SMART FOREST FIRE DETECTION SYSTEM BASED ON OPTIMIZED SOLAR ENERGY USING ARDUINO WITH SOURCE OF TANK WATER

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Abstract*—Now a days movement of animals from forest area to residential area is a big problem. The main reason for that problem is forest fire. The number of trees has reduced from the forest that creates worst environment for animals to survive in the forest. Arduino platform based IOT enabled early fire detector and monitoring system is the solution to this problem. In our project, fire detector using Arduino which is interfaced with some sensors and buzzer.GSM is used to provide the final SMS to the user through the given number.The LCD is the output device. The sensor values are displayed in the LCD display. Tank of water source is included to control the fire without waiting for fire service at initial stage.*

Keywords— Arduino, sensors, buzzer, GSM module, LCD display, Tank water

1. INTRODUCTION

Forest fires are the most prevalent type of disasters studied in the literature since they are relatively easy to prevent, and with the threat of global warming they are increasing the importance to prevent the forest fire. In the present arena, wildlife and forest departments are facing the problem of movement of animals from forest area to residential area. The number of trees has reduced drastically from the forest that creates an unhealthy environment for animals to survive in the forest.

A forest fire is a disaster which consists of a fire that demolishes the large area covered mainly with trees and undergrowth, a big threat for the wildlife and people who live in forests. Every year, million acres of forests are burnt down. These forest fires have an important impact on the destruction of vegetation, on atmospheric pollution, and directly on human lives. Forest fire is a most common threat in forests which is as aged as forests. Fire possesses big threat not only to the wealth of forest but also reigns through total region, consisting animals and plants and causing serious effect on the bio-diversity and environment. A wild land fire is an uncontrolled fire that occurs mainly in forest areas, although it can also invade urban or agricultural areas. Among the main causes of wildfires, human factors, either intentional or accidental, are the most usual ones. The number and impact of forest fires are expected to grow as a consequence of the global warming. Early detection is the primary way for reducing the damages of forest fires hazard.

Wireless sensor networks can detect and monitor fires among forest in real time and immediately in comparison to the satellite based techniques. Satellite based detection is more popular method for detection of fire but their long duration of scanning and low resolution limits the satellite based systems. In wireless sensor network, sensors in large amount are deployed in a forest.
This could have been avoided if the fire was detected in the early stages. In our project proposes a system for tracking and alarming for the protection of trees against forest fires. Nowadays IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, flame, ultrasonic, moisture etc. Arduino platform based IOT enabled fire detector and monitoring system is the solution to this problem. In our project we have built fire detector using Arduino mega which is interfaced with a temperature sensor, a smoke sensor and a buzzer.

Here we are using GSM which is used to provide the final SMS to the user through the given number in the simulation program, temperature sensor which is used to denote the temperature values that will be displayed in the LCD Display. Flame sensor which is used to denote the flame ranges and if it is high the forest fire will be detected in the LCD display and if it is low forest fire won't be detected. Whenever a fire occurs, the system automatically senses and alerts the user by sending an alert message.

II. LITERATURE SURVEY

[1]IOT devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, moisture etc. Arduino based IOT enabled fire

detector and monitoring system is the solution to this problem. Here we have built fire detector using Arduino UNO which is interfaced with a temperature sensor, a smoke sensor and a buzzer. We will be using GSM which is used to provide the final SMS to the user through the given number in the simulation program, Flame sensor which is used to denote the flame ranges and if it is high the forest fire will be detected in the LCD display and if it is low forest fire won't be detected. Whenever a fire occurs, the system automatically senses and alerts the user by sending an alert to an app installed on user's android mobile or webpage accessible through the internet.

[2]It consist of fire sensor which is used for fire detection, PIR sensor for intruder detection with the help of image processing and humidity sensor for temperature detection. If any catastrophic event occurs the system will immediately sends the alert message along with picture of the affected region and device location. Raspberry Pi 3 has 1.4GHz processor with 1GB memory. Depending on the budget, any webcam or Pi camera which is compatible with the Raspberry Pi can be used, here we have used a normal webcam to keep the overall cost low. The picture is captured in the event of a fire or an intruder and is sent to the registered email id via Wi-Fi and activates buzzer.

[3]The sensor 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 helps knowing the temperature variations and pressure in several areas of the forest. 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 sent to the monitoring through Iota to cloud.

[4]DHT11 is a humidity and temperature sensor is used to measuring humidity which has two electrodes with moisture holding substrate between them. Due to change in the humidity there is a corresponding change in the conductivity of the substrate and also the resistance between these electrodes changes. On the other hand, for measuring temperature these sensors use a NTC temperature sensor or a thermistor. A thermistor is actually a variable resistor that changes its resistance with change of the temperature. These sensors are made by sintering of semi conductive materials such as ceramics or polymers in order to provide larger changes in the resistance with just small changes in temperature. The term "NTC" means "Negative Temperature Coefficient", which means that the resistance decreases with increase in the temperature.

[5]The two main modules present in the project are the Monitoring Area Module and the Forest Area Module. The outcome of the above implementations reveal that various sensors used in addition to the temperature sensor improves security level for areas located near the forests. It also shows that the Optimized Solar Energy Harvester increases the efficiency to about 85 % and the use of PC based Web Server reduces the bulkiness and cost of the entire system. In forest when fire is detected the location information is send to forest department through GPS and fire detector alarm. If any dangerous situation occurs, through our model the temperature of forest area is also detected so that we can control the fire.

[6]Wireless sensor network is a network in which a large number of sensors are deployed and data is collected from them and send to a particular system for processing. Some of those techniques had been included for fire detection using image processing. Fire detection using ZigBee is a kind of personal area network. So this system is capable of early detection of fire and generating alarm in case of emergencies. The period of computation is too small for the fire to spread from one place to another. To increase the dynamics of the fire detection, a pre-alert for the nodes is generated which can potentially captured during fire, in the next computation stage. A soft intermediate threshold valueis measured between sensing threshold and proximity threshold and the value is used. It is called warning threshold.

[7]Localization has become very essential as assisting technology, the effectiveness of WSN is directly linked to the accuracy of localization as better localization is a basic of next measurement and decision. Localization algorithm is mainly divided into two main parts which are range based localization algorithm and range free localization algorithm. The advantage of localization algorithm that is based on ranging is higher than compared to the algorithm that is not based on ranging. Range finding algorithm generally provides strength of received signal, the angle of arrival and time difference in arrival.

[8]A rotating motor is installed to provide a full round view of the forest. The images obtained from the camera are processed using program or MATLAB code and are compared with the reference images taken at initial stage. Another method is the use of satellite system to detect the forest fire. The main components of the system are satellite(s) and the base station that collects the data send by the satellite(s) and runs the analyzing algorithm. The raw data from the satellite(s) is processed and then Advanced Very High Resolution Radiometer (AVHRR) instrument is used to detect presence of Hot Spots. Forest Fire Surveillance System which consists of WSN was also proposed for detection of forest fires in South Korea. The WSN determines the temperature and humidity after

middleware program and web application analyses the collected data. WSN consisting of temperature sensor setup and GPS module also proposed for detection of forest fire. In this, temperature data was transmitted to base station via primary and main antenna using satellite. Some of the limitation of system was installation of too many antennas; continuous power was required to both temperature sensor setup and antennas.

[9]It presents the prototype for early forest fire detection in which an alert is send to base station via SMS(Short Message Service) and call using GSM module when the temperature exceeds the threshold value. Also data is send continuously to base station using Bluetooth module. An increase in the temperature than normal temperature can give us indication of forest fire. DHT-11 can be used to detect temperature in the range of 0- 50°C with the accuracy of ±2°C. Smoke sensors can play a vital role in detecting fire in the forest. Various types of smoke sensors are available in the market. Depending upon the availability and cost factor of sensors the smoke sensor used in this project is MQ-2 sensor which is sensitive for methane, butane and LPG. The sensor is also sensitive for flammable and combustible gases.

[10]In this system consists of various sensors like flame sensor, smoke sensor, LPG/CNG sensor, a LCD display, GSM module, GPS module, buzzer, and a water sprinkler. The proposed system is controlled by an ARM LPC2148 microcontroller. If the fire or smoke sensor detects fire or smoke then it (sensor) sends the control signal to the microcontroller interfaced to it. The microcontroller then takes the necessary action like ringing the emergency alarm (in this case a buzzer), sprinkling water for on-site control of fire, sending location information to the fire station using GSM and GPS. The fire station use location information by means of longitude and latitude and we can also find the shortest route to the location with the help of Google maps.

III. BLOCK DIAGRAM

The figure1 shows the early forest fire detection is done by IoT based Arduino ATmega 2560 is used. This system consist of GSM module, flame sensor, smoke sensor, DHT humidity sensor, ultrasonic sensor, soil moisture sensor, current sensor, buzzer, solar, charge controller, 12V battery, motor, LCD display and tank.

Generally, temperature will increase and decrease everywhere in the world. This is the main reason for the forest fire. In our project we are using Arduino program. In that program we are predefined the rated values of sensors. Whenever temperature gets increases, the value can displayed in LCD. In forest, the starting stage of fire is temperature change. Also the flame and smoke are created. In our project uses sensor for monitor the weather condition. In case forest fire occurs, the smoke is generated, the smoke sensor detects the smoke value and the value crosses its rated value the buzzer will automatically on position. In our project the tank water is added. When the buzzer on position the motor will on inside the tank. So water can spread on the smoke. The process is same as the flame sensor.

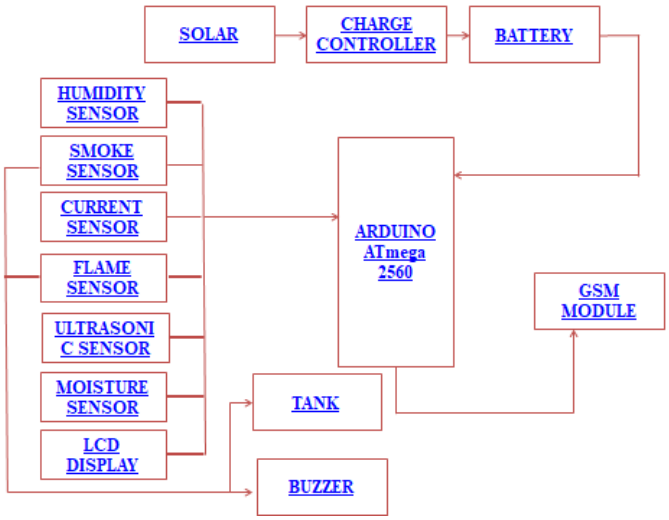

Fig1 Block diagram

3.1ARDUINO MEGA 2560:

It is a microcontroller board based on ATmega 2560 microcontroller. Arduino Boards have revitalized the automation industry with their easy to use platform where everyone with little or no technical background can get started with learning some basic skills to program and run the board. The Arduino MEGA 2560 is designed for projects that require more I/O lines, more sketch memory and more RAM. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects.

The Arduino Mega 2560 is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline.

Fig2 Arduino ATmega2560

Arduino is a tool for the design and development of embedded computer system, consisting of a simple open hardware design for single board microcontroller. Arduino ATmega2560 is a major part in our project. Sensor outputs are connected to this board. Our project coding build to this board. In that program, sensor coding also included. It act as a mother board in our project. Power supply gives to the Arduino board.

3.2 GSM MODULE:

GSM (global System for Mobile Communication) is a digital mobile telephony system that is widely used in all parts of the world. It uses a variation of time division multiple access(TDMA) and is most widely used of the three digital pins.

GPRS module is a breakout board and minimum system of SIM900 Quad-band/SIM900A Dual-band GSM/GPRS module. It can communicate with controllers via AT commands. This module supports software power on and reset operation. This is a remote modem that works with a its remote framework.

Fig3 GSM module

In order to acquire the sensor data Arduino Development Board is used. The data acquired by Arduino Development Board is then transmitted wirelessly to base station using Bluetooth and GSM module. Arduino is a tool for the design and development of embedded computer system, consisting of a simple open hardware design for single board microcontroller, with embedded input/output (I/O) support and standard programming language. An Arduino is tool for making that can sense and control more of the physical world. In our project it sends sms to the registered mobile number.Our GSM module requires a 12 volts input. So we feed it using a 12V,1A DC power supply. I have seen GSM modules which require 15 volts andsome otherwhich needs only 5 volts.

3.3 FLAME SENSOR:

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. Sensor interfaced by the microcontroller.

A flame detector is a sensor designed to detect and respond the presence of a flame or fire. The Flame sensor is used to detect fire flames. The output of the flame sensor connected to the required Arduino board. This sensor has both digital and analog pins.

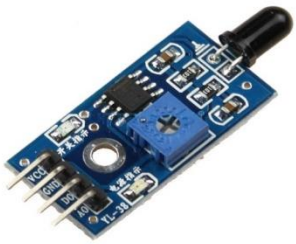

Fig4 flame sensor

It includes four pins which include the following. When this module works with a microcontroller unit then the pins are

- VCC : Voltage supply rages from 3.3V to 5.3V
- GND : This is a ground pin
- AOUT: This is an analog output pin (MCU.IO)
- DOUT: This is a digital output pin (MCU.IO)

3.4 SMOKE SENSOR:

MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application. Sensitive material of MQ-2 gas sensor is SnO2, which has lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. Use simple electro circuit, Convert change of conductivity to correspond output signal.

Fig5 Smoke sensor

This **sensor** has four pins in total, which are:

- Vcc: We need to provide +5V.
- GND: We need to ground it.
- D0: Digital Output.
- A0: Analog Output.

In our project smoke sensor has important role. The working of smoke sensor same as the flame sensor. But it detects the smoke. In our project, the smoke value displayed for every 3 seconds.

3.5 HUMIDITY SENSOR:

Humidity is a very important feature in detecting a fire. In case fire the air will be dry thus decreasing the humidity. This decrease in humidity can give us indication of forest fire. The DHT-11 sensor can be used to detect humidity in the range of 20-90% RH with the accuracy of ±5% RH. DHT-11 uses resistive type humidity measurement component.

Humidity Sensors are the low cost-sensitive electronic devices used to measure the *humidity* of the air. These are also known as Hygrometers.

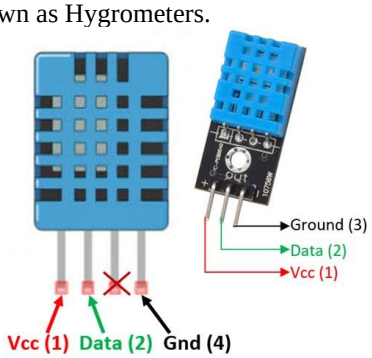

Fig6 humidity sensor

3.6 SOLAR:

In our project we are using solar panel to provide supply to the controlling unit at the forest side. Since in a forest the electrical energy may be critical and sun is a big source of energy during the day time. In a day time battery is charged as well as it is used as a supply for controlling unit. Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), indirectly using concentrated solar power, or a combination.

Concentrated solar power systems use mall beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect. lenses or mirrors and solar tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect.

IV.HARDWARE SETUP:

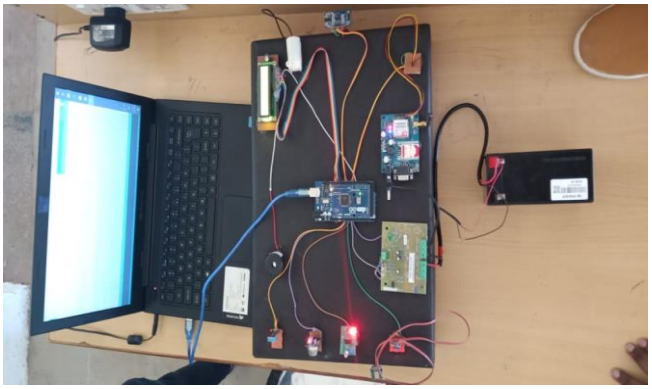

Fig:7 Hardware setup

V.RESULT:

Fig:8 Working condition

The fig:8 shows the working condition of our project. It shows the buzzer ON condition, motor running condition and message received to the registered mobile number due to the fire occurred.
The fig:9 shows snapshot of fire detection intimation.

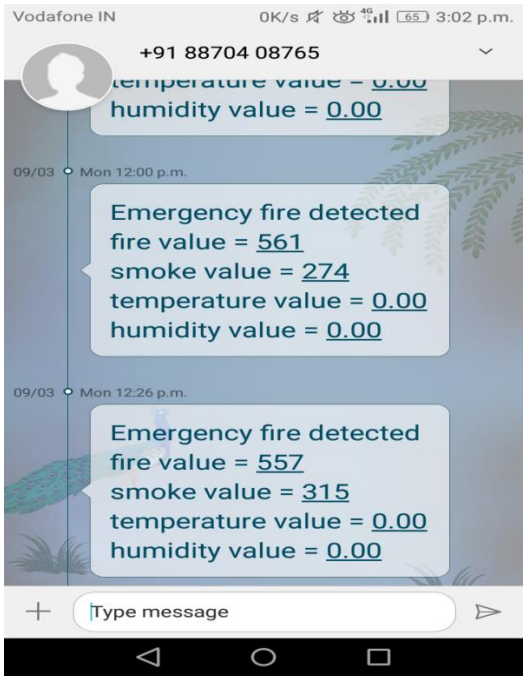

Fig:9 Snapshot intimation

The fig:9 shows fire and smoke values at that time of fire detection.

V.CONCLUSION:

In this paper, an IOT based forest fire detection was implemented using the Arduino. So when the temperature is increased it will display on the LCD and also gives message to authorities by using the registered mobile number. Same process is implemented for the fire detection, when the flame gets increased the buzzer will get activated and intimation will be conveyed to the authorities. So by using this technic we can protect the forests and we can save wild animals.

VI.FUTURE WORK:

In future, we will be updating the system with additional features like increase the range of sensing of the sensor, monitoring the count of animals present in the forest and in winter season the energy is generated by using wind source.

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