Forest Fire Detection and Prediction Using NodeMCU With IoT

Meghana DA [1], Nisha SN [2], Pooja Magadum [3], Prajnashree D [4], Prof. Shobha PC [5]
[1, 2, 3, 4, 5] Dept of ECE
[1, 2, 3, 4, 5] Atria Institute of Technology

Abstract- *Internet of Things (IoT) is driving an intense research activity targeting novel consumer applications. It finds its application in connecting several sensors together into a proprietary network, i.e., into a Wireless Sensor Network (WSN). Wireless Sensor Networks (WSNs) can track physical objects or monitor environmental data and collectively transmit the data to master station. One among the most alarming issues today is forest fires. Regardless of the reason of ignition of fire (in any environment), they usually cause devastating damage to both nature and humans. In order to deal with this, we have come up with a WSN which can both predict and detect forest fire. The proposed idea employs multiple sensors to monitor the environmental data. The data is collected from the sensors and uploaded to the cloud.Threshold values are set in advance, the sensor values are taken into consideration and an analysis is made for the fire detection. If a fire is detected, then an email is triggered with an alert message comprising of the sensor values ergo the fire is predicted.*

Keywords- IoT, WSN, Detection, Thingspeak

I. INTRODUCTION

The world is pacing towards modern societies comprising of multistorey buildings, apartment blocks and huge factories. At the same time increasing the possibility of fire outbreaks. For when a fire occurs in the metropolitan cities, considering the crowd, high temperature, smoke and danger of explosion, fire engines and chemical fire repression systems are installed. The effects of a fire are deadly, destroying homes, loss of lives, polluting the air with harmful emissions. Somehow, the mankind is able to deal with the fires in populous areas but when it comes to environments where humans cannot work efficiently, it is a challenge. Forests are an essential part of the Earth, protect the Earth's ecological balance, home to the wildlife and cater the needs of humans. Forest are precious and play an important role on our lives. Forest fire has lashing effects on human beings. Wildfires are lethal and burn large scales or area within just a few minutes.This issue has been the research interest for many years. When a forest is set on fire, large amounts of smoke are released into the air causing both immediate and long-term impact on air quality. The smoke particles get lodged deep within our lungs and cause difficulty in breathing. The wildfires produce an increased amount of carbon monoxide which could lead to a variety of health implications. Numerous buildings and homes which lie near the wildfire are destroyed, exposing hazardous materials that pose a threat to human life. The effects of wildfire are countless. From a wildfire, vegetation can also be impacted. Plants and small trees on the forest floor are destroyed, while large trees can survive if the fire does not spread into the tree canopy. Not only the flora is destroyed, but fires also effect the habitats of the animals, it can influence the physicochemical property of the soil. In short, fire affects people, property, wildlife and environmental aspects. Now, let us focus on the methods employed in reducing the effect of forest fires through its early detection. Forests can be categorised as an environment where humans cannot work effectively. The problem with forests is that forests are usually remote and abandoned areas with trees, dry leaves or sawdust which act as a fuel source. Fire ignitions might be a result of human actions or natural reasons like high temperature or a broken glass working as a collective lens focusing the sunlight on a spot for a duration of time thus leading to an ignition. Once ignited, combustible materials may easily feed the fire causing its widespread. Hectares of forests are destroyed by fire year after year. Keeping all this in mind, a number of detection and monitoring systems are used. These include observers in form of patrols or monitoring towers, ground, aerial and satellite monitoring and different types of detection sensors or their combination. The most common measure among all is controlling the burning through early detection of fire. Watch towers are installed where a human constantly observes any changes or fire and informs any fire observed through a walkie-talkie. Then we have the Unmanned Aerial Vehicles (UAV) and Unmanned Ground Vehicles(UGV). The UAV transmit aerial observations to the UGV, and this data is used to approach the fire location and extinguish it. Fire fighting robots are deployed to detect fire through temperature sensors and extinguish the fire. All these methods assist earliest detection of the wildfire and its extinguishing. The proposed idea intends to predict and detect a fire. Multiple sensors shall be used to monitor the environmental data constantly. These sensors are controlled by the microcontroller. The sensors values are uploaded to the

open-source cloud. Here,the live updated values can be visualized in form of plots. Using the cloud API, we can predict if there is a fire as and when the threshold is exceeded. On the threshold exceeding, an automatic email is triggered and sent to the end user indicating the sensor values. This way the fire is predicted and even the slightest chance of damage can be avoided. Through this idea we intend to bridge the gap between the drawbacks such as false alarm, loss of data, transmission delay and noise distortion. The whole idea of IoT lies on the sensors allowing the user to access data at any time. IoT allows user to manage wireless networks hence saving a lot of resources. This paper gives a detailed survey of the forest fire detection systems and prediction of possibility of fire. The constraints and merits are all considered and studied.

II. LITERATURE SURVEY

Author (Year)	Contributions and Observations
Vidya Zope; Tarun Dadlani;Ashutosh Matai;Pranjali Tembhurnikar; Richa Kalani (2020)	This idea predicts the occurrence of wildfire using ML with the help of historic data as well as recording the environment changes using various sensors which feed the real time data.
Mayuresh Kharade; Shubham katangle;Ganesh M. Kale; S. B. Deosarkar (2020)	Surroundings humidity and temperature values are obtained on the serial monitor with its graphical representations on the cloud storage platform (Thingspeak cloud).
Arjun D; Aravind Hanumanthaiah (2020)	When the temperature exceeds the threshold value, all the other types of sensors are turned active and streams the data
Debapriya Parida; Asish Behera; Jagdish Kumar Naik; Soumyaranjan Pattanaik; Rajat Sekhar Nanda(2019)	The system consists of a NodeMCU ESP8266 Wi-Fi module which interfaces with DHT11 sensor and MQ-7 gas monitoring system and the sensed data is sent through Internet to cloud storage ThingSpeak
Moumitha Ghosh; Rama Sushil; Kaushik Ghosh (2019)	A node transmits its sensed data to three sinks using a Fermat point based data forwarding scheme which ensures minimum distance traversal and thereby reduce energy consumption
K. Jayaram; K. Janani; R. Jeyaguru; R. Kumaresh; N. Muralidharan (2019)	The objective of this work was to implement an IoT based system which would predict and detect the forest fires and sendexact location to concerned officials to extinguish the fire in the location where it starts slowly.
A. Divya; T. Kavithanjali; P. Dharshini (2019)	The device presented utilize various sensors attached and data transmission through wireless medium. The gathered data is sent to a small satellite which transmits them to ground station and then analysed.
Deepti Sehrawat; Nasib Singh Gill (2019)	This paper analyses several sensors based IoT applications and explains which IoT application requires which type of sensor
Emir Husni, Folkes Laumal (2018)	The accelerometer has ± 3g sensitivity for each axis (x, y, z) and can be used to measure static and dynamic acceleration, object motion, collisions, and vibrations
Georgi Hristov, Jordan Raychev, Diyana Kinaneva, Plamen Zahariev (2018)	Fire can be detected earliest andmeasures can be taken for damage control. Prediction is not possible.
Ahmed Imteaj; Tanveer Rahman; Muhammad Kamrul Hossain; Mohammed Shamsul Alam; Saad Ahmad Rahat (2017)	Two microcontrollers are used which act as server to take the sensor values, compare them to threshold and perform the necessary action.
Yingxin Wei; Haonan Qiu; Yuanhao Liu; Jingxin Du; Man-On Pun (2017)	UGV can improve its path or route planning as it has a more global view on the terrain that it may travel through. As a result, it can perform more sophisticated obstacle avoidance and smart path optimization.
Anand.S. Bhosle; Laxmikant M. Gavhane (2016)	Sensor values are sent to the nearest sink node which is compared with the predefined data(threshold)
Hamra Afzaal; Nazir Ahmad Zafar (2016)	Forest Fire Detection and Extinguishing Algorithm (FFDEA) using Wireless Sensor and Actuator Networks (WSANs) is proposed in this work to detect and extinguish fire.
Shreedeep Gangopadhyay; Molay Kumar Mondal (2016)	The weather data is recorded, monitored and processed to forecast weather events and predict the upcoming disasters. Composed of three major modules-wireless sensor module, Arduino microcontroller with Ethernet/Wi-Fi network connectivity and android app for users.

[1] Vidya Zope, Tarun Dadlani, Ashutosh Matai, Pranjali Tembhurnikar and Richa Kalani have proposed the work on wildfire prediction based on IOT sensor and deep neural network. This proposed system uses machine learning, cloud storage and IOT sensor configuration. In this system, they have used DHT11 temperature and humidity sensor for detecting temperature, YL-69 soil moisture sensor for detecting moisture content in the soil, BMP280 altitude and pressure sensor and GPS sensor for detecting the location of forest where forest fires are about to happen. In this system, they have used BOLT cloud which is the cloud storage for storing the data detected by various sensors. These sensors record real time values and store it in the cloud.

[2] Mayuresh Kharade, Shubam Katangle, Ganesh M Kale, S.B Deosarkar and S.L Nalbalwar have proposed the work on fire safety and air quality monitoring based on NodeMCU. This system talks about the device which is capable of monitoring the air quality index in the industrial area and also fire safety measures for the employees. It is achieved using ESP8266 NodeMCU microcontroller which is Wifi enabled. This microcontroller is interfaced with MQ135 air quality monitoring sensor, DHT11 humidity and temperature sensor and IR based flame sensor for fire safety. Also, this device uses Blynk application along with Thingspeak for storing the detected sensor values.

[3] Arjun D and Aravind Hanumanthaiah have proposed the work on early detection and warning of forest fire based on wireless sensor network framework. This system works on wireless sensor network (WSN) framework for continuous evaluation and real time detection of forest fires. It uses sensors like temperature sensor, humidity sensor, gaseous sensor. These sensors are integrated into MICAz motes and also the IR camera sensor for the purpose of surveillance. The proposed WSN architecture notifies forest fires faster than the conventional methods and also helps in predicting the direction in which the forest fires will be spreading.

[4] Deabapriya, Parida, Ashish Behera, Jagdish Kumar Naik, Somya Ranjan Pattanaik and Rajat Sekhar Nanda have proposed the work on real time environment monitoring system based on IOT using ESP8266 and Thingspeak cloud. The proposed system works on monitoring real time values of temperature, humidity and air quality index using IOT and store the real time values on thingspeak cloud. This system uses DHT11 sensor for recording real time temperature and humidity values, MQ7 gas sensor for monitoring air quality of the environment. These sensors are interfaced with NodeMCU ESP8266 microcontroller which is wifi enabled. This NodeMCU microcontroller is connected to thingspeak via internet. All the real time sensor values are stored in thingspeak cloud to keep a track on the environmental parameters like temperature, humidity and air quality.

[5] Moumitha Ghosh, Rama Sushil and Kaushik Ghosh proposed a work in which the nodes are expected to be

deployed as expressed in the model (The system model considered, contains n nodes deployed over a three-dimensional Cartesian plane. The nodes should report their findings to three unique sinks. This repetition lessens the likelihood of single point failure.) A node communicates its detected information to all the three sinks utilizing a Fermat point based information sending plan. A Fermat point based information sending plan guarantees least distance traversal and subsequently lessen energy utilization. According to definition, Fermat point within a quadrilateral is that very point inside its limit, with the end goal that, the sum of the distances of all the vertices to that point is minimum. Following this proposal, on the off chance that it very well may be guaranteed that information transmission to three sinks from a given source happens by means of the Fermat point only, at that point it makes sure to travel the least distance and, in this manner, moderate energy.

[6] K. Jayaram, K. Janani, R. Jeyaguru, R. Kumaresh and N. Muralidharan proposed a plan to detect the fire in the forest by utilizing modern supplies. The framework is proposed to detect the fire in the forest and furthermore to caution the forest official about the fire in the forest. The framework is a complete IoT based framework where the activities of the framework is ceaselessly monitored. The subtleties are put away as an information and this information can be viewed at any time. In this framework one of the primary components is Arduino where the entire controlling operation takes place. It is interconnected with certain sensors like temperature sensor and smoke sensor. The Arduino is associated with a Wi-Fi Module and a GPS module. Wi-Fi module contains a component called ESP8266. This ESP8266 is utilized in three ways, one as a client like a Wi-Fi, other is a server like hotspots and another is going about as both client and server at the same time. So numerous frameworks can be interconnected as a chain. Another module utilized is GPS module where the exact location of the fire can be detected and found. The framework gives the location of the fire with latitude and longitude esteems by which the exact location of the fire can be found. Here IoT is utilized to monitor and record the data regarding the fire in the forest.

[7] A. Divya, T. Kavithanjali and P. Dharshini proposed a framework that relies upon different sensors attached to it and the information from wireless transmission, to satisfy the requirement. A little satellite in the system dispatches the sensor information to the station on ground where they are investigated. Temperature sensor and smoke sensor are conveyed at specific distances with the goal that the entire forest zone can be kept inside the view to distinguish the start of disturbing temperature and the variation in range of carbon dioxide gas (CO2). These sensors will impart the sign or the data to the microcontroller. These sensors will all detect changes in the climate and respond consequently in the case of a crisis. We have a few advantages here, fast response, one-time installation, and the climate can be checked whenever needed.

[8] Deepti Sehrawat and Nasib Singh Gill propose this paper presenting different kinds of sensors in IoT like proximity sensors, temperature sensors, humidity sensors, chemical sensors, position sensors, motion sensors, pressure sensors and so on. Various sorts of sensors are utilized by different IoT applications to make an IoT empowered smart environment. This paper dissects a few sensors based IoT applications and clarifies which IoT application requires which sort of sensor. IoT (Internet of things) is a vast wide, ruling and comprised area (cloud, AI, RfID) technology with different sensor and actuators for creating a smart environment around us. For any smart application, sensor plays a vital role, where it detects/measure physical or chemical change and responds to it. It also helps in data delivery, access and authorization of cloud-based resources for data extraction and collection. This paper talks about mainly sensors, their classification based on their properties, physical/chemical change, material used etc. The sensors find applications in health, parking, traffic management, forest fire detection, explosive detection and prediction, smart homes and more, sensors have enormous applications and are used in IoT application.

[9] Emir Husni and Folkes Laumal have proposed the work on earthquake early warning system using ADXL335 accelerometer. In this system, ADXL335 accelerometers are used as seismic sensors. The early vibrations that occur before an earthquake, P-wave date are detected by the ADXL335 sensor and is successfully buffered, calibrated, transmitted and then displayed on the server. If any errors are found during the transmission, a request for retransmission is given by the server. If at least three sensors successfully transmit P-wave data, then the earthquake alarm early warning system will be activated. This is done to avoid fake seismic wave alarms.

[10] Georgi Hristov, Jordan Raychev, Diyana Kinaneva and Plamen Zahariev have proposed the work that recent advances in the development of the unmanned aerial vehicle (UAVs) provided the possibility to use them in the fight against the forest fire as a replacement of the piloted aircrafts. The most basic configuration of the system involves the use of a network of ground cameras, which provides constant observation of the targeted forest areas. The used cameras within the project are dual lens & provided both standard and IR images. This system is developed by introducing a multi-rotor UAV, it will report at which area the fire might have occurred this will significantly reduce the false -positive

alarms. This paper presents early forest fire detection, including part of their characteristics and main components.

[11] Ahmed Imteaj, Tanveer Rahman, Muhammad Kamrul Hossain, Mohammed Shamsul Alam and Saad Ahmad Rahat proposed the work on an IOT based alarming system to help identify fire at the right time before it spreads wide and cause damage to lives. Dominant part of the mishaps is brought about by fire in factories and industries. The system will use several sensors to detect any symptoms of fire. The sensors are placed in specific spot subsequent to doing an overview on the factory, then sensors shall be initiated. The microcontrollers will get the information from the sensors. All the microcontrollers are centrally controlled by Raspberry Pi microcomputer. Intelligent algorithm is utilized to choose when to light alert for fire. The system will stop the gas & electricity supply after detecting the fire break, simultaneously the system will send SMS using GSM module to close by fire station informing them regarding the incident likewise it educates the location using GPS module. This paper shows the latest innovation that can help diminish mishaps brought about by fire.

[12] Yingxin Wei, Haonan Qiu, Yuanhao Liu, Jingxin Du and Man-On Pun have proposed the work on Unmanned Aerial Vehicle UAV-assisted Unmanned Ground Vehicle UGV. The data is transmitted via wireless signals to the UGV which is susceptive to transmission delay and noise distortion.Likewise, the pictures captured by the camera need to be aligned before advantageous data can be citated.Since UAV has confined computational ability because of its restricted battery power, it is critical to determine basic yet viable schemes for the UAV to acquire helpful data.At last, regardless of whether both the wide-area terrain data and UGV location are entirely acknowledged, it stays testing to plan the ideal courses. Specifically, the briefest way may not really be ideal in terms of travel time because of the way that extreme changes in speed and moving headings may cause the UGV precarious. Subsequently the briefest way planed without considering the extra imperatives on controlling point and speed acceleration will be suboptimal.

[13]Anand.S. Bhosle and Laxmikant M. Gavhane proposed A wireless sensor network comprising of self-configuring network of small sensor node that will communicate among themselves utilizing radio signals. This paper shows that wireless sensor network plays a significant role in disaster management and to secure wildlife. The principle function of WSN is to indicate the status regarding influenced territory to decrease the ill effects of harms of occurrences. In the fire exposed region more than one sensor may detect fire and send it to the closest sink node. When the information is gathered from a few nodes is more than the predefined edge. It sends a caution; microcontroller is utilized to contrast the predefined edge to decrease harms due to the incident. Through this paper our point is to review advancements standard in WSN for overseeing calamity in different regions.

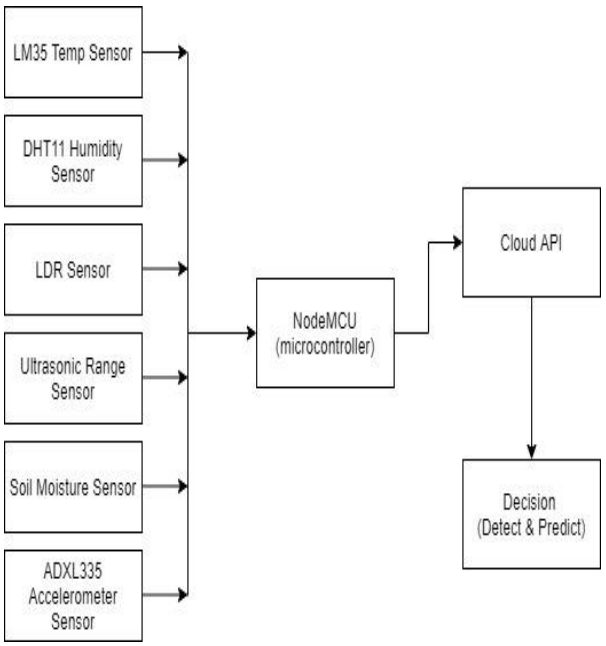
[14] Hamra Afzaal and Nazir Ahmad Zafar proposed a work on Forest Fire Detection and Extinguishing Algorithm (FFDEA) utilizing Wireless Sensor and Actor Networks (WSANs) to detect and extinguish fire. Temperature sensors are utilized to detect and actors to extinguish the fire. The actors are sent arbitrarily in the forests forming clusters. Clustering, sleep/active schedule and idle/working modes is used to limit utilization of energy. Actors are considered as robots to perform activities. Temperature sensor reports activates the robots. WSANs are sent randomly to form clusters. A cluster head is chosen in a group which is really the most remarkable robot in a cluster. The robots extinguish the fire in a cluster however on the off chance that the fire can't be stifled, at that point robots from close by group move to that group to extinguish the fire.

[15] Shreedeep Gangopadhyayand Molay Kumar Mondalproposed the work on an embedded live weather station which can be introduced inside an apartment or in an area to screen, update and conjecture the weather data and warn the clients about the forthcoming catastrophes at regular intervals of time. The proposed battery fueled unit is well furnished with the variety of sensors to quantify temperature, humidity, pressure, dew point and light intensity with precipitation, wind speed are the recreated boundaries. The model unit is introduced at the housetop well furnished with an opensource microcontroller Arduino UNO and Xbee transceiver to send the measured environmental information. The measured information is gotten by the Xbee receiver (IEEE 802.15.4 norm) module joined with another Arduino which is associated with a Wi-Fi modem through an IEEE 802.3af standard Ethernet Shield or IEEE 802.11 b/g/n Wi-Fi module (esp8266) interface. The amassed gadget information is transferred to Thingspeak and Xively cloud information base. Nonstop alarm messages are gotten over client's cell phone as SMS, email, tweet notifications through the designed Android application that permits client to view and screen his continuous real time climate information and estimate easily.

III. PROPOSED BLOCK DIAGRAM

The proposed idea intends to predict and detect a fire. Multiple sensors shall be used to monitor the environmental data constantly. These sensors are controlled by the microcontroller. The sensors values are uploaded to the open-source cloud. Here, the live updated values can be visualized

in form of plots. Using the cloud API, we can predict if there is a fire as and when the threshold is exceeded. On the threshold exceeding, an automatic email is triggered and sent to the end user indicating the sensor values. This way the fire is predicted and even the slightest chance of damage can be avoided.



IV. CONCLUSION

Natural processes are highly complicated and thus not easily predictable. Above is a study on various IOT based Wireless Sensor Networks to detect fire in various locations ranging from homes to forests. Numerous parameters can be considered in order to detect a fire, the idea proposed uses numerous sensors to cover multiple parameters. The sensor data is uploaded to the microcontroller and analysed on the cloud, depending upon the scenario an e-mail is sent to the respective user by using cloud API. The fire is predicted based on the threshold values. The system has various advantages, it is portable, economic and satisfies the monitoring parameters through cloud.

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