УДК 004.424

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Розробка системи виявлення лісових пожеж з використанням сенсорних мереж

Development System Of Forest Fire Detection By Using Sensor Networks

Кожного року на Землі відбувається понад 400 тисяч лісових пожеж, які пошкоджують близько 0,5% загальної площа і забезпечують викидання мільйонів тон продуктів згоряння в атмосферу. Деякі випадки обертаються катастрофою.

Робота присвячена розробці системи моніторингу лісових пожеж на основі відеоспостереження і бездротових сенсорних мереж для прогнозування раннього виявлення лісових пожеж. Розглянуто варіанти побудови бездротових сенсорних мереж на базі технологій ZigBee та MeshLogic. Запропоновано реалізацію інтелектуального оптоелектронного детектора диму вузла сенсорної мережі.

Ключові слова: лісові пожежі, моніторинг, сенсорні мережі, покриття, проектування.

Every year there are up to 400 thousand forest fires occur on Earth, damaging about 0.5% of the total forest area and discharging millions of tons of products combustion into the atmosphere. Some of them turn into catastrophic.

Was designed system to protection forest fire and we must make analysis of the ground based systems for monitoring forest fires. The proposed architecture of the hybrid system the terrestrial monitoring of forest fires on the basis of video surveillance and wireless sensor networks for forecasting and early detection of forest fires. The variants of the construction of wireless sensor networks based on technology ZigBee, Mesh Logic and Network Equipment by Digi XBee. Proposed implementation of intellectual optoelectronic smoke detector sensor network node.

Key words: forest fires, monitoring, video, sensor networks, coverage, design.

Статтю представив д.т.н., проф. Погорілий С.Д.

1. Introduction

One of the most haunting aspects of naturally caused forest fires is that they form so quickly and are unpredictable. Research has shown that increase heat in areas can be the cause for fires significant economic losses in the forest industry [1]. However around the twentieth century fires mostly occurred because of natural causes and people grew a larger fear of the destruction that they could cause. The researchers from this article have predicted that in about forty years climate will put the world at risk for more fires, specifically in areas with very dry climates. The combustion temperature of about 700°C. Crown fire covers leaves, pine needles, branches, and all the crown, can cover grass-moss cover the soil and under-growth. The speed of propagation of 5-70 km/h. Temperature from 900°C to 1200°C. In forest specifically, help must arrive quickly because the trees act as fuel to the flame. Being able to predict when a fire starts would give an advantage to those controlling it.

This could make for big steps forward for control fire by using computer can bring monitoring of these destructive fires under control.

Based on the foregoing it is clear that the problem of monitoring and early detection of forest fires to date is relevant.

because some time arrive to speed of the fire in the wind 0.25-5 km / h, the flame height up to 2.5 m.

Early detection of fire is the most effective way to fight forest fires.

2. Analysis of the work in this subject area

Ground-based monitoring includes the organization of observation posts, patrols the most fire zones, installation of towers for video surveillance. [2]

Video surveillance systems can significantly improve the efficiency of detection and extinguishing forest fires [3, 4]. However, in the woods with hilly terrain angle and range of cameras is limited. In addition video surveillance is ineffective because of the low probability of

detection of underground and surface fires in the event that the smoke and the flames do not rise above the tree crown.

The perspective is the architecture of the hybrid monitoring system (GPS), which includes video surveillance, and in the "blind" and most fire hazardous areas - the use of wireless sensor network (WSN) [5-7].

3. The goal of research

The goal of research significance of the results is determined by the fact that on the basis of the research, and the proposed method:

- Recommendations on the choice of interfaces, protocols and components for the design of terrestrial systems to detect forest fires;
- Set up a project of detection of forest fires;
- Developed and investigated a smoke detector.

4. Hybrid detection system forest fires

The architecture of the system is shown in Figure 1 for the detection and fire inspection is proposed to integrate sensors with IP-cameras. When a sensor detects fire, it sends an alarm signal via the wireless network server. Software application server selects the closest to the camera's sensor and turns them into a sensor that raised the alarm.

Video camera transmits images in real time and allows you to confirm the existence of a fireman fire and avoid false alarms. FSU can be connected to the Internet through a gateway.

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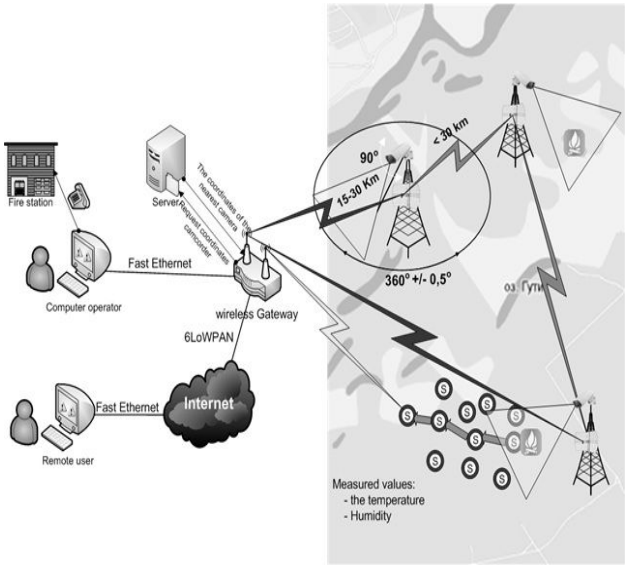

Fig.1 Architecture of the ground system to monitor forest fires

To ensure covering of the observed area during placement and construction of towers are taken into account peculiarities of the terrain. This increases the visibility of each of the chambers, and in the case of fire detection - accurately determine the coordinates of the fire at the intersection of the lines from 2-3 cameras. The information obtained from the cameras is transmit-ted wirelessly to the control room, which provides re-mote control of cameras. Following the discovery of fire coordinates information is stored on the server for further analysis and implementation of the fire prevention measures. Architecture wireless sensor networks

Any sensor network consists of three parts: a system for the collection, transmission and processing of the data. Today we know two basic options organizations WSN of the standard IEEE 802.15.4: ZigBee technology and MeshLogic. The advantages of each system can be attributed low power consumption and cost of the devices, self-organizing network, thanks to build software support for a large number of clients. ZigBee technology includes three types of devices: coordinator ZigBee, ZigBee router and terminal. The terminal device reads out investigated parameters with embedded sensors and transmits them over the wireless channel to the nearest router, which in turn delivers the delivery of the data to the network coordinator. Meals terminal devices carried from the portable power supply. The life of a single power supply can range from several months to one or two years. Fault tolerance network built on technology ZigBee, is sufficiently low be-cause in the case of failure of one of the routers stops functioning one of the sections of the network and in the case of a failure of the coordinator – network stops functioning altogether. The principle of technology MeshLogic similar to technology ZigBee, but has a number of significant differences. First, the network topology does not require a specific hierarchy of devices, as every node performs a role as a terminal device and a router. Second, the power of each of the nodes is provided by a portable power supply, and a long service life of the latter, as in to the previous technology, carried out due the ability of nodes spend most of their time in sleep mode. Thirdly, the fault tolerance of such a network is rather high, as in the case of failure of one of the nodes, the network automatically paves new route, which is a significant advantage. The disadvantage of this technology is the problem of ensuring of simultaneous exit hibernation all the devices as the "awaken" of a node is measured in milliseconds.

In view of the above problems as an alternative to WSN can serve as a monitoring system in which data is transmitted over a radio frequency channel. In the construction of such a system is necessary to provide a different distance from the terminal devices to the control tower. The time for which the

data will overcome the way can be seen as a particular node location coordinates.

5. The node wireless sensor network with optoelectronic smoke detector

Depended on the technology chosen wireless sensor network, its nodes should have sensors for fire detection, the microcontroller (MC) which controls the sensors, processing the data and transmitting WSN by means the transceiver (T). Given the mass character of network nodes which are not subject servicing over an extended service life, a natural requirement is reliability and low cost with rigid restrictions on overall weight and dimensions parameters and energy resources. Keep in mind the limitations of memory and microcontroller performance when selecting data processing algorithms. An important component of the network node is the energy system based chemical current sources (galvanic cells, batteries), electric generators, devices collecting energy from the sun, wind, vibration and others. Instead of batteries for energy storage is widely used ionizers. They are usually designed to be installed in the premises having relatively large size, power consumption, require adjustment and service is what limits their application for the detection of forest fires. The analogue of the proposed sensor is an optoelectronic smoke detector [8], comprising a source (S) and receiver (R) of infrared radiation and positioned so that a straight path from the source to the receiver the light rays cannot penetrate. In the presence of smoke particles in the region where the optical density is monitored radiation smoky environment, smoke particles scattered light radiation enters the

The most effective and affordable receivers are modulated have optical radiation receivers IR transmission channels of remote control commands produced integrally (series TSOPxxxx) for different modulation frequencies. Several sensors can be controlled by one MK (Fig. 2).

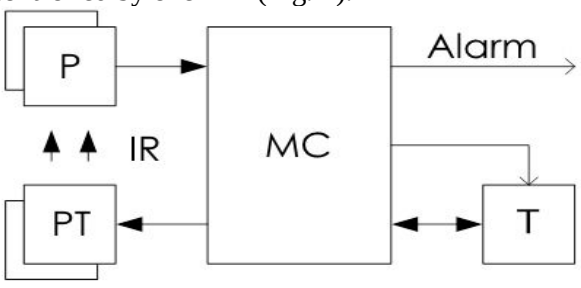

Fig.2 Structural diagram of the device

To assess the choices sensor elements, their optimal placement and layout algorithm implemented interrogation devices based on microcontroller AVR ATtiny13.

The sensor used IR LED and TSOP4836 receiver (36 kHz). Use LED indication of smoke pollution detection. Appearance of the device shown in Figure 3.

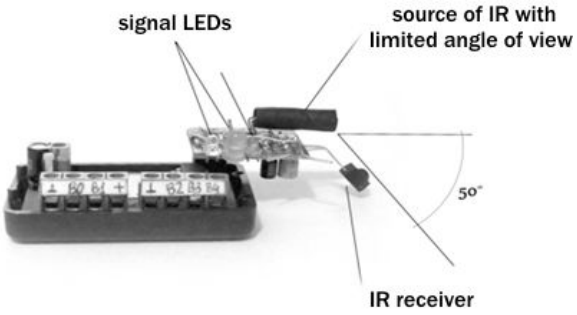

Fig. 3 Appearance of the device

Working principle. IR Source sends intermittent radiation of definite frequency narrow beam that misses to the receiver. As soon as in the zone of intersection of the directivity pattern of the source and the receiver there is smoke - rays are reflected from the smoke particles and strikes on the receiver. At a sufficient intensity of reflected radiation on the receiver output signal varies and apparatus by means of LEDs indicating the detection of smoke. Given the radiation pattern of the receiver and the source of infrared radiation can to change the angle between them, thereby changing the volume and the distance from the zone of intersection of the device, which is a reflection IR radiation. By changing the number of pulses and the parameters of the infrared installing the necessary sensitivity sensor. Is extremely important for increasing the lifetime of the wireless node is to optimize the energy consumption profile, including activity cycle functioning and sleep. In developing the algorithm and program functioning of the microcontroller stipulated deep sleep mode with the awakening of the watchdog timer. The LED indicators, which are included in the active mode, consuming the same power as a transceiver, which gives better understanding of the profile of energy consumption node WSN.

6. Experimental sensor research

As part of this work outdoors in the conditions approached to the real use of WSN, a series of experiments to assess the ability of this device to detect smoke of different densities. As a source of the smoke used smoke bombs and the device was placed at a height of 1.3 m from the ground at different distances from the source of the smoke. As the distance decreases the density of the smoke. The aim of the first experiment was setting mutual position of the IR emitter and receiver unit in the absence of smoke pollution. The emitter emits a signal which is scattered in the air and does not reach the receiver. Subsequent experiments were designed

to assess the sensitivity of the sensor. The distance from the source device to smoke ranged from half a meter to 20 meters in order to ensure different densities of smoke pollution. During performance of all above described experiments, a device to detect the presence of smoke. These results indicate that the device can be used as the basis for the development of a smoke detector in the forest stands.

7. Conclusion

In this work it was an analysis of technologies for construction of ground-based monitoring. We formulate the task of designing a technique of designing terrestrial forest fire detection based on sensor networks. Considered in detail the stages of the procedure including selection of protocols, interfaces, topology, and equipment for a sensor network. The choice of topology and Mesh-defined physical devices, which are the nodes of the network.

The calculation power node which confirmed efficiency of the wireless device sufficient for the sensor network through practical experiences .

Completed development and experimental investigation of the smoke detector, confirming its efficiency. The problem of placing a sensor network hardware. Skill infrastructure design a sensor network to detect forest fires.

The results can be used for the design of terrestrial forest fire detection system based on wireless sensor network technology to build a Zigbee based on the existing infrastructure.

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Надійшла до редколегії 13.03.15