

Fire detection and notification using a Zigbee wireless sensor network

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Abstract:

Forest fires are the most common threat in the woods. A combination of natural and human-made factors contributes to forest fires. Forest fires destroy trees, which are essential to produce oxygen, which we need to live. This new Zigbee-based wireless sensor network is being developed to overcome the limitations of existing technologies like the MODIS satellite-based detection system and a basic wireless sensor network. It's difficult to contain a forest fire that wasn't predicted or noticed in time. As a result, it's critical to catch a wildfire early enough before it spreads too far. Using a GSM device, the proposed method would gather data on forest conditions such as temperature, humidity, smoke, and flames, and deliver it to the appropriate authorities. There are three parts to the project's concept. Modules for sensors, gateways, and control centres make up the three sections. This project's main objective is to benefit others.

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

1. Introduction

Every year, man-made and natural fires burn through millions of acres of forest. Forest fires have a significant impact on the loss of vegetation, air pollution, and human life. In many circumstances, the authorities lack a fire alarm system that can send and receive warning messages. As a result, the public and rescue forces receive warnings too late. As a result, the goal of this project is to create a fire alert system with more functionality for monitoring and detecting forest fires. These capabilities include the capacity to connect data from the forest to analyse it and spot fires early on. Furthermore, the massive acres of land that have been burned make it exceedingly improbable that vegetation will grow on this land again. The highly burned soil becomes water resistant, there is no plant left to hold the soil together, and the earth can no longer absorb any more water, resulting in a drop in ground water level. To add to the severity of the situation, when this soil flows into rivers, it pollutes the river's water. When you consider how much vegetation is burned, you can't overlook the emissions that arise from the process. Forest fires are mentioned in the 2008 global warming report as one of the key causes of global warming due to the massive amount of greenhouse gases released into the atmosphere.

2. Existing Solutions:

A. Video surveillance system

Many solutions were implemented for forest fire detection during past years. To begin, there's video.

surveillance systems, are the most widely used due to its low cost and performance. In video surveillance, there are four kinds to choose from: smoke gases are identified using infrared spectrometers, and laser light backscattered by smoke particles is measured using LIDAR devices. Thermal imaging cameras using infrared to detect heat flux from a fire, thermal imaging cameras using infrared to detect heat flux from a fire, infrared to detect heat flux from a fire, and infrared to detect heat flux from a fire. Infrared and laser-based technologies are widely utilised because of their superior precision compared to other methods. Although there are certain benefits, the main disadvantages are that false alarms occur, and the costs are astronomical when compared to those of conventional video cameras.

B. Visual camera on watch towers

Using visual cameras to capture pictures of the forest to detect fire is another option. Communication towers are outfitted with visible light cameras and sensors to cover a large area of forest. With the help of the device's spinning motor, you may get a complete view of the forest with a rotating camera. A programme or MATLAB code analyses the camera sensor's captured picture for the purpose of detecting smoke. The advantage of this technology is that it can be programmed to take atmospheric variables into consideration. With the help of a computer software, the gathered pictures will be analysed and compared to the reference images. photo of the scene as it appeared when it was shot. As a result of the axiom that a "false fire alarm is less expensive than a missed fire," this system has several drawbacks, the most

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significant of which are the need for large digital storage units if images are taken at higher rates with greater resolution, and the cost of installing an additional.

One of the most frequently used forest fire detection technologies is the MODIS satellite-based fire detection system. To detect forest fires, NASA sent the Moderate Resolution Imaging Spectroradiometer into orbit. Two flaws may be found in this system. First, it takes at most two days for the whole earth's surface to be photographed, and the resolution of the picture taken by this technology is pitiful at best.

Wireless sensor network of the most basic kind

After the satellite-based detection system was deployed, a wireless sensor network-based forest fire detection system was developed, which included a radio frequency module. The CC2430 chip is utilised as the foundation of the RF module in this system for wireless communication to detect forest fires, and it has certain drawbacks. The processed picture can't identify the little patch of woodland because of its poor resolution. Another problem with this scanning method is that the cloud layers obscure the images being scanned. When the earth's surface is obscured by cloud layers, it is almost impossible to detect concealed forest fires. On the other hand, there is no way to fix the faults in the satellite-based detection system. These are the most serious faults in the system. Furthermore, this system suffers greater power losses during reception and transmission operations. During receive operation, the device uses 19.4 mA of current, while transmitting uses 23 mA, which is inefficient.

3. Proposed Solution

Stand-alone boxes would be placed throughout the forest, covering every inch of it. Each box has a wide range of sensors. Messages from the sensor node are sent to the gateway, which is made up of a zigbee coordinator and a global system for mobile communication, and the data from the sensor node is given to the base station (GSM). By using the internet of things, the gathered data will be transferred to a database on the base station computer. The sensor node's gathered data has been stored in this database for all of its life. There will be no downtime since these sensors are active all the time. This sensor node takes measurements every 15 minutes and transmits the results back to the central station. The captured data will be uploaded to the base station without user intervention. These gadgets can't be powered up, of course. As a consequence, using a solar system to charge the battery is preferable than using a conventional power source.

As many detection devices as feasible must be spread out evenly across the forest to obtain the best findings

as soon as possible. It differs from forest to forest in terms of the number of detecting sensors used. For a wide coverage area, it's critical that these devices be able to communicate wirelessly.

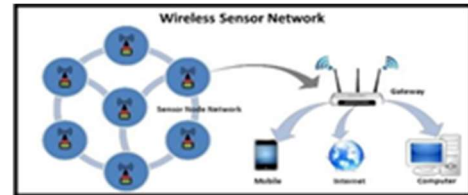


Fig. 1. Wireless sensor network

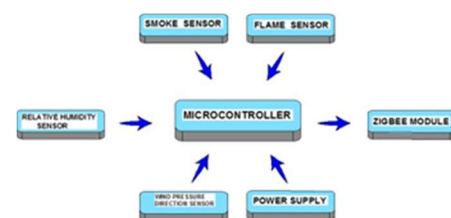
An interconnected mesh network is created, therefore. A database will store all the information collected by these devices and sent to a base station outside of the forest. The website has all the previous forest sensor data. To get the most accurate findings, the new data will be contrasted with the old data.

4. Methods

Sensing node, gateway node and control centre all fall within this project's purview.

Node of detection

To collect data from everywhere around the forest, sensor nodes use zigbee and GSM to communicate with the gateway node. The gateway node then transmits the collected data back to the sensor nodes. sent to a gateway node by zigbee or GSM that processes the temperature, humidity and other data from sensors spread across the forest. The sensor node in Figure 2

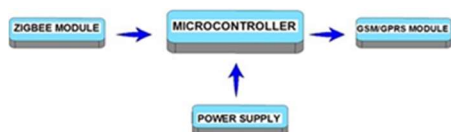


GSM transmits fire alert signals to the control centre if the temperature and humidity exceed the threshold values.

B. Node serving as a gateway

The gateway node's CPU oversees controlling logic flow of events, while the ZigBee module receives

wildfire notification messages from the sensor node



wirelessly.

Fig. 3. Gateway node

Sensor node data is sent to the coordinator zigbee from the distributed router zigbee, which is spread across the forest.

centre of control

The gateway node serves as a conduit for data to be sent to the central processing station. Firefighters are notified as soon as the gateway node gets wildfire information from the detection nodes, enabling them to react as fast as possible. The gateway node controlling code pre-defines the position information based on the region where it is placed.

5. Details of Hardware's Used

One of the most frequent side effects of a forest fire is an increase in temperature. Forest fires are to blame for the rise in temperatures. A DHT-11 measures the temperature (digital temperature and humidity sensor). A higher-than-normal temperature in a particular region indicates the discovery of a forest fire. A temperature range of 0 to 50 degrees Celsius may be accurately detected by the DHT-11 with a 2-degree accuracy.

B. Sensor for humidity

In addition to temperature, humidity is a critical indicator of forest fires. Because of the reduced moisture in the air due to a forest fire, it will be less pleasant to be outside. If the humidity drops in a forest, it may be a sign of a forest fire. The DHT-11 sensor has a 5 percent RH accuracy range and measures humidity from 20% to 90%. A resistive component of the DHT -11 monitors humidity.

C. Detector of cigarette smoke

Seeing a forest fire requires a smoke sensor since smoke is such an important fire aspect. The MQ-2 sensor is one of several smoke sensors available on the market. By detecting when a gas comes into touch with it, the MQ-2 sensor is able to deconstruct the gas into its component elements, which may be read. There is a potential difference on the element as a result of this absorption, and this difference is subsequently sent as current to the CPU and ZIGBEE unit through the output pins.

In the forest, Zigbee nodes interact wirelessly using the Zigbee protocol. The IEEE 802.15 standard is used in Zigbee, which has a transmission range of 10 to 100 metres and consumes little power. Keep in consideration the line of sight while doing a

comparison with an RF module. Using a mesh network, the intermediate devices can exchange data across long distances. For sensor data transfer, Zigbee's fixed rate of 250 kilobits per second is suitable. It's less costly than Bluetooth and Wi-Fi, and it's also simpler to use. ZIGBEE is programmed and configured using the X-CTU software tool.

E. GSM that is increasing in use There is a lot of reliance on the Global System for Mobile Communication for sending and receiving messages. Using GSM TDMA technology, a single frequency channel may be shared by several users at once. SIM - 900 GSM module was used in this project, which uses frequencies up to 900MHz in India. The SIM-900 sends an SMS to the base station when the temperature exceeds a certain threshold. The SMS will also contain data of things like temperature, humidity, and even smoke. The GSM module uses the microcontroller to wirelessly transmit the data it has gathered to the base station.

F. Microcontroller

An Arduino development board is used in conjunction with an ATMEGA328 microcontroller in this system. Arduino can sense its surroundings thanks to data it receives from a sensor attached to the board. The microcontroller board is programmed using the Arduino coding language.

6. Conclusion

Using the system as a base, a more complete design and many new advancements may be implemented. The device must be updated to get the greatest detecting results. You may add more sensors like carbon dioxide sensors, wind direction sensors, and pressure sensors if you want to. When firefighters know the wind's direction and pressure, they may travel in the opposite direction of the fire to prevent it from spreading over a large area. There are several things that will obstruct the output voltage of the solar panel, so installing wipers to clean the surface on a regular basis may be the best option.

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