International Journal of Research in Engineering, Science and Management
Volume-2, Issue-3, March-2019
www.ijresm.com | ISSN (Online): 2581-5792

Forest Fire Detection and Alert System using Zigbee Wireless Sensor Network

Abirami Sivakumar[1], Hemamalini Ravi[2], Jossie Dennis[3], Logeshwaran[4]
[1,2,3]*B.E. Student, Department of ECE, Anand Institute of Higher Technology, Chennai, India*
[4]*Assistant Professor, Department of ECE, Anand Institute of Higher Technology, Chennai, India*

***Abstract*: Forest fire is the most common hazard in forest. Forest fires are generally started by natural causes and anthropogenic causes. Forest fire destroys trees which gives us oxygen. The main purpose for choosing this Zigbee based wireless sensor network is to overcome the demerits present in the existing technologies like MODIS satellite-based detection system and basic wireless sensor network. Controlling a forest fire is difficult, if it is not predicted or detected early. So it is very important to detect a wild fire before it spreads over a large area of the forest. The proposed method senses temperature, humidity, smoke and flame from all over the forest and sends those data to the authority using GSM. The concept of the project is divided into three segments. The three segments are sensor node module, gateway node module and control centre. The purpose behind this project is to contribute**

***Keywords*: Flame, GSM, Humidity, Smoke, Temperature, Wireless Sensor Network and Zigbee**

1. Introduction

Million acres of forest are burnt down every year by manmade and natural cause. The forest fires have a great impact on destruction of vegetation, on atmospheric pollution, and directly on human lives. In many cases, the authorities do not have any fire prewarning system to send and receive the warning messages. Therefore, the alerts to the population and to the rescue forces come too late. Thus, the objective of this project is to built a fire alert system that provides more features in the supervision and the detection of forest fire. These features include the capability of connecting data from the forest to analyse it and detect the fire in early stage. Moreover, the burnt vast acres of land make it highly unlikely for vegetation to grow on this land again. The severely burnt soil become water repellent, no vegetation remains to hold the soil, and the ground cannot absorb any more water, leading to the reduction in ground water level. To compound the seriousness of the problems, when this soil flows into rivers, it ends up polluting the river's water. Taking into consideration the amount of vegetation that is burnt, one cannot ignore the gases that result in the process. The global warming report 2008 mentions forest fire as one of the main reasons behind the increases in global warming due to the vast amount of greenhouse gases being released into the environment.

2. Existing solutions

A. Video surveillance system

Many solutions were implemented for forest fire detection during past years. As a start, video surveillance systems, are the most widely used due to its low cost and performance. Video surveillance systems can be divided into four categories: Video cameras sensitive in visible spectrum like smoke recognition and flame recognition during day and night, infrared based thermal imaging cameras on detection of heat flux from the fire, IR spectrometer identify the spectral characteristics of smoke gases, and light detection and ranging (LIDAR) systems which measures laser light backscattered by smoke particles. Infrared and laser-based systems are mostly used because of its high accuracy than others. The main disadvantage is some false alarms and prices are very high compared to normal video cameras.

B. Visual camera on watch towers

Another method makes use of visual cameras that takes snapshots of forest in order to detect the presence of fire. Visual light cameras sensors are mounted on communication towers to cover large area of forest. A rotating motor is installed in the system to enable the camera to rotate in order to provide a full surrounding view of the forest. The image captured by the camera sensor are processed using a program or a MATLAB code for detecting smoke. The advantage of this system is that it can be programmed to take into consideration the atmospheric conditions. The program used in this system will analyse the captured images and compare these images with the reference image taken at initial state. However, this systems has several disadvantages, the most important drawback in this system is high false alarm rate due to the fact that it relies on the saying that "a false fire alarm is less costly than a missed fire", the large digital storage units are needed in case the images are taken at higher rates with larger resolution, and the associated cost with the instalment of an additional visual light camera sensor is the cost of the tower upon which it will be mounted on.

C. Satellite based fire detection system

One of the most commonly used for forest fire detection system is MODIS. Moderate Resolution Imaging Spectroradiometer was sent to space by NASA for capturing the

images of the earth surface to detect the forest fire. There are two demerits present in this system.

One is it takes maximum of two entire days to capture the entire surface of the earth and the image taken by this system is of very low resolution. If the processed image is zoomed to detect the small area of the forest, it cannot be determined clearly because of its low resolution. Another problem associated with this system is that the cloud layers mask over the images during the scanning period. When the cloud layers mask the earth surface it is very difficult to capture the hidden fires from the forest. However, the demerits present in the satellite- based detection system cannot be overcome in anyway. These are the major demerits present in the system.

D. Basic wireless sensor network

Wireless Sensor Network based forest fire detection system was implemented after Satellite based detection system and it used radio frequency module. The basic RF module used in this system for wireless communication for detecting forest fire is based on CC2430 chip and it has certain disadvantages. When the distance between the two RF module increases, the power loss increases exponentially so the modules cannot be moved to cover large area of the forest. In addition, the power loss associated with this system is also higher during receive and transmit operation. During receive operation the current consumption is 19.4 mA and during transmit operation 23 mA which is high and inefficient.

3. Proposed solution

The proposed solution is that stand alone boxes must be deployed throughout the forest, covering all the areas of the forest. Each box contains different type of sensors. These systems communicate wirelessly by using zigbee module and the data collected from the sensor node is sent to base station that contains central computer and internet connection and the messages from the sensor node is sent to the gateway consisting of coordinator zigbee and the global system for mobile communication (GSM). The data collected will be uploaded in a database from base station computer to online using internet of things. This database consists the history of data from the sensor node that has been collected from all the areas of the forest.

Every wireless system contains temperature sensor, humidity sensor, flame sensor, smoke sensor. These sensors will be always in active mode. These node measures sensor parameters for every 15 minutes and sent that information to the base station. The captures data will be automatically uploaded to the base station. Naturally these devices cannot be charges with electricity. Hence here it is preferred to have renewable form of energy that charges the battery by solar system.

In order to achieve the best results faster, the number of detection devices must be deployed in different areas of the forest at equal distance. This number of detection devices deployment varies from one forest to another. The most important is that these devices should communicate wirelessly to cover large area.

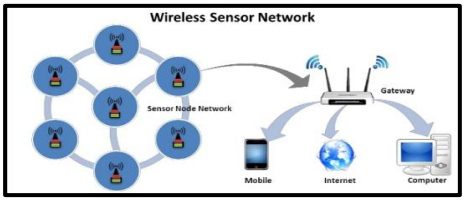

Fig. 1. Wireless sensor network

Accordingly, a mesh network links all these detection devices together. All the data collected by these devices will be sent to base station located somewhere away from the forest area and these data is stored as database in website. The website contains all the historical data of the sensors deployed in the forest. The new data will be compared with the received data for obtaining best results.

4. Methods

The project is divided into three main parts: the sensor node, the gateway node and control centre.

A. Sensor node

Sensor node senses temperature, humidity, smoke and flame from all over the forest and sends the data to gateway node consisting of zigbee and GSM for further processing.

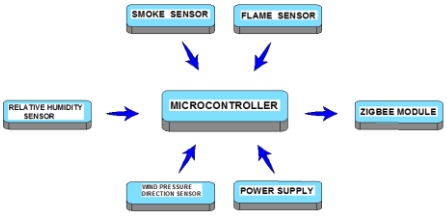

Fig. 2. Sensor node

If the temperature and humidity reaches the threshold value GSM sends fire alert messages to control centre.

B. Gateway node

The gateway node consists of the microcontroller for controlling logic flow of events, ZigBee module for receiving wildfire notification messages from the sensing node wirelessly.

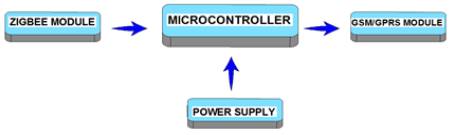

Fig. 3. Gateway node

The coordinator zigbee receives sensor node data from the distributed router zigbee which is placed in different area of the forest.

C. Control center

The source which send messages to the control center is the gateway node. When the gateway node receives wildfire notification from the sensing nodes it sends fire alert to control center so that the fire fighters can take quicker and prompt action as soon as possible. The location information is pre-defined in the gateway node controlling code based on area where it is deployed.

5. Details of hardware used

A. Temperature sensor

One of the important phenomenon that usually happens during forest fire is that the increase in temperature. The increase in the temperature is because of fire in the forest. DHT-11(digital temperature and humidity sensor) is used to detect the temperature. An increased temperature than normal temperature in a particular area indicates that the fire has detected in the forest region. DHT-11 can be used to detect the temperature in the range of 0-50°C with an accuracy of ±2°C.

B. Humidity sensor

For detecting forest fire humidity is also the important feature. In case of fire in the forest, the air will be dry thus it will decrease the humidity. These decrease of humidity in a forest region can give us indication of forest fire. The DHT-11 sensor can be used to detect humidity in the range of 20-90%RH with the accuracy of ±5%RH. DHT -11 uses resistive type of component to measure humidity.

C. Smoke sensor

The main parameter of fire is the smoke and thus smoke sensor plays a vital role in detecting the fire in forest. Several types of smoke sensors are available in the market and this method uses MQ-2 sensor. The principle of MQ-2 sensor is that when gas comes into contact with the sensor it is ionized into its constituents and then it is absorbed by sensing element. This absorption creates potential difference on the element then it is conveyed to the processor and ZIGBEE unit by means of output pins in the form of current.

D. Zigbee

Zigbee is used for wireless communication between nodes distributed in the forest area. Zigbee is based on IEEE 802.15 standard and low power consumption with transmission distance of 10-100 meters line of sight while comparing with RF module. The intermediate devices share information for long distance by forming a mesh network. Zigbee has a defined rate of 250Kbits/s, best suited for data transmissions among sensors. It is simple and less expensive than Bluetooth and Wi-Fi. ZIGBEE is programmed and configured using X-CTU software tool.

E. GSM

GSM that expands Global System for Mobile Communication is widely used across the world for sending and receiving messages. GSM TDMA technique which allows different users to share same frequency channel by dividing signal into different time slots. The GSM used in this project is SIM -900 GSM module and it works on frequencies upto 900MHZ in India. SIM-900 is used to send SMS to base station when temperature exceeds threshold value. The SMS obtained will have temperature, humidity and smoke values. The data acquired by microcontroller is then transmitted wirelessly to base station using GSM module.

F. Microcontroller

The microcontroller used in this system in ATMEGA328 and it is used with Arduino development board. Arduino can sense the environment by receiving data from the sensor connected to the board. The microcontroller board is programmed using Arduino programming language.

6. Conclusion and future work

The system can be considered as the bedrock on which a more comprehensive design can be built and several developments can take place. The device must be upgrade for best results for detection method. Additional sensors can be added like carbon dioxide and wind direction and pressure sensor. If the direction and pressure of wind is known, the fire fighters can move in opposite direction of the fire to control the spreading of fire over large area. The surface of the solar panel will be surrounded by many objects, which with block the output voltage, hence as a solution, wipers that regularly clean the surface of the panel may be installed.

References

[1] Guozhu Wang, Junguo Zhang, Wenbin li, Dongxu cu's, Yejng, “A forest fire monitoring system based on GPRS and zigbee wireless sensor networks,” 5th IEEE conference industrial electronics and application, 2010.
[2] Ajay V., Cheton B., Ganesh S., Kumaran S., "Sensor Nodes Approach to forest fire prediction and prevention, “Stony Brook University, 2009.
[3] S. S Baskakov, "Zigbee standard and Mesh logic plateform", routing efficiency in the "many-to-one". The first mile, pp. 32-37, 2008.
[4] Alkhatib, A. A. A. “A review on forest fire detection techniques,” international journal of distributed sensor networks, 2014.
[5] Hariyawa M. Y., Gunwan A., Putra E. H.," wireless sensor network for forest fire detection", vol.11, No.3, PP.563-574, September 2013.
[6] P. J. Vivek, G. Raju, S. Akarsh,"Forest fire detection system", International journal of innovative Research in science, Engineering and Technology, vol. 3, no. 6, June 2014.
[7] Molina- pico, A., et al., “Forest monitoring and wildland early fire detection by a Hierarchical wireless sensor network”, IEEE, 2016.
[8] Angayerkkani. K, and N. Radhakrishnan, “An effective technique to detect forest fire region through ANFIS with spatial data in Electronics computer technology (ICECT),” 3rd international conference on 2013, IEEE.