Forest Fire Detection, Prevention and Response System using IoT

Mr. Prateek Lakkar[1], Ms. Meghana Narayan [2]

[1]*Freelance Developer, 147 Thadagam Road, Venkitapuram, Coimbatore, Tamil Nadu*, India.
[2] *Freelance Developer, 1st main Road, 3rd cross, Sriramnagar, Tumkur-01, Karnataka, India.*

---***---

Abstract - *A Large destructive fire that spread over a forest or area of woodland is a Forest fire that causes loss of humungous amount of Property, Wildlife, Ecosystem and Economy. The project is focused on creating a permanent solution for this problem. It consists of an integrated IoT based system to detect, monitor and solve the issue without any manual involvement. The system consists of regular monitoring of the forest area with the help of cloud computing and analysis of the root cause of the fire. The system uses the latest Microcontroller, Wi-Fi communication and precision sensors such that there is no error in this part. The system also provides a quick response system so the fire can be controlled at the earliest stage.*
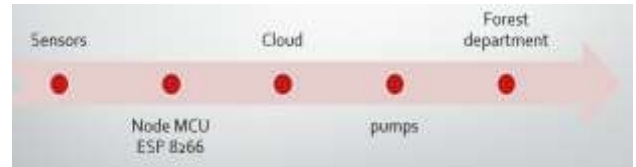
1. INTRODUCTION

The project consists of a series of sensors to measure parameters involved in Forest fire. These sensors are connected to a microcontroller which has inbuilt Wi-Fi module that can communicate to the cloud and send data on regular basis. This data is monitored in cloud and for any detection of flame a message is sent to the mobile, notification to the fire department and mail to the rescue department. A response is generated and the default pump gets powered to start sprinkling water thus preventing the spread and stop the problem from the cause. The data and mail points can be tracked to know the root cause of the problem and thus further accidents can be prevented.

1.1 PROBLEM DEFINITION: FOREST FIRE

A Large destructive fire that spread over a forest or area of woodland which leads to damage in Wildlife, humans, property and Environment. The major Causes Are Lightning. Sparks from Rock falls. Volcanic Eruption or any other manual Ignition from the Humans on purpose which leads to the following disadvantages: A forest fire sets up the potential for soil erosion to occur, Forest fires always bring death to life of humans and animals, Uncontrolled fires can cause localized air pollution, Homes can be destroyed without compensation.

1.2 METHODOLOGY

The methodology remains simple, an integrated device powered by Solar Energy is setup in various location of the forest based on the rage and efficiency. These devices use the MQTT Algorithm to send immediate notifications to the cloud and trigger the attached pump. The Following flow chart gives an illustration of the methodology.

Fig -1: Methodology Flowchart

The sensors first detect the presence of Flame in their Area of Observation, The Microcontroller immediately sends the necessary sensor readings to the cloud and triggers the pump. The Cloud acts on the readings of the sensors and notifies the necessary departments.

2. PROCESS STUDY

IoT devices are becoming a part of the mainstream of proposed systems which incorporates smart devices into the lives of people faster than ever. Growing need for real-time monitoring, tracking and automation coupled with favorable government initiatives has driven Internet of Things (IoT) market in India. Growth in the market is anticipated on account of ongoing technological developments in Internet of Things technology for providing better connectivity and coverage as well as real-time monitoring & tracking of services and systems across diverse industry verticals to reduce operational and manpower costs. Equipment used in the project are easily available in market with in a common man budget. The main Components in the proposed paper are sensors like Flame detector, temperature, Light sensor with proper range and Quality checked, Microcontroller which is Node MCU ESP 8266 with Wi-Fi module inbuilt, Actuators like Pump, tubes, relay, buzzer and Softwares and technical support members like Data Management devices through Cloud, Servers and Display LED, some miscellaneous items like Resistors, diodes, Capacitors, Inductors, wires and the most important Solar Powering Device with battery. All these components can be assembled into a Small box which can be called as Flame Detector. The solar panel may remain outside the box for better performance.

2.1 SENSORS

These types of sensors are used for short range fire detection and can be used to monitor projects or as a safety precaution to cut devices off / on. I have found this unit is mostly accurate up to about 20 feet. The flame sensor is very sensitive to IR wavelength at 760 nm ~ 1100 nm light. Analog output (A0): Real-time output voltage signal on the thermal resistance.

Digital output (D0): When the temperature reaches a certain threshold, the output high and low signal threshold adjustable via potentiometer.

Pins:

VCC...... Positive voltage input: 5v for analog 3.3v for Digital.

A0.......... Analog output

D0......... Digital output

GND..... Ground.

This sensor is only taken for Experiment purpose but for the real time application very high range sensors can be used. For huge area coverage usage of drones with high range sensors is also possible which can cover upto 5 Km area at a single sight. A GPS module will also be attached to the circuit for detecting the Exact location.

2.2 MICROCONTROLLER

Node MCU is an open source IOT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from espress if systems and hardware which is based on the ESP-12 module. The term "NODE MCU" by default refers to the firmware rather than the dev kits the firmware uses the Lua scripting language. Wi-Fi is the primary communication module for this project. Through this option the project can be enabled by connecting the hotspot of the users to the sensors connections. When the forest gets fire, the flame sensors automatically sense it and send a notification as "FIRE in sector 1" to the mobile with the help of the app. For this action proper internet connection is required.

2.3 CLOUD ARCHITECTURE

The cloud is like an online version of a hard drive

Instead of having the drive within your computer or on another device, you save your files to virtual servers. Files saved to the cloud can be accessed by any device, anywhere you have internet access. The goal of this project is to combine ubiquitous and heterogeneous sensing, smart objects, semantic, big data and cloud computing technologies in a platform enabling the Internet of Things process consisting of continuous iterations on data ingestion, data storage, analytics, knowledge generation and knowledge sharing phases, as foundation for cross-border information service provision.

Most of the data is generated by people and process. IoT and big data can offer value to energy systems, climate change, and water and air quality.

We can use various clouds based on IoT which are open source like Blynk, Thinks speak, Bolt, particle.io, onion, firebase, etc. based on our requirements.
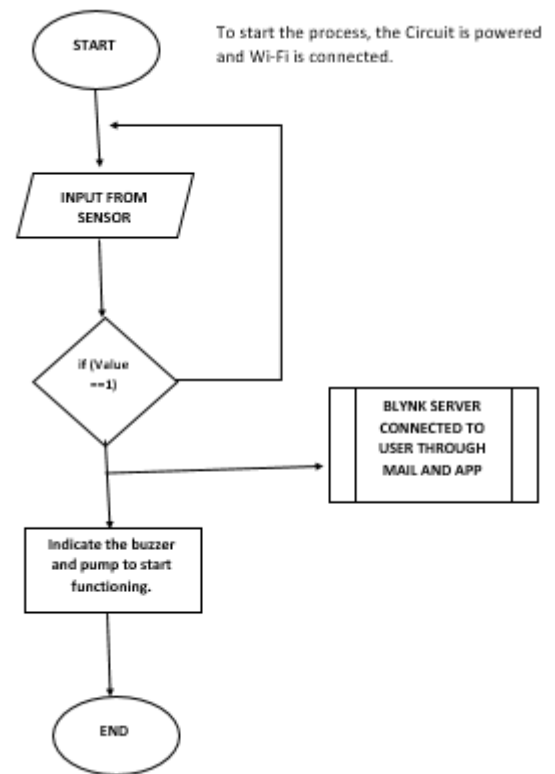

Fig -2: Fire Safety and response Algorithm

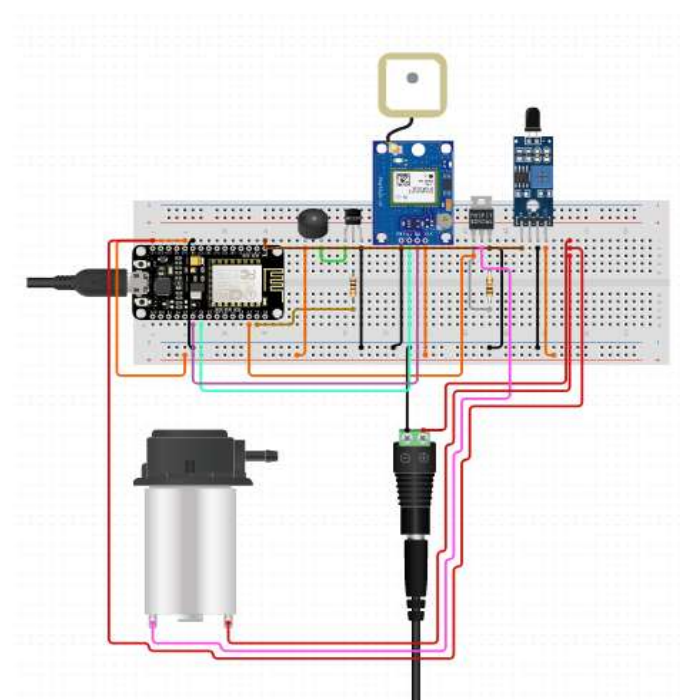## 2.4 CIRCUIT DESCRIPTION

Fig -3: Circuit Diagram

The Microcontroller and the circuit as seen in the diagram are powered by an External Solar Power Setup which provides 12V to the pump for smooth operations, The pump has strong suction power with silicon tubes attachd that

does not face damage easily, The pump hass two pins (VCC and Ground) where the voltage is drawn from the external supply whereas the Ground is controlled by the Microcontroller through relay or self which intur controls the pump. A Piezoelectric buzzer is also connected to the circuit to notifiy the nearest surroundings, which has two pins (Voltage and Ground) where Voltage is connected to Digital Pins of the Mictocontroller (D0,D1..) and the Ground is connected to the GND pin. The Sensor has the pin configuration as mentioned in the paragraph 2.1 which is connected as, A0 pin of the sensor is connected with the A0 pin of the Microcontroller and The Voltage and Ground Pins are Connected to the 3V and GND. Small components like Transistor and Mosfet are connected to manipulate Voltage for smooth functioning of the circuit. A GPS module is attached to the circuit as VCC to 3V, Ground to GND, Rx and Tx are connected to the D1 and D2 pins of the circuit and is run at a Baud rate of 9600 to provide the exact loaction in terms of longitude, latitude, speed and Direction which can be plotted easily.

2.5 IMPLEMENTATION

The Implementation is the most tedious part as we have to take care of the Surrounding infulences like plants, animals and Atmospheric conditions that can damage the device or disturb its range and efficiency. The Target range while implementation is estimated to be 20 feets if we use the most basic model. The sensor detects the presence of Flame in that range and immediately makes the circuit high. The Circuit in turn respons to these signal by doing the following things:

a. It makes the buzzer high to create a disturbing and alarming sound.
b. It notifies the cloud about the raise in reading of the sensor and feeds the location.
c. It turns on the pump to sprinkle water to prevent the fire from spreading and trying to cut the source.
The cloud receives the readings from the Microcontroller and is programmed to send a Notification to the forest department and a Mail to the Fire department. The notification sent to the forest department also has Location of the device where the fire was detected and the buzzer makes it simple for them to track and follow the lead.
Thus proper actions are taken by necessary authorities to prevent the spread of the Fire.
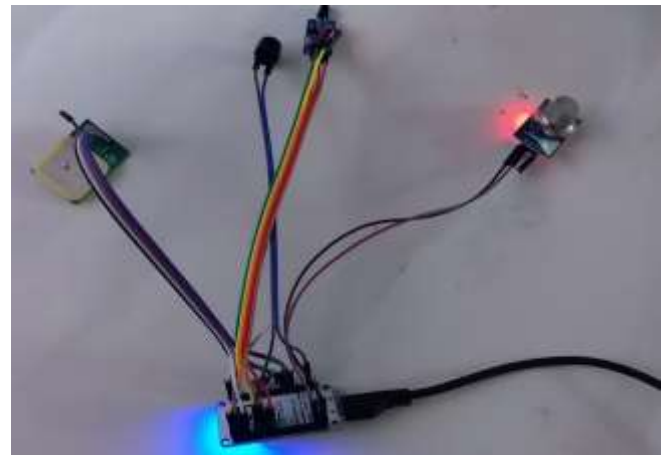

Fig -4: Sample Implementation Circuit

3. CONCLUSIONS

The Forest Fire is a serious issue as it has caused loss of huge amount of land, property and lives of people as well as animals. The Paper paves a way to prevent this loss by cutting the supply at the source and preventing the spread at the right time. The project when implemented has huge applications in domestic, Industrial, hospitals, Landscape areas like coal mining and petroleum industries to prevent fire accidents and take necessary preventive measures. The project has huge scope in the future where we will be able to cover huge areas of forest land with the help of Satellites, Thermal Images and Drones. The connectivity of the Wi-Fi in forest areas still remains a technical challenge as using high frequency waves for connectivity may lead to disturbance in birds and animal's life and low frequency may not respond properly, Alternate methods are either too expensive or not effective. The future scope of the project lies in the areas like Connectivity of Network and Range of sensors. Forest still remain an important resource to balance the climate and a possible solution to global warming. Thus when a forest fire occurs not only the valuable forest resource meets damage but the fire tears of the surrounding causing enough pollution by the very source that prevents it.

Fig -4: Sample Notification Panel

BIOGRAPHIES

I am Prateek Lakkar, I am aspiring to Study Masters of Science in Politechnico Di Milano and I had this idea and interest from a long time.

I am Meghana Narayan, aspiring to study of Masters of Science. I have always been interested in the field of Electronics and wanted to learn more.

REFERENCES

[1] Casbeer, D., Beard, R., Li, S., McLain, T., and Mehra, R. "Forest Fire Monitoring Using Unmanned Air Vehicles", Proceedings of the American Control Conference, pp. 3530-3535, June 2005, Portland, Oregon. DOI: 10.1109/ACC.2005.1470520, (c) 2005 IEEE.

[2] Mulayim Gure ; Mehmet Emin Ozel ; H. Hulya Yildirim ; Muzaffer Ozdemir, "Use of satellite images for forest fires in area determination and monitoring", (c) 2009 IEEE.

[3] Li Guang-Hui ; Zhao Jun ; Wang Zhi, "Research on Forest Fire Detection Based on Wireless Sensor Network," (c) 2006 IEEE.

[4] Alexander A. Khamukhin ; Silvano Bertoldo, "Spectral analysis of forest fire noise for early detection using wireless sensor networks", (c) 2016 IEEE.

[5] Liu Longshen ; Shen Mingxia ; Zhao Xianlin ; Sun Yuwen ; Lu Mingzhou ; Xiong Yingjun, "Embedded forest fire monitoring and positioning system based on machine vision", (c) 2011 IEEE.

[6] Hong Li ; Guang-hui Li ; Hai-lin Feng ; Zhi Wang, "Research on Forest Fire Monitoring Quality Variation with Wireless Sensor Node Density", (c) 2010 IEEE.