

Conference Paper

The Utilization of Modern Technologies of Wireless Sensor Networks in Medicine

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Annotation

Currently, wireless sensor networks (WSN) are used in many areas of medicine, especially where there is a need for constant monitoring of the patient's condition. However, in many cases, the lack of technical resources for processing information does not allow monitoring the patients' condition in the necessary way. Also, there are difficulties in monitoring the status of patients on outpatient treatment everywhere.

Keywords: Big Data, Body Area Networks, Cloud technologies, Wireless Sensor Networks.

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1. Introduction

The term "wireless sensor networks" means information networks consisting of miniature computer devices capable of exchanging data using wireless information transmission technologies, usually radio communications. These computer devices, - sensors, - are able to measure the most diverse parameters of the external environment, such as temperature, sound, vibration, pressure, noise level, movement of objects, chemical indicators, etc. The main area of application of sensor networks is control and monitoring of measured parameters of various physical fields, environments and objects.

Each node of the sensor network commonly consists of four parts:

- sensor (sensors) for monitoring the external environment;
- microcomputer (processor module), with the ability to perform initial processing of data and capable of communicating with other nodes of the network using a wireless module;
- a wireless communication module (typically a radio receiver / transmitter) to enable wireless communication;
- A power source (for example, an electrochemical or solar battery).

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The special software allows the sensor nodes to exchange information with each other, self-organizing into a distributed information network, and transfers the collected data (usually along a chain) to information receivers, which also often act as a network coordinator and a gateway with external information networks [1].

In recent years, the popularity of wireless sensor networks has been growing rapidly. The use of modern microcomputer technologies, reducing the cost of deploying these networks on the one hand, and the ubiquitous complication of technological processes on the other, makes the use of wireless sensor networks rational for a wide range of human activities, including biomedical applications. These technologies are used in the collection of medical data or in the process of monitoring vital parameters (ECG parameters, pulse, blood pressure, temperature, detection of cancer cells, measurement of insulin level), measuring the effectiveness of sports training, personalized medicine, personal safety of patients (for example, cases of falling).

To denote the network of sensors transmitting various indicators of vital activity to the receiving device, the term Body Area Network (BAN) is used. In networks of this kind, different types of sensors are used, which differ in wearing. The sensors can be made in the form of bracelets; a small patch on "smart" clothing or sewn into it; in some cases, the sensors are implanted in the body, especially in the field of medicine such as cardiology; "flexible" sensors are located directly on the human body.

2. The topology of WSN networks

The general topology of wireless networks of wearable sensors is as follows. As shown in Fig. 1, WBAN networks have a three-tier architecture: Intra-BAN communications, Inter-BAN communications and beyond-BAN communications. The Intra-BAN communications layer is responsible for communication among the wireless sensors and the main node of the WBAN (access point). The Inter-BAN communications layer provides communication between the main WBAN node and personal devices, such as laptops, home service robots, Wi-Fi router, etc. At the beyond-BAN communications level, the personal device is connected to the Internet or to the local network medical organization [2].

Currently, data exchange at the level of Intra-BAN communications is mainly governed by the specification of network protocols of the IEEE 802.15 standard, which describes wireless networks characterized by short data transmission distances, low complexity, low device cost and low cost. For medical needs, the following standards are generally used: IEEE 802.15.1 (Bluetooth Low Energy specification), ZigBee (in turn

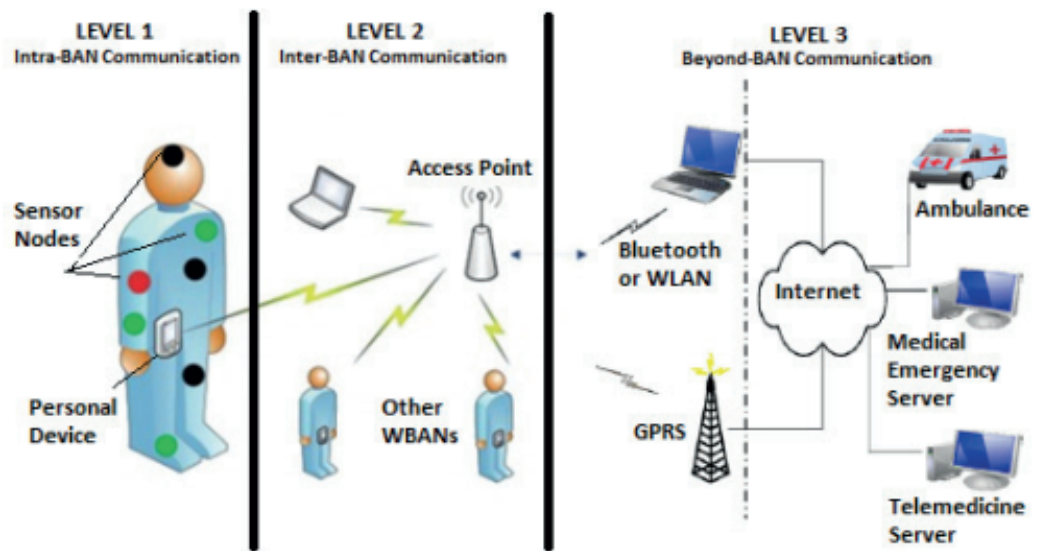


Figure 1: WBAN architecture [2].

based on the IEEE 802.15.4 standard); IEEE 802.15.6 (Wireless Body Area Networks). The characteristics of these standards are described below.

The Bluetooth Low Energy specification version 4.0 and higher provides ultra low power consumption, data transfer rate up to 1 Mbit / s, 10 m range and fast startup time (less than 3 ms) [3]. An example of a mobile complex that transmits data on bio-telemetry using this technology is the Russian mobile complex for round-the-clock self-diagnosis and remote monitoring of cardiac activity and other physiological parameters «Opeka-04» [4].

The open standard IEEE 802.15.4, controlled by the ZigBee Alliance, was developed to provide wireless communications for low-power monitoring and control devices. The IEEE 802.15.4 specification is the most widely used point-to-point communication standard for low-speed wireless personal networks. The standard allows you to transfer data at a rather low speed from 20 to 250 Kbit / s, and some modern devices range up to 500 m [5]. Some systems, such as LOBIN (the health IT platform for monitoring several physiological parameters), MASN (cluster-based ECG data collection scheme) that, despite processing high traffic levels, use the 802.15.4 / Zigbee protocols in their work to optimize energy consumption and reduce the size of the battery and, therefore, the size of the wearable devices [6].

The operation of devices supporting the IEEE 802.15.6 standard, issued in 2012, is optimized for work on the human body and around it, and can serve various applications, including medical ones. The IEEE 802.15.6 standard can achieve data rates of up

to 10 Mb / s at very low power, and transmit data up to 1.2 m. The size of the sensors, as a rule, does not exceed 1 cubic meter. see [7, 8].

Examples of projects supporting the IEEE 802.15.6 standard, the Cardiac Arrhythmia Network of Canada (CANET), or the Parkinson's disease monitoring system [9].

Among the existing alternative low-power wireless standards can be noted such as ANT + (supported by YotaPhone2), Rubee, Sensium, Zalink, Insteon, Z-wave, Dash7, ONE-NET, e.t.c. [10].

3. WBAN and cloud technologies

Currently, the area of operation of BAN networks is usually limited to a small space, usually consisting of either a few separate, compactly located rooms, or one room of a larger area, such as a gym or a hospital room. For this reason, for the distributed systems of data collection that are of practical interest - on the scale of the department, medical institution, etc. - it is necessary to use additional information technologies. The solution of this problem consists in the joint use of personal, local area networks (LAN), and global networks (WAN) for data transmission to monitoring and analysis centers. From the point of view of modern technologies, the processing of large amounts of information is based on the concept of cloud computing, which involves the use of existing data transmission channels for remote access to computing resources and software infrastructure, including operating systems. Cloud systems offer three service models [11]:

- Software as a service (Software as a Service, SaaS);
- Platform as a service (Platform as a Service, PaaS);
- Infrastructure as a service (Infrastructure as a Service (IaaS)).

Different service models can be applied to different client groups. For example, the SaaS model can illustrate the provision of access to the system for medical professionals - employees of medical institutions. The PaaS model can be used when a medical institution wants to access the electronic monitoring system to continue to provide its services to patients. Accordingly, the IaaS model can be applied to patients or their representatives who have applied to a medical institution and who wish to use the electronic monitoring system.

Systems of processing large amounts of medical data are usually created within the data centers, - specialized buildings for the placement of network and server equipment. The structure of data centers necessarily includes rooms with special technical

conditions, as well as qualified personnel. The main tasks of the data center are, first of all, effective efficient storage and processing of data, provision of application services to users, and support for the operation of external applications [12].

The using of data centers can reduce the cost of managing computing resources, technical support, and increases the physical protection of servers, and provides a comfortable environment for equipment and technical personnel. In addition, the operation of backup and power systems is simplified through the use of standard configurations. There is an improvement and network security, because the servers are protected by a single, centrally managed firewall [13].

4. Conclusion

Modern technologies for the organization of wireless sensor networks are not only continuously progressing, but even now they allow solving a lot of not only relevant at the moment promising medical issues. Timely control over the patient's condition is able to provide not only his satisfactory state of health, but also a huge base for additional knowledge in the field of the physical state of the body, primarily for the purposes of diagnosing and treating not only the currently known diseases, but also those with which we will meet perhaps in the foreseeable future. And the use of cloud technologies in modern medicine for monitoring the physical parameters of patients allows to significantly expand the possibilities of distributed processing of information, which will lead to a new level of the process of analyzing statistical data. In this case, the quality, completeness, and consequences of analyzing statistical information can play a decisive role in the decision-making process by medical personnel in the case of a particular patient's condition.

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