monitoring System

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Abstract: The paper deals with Wireless Health Monitoring System. It presents a prototype of a medical system which consist of a Wireless Health Monitoring Device and a base station in the form of a smartphone. The presented system enables to monitor ambient and human body conditions. Current health monitoring market conditions and available devices are discussed. The issues relating to the population in Europe and its impact on the health monitoring market are considered. The paper presents review of wireless communication systems currently available on the market. The information presented in this paper may help develop portable, low-power and wearable devices.

Keywords: health monitoring, embedded systems, wireless body area network, wearable devices.

1. INTRODUCTION

The fast lifestyle, the lack of time or living in a large city causes difficulties to take care about elderly family members. Disappearance of the multi-generational family model contributes to loneliness of elderly persons, who most often live alone.

The analysis of Europe population shows that in the greater part of the continent almost one third of the people is aged over 65 years old and that trend is growing. Countries with high percentage of the elderly include inter alia Germany, Italy, Sweden, Finland and Greece. On the other hand, countries with younger society such as Poland, the Czech Republic and Ireland account for the small percentage of the overall Europe's population. Even in these countries in the next decades the number of young people will drastically decrease as compared to the elderly.

Figure 1 presents the comparison of the past as well as the predicted future aging trends in Poland. As it can be seen in Fig.1 in the near future the percentage of young people will be approximately only half of those aged over 65 years old. "At the end of 2013, the population in Poland was 38,5 million including approximately 5,7 million people aged 65 years old and more." Over fifty years ago, young people accounted for the vast majority. Right now, the situation has reversed. It can be clearly seen that elderly people will dominate in society. The analysis of the data presented by the Polish Central Statistical Office (GUS 2014) shows a continuous increase in the number of the elderly from year to year. Such situation will result in shortage of medical personnel, who can take care of the elderly.

Furthermore, the domain of physical examination and medical procedures will expand in the future. Methods of medical diagnosis are continuously being improved and extended. All that results in expanding the range of needed medical services and poses new challenges for medical care. It is particularly difficult to take care over elderly persons, who live a lonely life and require a day-long medical supervision.

All these factors, create the demand for the hardware support in health care. It will allow to increase the number of protégées to take care independently and reduce the necessity of direct contact with health service employees.

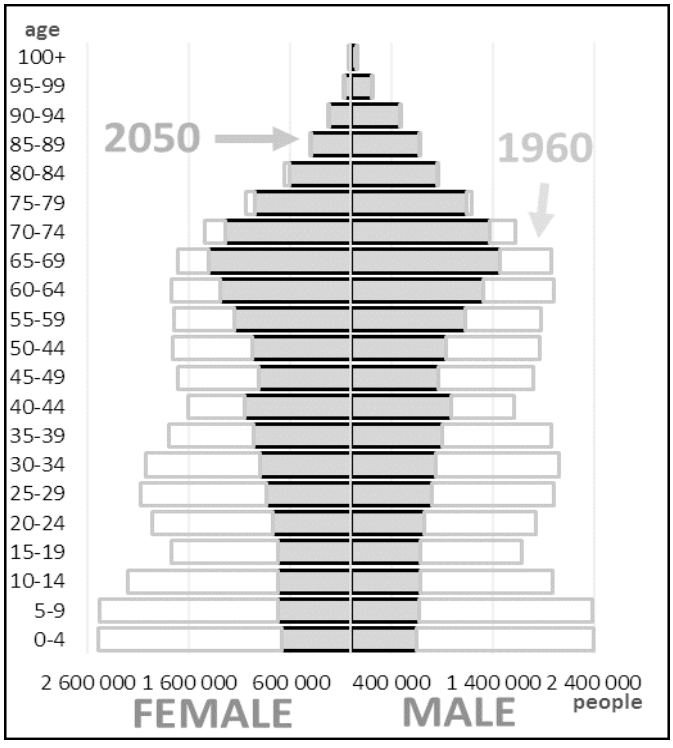

Fig. 1. Estimated age proportion of people in Poland.

Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2015.07.053

There is a need of a device or system, which will enable to monitor the condition of a person, take action in the case of emergency and predict potential threads to human life.

It must be taken into account that the receiving station (supervising station) may be located at a certain distance from the people who are monitored by health care system. . Thus wireless solution is necessary. For great distances, exceeding the range of 200 meters from the receiver, such solutions as wireless Internet access over Global System for Mobile Communications (GSM) should be used. For smaller distances, the wireless standards compared in this paper will be sufficient.

Nowadays smartphones with an Android system are becoming increasingly popular, which makes them suitable for acting as a supervising station and ensures connection between monitored person and a supervisor.

At present, a trend to combine alert monitoring devices with consumer devices such as smartphones can be observed. This tendency will remain prevailing in the consumer monitoring systems in the future. Currently, these systems use another form of integration than smartphone systems.

The most popular, supervision monitoring systems that can be found on the market, consist of a small monitoring device in the form of a watch or tag, and a base station installed in the home. Capabilities of that system allow the user to move away from base station within the distance of 150m (Pappas 2015). The best examples of this type of system are Medical Guardian or Bay Alarm Medical, which are very popular. This indicates that, the need for supervisory monitoring of elderly people has been noticed and companies try to meet the market needs.

Thanks to industrial progress medical technology becomes more and more user friendly and enters into new opportunities. A good instance of this movement are Metria Informed Health devices.

The scale of integration in electronics, allow to design really small and comfortable systems. The best example is wearable electronics, which has become a part of our wardrobe. Electronics integrated with clothes, open up new possibilities in the field of user monitoring. For instance, new sport bras with integrated electrodes for heart rate sensing can be found on the market. Wearable patches, that stretch and move with the skin with integrated electronics should be mentioned here. The patches were created by John A. Rogers and Y. Huang, (Ahlberg 2014). “The researchers did a side-by-side comparison with traditional EKG and EEG monitors and found the wireless patch performed equally to conventional sensors.” This invention with integrated electronics has a great potential in monitoring field. It can be expected it will be very popular in the future.

Following medical devices expansions trend, the authors propose a prototype of a medical system of the Wireless Health Monitoring System which consist of a Wireless Health Monitoring Device (WHMD) and a base station in form of the Smartphone.

2. DEFINITION OF DEVICE TASKS

Information about the condition of the monitored persons and any occurring irregularities increase safety of their lives and health. In the event of irregularities, immediate response, may help avoid irreversible unpleasant consequences.

In many places such as home or park, the safety of elderly people should be monitored constantly. Access to the information on user’s condition should be granted to qualified persons defined by the user. It should allow for almost immediate response in the case of any threats.

The need for cardiac diagnostics, like electrocardiography (ECG) holters or cardiac event recorder resulted in creation of such devices about 50-years ago. This need has moved to day-to-day life and its result was the creation for example of heart rate monitors and personal health monitors in the commercial form of a small, light electronic device. The most significant improvement in these devices as compared to their precursors was introducing wireless connection.

Nowadays such devices are very popular especially in sport, mainly thanks to technology development, availability and provided functionality. Wrist heart rate monitors in the form of a watch are the best example. Chest belt heart rate monitors are another example of this type devices.

Wrist monitors, contrary to chest belt monitors use optical sensor and measure heart rate by using the pulse oximetry method. This sensors are more handy, and easier to use than chest belt heart rate monitors, and therefore have become more popular. However measuring biological signal in the form of blood flow for calculating heart rate provides less data. Also the measurement will be unsettled during dynamic hand movements and shakes. Thus, device monitoring health parameters, should monitor heart activity by analyzing ECG traces collected from chest.

A system which monitors only the heart rate provides too little data concerning the overall condition of the user state and should be extended with additional features. The system should be able to monitor different types of users like: athletes, the elderly, the lonely, workers and rescuers. It must be able to detect faintness slip-up, stumbles, falls etc. These events can be detected by means of accelerometers, which should be built in the device. It was assumed that the aforementioned events should be detected and signaled to the supervisor.

For the safety of a monitored person, environment parameters should be checked, by mean of sensors built in the system. The minimum set of sensors providing data for monitoring environment should include temperature, atmospheric pressure, altitude sensors. Thanks to this data, it will be possible to predict any potentially dangerous situation.

3. WIRELESS COMMUNICATION

A modern mobile health monitoring system requires a wireless solution that meets the requirements for portable, wearable and healthcare devices. Choosing the type of wireless communication is one of the basic problem that need to be solved according to expected function of the designed device.