Organization of a Wireless System for Individual Biomedical Data Collection

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***Abstract*: The article discusses the organization of a wireless system for collecting biomedical information, which is intended to everyday control the basic human life parameters. The system is based on a wireless sensor system and allows the data transfer to mobile devices or a computer for further processing.**

***Keywords*: ZigBee, transmission speed, biomedical parameters, topology, Wi-Fi, Bluetooth.**

I. INTRODUCTION

In a modern dynamic world with a busy rhythm of life, constant stress and a continuous pursuit of success, it is extremely important to maintain working capacity and accordingly, health in order to achieve goals and successfully function in society. Therefore, it is extremely important to control the biomedical parameters of an individual, which should be carried out continuously, preferably daily and at home. Human must control his basic parameters, such as heart rate, respiratory rate, blood pressure, blood glucose, weight and the like.

To collect such parameters, a sensor system is required. And the question arises of collecting data from sensors, signal transmission to a receiving device with subsequent transmission to a computer or mobile device and processing using the appropriate application, or software for obtaining a preliminary opinion. In this case, data accumulation is necessary, statistical calculations and analysis of their dynamics. Thus, you can control these parameters over a long period of time and make the right decisions for organizing outdoor activities, rehabilitation procedures or drug treatment.

Such devices for individual use are very promising health prospects. With their help, you can reduce the burden on medical facilities, qualified medical staff and at the same time provide control and correction of human physiological parameters.

Revised Manuscript Received on February 07, 2020.
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II. LITERATURE SURVEY

When constructing such systems, it is necessary to organize, first of all, the network. There are two possible ways to organize network, these are wired network and wireless. It is clear that the wired network in this case is of no interest. Therefore, the only option is to use wireless networks.

Thus, the sensors must support wireless protocols, that is, take information and wirelessly transmit information to the receiver.

Currently, there are several wireless data transfer protocols that will be analyzed below.

Currently, several wireless data transfer protocols are known, which will be below. The first protocol, the most common, is the Wi-Fi protocol. It is a standard information transfer protocol. The 802.11b Wi-Fi standard has high bandwidth, which is an undoubted advantage, many devices support this standard.

The above standard is great for transmitting large amounts of information. Devices based on it are able to work offline (from batteries and accumulators) at a transmission range of 10 to 100 m. These standards allow you to replace wired connections in devices [1].

The main disadvantage is the high energy consumption and many sensor systems that do not have the ability to use technology with 100% efficiency [2]-[3], to wit excessive transmission rate for biomedical signals.

And the third drawback - organization is based on a star networks, that is, communication between devices cannot be organized directly.

The next data transfer protocol is the Bluetooth protocol. It has a lower transmission speed, correspondingly lower power consumption, especially Bluetooth 4.0, but the data transfer distance is much less. There is also the ZigBee protocol, developed in 2003 specifically for the implementation of the smart home concept. It is characterized by a low data transfer rate, but for the transfer of biomedical information is quite sufficient, because all signals have a low-frequency characte. There are two main differences. First, extremely low power consumption. The sensor has already built-in batteries and is able to work for several years and transmit information. And secondly, the network structure has increased reliability, since the following organization scheme is provided Fig. 1. ZigBee protocol gateway, 2.4 GHz WI-FI band, works only at this frequency, 2.4 GHz and provides communication, if necessary, with a WI-FI router. The difference between this technology is the lack of IP addresses of sensors, which is also an advantage.

The standard provides for the ZigBee network topology «mesh».

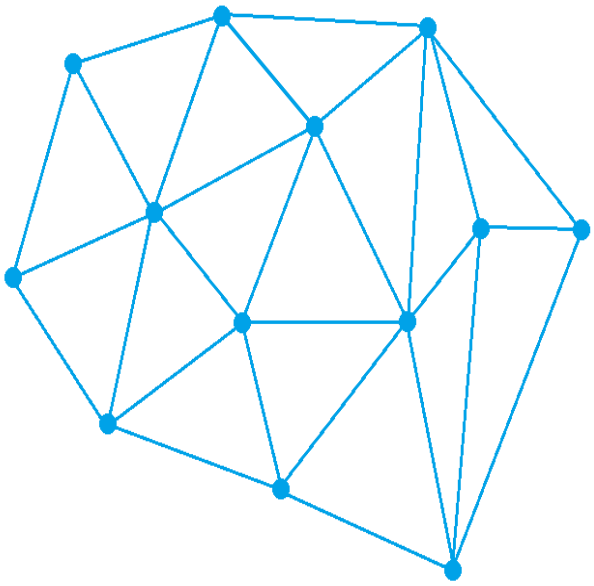

Fig. 1 Network Topology Example «mesh»

Fig. 2 shows a typical ZigBee network structure.

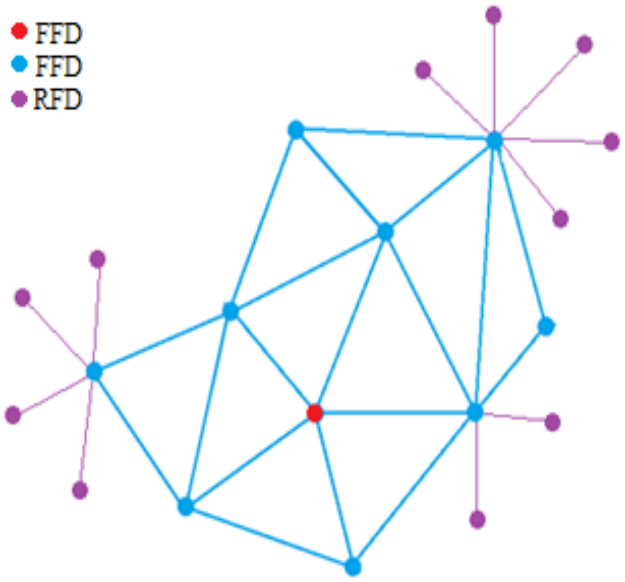

Fig. 2 Typical ZigBee Network Structure

Table 1 compares Wi-Fi, Bluetooth, and ZigBee protocols.

Table 1 Comparison of Wi-Fi, Bluetooth and ZigBee Protocols

Standard	Frequency, GHz	Maximum speed	Range, m	Sensitivity, dBm
802.11b Wi-Fi	2,4	11 Mbps	100	-76
802.15.1 Bluetooth	2,5	1 Mbps	10 -100	-70
802.15.4 ZigBee	0,868 0,915 2,4	20 Kbps 40 Kbps 250 Kbps	10-100	-92 -92 -85

One of the few limitations of the 2.4 GHz band can be considered a certain saturation of its spectrum by subscribers of various origins (microwave ovens, 2.4 GHz cordless phones, Bluetooth devices and 802.lib) [3]-[5].

Thus, to implement such a system, it is first necessary to have a set of sensors and devices with integrated wireless modules for transmitting information or interfaced with external modules that can transmit data via digital protocols.

As such sensors and devices, you can use heart rate sensors, blood pressure, blood oxygen saturation (for example, built-in watch or fitness bracelet), electronic scales, digital meters of human body temperature and the environment, humidity and lighting sensors, as well as ECG, EMG and other devices. Their set can be expanded or narrowed depending on the purpose, capabilities and cost of the system.

III. METHODOLOGY

For remote control via a mobile application on Android use network Bridges, Smart Hub or Gateway [6]-[9].

Digi XBee modules can be used as plugins for ZigBee networks. These are complete ZigBee modules that do not require external components to operate. The modules have stacks, which are controlled using AT commands or API frames via the USB interface. Modules can work as standalone nodes, even without the use of an external microcontroller. The work then occurs with a certain module configuration and is stored in non-volatile memory. The configuration may include automatic measurement of analog signals (10 bits) and / or levels on digital inputs and sending these values to the nodes of the ZigBee network. The data sending interval can be set by the user and can vary from fractions of seconds to several days and weeks.

The connection of a wireless ZigBee network with the Internet is shown in the Fig. 3.

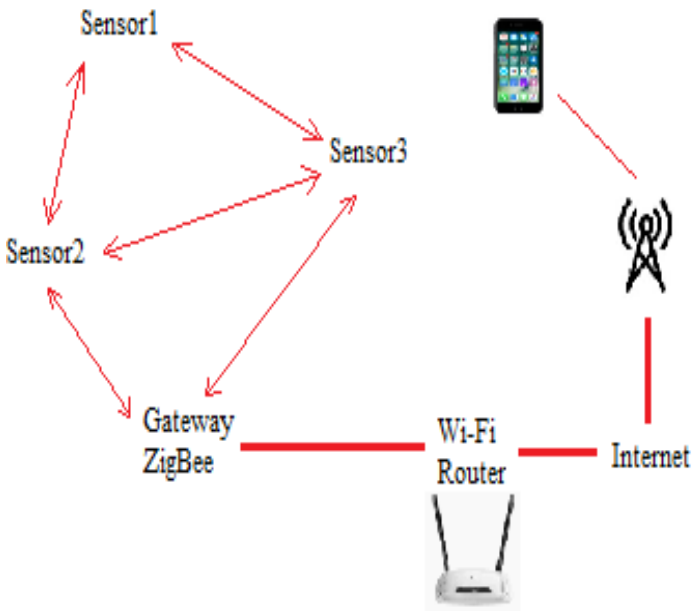

Fig. 3 Connecting a ZigBee Wireless Network with the Internet

The gateway acts as a bridge between devices (sensors) and the Internet.

It allows the user from anywhere in the world to monitor and control all devices or sensors. A mobile application is used to connect to sensors.

By a device is meant a complex for muscle electrical stimulation [8]-[14], receiving commands from a mobile application, as a result of which processes the data of an electromyographic signal (EMG signal), capable of transmitting feedback information [15]-[20].

The obtained data of EMG signals are processed by the time-frequency method and we calculate the amplitude-frequency coefficient [10], that is the value of the average amplitude of the total EMG using a mobile application.

The Fig. 4 shows the appearance of the mobile application window.

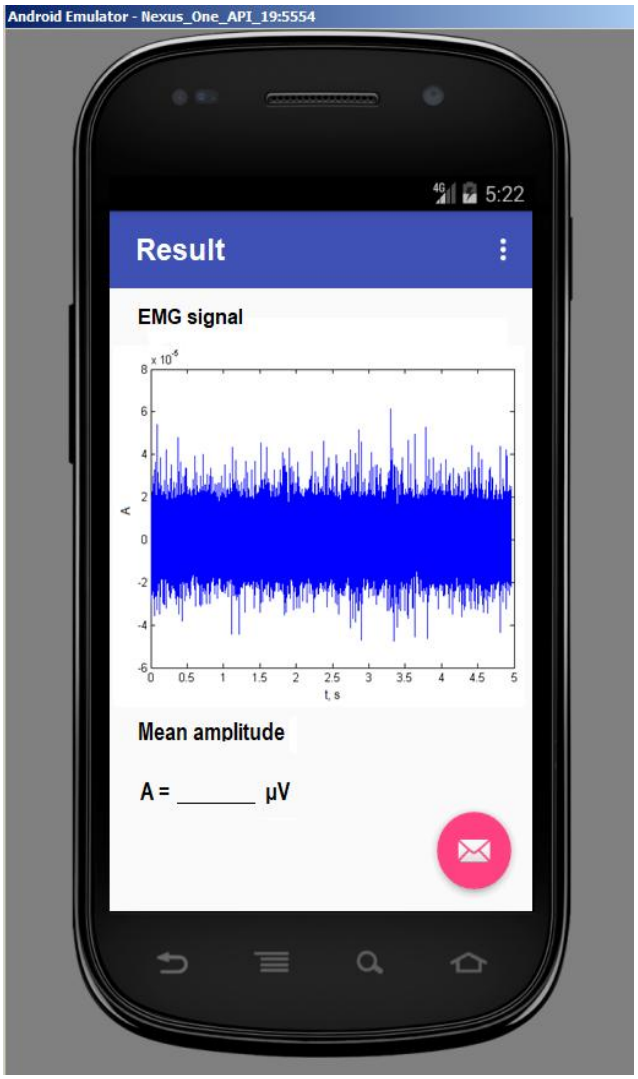

Fig. 4 Appearance of a Window of a Mobile Application

For switching the complex of electrical stimulation of muscles and a mobile application, a data transmission module is used, which is built into the device

IV. CONCLUSION

The proposed structure based on the device for removing the EMG signal and a set of sensors allows daily monitoring of the state of the human body and transmit biomedical information to the processing device in order to diagnose possible disorders and monitor therapeutic procedures during rehabilitation.

The system is based on a combination of ZigBee and Wi-Fi transmission protocols, which makes it possible to combine the advantages of low power consumption, reliable data transfer and remote access for authorized users.

Moreover, the data collected by wearable electronics are of great importance, since this is round-the-clock information about the patient's condition, obtained in a normal home environment, and not in a hospital's stressful environment

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