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WIRELESS SENSOR NETWORKS FOR MONITORING REACTIVE POWER PARAMETERS OF ELECTRICAL SUPPLY OF TELECOMMUNICATION SYSTEMS

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Abstract

In this article, a number of scientific studies are given in the world aimed at using and improving "Smart" power supply system's when ensuring telecommunication equipment with reliable, uninterrupted and high-quality energy. In this area, including Smart Grid systems, special attention is paid to solving many problems, such as the development of models, algorithms, software and modern measures to improve them, devices and tools for remote monitoring of power supply sources, double-sided information system, control of energy consumption, increase in demand for energy.

Keywords: control, sensor, monitoring, networks, parameters, power supply, source, distance, smart.

Introduction

In the world, attention is paid to the use of economical sources of power supply to ensure uninterrupted operation of systems telecommunications and information technologies, improvement control, and management devices through wireless sensor networks. In this area, including remote control of

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sources of power supply means of telecommunications, models, algorithms, hardware, and software on which the accuracy parameters depend, reliability, stability, and efficiency in source monitoring renewable energy and control them through networks of wireless sensors, special attention is paid to the development of information and measurement funds. In developed countries such as Germany, the UK, Holland, Denmark, Russia, China, and Japan, one of the main tasks is the development of remote monitoring and control systems power supply of telecommunications facilities based on IoT.

Scientific research on the principles of organizing remote monitoring of autonomous sources of power supply of telecommunications objects, solving problems. Remote control of power supply based on networks wireless sensors using signal sensors in them various physical origin (devices and means, transforming measured physical quantities, such as temperature, humidity, electric current, voltage, etc.) in the signal (secondary signal in the form of electric voltage), suitable for transmitting, processing and storage, creation, acceptance, processing and transmission of data and information about measured and transmitted signal between the wireless network nodes monitoring.

Materials and Methods

The purpose of the study is to model, research and Practical inspection of monitoring of power supply sources telecommunication facilities based on wireless sensors.

Research Tasks

Analysis of types of energy supply sources, methods, devices and means their monitoring used in telecommunications facilities;

Analysis and study of the principles of building wireless networks sensors for monitoring power supply sources;

Modeling tools for monitoring wireless sensors sources of power supply of

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telecommunications facilities;
Development of IOT models of devices for monitoring values and parameters sources of power supply of telecommunications facilities;
Development of the immigetric model, algorithm and software provision for monitoring power supply sources.

Research Methods

In the process of research, theory was used Errors, signal theory, methods of immitative modeling.
The reliability of the results research is due to the comparison of the research results and constructing networks of wireless sensors developed for the system monitoring of energy supply sources, data transfer methods and research results in comparison with generally accepted criteria.

Requirements For Wireless Sensor of Distance Monitoring

Wireless sensor nets used in the monitoring process are characterized by a low data rate compared to other nets types, because they are designed to carry a small amount of traffic and are characterized by extremely low power consumption of devices that are often in the «sleep» state [1; 2; 3; 4].
The following factors have an important role in the selection of wireless technology for nets in monitoring system:

- field level data exchange intensity;
- big powerful autonomous power from sources use opportunity;
- radio nets to build topology.

The ZigBee wireless communication standard was developed to introduce wireless sensor nets into the distance monitoring system. This standard was originally developed with a focus on distance monitoring system applications, taking into account the basic requirements for data transmission nets [1; 2; 5; 8].
Based on these, the sensor nets used in the monitoring system have the following

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requirements:
-Self-organization and treatment ability during the monitoring process;
- Ability to transmit information over long distances at low power of transmitters (using retransmission);
- Cheapness of data transmission nodes and their small size during the monitoring process;
- Minimum restrictions on placement of wireless devices in data transmission;
- Low power consumption and the ability to receive power from autonomous sources for data correction during the monitoring process;
- It Is easy to install sensors during the monitoring process, there is no need for electric cables and data transmission (due to completely wireless technologies and battery power);
- The possibility of installing such networks in an existing and working object without interfering with the service process;
- Reliability and fault tolerance of the entire system in case of failure of individual connections between nodes of the data transmission network;
- Low cost of installation, commissioning and maintenance in the remote monitoring system.

These advantages of wireless sensor nets over existing wired data transmission nets create several advantages for an distance system. The main component of the wireless systems proposed for monitoring system is the wireless data transfer node. Through such nodes, it is possible to develop a network of any scale of the monitoring system. The ability to connect the wireless data transmission node to various types of sensors makes the distance monitoring system universal [6; 7; 9].

Results and Discussion

On the basis of researching:

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developed the principle of construction of forming of topology and a model for distance monitoring of power supply sources based on wireless sensor nets data transmission system;

created the IoT model for distance monitoring of power supply sources with renewable power sources;

developed the simulation model and an algorithm for constructing nets of a wireless sensor system for remote monitoring of power supply sources with renewable power sources;

A model of a device of the converter of current into voltage was created the first time for the structure of wireless sensors nets for monitoring the power supply source with renewable power sources.

One of the main problems in designing a monitoring system is the organization of a data transmission network at the source level power supply. This requires an analysis of the following wireless technologies networks for identification and quality control and reliable communication between sensor nodes:

– Wi-Fi – named after the IEEE802.11 standard, which refers to family of wireless network technologies. In the studied studies. IEEE802.11 Bandwidth and Power Consumption were evaluated by the following basic analytical expression with using RTS/CTS transmission mechanisms (Request/Clear to Send - transfer request).

$$T_W^{RTS} = \frac{P_{succ}^{RTS} * 8 * L_{pl}}{\sum_{n=0}^{r_{short}-1} \sum_{m=0}^{r_{long}-1} \left(\left(\frac{n+m}{n} \right) P_{col}^{n} P_{err}^{m} (1-P_{col})^{m+1} (1-P_{err}) t_{n,m} \right)} * \frac{1}{\sum_{m=0}^{r_{long}-1} \left(\left(\frac{m+r_{short}-1}{r_{short}-1} \right) P_{col}^{r_{short}} P_{err}^{m} (1-P_{col})^{j} t_{r_{short},m} \right) + \sum_{n=0}^{r_{short}-1} \left(\left(\frac{n+r_{long}-1}{r_{long}-1} \right) P_{col}^{n} P_{err}^{r_{long}} (1-P_{col})^{r_{long}} t_{n,r_{long}} \right)},$$

where: T_W^{RTS} - throughput in case of using mechanisms input RTS/CTS RTS/CTS, P_{succ}^{RTS} RTS is the probability of successful packet transmission, P_{col} is the probability of occurrence of collisions, P_{err} is the probability of an erroneous packet transmission, L_{pl} is the amount of basic data, r_{short} is the maximum

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number of retransmissions for RTS, r_{long} is the maximum number retransmissions for data packets, n,m is the number of collisions and errors.

– Bluetooth (IEEE 802.15.1 standard) – considered wireless technology operating in the microwave range from 2.402 to 2.480 GHz and used to transmit data over short distances between stationary devices and for creating personal networks. AT In the work studied, the following analytical expression is proposed for network bandwidth, which is the main network characteristic:

$$T_{BLE}(n,s) = \frac{n*8}{\frac{S_h}{R_b}+\frac{(n+s)R_s*8}{R_b}+2\tau+2\max(t_{int},t_{tx}+t_{rx})},$$

where: n is the amount of basic data in bytes transmitted from coordinator to the managed node, s is the size of the main data in bytes response packet, R_b – intensity (bitrate), R_c – code intensity (code rate), S_h is the amount of heading in bits, t_{tx} is the time required for processing packet before it is transmitted, t_{rx} is the time required to process the packet after receiving it, t_{int} – interframe time, τ – propagation delay signal.

– Zigbee is a wireless network technology based on the IEEE 802.15.4 specification, which includes a set of communication protocols high level. This technology, called Zigbee, is developed as a more simple and cheap technology than other wireless personal area networks (USAT) such as Bluetooth or Wi-Fi. In the course of the study to study the throughput wireless sensor network, the following expression was formed:

$$T_{ZB} = \frac{S_p}{t_d} = \frac{l_{pack} * \sum_{j,i,t_b} \pi_{(i,j)} p(t_b,j) P_s(t_b,j)}{t_B * (\sum_{j,i,t_b} \pi_{(i,j)} p(t_b,j) t_v + \sum_j \pi_{0,j})}$$

here: S_p is the average number of bits transmitted in each transition state, t_d is the average time spent on each transition, l_{pack} is the number of bits corresponding to the packet, t_b is the duration of the slot retransmission, $\pi_{(i,j)}$ is the probability of a stable Markov state, defined in the buffering model, $p_{(t_b,j)}$ is the probability of detecting of the first channel, $P_s(t_b,j)$ is the probability of

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successful input of the specified node to channel, t_B is the duration of the retransmission slot, t_v is the time virtual service.

Comparative graphs of network standards by bandwidth and energy efficiency is shown in fig. 1. These graphs are based on the values of the cases with the highest performance on the charts, given for each network standard studied above.

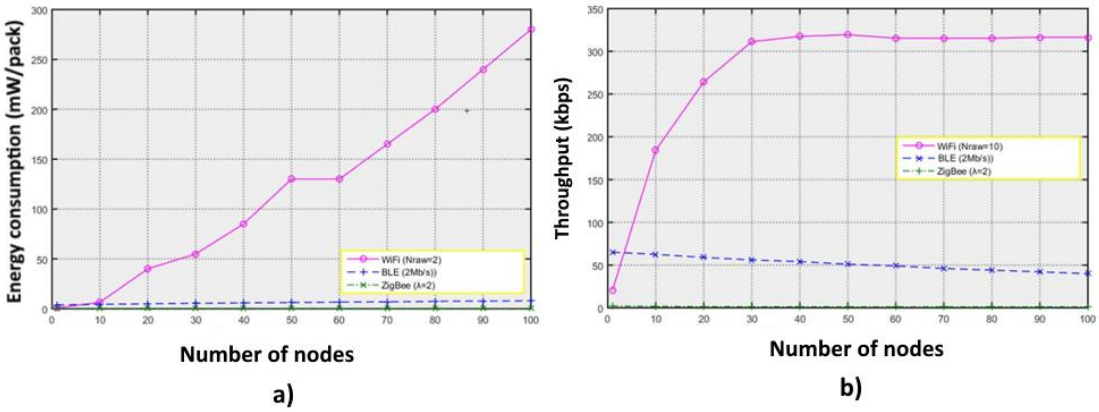

Figure-1. Comparative graphs of WiFi wireless network standards, Bluetooth and ZigBee by bandwidth (a) and energy efficiency (b)

One of the main problems in remote monitoring systems is the power supply. For this reason, monitoring systems usually devices with the lowest power consumption are used. Besides, sensors installed on controlled objects generate a small data set, and such systems do not require high-performance technologies. You can appreciate the benefits of using technology ZigBee for monitoring systems formed on these foundations.

Conclusion

The following conclusions are presented as a result of the research conducted on the article "Wireless sensor networks for monitoring reactive power parameters of electrical supply of telecommunication systems" topic:

1. The possibility of high accuracy and reliability of control and operation of energy supply sources with the high accuracy and reliability of the developed

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models and the improved monitoring system was substantiated.

2. Based on remote monitoring of solar energy supply sources taking into account electric load size and parameters, energy source temperature, dustiness of solar panel surfaces, it was possible to improve their service life and technical condition by 4-5%.

3. Based on the developed analytical expressions of the study of wireless sensor networks, it was found that the positive results obtained for 4, 6 and 16 nodes are significantly different from the classifications with a large number of nodes (32 and 64).

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