International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 17 (2015) pp 38567-38571


# Features of construction of a software project for medical wireless sensor networks

**Dmitry SergeevichUbiraylo**
Scientific and Technical Center "Technocenter" Southern Federal University,
347900, 81 Petrovskaya street

**Sergey AlexeevichSinyutin**
Scientific and Technical Center "Technocenter" Southern Federal University,
347900, 81 Petrovskaya street

Abstract-The paper discusses the features of the construction of the project for medical wireless sensor networks include a microcontroller and a number of sensors that allow you to monitor the condition of the patient. The paper also shows the examples of constructing the structure of a software project, showing the advantages and disadvantages of each approach. The wireless sensor network is called a distributed network that is composed of a large number of sensors, and allowing the exchange of information with the help of wireless technologies, such as: Bluetooth, ZigBee and Wi-Fi. These networks have begun to actively develop due to inexpensive hardware components for the design of wireless systems and devices, and the rising popularity of their application. Medical equipment is also considered an industry that is actively developed, and that gets the most modern technological advances. Wireless technology allows the system to monitor the condition of the person, while not interfering with his everyday life cycle, allowing you to maintain good health. Comprehensive solution that explores the different characteristics and sends them to the server allows you to respond quickly to changes in the body, as well as remotely to consult with your doctor. When you create hardware-software complexes of this type of problems with software development, one of which is the choice of the structure of the project, which would allow leading the development of a large number of developers and gave the necessary resources and facilities to oversee the development. Using the convenient configuration of the project will reduce the time spent on writing and debugging a code, as well as simplify the solution of possible problems in the system.

Keywords: Sensor networks, medical systems, microcontrollers, software design, Bluetooth.

## Introduction

The wireless sensor network is a distributed and self-organizing network that is composed of a large number of sensors or systems for information collection which are combined with each other with the help of any available wireless technologies, such as Bluetooth, ZigBee, Wi-Fi, etc. In the mid-1990s electronics and microelectronics have actively started developing that at the beginning of the 2000th allowed to receive the inexpensive element base for the design of wireless systems and devices. With the rising popularity of these networks a number of branches which have underwent the introduction of these technologies only increases, a number of consumers also constantly grows. This tendency is inseparably connected with the development of production where there are new practical and theoretical tasks demanding the use of wireless sensors. Moreover, the development of such technologies allowed introducing them to such spheres of activity, as: a housing-and-municipal complex and a household. However, despite the long development of these networks the structure and the concept of sensor networks still are not finally created that allows producers and developers to find additional niches for the use of this technology.

The wireless sensor networkis a distributed and self-organizing network that is composed of a large number of sensors or systems for information collection which are combined with each other with the help of any available wireless technologies, such as Bluetooth, ZigBee, Wi-Fi, etc. In the mid-1990s electronics and microelectronics have actively started developing that at the beginning of the 2000th allowed to receive the inexpensive element base for the design of wireless systems and devices. With the rising popularity of these networks a number of branches which have underwent the introduction of these technologies only increases, a number of consumers also constantly grows. This tendency is inseparably connected with the development of production where there are new practical and theoretical tasks demanding the use of wireless sensors. Moreover, the development of such technologies allowed introducing them to such spheres of activity, as: a housing-and-municipal complex and a household. However, despite the long development of these networks the structure and the concept of sensor networks still are not finally created that allows producers and developers to find additional niches for the use of this technology[1].

Medical equipment which is used for monitoring of the person's condition with the use of various quantity and types of sensors, which for achievement of a maximum effect need to be united in the general network, is considered to be one of these niches can consider [2].

The classical architecture of the sensor network is based on a standard knot which describes the standard IEEE 802.15.4 describing two lower levels according to the OSI model, two lower levels - channel and physical levels. The example of a standard knot looks like:

- a radio module;

- a microprocessor module (MP);
- sensors;
- a power supply element.

## The main part of research

Figure 1 presents the architecture of the typical sensor network.

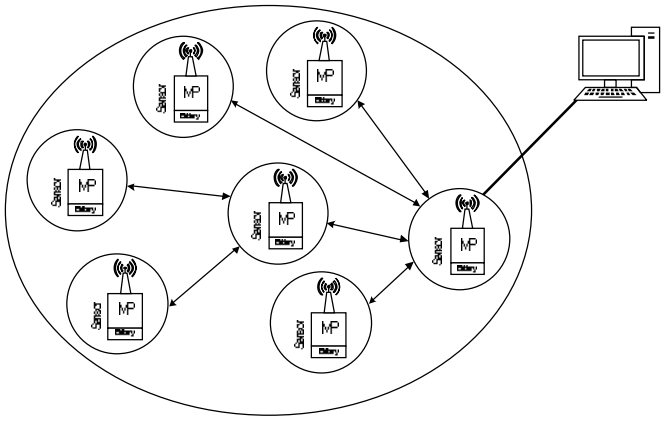


Fig. 1.The architecture of the typical wireless sensor network

This infrastructure of the wireless network fully is right for the concept of complex control of a the organism's condition consisting in diagnostics and monitoring of a large number of characteristics and parameters of the person allowing making conclusions about the condition of his organism totals and influence of problems with health at each other, but not just to reveal dot problems which are perhaps connected with other diseases hidden because of a lack of control inaccessible to the majority of modern portable medical and household devices [3].

The necessary condition or the normal functioning of the organism is a trouble-free operation of the blood circulatory system which consists of the network of blood vessels, heart and muscular pump. Heart diseases can a long time proceed in a hidden form, showing itself no way clinically. An electrocardiograph is the necessary means of heartbeat state monitoring, on the received results a cardiologist can make conclusions about the heart work, the pathologies development, possible inflammatory processes, a portable version of which can be used in ordinary life and also during sports activities [4]. In total electromyography, which during trainings of the athlete or various household activity of the person allows watching over the condition of muscles, is used for electrocardiography and have a great applied value: monitoring of age change of muscles, diagnostics of defeats of the peripheral and central nervous system, the research of exhaustion, the development of a movement skill etc. The use of the module for control over the developed by the person power allows optimizing trainings and sports activities, thus this indicator is directly connected with measurements with the use of the electrocardiograph and the electromyograph. At an addition in this structure of the module which would allow to define the person's geoposition and to write down the trajectory and the direction of his movement, to transfer data to a server, it is possible to receive the autonomous monitoring system of the human body condition. Using the low-consuming wireless technology the wireless sensor network turns out considering that this system will be mainly used by athletes and people in living conditions, it is necessary to provide the convenient control system and displays of the organism's condition [5]. In this case the portable devices on the basis of Android, in particular smartphones, computerized watches with the expanded functionality and tablets which are available practically in each house and having the widespread distribution come out on top. In this regard the use of the wireless Bluetooth Classic and Bluetooth 4.0 Smart technology will be an important detail. Thus, the scheme of interaction between modules will look according to the figure 1.

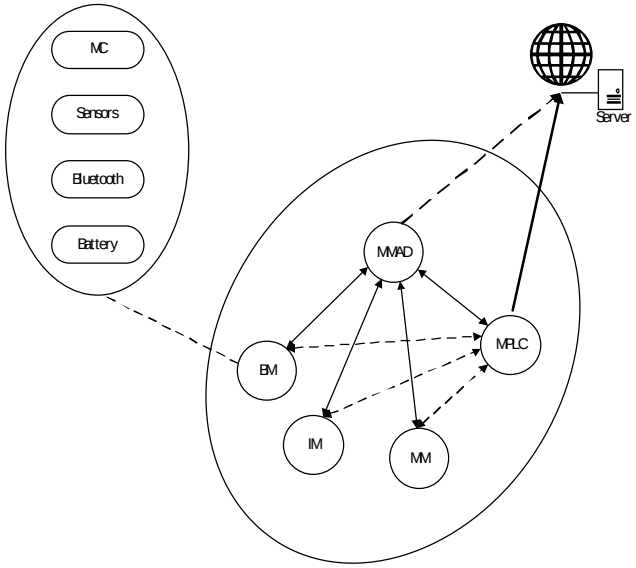


Fig. 2. The scheme of interaction of the medical wireless sensor network modules

Figure 2 makes it possible to say about belonging of such network to sensor networks because each element of this network is typical and follows the IEEE 802.15.4 standard including the microcontroller (MC), sensors, a radio link - Bluetooth and the battery. Figure 2 and the further text present the electrocardiograph - the basic module (BM), the electromyograph - the myographmodule (MM), the module for control of the developed by the person power - the inertial module (IM), the module which allows to define the person's geoposition - the module of a positioning and a long-distance communication (MPLC), the module providing the convenient control system - the module of management and display (MMAD).

The organization of the program project is a quite complex task for this type of developments and that is why a developer is facing a problem of effective management of the project, in particular a need of creation of several projects for the software development for each module in the network is meant, thus the figure 3 presents the following structure.

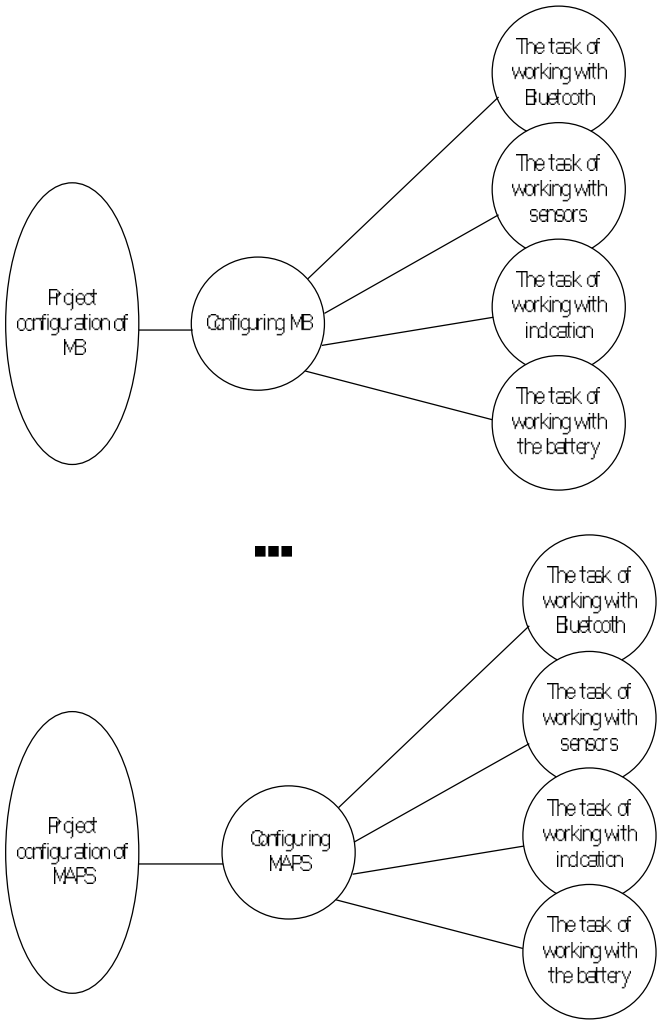


Fig. 3. The first variant of the configuration of the project

The variant of the configuration of the project, which the figure 3 presents, despite such advantages, as: reliability, i.e. the change of the excellent project will not influence others, convenience and efficiency of the development for the one concrete module, there are obvious disadvantages, such as:

- when using identical radio modules it is necessary to synchronize between all projects of the same change, even the insignificant one. It concerns all program libraries which are used in all projects;
- a large number of the created projects is developed and complexity over control of each of them increases;
- there is a need to separately control the general logic of each module.

One of decisions allowing to solve some of the above-stated problems are reduction of all projects in one and creating the unique configuration file for each of modules that is described by the structure given according to the figure 4.

This decision has a number of advantages over the variant which the figure 3 presents. Probably, the most important one is the solution of the problem of the use of identical program libraries [11 - 13]. In this variant the changes of a library will influence at once all modules for which configuration files were created. The only complexity will be a need of switching of libraries settings, this complexity solves the use of preprocessor definitions which will allow to separate the configuration of projects for each module at a compilation stage.

However, in this case there are the following problems:

- a need to control the installation correctness of preprocessor definitions;
- a need to separately control the logic work for each module, a similar problem of the previous variant of the configuration of the project;
- a need of disconnection on the project of no used files of the configuration for other modules because each of them has the function “main”.

The problem of control of the logic work each module is quite large and expensive on time. For this purpose it is necessary to develop and realize separate algorithms for each of modules, to control changes of each of them and to make the corresponding changes. However, paying attention to that that this system works in one network and has a common goal, it is much more effective to develop the general algorithm of functioning which would allow each module to work similarly despite its specialization [6 - 10].

In this case the figure 5 presents the system of change of each module’s conditions.

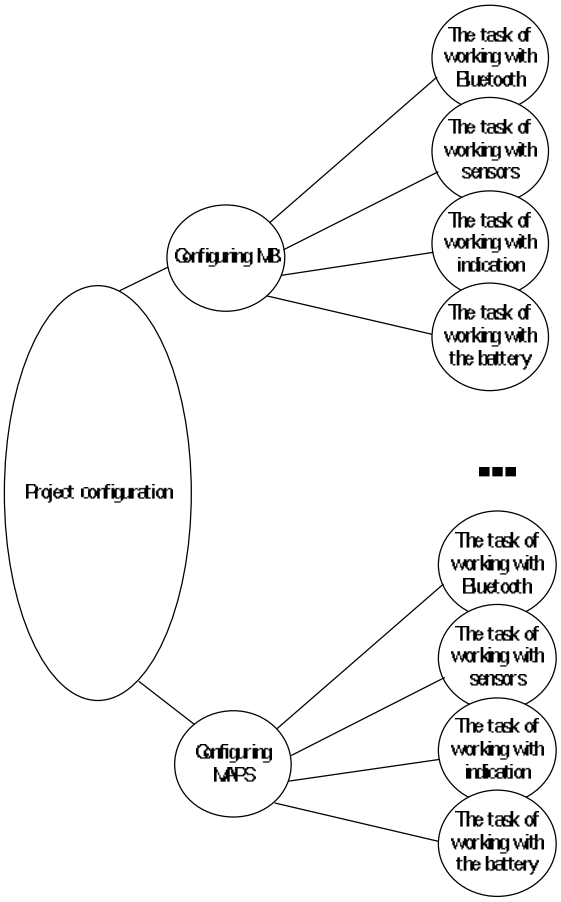


Fig. 4. The second variant of the configuration of the project

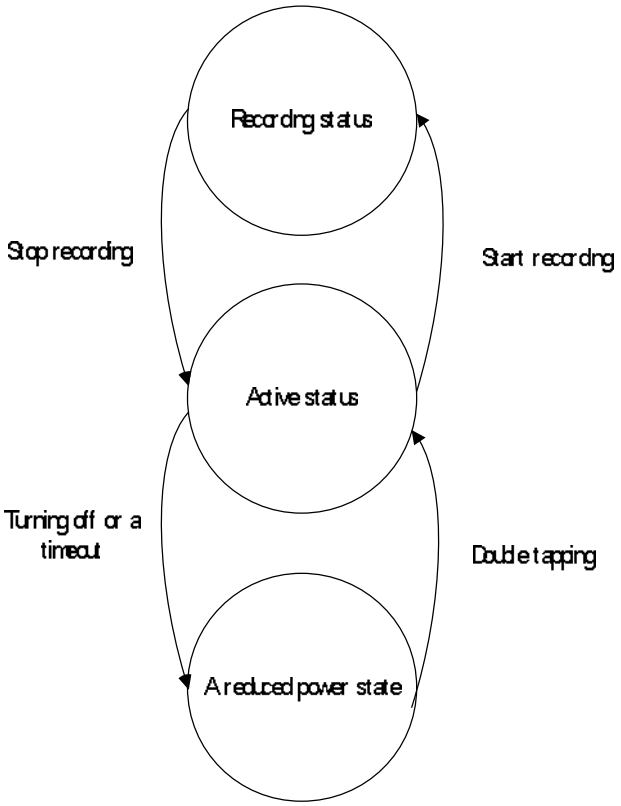


Fig. 5. The scheme of change of each module's condition in the system

The used scheme of change of states allows unifying the algorithm of work for each of modules and increases the performance of each of them at the expense of the debugged mechanism [14]. However, it creates a difficulty in synchronization of the made changes in the algorithm, especially it is noticeable when an additional functionality, for example, an additional command of data exchange or reaction to any influence, is added. For this purpose it is necessary to open each file and to add not only new functions, but also flags, variable and additional initializations.

Figure 6 shows the decision allowing improving the configuration of the project which solves a problem of synchronization of the main tasks between files of the project. This variant is deprived of a set of disadvantages and is quite convenient for control, allows to make changes to the general algorithm of the system functioning, and also there is no need to exclude no used files from the project. However, this method has also a disadvantage: it is necessary to control each specific file of settings of the module with the use of directives of the compiler that considerably increases complexity of management of such project [15, 16]. Thus, this method is the most optimal for the development of this type, efficiency of the written code increases, time expenditure decreases and there is the extra time on debugging of a written code.

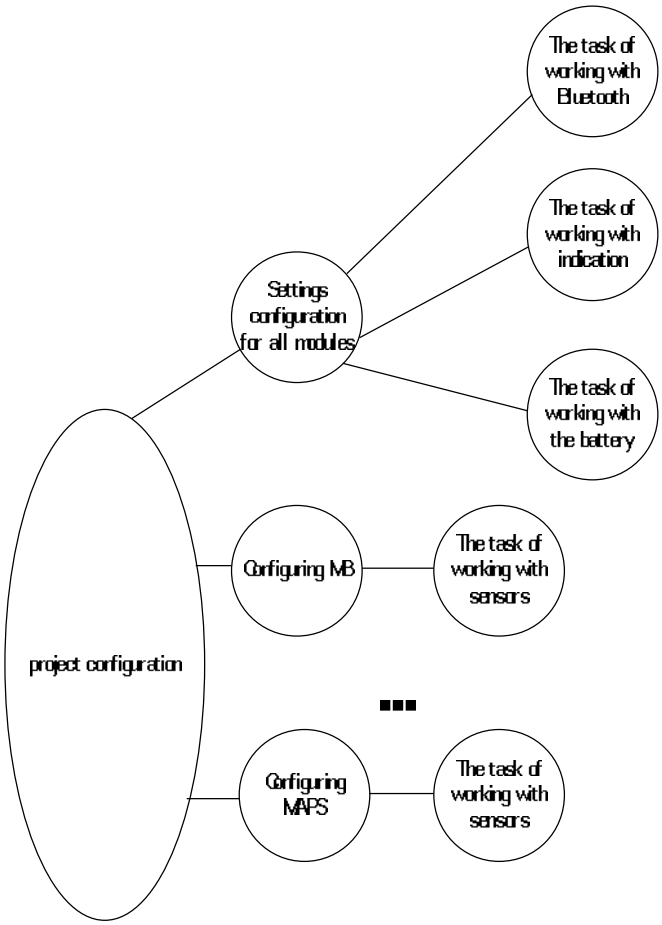


Fig. 6. The third variant of the configuration of the project

Comparing the given above examples it is possible to say that the final variant will allow to reduce the time spent on writing and debugging a program code, will reduce a number of the traced projects, will allow developers to make changes to a specific part of a code without affecting the basic algorithm of functioning and also allows to point out the certain time interval for the performance of a specific code for each module. This approach will allow to debug general libraries, in particular a library for work with Bluetooth, on other modules, gathering statistics about the quality of the written library and about possible problems.

## Conclusion

Thus, the possibilities of the configuration of the project for medical wireless sensor networks allowing to control effectively its development and to make the corresponding changes to the main algorithm of functioning of each module were presented. The results of researches which this paper has presented are got with the financial support of the Ministry of Education and Science of the Russian Federation within realization of the "Creation of Advanced technology production on fabrication of a mobile multipurpose hardware-software complex of long cardiomonitoring and ergonometry" project according to the governmental resolution № 218 (9 April, 2010). Researches were conducted in FSAEI of HE of the SFU.

## References


1. Ragozin, D.V. 2008,Modelirovaniesinhronizirovannyhsensornyhsetei. Problemyprogramuvannya. № 2-3. A special edition.pp. 721-729.
2. Nitaigour, P.M. 2007, (Editor) Sensor networks and configuration fundamentals, standards, platforms, and applications / P.M. Nitaigour // Springer. pp. 510.
3. Faludi, R. 2010, Building Wireless Sensor Networks // O'Reilly Media.pp. 320.
4. AlgoritmicAcpects of Wireless Sensor Networks. // MiroslawKutulowski, Jacek Cichon, Przemislaw Kubiak, Eds. Poland, Wrozlaw: Springer, 2007.
5. BLUETOOTH SIG Introduces BLUETOOTH Low Energy Wireless Technology, the Next Generation BLUETOOTH Wireless Technology (eng.) (inaccessible reference — the history). The official site. Checked on 16 January 2010. Archived from a primary source on 20 December 2009.
6. Ubiquitous Sensor Networks (USN). ITU-T Technology Watch Briefing Report Series, No. 4 (February 2008) / URL: http://www.itu.int/dms_pub/itu-t/oth/23/01/T23010000040001PDFE.pdf
7. Intellektualnyesistemynabazesensornyhsetei. // Lebedev Institute of Precision Mechanics and Computer Engineering (IPMCE) RAS, 2009.
8. Tanenbaum, E. 2003,Kompyuternyeseti / E. Tanenbaum.Spb.: Saint-Petersburg, pp. 992.
9. Shimkevich, V.M., Dogel A.S.&Tarhanov, Ostrovsky V.M., Heart // Brokgauz and EfronEncyclopaedia: in 86 volumes (82 v. and 4 add.). SPb.,pp. 1890-1907.
10. Kubryak, O.V. 2010,Vospriyatieserdtsebienyikognitivnyeaspektykardioritma. Psihologiyaikardioritm. — M.: URSS: Librokom. pp. 112.
11. Zudbinov,Yu.I. 2003,The alphabet of ECG. Edition 3. Rostov-on-Don: «Feniks». pp. 160.
12. Leonova, A.V., Zinovkin P.K.&Boldyrev E.B. 2012.Apparatno-programmnyikompleksregistratsiinagruzkidlyafunktsionoalnoidiagnostiki //Inzhenernyvestnik Dona 2012, №4 URL: ivdon.ru/ru/magazine/archive/n4p1y2012/1130
13. Baikushev, St., Manovich Z.H.&Novikova V.P. 1974, Stimulyatsionnayaelektromiografiyaielektroneirografiya v klinikenervnyhboleznei, M.
14. Komatineni, S., Maklin D.&Heshimi S. 2011, Google Android: programming for mobile devices = Pro Android 2. 1-e cop. SPb.: Saint-Petersburg. pp. 736.
15. Soltanian, A.& Van Dyck R.E. 2001, Performance of the Bluetooth system in fading dispersive channelsand interference // IEEE Global Telecommunications Conference. (GLOBECOM '01). pp. 3499-3503.
16. Kirienko, V.V., Semenistaya, E.S.&MaksimovA.V. // Inzhenernyvestnik Dona №1, p.2 (2015)ivdon.ru/ru/magazine/archive/n1p2y2015/2805 Analizinstrumentalnyhsredstvdlyaproverkimeditsinskogooborudovaniya.