IoT based forest fire monitoring system

Task 1:- Research the problem statement

1)Problem Statement Understanding

1. What are Forest Fires?

Wildfire, also called forest, bush or vegetation fire, can be described as any uncontrolled and non-prescribed combustion or burning of plants in a natural setting such as a forest, grassland, brush land or tundra, which consumes the natural fuels and spreads based on environmental conditions (e.g., wind, topography).Wildfire can be incited by human actions, such as land clearing, extreme drought or in rare cases by lightning.

There are three conditions that need to be present in order for a wildfire to burn: fuel, oxygen, and a heat source. Fuel is any flammable material surrounding a fire, including trees, grasses, brush, even homes. The greater an area's fuel load, the more intense the fire. Air supplies the oxygen a fire needs to burn. Heat sources help spark the wildfire and bring fuel to temperatures hot enough to ignite. Lightning, burning campfires or cigarettes, hot winds, and even the sun can all provide sufficient heat to spark a wildfire.

1.1. Types of Forest Fires

There are three types of forest fires; ground fires, crown fires and surface fires.[2][3]

    1.1.1. **Ground fires** occur below materials such as leaves and peat, these fires are slow moving but when left unattended, can take out large areas. These fires are particularly dangerous as they can 'hibernate' below the surface during a warm winter and re-emerge once the weather gets warm again.

    1.1.2. **Crown fires** pose the highest risk by far due to their fast spreading behavior, they develop on top of trees and in some cases can jump from one tree to another making these the most aggressive form of fire.

    1.1.3. **Surface fires** are the most tame and can be put out relatively easily, these fires only occur at the surface and are generally no taller than the average human.

Surface fires create the least amount of destruction.

1.2. Causes of Forest Fires

Forest fires are caused by Natural causes as well as Man made causes

1.2.1. Natural causes- Many forest fires start from natural causes such as lightning which set trees on fire. However, rain extinguishes such fires without causing much damage. High atmospheric temperatures and dryness (low humidity) offer favorable circumstances for a fire to start.

1.2.2. Man made causes- Fire is caused when a source of fire like naked flame, cigarette or bidi, electric spark or any source of ignition comes into contact with inflammable material.

1.3. Economic and Social Impacts

1.3.1. Fires are a major cause of forest degradation and have wide ranging adverse ecological, economic and social impacts, including:

1.3.2. loss of valuable timber resources

1.3.3. degradation of catchment areas

1.3.4. loss of biodiversity and extinction of plants and animals

1.3.5. loss of wildlife habitat and depletion of wildlife

1.3.6. loss of natural regeneration and reduction in forest cover

1.3.7. global warming

1.3.8. loss of carbon sink resource and increase in percentage of CO_2 in atmosphere

1.3.9. change in the microclimate of the area with unhealthy living conditions 1.3.10. soil erosion affecting productivity of soils and production

1.3.11. ozone layer depletion

1.3.12. health problems leading to diseases

1.3.13. loss of livelihood for tribal people and the rural poor, as approximately 300 million people are directly dependent upon collection of non-timber forest products from forest areas for their livelihood.

2. Wireless Sensors Network(WSN)-

Wireless Sensor Networks (WSNs) can be defined as self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound,

vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink.

Structure of a Wireless Sensor Network includes different topologies for radio communications networks. The different types of network topologies are given below:

- Star network (single point-to-multipoint)
- Mesh network
- Hybrid Star-Mesh network

3. Literature Review

It has been found in a survey that 80% losses caused due to fire would have been kept away from if the fire was identified promptly. Node Mcu based IoT empowered fire indicator and observing framework is the answer for this issue. The temperature sensor detects the warmth and smoke sensor detects any smoke produced because of consumption or fire. The buzzer associated with Arduino gives us an alert sign.

At whatever point the fire activates, it consumes adjacent protests and produces smoke. A fire caution can likewise be activated because of little smoke from candlelight. Likewise, at whatever point the warm force is high then additionally the alert goes on. Bell or alert is killed at whatever point the temperature goes to ordinary room temperature and smoke level decreases. Additionally an LCD is interfaced to the Node Mcu board.With the assistance of IoT innovation.

At whatever point the system recognizes fire or smoke then it immediately alarms the client about the fire through the ethernet module. For this reason, ESP8266 is utilized which is from Arduino IDE. Likewise, the Node Mcu interfacing with LCD show is done to show the status of the framework whether the Smoke and Overheat is identified or not. Node Mcu interfacing with the Ethernet module is done so that clients become more acquainted with the predominant condition message. It insinuates the client about the fire identification.

This framework is extremely helpful at whatever point the client isn't in the closeness of control focus. At whatever point a fire happens, the framework naturally faculties and alarms the client by sending an alarm to an application introduced on a user's Android portable or page open through the web.

2)Software and Hardware Requirement

Hardware Requirements:-

1. Sensors used:
  ○ **Smoke Sensor:**

   MQ2 is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as
   Chemiresistors as the detection is based upon change of resistance of the sensing material
   when the Gas comes in contact with the material. Using a simple voltage divider network,
   concentrations of gas can be detected. The MQ2 Gas sensor works on 5V DC and draws
   around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and
   Carbon Monoxide concentrations anywhere from 200 to 10000ppm.

  ○ **Heat and Temperature Sensor**

   LM35 is a precession Integrated circuit Temperature sensor, whose output voltage
   varies, based on the temperature around it. It is a small and cheap IC which can be used
   to measure temperature anywhere between -55°C to 150°C

2. Communication Modules used
  ○ **Xbee S2 Module**

   XBee (S2) 2mw XBee ZB module is used for embedded solutions providing wireless
   end-point connectivity to devices.This module incorporates the ZigBee PRO Feature with
   Set mesh networking protocol. Series 2 modules allow you to create complex mesh
   networks. It has an Indoor/Urban Range up to 133 ft. (40 m) and Outdoor RF
   line-of-sight Range up to 400 ft. (120 m)

  ○ **SIM900A GSM GPRS Module**

   The SIM900A is a readily available GSM/GPRS module,used in many mobile phones
   and PDA. The module can also be used for developing IOT (Internet of Things) and
   Embedded Applications. SIM900A is a dual-band GSM/GPRS engine that works on
   frequencies EGSM 900MHz and DCS 1800MHz. SIM900A features GPRS multi-slot
   class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and
   CS-4.

3. Arduino UNO - It is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

Software Requirements:-

1. Proteus Software
2. Arduino IDE
3. Firebase
4. HTML and CSS for website development

3)Additions and Updates

Some new additions that can be done to the project are using solar panels to power the individual sensor nodes kept in the forest so that the periodic battery replacement of the nodes is avoided. Use of solar panels would not only benefit the environment but also reduce the maintenance cost.

4)Application, Advantages, Challenges

Applications and Advantages of Forest Fire Detection System-

- It will help in early detection of fire.
- It will help in saving a lot of human and animal life that would have been lost.
- Diversion of manpower to other useful tasks such as forest conservation.

Challenges of Forest Fire Detection System-

- False alarms in case of small intentional campfires
- Timely maintenance is required for proper error free working of this system.

5)Conclusion

Early cautioning and quick reaction to a fire breakout are the main approaches to dodge incredible misfortunes and natural and social legacy harms. Hence, the most critical objectives in flame obser-vation are fast and solid identification and restriction of the fire. From the research work it can be seen that the forest fires can be detected by using a mesh of smoke and heat sensors put out

in the forest and this would help in easy detection of fires.

6)References

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3. J. Zhang, W. Li, Z. Yin, S. Liu and X. Guo, "Forest fire detection system based on wireless sensor network," 2009 4th IEEE Conference on Industrial Electronics and Applications, 2009, pp. 520-523, doi: 10.1109/ICIEA.2009.5138260.
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