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AN AUTOMATIC FOREST FIRE DETECTION USING LoRa WIRELESS MESH TOPOLOGY

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Abstract-A wildfire/forest fire is a fire in an area of combustible vegetation occurring in rural area which is difficult to control. LoRa technology connects sensors to the cloud and they are used for real time communication. Forest fires occurs usually in dry season. They cause huge damage to humans, property and the environment. The proposed system consists of flame Sensor Module that has been integrated in LoRa and GPS can be an alternative to solve the problem of fire. Flame Sensor Module is a sensor component that can detect fire. LoRa and GPS is a hardware media data transmission communication using radio frequency. Every device connected to a network which gives rise to a protype fire detector.

Keywords - Fire detection, LoRa technology, Arduino, Sensors, GPS module, GSM, Buzzer, Notification

1. INTRODUCTION

Forest fires are a great barrier to ecologically healthy grown forests. Forest fire affects the vegetation of that particular area. Forest fire is one of the major causes of global warming. Between November 2018 and February 2019, forest fire raised to 14,107 from 4,225 in India. Recently over 1.25 billion animals have died in the 2019-2020 Australian bushfire season. Nowadays the detection mechanisms are used, but this do not provide quicker response which is important in forest fire detection. The objective of this work is to design and implement an IoT based system which is self-sustaining and would predict and detect the forest fires and sends the emergency SMS to the respective person. The IoT system aims to provide a 24/7 on-site forest fire monitoring and detecting service. If fire is detected at early stage, the spread of fire over large area can be prevented and immediate actions can be taken to reduce the fire. The Arduino is connected with an IOT module, LoRa transmitter and receiver. This would predict and detect the forest fires and sends the exact location to concerned officials. The main objective of this method is to detect the forest fire as early possible, reduces cost and time of human resources and can save lives.

2. PROPOSED SYSTEM

In this system we have given an idea to detect the fire in the forest using modern equipments. The system is proposed to detect the fire in the forest and also to alert the forest officer about the fire in the forest. Here a micro-controller is used to control the system activities, some sensors are used to detect the fire in the forest, with detecting the fire the exact location of the fire is detected and located to the nearby forest officer. So, the system is a complete IoT based system were the activities of the system is continuously monitored and the monitoring details are stored in online pages which is viewed by the officer regularly. The details are stored as a data and this data can be viewed at any time. GPS is used to find the exact location of the fire in the forest. The water pump motor sprays the water through 360 degree. In this system the main component is Arduino, where the entire controlling operation takes place. It is interconnected with some sensors like temperature sensor, gas sensor and fire sensor. Humidity sensor measures the temperature and humidity. During fire there will be a steady increase in the temperature which is sensed by the humidity sensor. A fire sensor is used to detect and response to the presence of a fire. A gas sensor detects the changes in the composition of the gases in the atmosphere. The smoke level also increases during fire in the forest. So, this increase of the values are continuously monitored by the Arduino were the sensors are interconnected. When the temperature reaches beyond a certain level, the Arduino operates its function to transmit the information about the fire in the forest. This Arduino is connected with an IOT module and LoRa transmitter. IOT module contains a component called ESP8266 which has some special features which is used to transmit the information to the officers through cloud or through online mode.

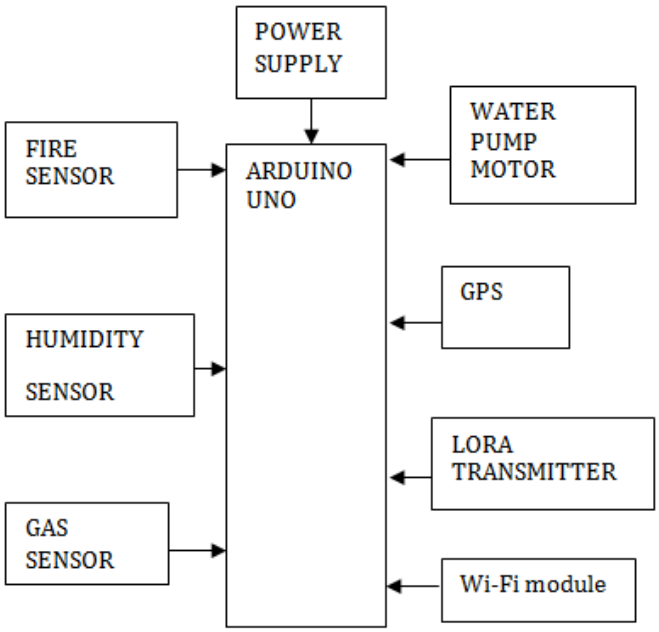

Fig 1. Transmitter block diagram

At the receiver side, there is a LoRa receiver which is used to receive the signal transmitted by the LoRa transmitter. LoRa receiver is connected to the Arduino. The GSM module is used to transmit the alarm signal to far and control center. Buzzer associated with Arduino gives us an alert signal.

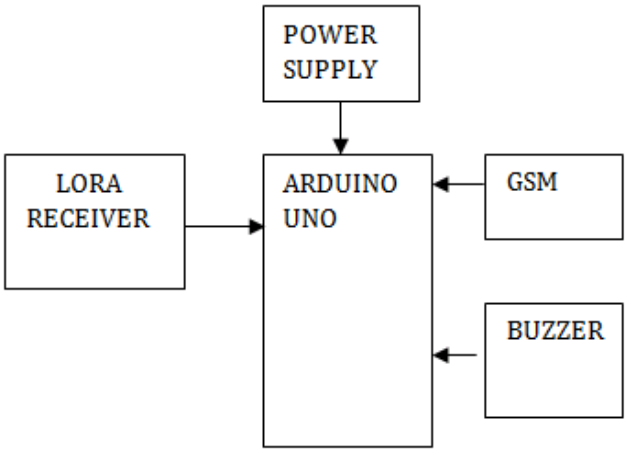

Fig 2. Receiver block diagram

3. SYSTEM CLASSIFICATION

3.1 HARDWARE COMPONENTS

Arduino

Fire Sensor

Humidity Sensor

Gas Sensor

Lora Transmitter and Receiver

Wi-Fi Module

GSM

Buzzer

Water pump motor

GPS

3.2 SOFTWARE COMPONENTS

Embedded C

Arduino IDE

3.1 HARDWARE COMPONENTS

3.1.1 ARDUINO

This is the new Arduino Uno R3. This Arduino Uno offers extra memory and transfer rate is high. It adds Serial Data and Serial Clock pins after the Analogue REFerance. It also adds two new pins placed after the RESET pin. There are 14 digital input, output pins and 6 analog input pins and it operates at 5V.

Fig 3. Arduino Uno

3.1.2 FIRE SENSOR

A fire detector detects the fire. The response is quick and more accurate than any other sensor. Range is between 760nm to 1100nm. It has three pins, they are Vcc, GND, Dout. Infrared emitted by the flame, initiates the detection in fire sensor.

Fig 4. Fire sensor

3.1.3 HUMIDITY SENSOR

Humidity sensor/Hygrometer measures moisture and temperature. Hygrometer working is based on changes in temperature in the air. It is sensitive and low-cost device. It has three pins (Vcc, GND, Data Out). The range is between 20 to 90% and accuracy is + or – 5%.

Fig 5. Humidity sensor

3.1.4 GAS SENSOR

A gas sensor detects the changes in the composition of the gases in the atmosphere. This sensor contains a chemiresistor that comes in contact and also reacts with the target gasses. Gas sensor operates at temperature from 10 - 50 C and consumes less power.

Fig 6. Gas Sensor

3.1.5 LoRa TRANSMITTER AND RECEIVER

LoRa stands for Long Range. Power consumption is low in LoRa. LoRa is a spread spectrum modulation technology that is derived from chirp spread spectrum technology. LoRa can be used to connect sensors, gateway, machines, devices, etc. wirelessly. Working of LoRa is more like a cellular communication. LoRa gateway is used to transmit the signal from one node to other.

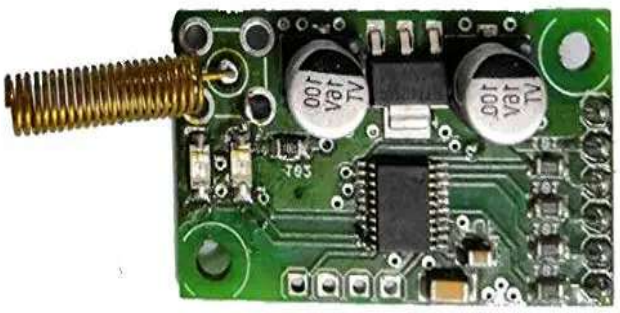

Fig 7. LoRa Transmitter

Fig 8. LoRa Receiver

3.1.6 Wi-Fi Module

ESP8266 is the Wi-Fi module used in the device which is used to store the information in the cloud and can be retrieved whenever needed. The range of Wi-Fi module 50 meters.

Fig 9. Wi-Fi Module

3.1.7 GSM

The Global System for Mobile Communication is used to transmit the signal to mobile phones through e-mails. The terminal uses a GSM to pass the information to a cell phone. Initially the information from sensors are converted into digital data using GSM transmitter and it is transmitted using GSM network.

Fig 10. GSM

3.1.8 BUZZER

A buzzer/beeper may be mechanical, electromechanical, or piezoelectric and it provides output which is audio in nature. Uses - alarm device, timers, mouse click or keystroke which

is a confirmation of user input. Buzzer associated with Arduino gives us an alert signal.

Fig 11. Buzzer

3.1.9 WATER PUMP MOTOR

A pump motor is based on the principle of DC motor device which is helpful in moving the fluids. A DC motor is one which converts electrical power to mechanical power. Operating voltage is 3 to 6V. Flow rate is 80 to 120L/H.

Fig 12. Water pump motor

3.1.10 GPS

The Global Positioning System (GPS), is used to locate the exact location where the fire occurs. It is based on satellite navigation system. The operation of GPS is based on trilateration. It can be used in a vehicle, cell phones, any portable or fixed devices.

Fig 13. GPS

3.2 SOFTWARE COMPONENTS

3.2.1 EMBEDDED C

Embedded C is used to integrate hardware with software components. C Standards are used in Embedded C. The devices such as mobile phones, washing machine etc., are based on Embedded C programming. The components working on microcontroller is mostly based on Embedded C.

3.2.2 ARDUINO IDE

Arduino Integrate Development Environment (IDE)is written in C or C++. The operating system used in Arduino IDE is Windows, macOS and LINUX.

4. RESULT

When fire is detected by the sensors, the message is sent to the officials by the LoRa transmitter and the exact location is sent by the GPS. GSM is used to give alert signal through cell phones. Wi-Fi module stores the information online and can be retrieved for future use. When forest fire is detected the water pump motor sprays the water and reduces the fire.

5. CONCLUSION

An IOT based forest fire detection is implemented using the Arduino. So, when the temperature is increased it will give alert signal and also gives message to authorities. By using this technique, we can protect the forest and we can save wild animals. Our system will play a crucial role in curbing the forest fires which would prevent loss of huge resources and financial losses.

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