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Solar Powered Forest Fire Detection and Mitigation

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Abstract- Forest is a piece of land with many trees. Many animals need forest to live and survive. The forest fire is a type of disaster which create a great deal of environmental impacts due to which their early detection is very vital at the current appearance. The application of this project to detect the forest fire and fast operation in detecting and send information for infinite distance (world wide by cloud) to the forest officers to mitigate the forest fire.
Keywords – Forest Fire. Mitigation, IoT, Sensors.

I. INTRODUCTION

A forest is a large area dominated by trees, herbs and shrubs which is important and indispensable resources for human survival, and it is the social development that protects the balance of the earth ecology. However, because of some uncontrolled anthropogenic activities and abnormal natural conditions, depending on the type of vegetation present, a forest fire occurs frequently. The wildfire is the most serious disasters and impact to forest resources and the human environment. In recent years, the frequency of wild fires has increased considerably due to climate changes, human activities, lightning, volcanic eruption and other factors. At this stage the prevention and monitoring of Forest Fires has become a big global concern in Forest Fire prevention organizations. Currently, Forest Fire prevention methods largely consist of Patrolling, Observation from watch towers, Satellite Monitoring and Wireless Sensor Networks.

II. PROPOSED ALGORITHM

2.1 Proposed System For Forest Fire Detection –

The block diagram of the Proposed System is shown in Fig.1. The Proposed System overcomes all the drawbacks of the Satellite-based Forest Fire Detection Systems and Basic Wireless Sensor Network-based Forest Fire Detection Systems.

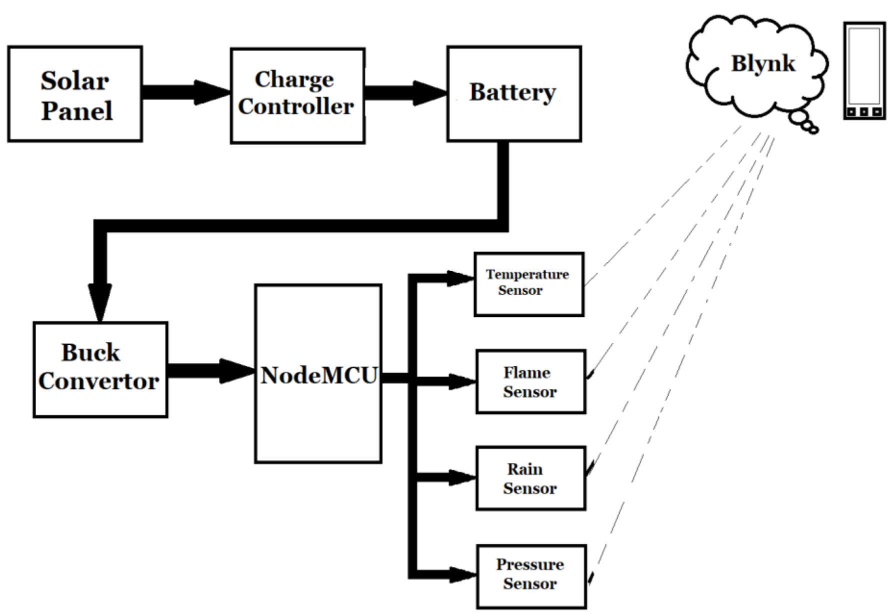
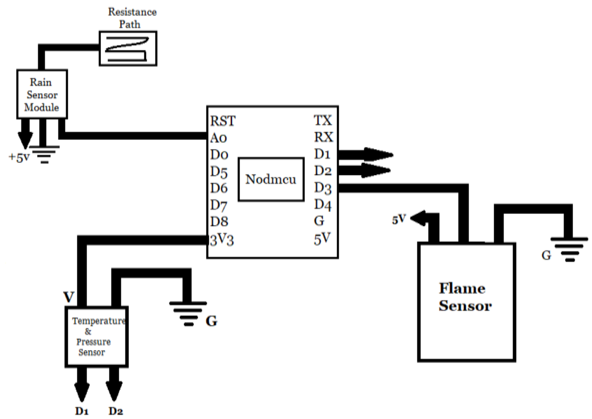


Fig. 1 block diagram of forest fire detection system

2.2 Sensing, It's Interfacing Technique

The Sensors namely, Temperature Sensor, IR Flame sensor, Pressure Sensor and Rain Sensor are used to detect the occurrence of Forest Fire, Abnormal Prowling and Rain respectively. The main sensor which is used to detect the forest fire is IR flame sensor detect the presence of fire around range of 20cm to 30cm. The Temperature Sensor and pressure sensor used is BMP180 Barometric Pressure/Temperature 5V. The main need for BMP180 is to detect Forest Fire. The advantage of using BMP180 is that it helps in knowing the Temperature variations and pressure in several areas of the Forest. The main need knowing Pressure is to detect Abnormal Prowling in the Forest Areas which may be due to some trespassing or some wild animal. It is mainly used to detect trespassers near the borders of countries which are covered by Forests. Rain sensor is used to detect rainfall in the Forest Area. The main need for Rain Sensing is when rain falls in some Forest Areas, the residents or the areas near the Forest may be subjected to floods and landslides. In order to warn the people near the Forest Areas about the possibility of Flood occurrence and Landslides due to rain, this sensor is used. The results of interfacing IR flame sensor, Temperature Sensor and Pressure Sensor with the microcontroller as shown in figure 4 sent to the monitoring through Iota to cloud.



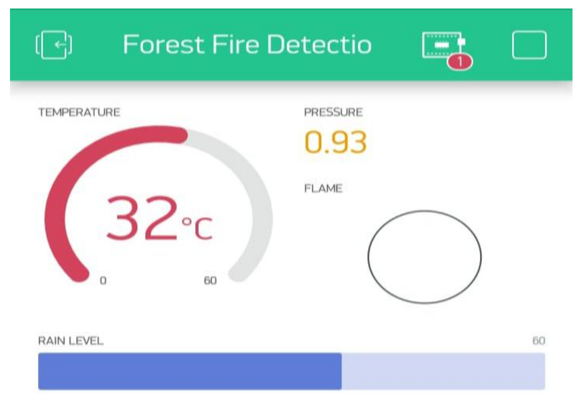


Fig. 2 Block of Integrated sensors to the microcontroller   Fig. 3 Monitored View from cloud Blink Application

2.3 Flame Sensors(IR Sensors)

The flame sensor is used to detect the presence of fire (Flame of a wavelength in the range of 20cm to 30cm can be detected). The IR flame sensor is small and compact in size with the adjustable threshold value works with 5v input. The detection angle is 0 to 60 degree so four sensor are integrated to detect in all angles of 360 degrees. The IR flame sensors are fixed at 4 directions equally to the pole and interfaced by the microcontroller.

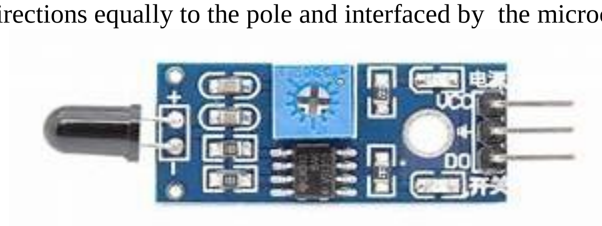


Fig. 4 IR Flame sensor

2.4 Temperature & Pressure Sensor (BMP180)

The BMP180 is the next-generation of sensors from Bosch. The BMP180 is a sensor based on piezo-resistive MEMS technology high quality standards as shown in Fig 5.The sensor ultra low power consumption and it is soldered onto a PCB with a 3.3V regulator. This sensor senses both temperature and pressure and sent directly to the microcontroller by converting analog to digital. The measurement flow of the BMP180 is as shown in Fig 6. This sensor is placed on the surface in which it can sense the both pressure and live temperature and it is monitored in station.

Pressure range: 300 ... 1100hPa
(9000m to -500m above sea level)
Temperature range: -40 to +85°C operational range

Fig. 5 BMP180

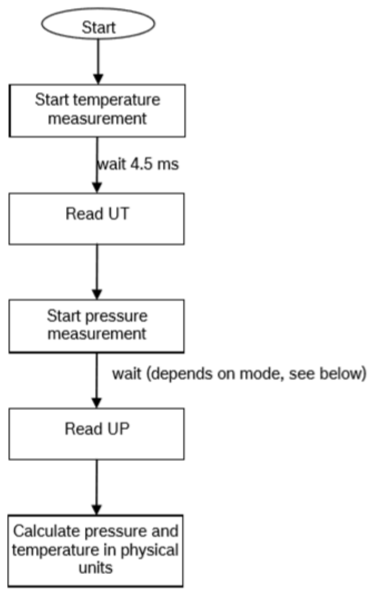


Fig. 6 Measurement flow BMP180

2.5 Development of Rain Sensor

The rain sensor module is an easy tool for rain detection. The input given to this 5v supply. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. Fig.7 shows the resistance path of rains sensor.The analog output is used in detection of drops in the amount of rainfall. The monitoring application shows the live data that the how much level of rain is present at the forest.

Fig. 7 Measurement flow BMP180

2.6 Hardware Results Of Sensors:

Fig.8. shows the graph of the Flame, Temperature, pressure and Rains sensor. Live data will be recorded and it can store one year data in the system to ensure the records through IoT(internet of things) module. This IoT module ensures the fast monitoring to the station and makes them to take action of decision making to mitigate.

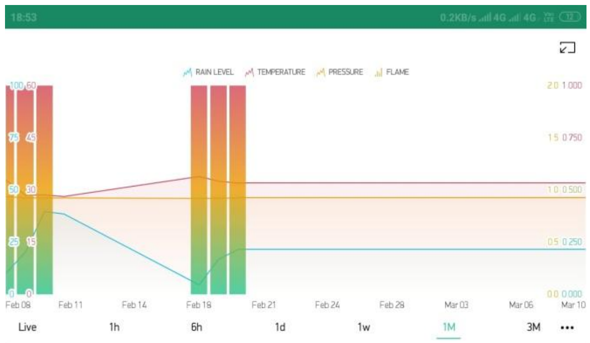


Fig. 8 Simulation data of all sensors

2.7 Optimized Solar Energy Harvesting

Normal solar harvesters do not utilize power generated during dim sunlight and so the efficiency of the solar harvester becomes very less. Even during bright sunlight, the light to the solar panel maybe blocked by leaves or other matter in the forest. Due to this, the entire focus of sunlight to the solar panel is lost. We propose a methodology for optimizing the solar harvester with maximum power point tracking for the wireless sensor network nodes. The development of perpetually powered systems avoiding periodical battery replacement and/or recharge is one of the ultimate goals in sensor network design. Maximum Power Point Tracking (MPPT) techniques are very common in the world of large-scale solar cells. The extra energy that is consumed by the Maximum Power Point (MPP) tracker is easily offset by the much higher amount of energy that can be harvested from the environment. Sensor nodes are often required to be small, and therefore, they are powered by small solar cells that generate limited energy. There are different algorithms for MPPT and at present more advanced algorithms are developed for increased efficiency of the solar harvesters. Perturb and Observe algorithm and Incremental Conductance algorithm are subjected to high relative efficiency. These two algorithms are compared again to find the suitable one for our implementation. Incremental Conductance algorithm is complex to implement and requires more time for processing. Perturb and Observe algorithm is simple to implement and takes less processing time. Also Perturb and Observe algorithm is used for many systems. So Perturb and Observe algorithm is chosen for the current solar harvester.

2.8 Hardware For Optimized Solar Harvester

The hardware blocks for implementation of MPPT are given in Fig.9. It contains the blocks that are necessary to perform Maximum Power Point Tracking for the optimized solar energy harvesting system.

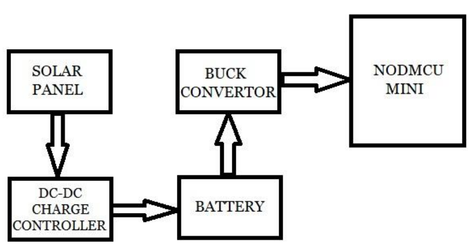


Fig. 9 Hardware block for MPPT

A mono-crystalline solar panel is used as mono crystalline panels have no internal losses unlike polycrystalline solar cells. Also an inductor is used for charging and discharging during conversion. A DC-DC charge controller LM2596 as shown in Fig.10 is used to supply constant DC supply to Battery ie, 13.7v constant to Battery. The LM2596 has a Adjustable Output Voltage Range 1.23 V − 37 V and it is series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator with high efficiency. Also after Battery unit Buck Convertor XL4015 as shown in Fig.11 is used to convert the battery constant supply to 5v constant to micro controller unit. The XL4015 is a fixed frequency PWM buck (step-down) DC/DC converter. XL4015 has a Wide 8V to 36V Input Voltage Range and Output Adjustable from 1.25V to 32V with efficiency of up to 96%. It has a main 5A Constant Output Current Capability. The entire unit should maintain current constant i.e., 500mA to work efficiently.

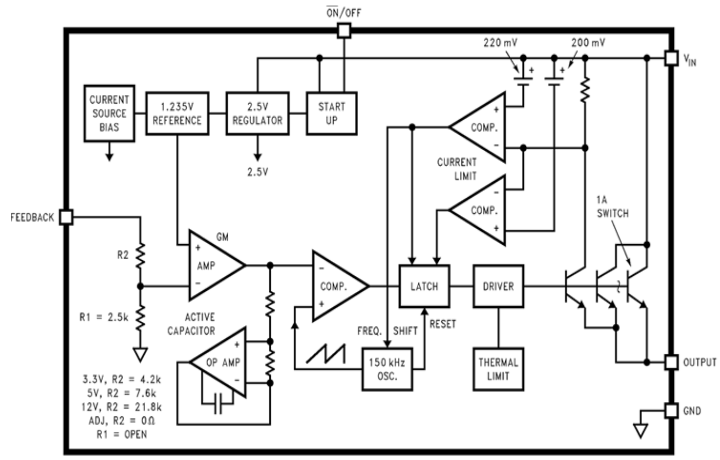


Fig. 10 Function block diagram of LM2596

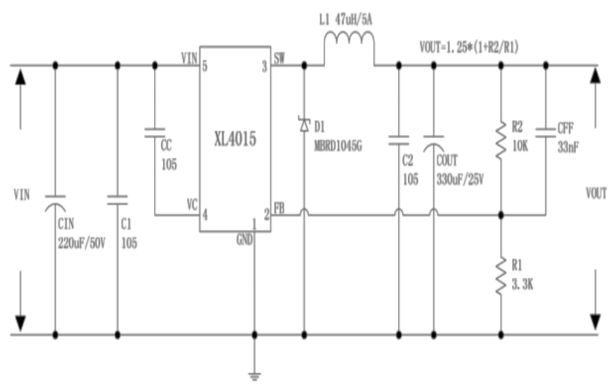


Fig. 11 XL4015 Typical application circuit

2.9 Network Topology Selection

The IoT(Internet of things) is used in this project to perform wireless mode of monitoring. The Internet of things (IoT) is the network of devices that contain software, sensors, actuators, and connectivity which allows these things to connect, interact and exchange data by cloud to the application. The suitable programming should be implemented to the Nodmcu as shown in Fig.12. The IoT involves extending Internet connectivity beyond standard devices such as desktops, laptops, smart phones and tablets, to any range of traditionally dumb or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled. Forest monitoring applications of the IoT typically use sensors to assist in forest protection by monitoring the Fire, temperature, rain and pressure in this project. Hence this is the emergency services to provide more effective aid. Entire unit in this project is controlled and monitored by this nodmcu module in which all sensors are integrated to this IoT.

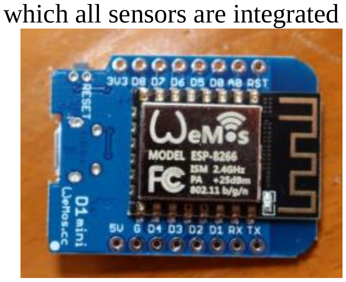


Fig. 12 Nodmcu mini Module

Fig. 13 Cloud Communication IoT

2.10 Proto Type Modeling

Mechanical Modeling must be done in a manner such that the components of the module lie intact without any damage and have the ability to tolerate any damage for itscontinued working. The Mechanical modeling is mainly concentrated for the Forest Area Module as it needs greater protection than the Monitoring Area Module. Mechanical modeling is done after a compact design of the module with all components contained in a small space or box yet it varies with the areas of placement is as shown in Fig. 14.& 15.

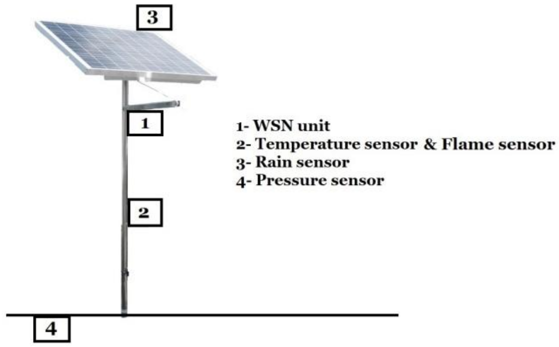


Fig. 14 Mechanical Model

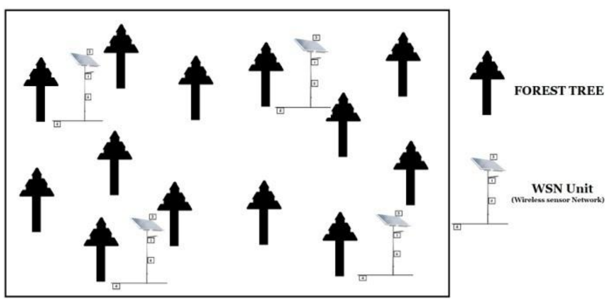


Fig. 15 Mechanical Model Placement

2.11. Results And Discussions

The output from WSN (wireless sensor network) module is the most important result of the entire project. It is vital for the monitoring area where it shows the sensed information and the corresponding warning in appropriate manner to the forest region or officer at a fraction of seconds with infinity distance (World Wide Monitoring). The warning produced when the fire attack takes place near by the unit module and live telecasting corresponding threshold changes in the Environmental Status are shown in Fig. 16. Similarly the warning produced due to the occurrence of rain is shown in the monitoring area as shown in Fig.16. From these results, it is evident that a record of the occurrence of abnormalities in the forest

Environment can be easily done and immediately compared with abnormalities that occurred earlier which cannot be done early detect and monitored.

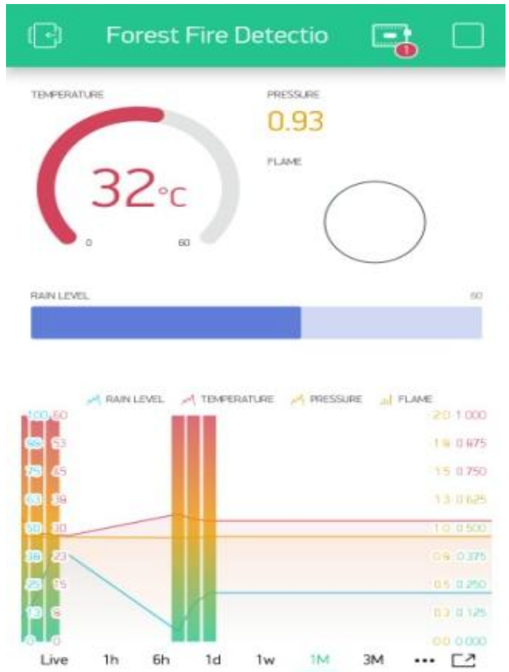


Fig. 16 Monitoring Panel

2.12 Acknowledgement

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IV.CONCLUSION

An Experimental Prototype model was fabricated and it's performance is studied & analysed. This will help to sustain the inhabitants, and maintain ECO system. An advanced system for Forest Fire Detection was developed which overcomes the demerits of the Existing technologies of Forest Fire Detection. It can be ensured that the system developed can be implemented on a large scale due to its promising results. And also we can get one year data management records of the forest. Mechanical modeling for accessible and inaccessible areas helps in the easy implementation of the Forest Area modules

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