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Forest Fire Detection Using Wireless Sensor Network

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ABSTRACT

A forest has various types of vegetation like herbs, trees, shrubs, and many species of animals. The renewables that are necessary to human beings. Forest fires are one of the common disasters in forests that lead to serious loss of forest wealth, biodiversity and the natural environment. Early observation and prevention measures need to be taken to protect forests from fires. To overcome this and prevent them, there are two most used traditional methods of human surveillance. First, is directly observed by human vision. The other is observation far away, by which one can achieve surveillance through a hardware approach of detection. In this paper, we are introducing an automated fire alert system that consists of two sensors, namely fire and smoke. These sensors detect a change in a physical environment and help in the early detection of a forest fire. The main characteristic of this fire detection system is to alert the user by using location detection and GSM module, whenever a fire is detected.

Keywords:*wireless sensor network, GSM module, GPS module.*

INTRODUCTION

Forests play a pivotal role in the universal, biological and recreational system. It is a component of nature that all living organisms are dependent on for survival. It provides us all our basic needs- food, water, shelter and air and it is even the livelihood of many. It provides the raw materials for various products and is the home to many species of flora and fauna. It is known as the oxygen provider of the world. It helps in the maintenance of the ecological balance of the environment, which in turn, aids the smooth functioning of biogeochemical cycles. Forests cover 31 percent of the global land area according to the State of World's Forest, in 2020 which is just over 4 billion hectares. (One hectare = 2.47 acres.) This is lower than the pre-industrial area of 5.9 billion hectares [1]. In recent years, we have seen tremendous growth in various fields due to industrialization and urbanization, which are the two key contributors to global warming.

Forest fires were initially a natural mechanism of nature to ensure the ecological balance in the environment. In recent times, the occurrence/frequency of forest fires has been increasing tremendously, as global warming is leading to longer, harsher droughts and more extreme weather events. If these forest fires are not controlled, the consequences will be irreversible. Hence, an efficient forest fire detection system is currently the need of the hour. The proposed system utilizes wireless sensors which can monitor real-time related parameters like temperature, gas and smoke. The data is then immediately sent to the system of the monitoring center whenever required for appropriate action to take place. The fire alert

system has low power utilization and quicker handling capacity at a lower cost and maintenance, making it economical as well as efficient.

1.1 Problem Statement

Catching of fire in many forests is being detected lately. Which causes a major impact on environment and a loss of wide range area, flora and fauna, animals are being harmed. In order to overcome these problems, we are using different types of sensor such as smoke sensor, fire sensor. which will detect early and send the information to the nearest forest department in this way we are trying to help nature from destruction.

1.2 Our Contribution

- Firstly, we provided the architecture that is compactable, low cost and rapidly detecting devices are been used.
- Secondly, we have used a Gsm and location detection module so that the information reaches quickly and we can take measures to save it.
- Finally, we discuss the analysis of the algorithm in ongoing detection operation and its behavior.

1.3 Organization of the paper

This paper contains the following section. Section1: introduction, section 2: related work, section 3: proposed working of forest fire detection, section 4: Results and discussion, section 5: Conclusion, section 6: References.

2. RELATED WORK

Already many research organizations have come up with various forest fire detection. These methods being successfully tested and deployed for commercial applications still cannot ensure accuracy in its operations, efficient enough and its performance needs to be improved.

[2]In the research paper, A Review on Forest Fire Detection Techniques by Ahmad A.A. Alkahtib, the author talks about the different techniques to tackle the increasing forest fires. Some ways do not involve technology like- fire weather forecasts and estimates of fuel and moisture, controlled burning, watchtowers, etc. A few other techniques mentioned are- optical smoke detection, where the Optical systems were designed to cover large areas with a minimum number of camera towers; each tower has to detect smoke in range of 15–80 Km, where it requires a long delay after the ignition to produce a watchable smoke cloud that can be detected by the camera. Weather conditions and night vision reflect on the camera performance. These systems are very expensive. Then we have satellite systems but this method is not only expensive but also ineffective and, in some ways, problematic as it does not provide real-time images and data. Its operation is also bound by various national and international regulations and agreements; hence it might be maybe less suitable to provide an apt solution. The most optimized solution currently is wireless sensors. They are scalable, accurate and even less complicated to install. If it is incorporated with AI and deep learning, it will definitively be an efficient methodology to obtain the expected results.

[3] In the research paper, Forest Monitoring and Wildland Early Fire Detection by a Hierarchical Wireless Sensor Network by Antonio Molina-Pico, David Cuesta-Frau, Alvaro Araujo, Javier Alejandre, and Alba Rozas, they describe a hierarchical wireless sensor network aimed at early fire detection in risky areas. To successfully address the requirements, a standard wireless sensor network approach using two levels for the nodes is adopted, central nodes and sensor nodes, and some optimization techniques to minimize power utilization. The sensor nodes collect data from the surrounding environment and the central node transmits this information to the information center for immediate action. The sensors would record its geographical location based on GPS information. In addition, data was also taken and managed for self-awareness network arrangement. According to the paper, the nodes can also be deployed in vehicles. Which offers additional functionality; since power requirements will be less challenging for such nodes, long-range communications will be easier, and the network is equipped with some degree of mobility.

[4] The paper, Early forest fires detection: smoke identification through innovative image processing using commercial sensors by Andrea Losso, Lorenzo Corgnati and Giovanni Emilio Perona (2009), comprises the critical issue of protection of forests from fire and conserving the environmental heritage. Early warning and preventive issues must be developed to aid the operator's safety in case of fire. The present work describes a system operating within a monitoring system in Piedmont Region and processing images sensed by a ground station equipped with commercial sensors. An innovative early smoke detection algorithm is implemented integrated processing (Static and Dynamic) at the core of the system and a pattern recognition method is used.

[5] Early forest fire detection using a radio-acoustic sounding system by YG Sahin, T Ince – Sensors (2009). This paper comprises automated early fire detection systems that have recently received a tremendous amount of attention due to their importance in protecting the entire global environment. Some emerging technologies like ground-based, satellite-based remote sensing and distributed sensor networks systems have been used to detect forest fires in their early stages. In this study, a radio-acoustic sounding system with fine space and time resolution capabilities for continuous monitoring and early detection of forest fires has been proposed. The simulations prove that remote thermal mapping of a particular forest region with the help of this system could be a potential remedy to the problem of early detection of forest fires that destroy our precious green cover. ICIMOD helped design a system that uses satellite data to monitor and assess the damage of forest fires and then automatically sends SMS messages and emails to district forest officers and rangers so they are better able to monitor the growth and direction of a fire and alert populations when there may be a need to evacuate.

[6] In the paper, Real-time Forest Fire Detection with Wireless Sensor Networks by Liyang Yu, Neng Wang, Xiaoqiao Meng. The wireless sensor network can detect and forecast forest fire more instantly than the traditional satellite-based detection approach. This paper mainly describes the data collecting and processing in wireless sensor networks for real-time forest

fire detection. A neural network method is applied to in-network data processing. They evaluate the performance of the approach by simulations.

3.PROPOSED FOREST FIRE DETECTION SCEHEME

This section of the report will include the proposed work as to how the project has been executed, showing the Hardware used, Software utilized and Algorithms used for the deep learning component of the project as well as the working of this project.

3.1 Network Architecture:

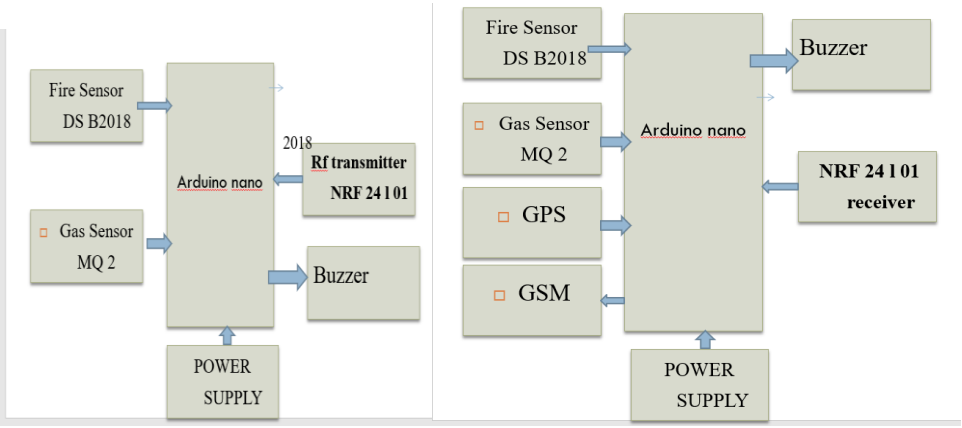

Figure 1. BLOCK DIAGRAM of TransmitterFigure 2: BLOCK DIAGRAM of Receiver

Arduino nano: Microcontroller (Atmel ATmega328 SMD Package), Operating Voltage (logic level)5 V. Input Voltage (limits)6-20 V, Digital I/O Pins 14 (of which 6 provide PWM output), Analog Input Pins 8.

MQ2-smoke sensor: Gas Sensor (MQ2) module is useful for gas leakage detection (in home and industry). This flammable gas and smoke sensor detect the concentrations of combustible gas in the air and ouputs its reading as an analog voltage.

GSM modem: A GSM modem or GSM module is a hardware device that uses GSM mobile telephone technology to provide a data link to a remote network.

Features Ublox NEO-6M GPS Module**:** -5Hz position update rate, Operating temperature range: -40 TO 85°CUART TTL socket, EEPROM to save configuration settings, Rechargeable battery for Backup, The cold start time of 38 s and Hot start time of 1 s.

DS18B20 Water Proof Temperature Sensor Probe**:**This is a 1 Meter Long Waterproof, sealed and pre-wired digital temperature sensor probe based on DS18B20 sensor. It is very handy for when you need to measure something far away, or in wet conditions

3.2 Phase 1- System initialization

- The system is provided with a 5V supply
- Assuming that there are no obstructions in the forest, the nodes are placed at a minimum distance of 500m for maximum coverage.

- We use a crystal oscillator to produce a repetitive signal for increasing system performance.
- For GSM module to work properly, there should be a minimum network coverage to send an SMS with location.
- The master node must have a bigger battery, because GSM module consumes higher energy.

3.3 Phase 2: Proposed Algorithm.

BEGIN

1. MQ-2 smoke sensor senses presence of combustible gases.
2. The temperature sensor senses variation in temperature.
3. The two sensors are present in the slave node.
4. The slave node passes on the data to RF receiver at master node through RF transmitter.
5. The master node successfully receives data from slave node
6. The LCD display turns ON and displays “FIRE ALERT”.
7. It is immediately communicated with the base station using GSM modem.
8. This alert gets transmitted to the user via SMS by GSM modem.
9. The alert displays longitude and latitude of the said fire sent by the GPS.

END

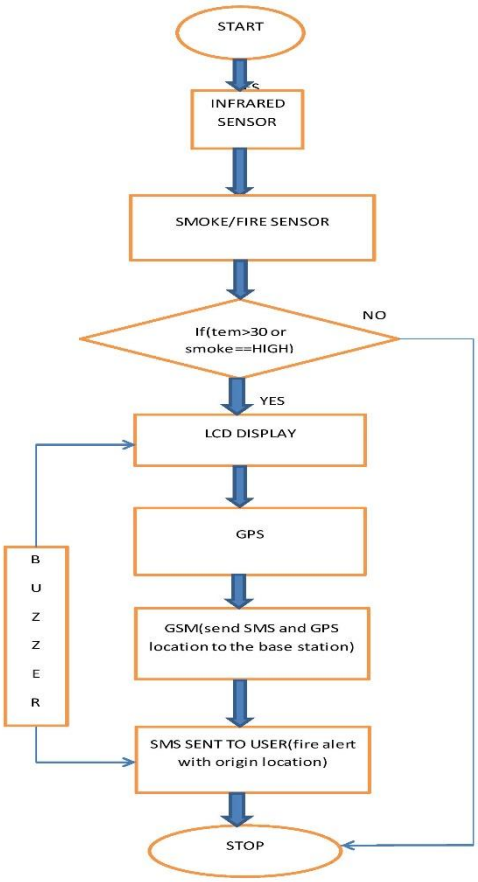

FIGURE 3: Flowchart

Fire alert system includes three vital stages: sensing, routing and communication. For sensing the physical change in environment, a couple of sensors are used, specifically smoke and fire sensor.MQ-2 smoke sensor is highly sensitive towards propane, methane, LPG, smoke, alcohol, carbon monoxide and hydrogen. At the point of target if combustible gases exist, the sensor's conductivity upswings correspondingly with a increase in concentration of combustible gases at focus. The fire sensor, which is extremely sensitive and responsive in the presence of a fire is another major sensor. These two sensors aid detect a fire in the forest and transfer the data to the master node via RF transmitter and receiver. The slave node consists of the interface of sensors, transformer, rectifiers with Arduino micro controller. If the sensors in slave node notice any fire, the slave node passes on the data to RF receiver at master node through RF transmitter. The main node examines data from all the slave nodes in its cluster and if there is a fire at any node. When the master node successfully receives data from slave node, the LCD display turns ON and displays "FIRE ALERT", then it will immediately communicate with the base station using GSM modem. This alert gets transmitted to the user via SMS by GSM modem with help of GPS for location. GSM receives and sends messages and it can be interfaced to a computer or to a microcontroller. GSM and GPS module has an extensive coverage and is very energy efficient. PS sends the location. The base station is alerted immediately when a node identifies fire in location.

3.5 Phase 3- computation

The slave node consists of the interface of sensors, transformer, rectifiers with Arduino micro controller. If the sensors in slave node notice any fire, the slave node passes on the data to RF receiver at master node through RF transmitter the main node examines data from all the slave nodes in its cluster and if there is a fire at any node. When the master node successfully receives data from slave node, the LCD display turns ON and displays "FIRE ALERT", then it will immediately communicate with the base station using GSM modem.

The receiver receives the fire alert as well as the longitude and latitude of the location of the fire sent the GPS. The wireless transmission using nRF, from one node to another node was experimented up to 100 m. As there would not be any obstructions in the forest, the RF modules can work up to half a kilometer efficiently. Sleep-based topologies are also included so as to reduce energy consumption. The fire and smoke sensors were tested up to 10 m.

4.Results and Discussions

The output of the proposed system is as follows:

The fire and smoke sensors detect the respective elements and this initializes an alert that activates the system. Then the location of the fire is detected by the GPS module triggering an alert message sent via SMS to the user with the help of the GSM module that has been incorporated into the system. Once the user receives the alert message with the data of the location, the required action can be taken to control and cease the fire immediately.

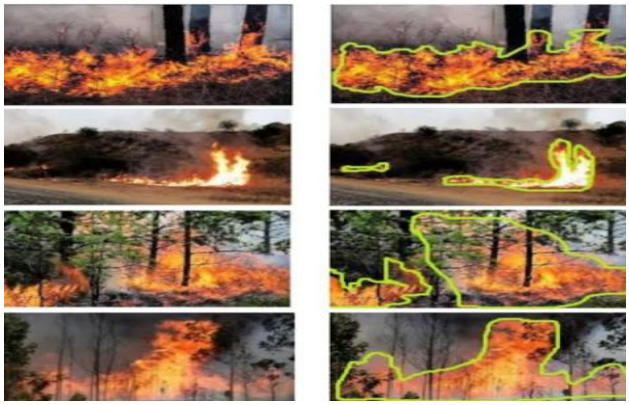

Figure 4: detecting and highlighting location of the fire

The wireless transmission using RF, from one node to another node was experimented with up to 100 m and the fire and smoke sensors were tested up to 10 m. As there would not be any obstructions in the forest, the RF modules can work up to half a kilometer efficiently. For the GSM module to function smoothly, there should be a minimum network coverage to send an SMS with the location. The nodes can be placed 500 m away from each other, for maximum coverage of the forest area with a minimum number of nodes. This will provide performance with good efficiency. Sleep-based topologies are also included to decrease energy consumption. The master node must have a larger battery as the GSM module consumes higher energy.

5.Conclusion

In this paper, in order to measure and transmit functional data we have put forward forest fire detection using wireless sensors in their own architecture. The role play of a sensor node is to sence the environment, transmission and trade sensory data with other nodes in the region. The importance of wireless sensor networks are in digital transmission to scan the temperature and humidity in the forest more in time and accurate way, we pointed out special benefits of protection in data transmission, flexibility in constructing the network, and cost efficient and energy specifications for a forest fire detection system based on wireless sensor networks that we have designed.

Figure 5: Procedure followed after detection.

6. ACKNOWLEDGMENTS

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