



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 4, April 2023

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 [ijirset@gmail.com](mailto:ijirset@gmail.com)

 [www.ijirset.com](http://www.ijirset.com)



# Forest Fire Monitoring System

R. Nithya Shree, Dr. Lavanya S

M.Sc. Computer Science, Auxilium College (Autonomous), Gandhi Nagar Vellore, India

Head and Assistant Professor, PG Department of Computer Science, Auxilium College (Autonomous), Vellore, India

**ABSTRACT:** Applications for surveillance systems are expanding rapidly, moving beyond monitoring of isolated buildings and into wider spheres of activity like monitoring forests. The oxygen we breathe and the honey we eat are two of the many benefits that come from having forests nearby. Forests are home to a wide variety of living creatures, including animals and birds. As a result, it is imperative to maintain vigilance and safeguard the woods and the treasures they contain. In order to accomplish this goal, sophisticated sensors have been implanted throughout the forest in order to monitor and record any effects that may have on the surrounding ecosystem. In order to mitigate the potential danger, the anomalous occurrences are analyzed and discovered with the assistance of the suitable Internet of Things devices. With an IOT module, the data that is sensed is examined, processed, and then it updates the information that is stored in the cloud. This helps to increase the accuracy. The many different existing methods that were used for learning the data and object detection were effective, but the process was sluggish, which meant that it failed to reduce hazards. In order to find a solution to these problems, this article makes use of IOT technologies to update the data in real time.

**KEYWORDS:** Internet of Things, Forest Fire, IoT, Surveillance system

## I. INTRODUCTION

Wildfires have been around nearly as long as woods have been. When there is no rain for several months during the summer, the trees in the forests become parched and strewn with dead leaves and twigs, which are very flammable and can be set ablaze by even the smallest spark. They pose a risk not only to the wealth of the forest, but also to the entire regime of fauna and flora, which can seriously disrupt the biodiversity as well as the ecology and environment of a region. In addition, there is a risk to wild life, domestic crops, and the people who live in the area immediately surrounding the forest. So, it is vital to contain the fire when it is in its early stages in order to prevent an excessive amount of losses caused by forest fires. [1] [2].

The environment has been significantly impacted in recent years as a result of climate change as well as other elements that are produced by humans. Wildfires, heat waves, droughts, dust storms, flooding, hurricanes, and floods are all examples of these types of natural disasters. The detection of wildfires and the accurate monitoring of the disturbance type, size, and impact over large areas is becoming increasingly important as a result of the devastating effects that wildfires have on both local and global ecosystems, as well as the severe damage that they cause to infrastructure and the serious injuries and fatalities that they cause to people. In light of this, significant efforts have been undertaken to minimize or at least lessen the effects of such repercussions by the early identification of fires or the mapping of fire risks. In the past, the primary method for detecting forest fires used human observation from fire lookout towers and the use of very simple equipment, such as the Osborne fire Detector; however, this method is inefficient since it is prone to human mistake and tiredness [3]. Conventional sensors for the detection of heat, smoke, flame, and gas, on the other hand, often require some amount of time for the particles to reach the site of sensors and activate them. Moreover, the range of these sensors is quite limited; hence, it is necessary to deploy a high number of sensors in order to cover broad regions [4].

Recent developments in computer vision, machine learning, and remote sensing technologies have offered new tools for detecting and monitoring forest fires. Additionally, the development of new materials and microelectronics have made it possible for sensors to be more effective in identifying active forest fires [5]. On video flame or/and smoke techniques in visible or/and Infrared (IR) range, on varied surroundings, and airborne systems, as opposed to earlier fire detection review studies that have concentrated on various sensor technologies. In this article, depending on the degree of acquisition, three broad kinds of frequently used systems that may detect or monitor active fire or smoke situations in real or near-real time are defined and explored. These three categories include terrestrial, aerial, and satellite systems.

In most cases, these systems are fitted with visible, infrared, or multispectral sensors, the data from which are analyzed by machine learning techniques. For early detection of forest fires as well as modeling the behavior of fire or smoke, these methods either depend on the extraction of handmade characteristics or on sophisticated deep learning networks. Both of these approaches are combined. In conclusion, we discuss the benefits and drawbacks of the methodologies and sensors that have been discussed thus far, as well as upcoming developments in the subject of early fire detection. Figure 1 depicts a forest fire that occurred earlier.



Figure 1: Forest Fire

Many often, forest fires start without anybody seeing them and spread extremely rapidly; as a result, they are responsible for millions of dollars' worth of damage and the loss of many lives every year throughout many nations. It is possible to prevent or, at the at least, significantly reduce the amount of damage and number of victims by performing early detection of hot spots and initiating necessary procedures. Lightning, meteorological conditions that are extremely hot and dry, severe drought, and human ignorance are common factors that contribute to forest fires. The current forest fire detection technologies, which are based on satellite images, are not able to identify forest fires with a high degree of precision and accuracy. A wireless sensor network-based forest fire detection system has the ability to reach the high detection resolution and accuracy that is necessary for early detection of forest fires. This would be beneficial since early identification of forest fires would allow for more time to contain the blaze. Our project's primary objective is to detect and monitor forest fires, as well as to minimize the effects of fire breakout by controlling it in its early stage, as well as to protect wild life and domestic crops by informing the appropriate forest department about the fire breakout as early as possible. In order for us to accomplish our goal, we decided to make use of IOT technologies. Combining software writing on the Arduino Uno platform with C programming, this approach also involves the development of mobile apps (applications).

## II. RELATED STUDY

Protecting the natural world is becoming an increasingly pressing concern in today's fast-paced society [6]. Across the world, there were a great number of natural and man-made disasters occurring simultaneously. The destruction of forests by fire is one type of environmental catastrophe. When the fire in the deep forest finally gets started, it will consume and kill everything there, and it will spread across the entire forest. In a forest region, dry conditions have reached their apex, which has led to the rapid spread of fire, which has killed trees and grasses. These kinds of forest fire disasters need to be contained in order to safeguard the habitats of the flora and wildlife that live in the forest. The purpose of this work is to design and implement an Internet of Things (IoT) based system that is self-sustaining, can predict and detect forest fires, and sends the exact location to concerned officials. This information will assist firefighting personnel in extinguishing the fire in the location where it starts slowly. This would stop the fire from spreading over a large region, and it would also make it possible to take preventative actions against fires that could break out in the not-too-distant future.

The author of paper [7] presents an innovative low-cost smart system of networked nodes that is based on narrow beam Far Infrared (FIR) sensors. This system has the ability to detect and identify intense heat sources, such as a fire, in real-time. This system is able to detect oncoming wildfires, and it may be used in conjunction with other active fire control devices, such as water sprinklers, in order to make an effort to halt the progression of the flame front. The primary purpose of this endeavor was to devise a strategy for the preventative protection of smaller locations of interest such as secluded residences, tiny villages, camping sites, music festivals, and other similar events. Tests carried out with live fire demonstrated that the proposed technique is effective.

Forests are an essential component of the natural world and play an essential part in the preservation of the natural environment. The consumption of air for breathing and the utilization of wood for housing are two examples of how humans are dependent on trees for their own existence. In recent years, forest fire has emerged as the primary threat because of the devastating effects it has on the natural environment. Because of this, it is essential to identify the early phases of a fire so that it may be contained before it ravages huge regions and depletes the natural resources of an area. This article presents a well-organized system for the detection and suppression of forest fires that is based on the internet of things (IoT) as well as drones. In order to cover the entire area of the forest, four different kinds of sensors are utilized in the form of subnets. These sensors are installed in trees and on the ground in order to gather data from regions that have been impacted by fire and to connect with gateways. Gateways are used to establish connections between the control room and the subnets so that information may be sent. Drones of various kinds, each outfitted with its own computer, are being utilized for real-time surveillance and for carrying out various tasks. The network is represented using graph theory, and this representation is then transformed into a formal model. The Vienna Development Method-Specification Language, also known as VDM-SL, is utilized in order to establish and demonstrate the accuracy of the formal specification [8]. In order to guarantee the model's verification and validation, many aspects of the VDM-SL toolkit are utilized.

The protection of the earth's native ecosystem is an urgent matter that is garnering a growing amount of attention not only from the scientific community but also from the general populace of the whole planet. Because of their capacity to take up considerable quantities of carbon dioxide, forests and woodlands are the primary agents responsible for reducing the effects of climate change. The protection of the woodland regions has been handled through the application of a variety of different strategies. The author of paper [9] proposes a new real-time fire monitoring and detection system that is built on Digital Mobile Radio (DMR) nodes and a platform for the Social Internet of Things (SIoT) on which artificial intelligence algorithms have been implemented. This system would be able to monitor and detect fires in real time. The findings that were obtained indicate that it is possible to identify even the smallest alteration in the recorded parameters, which may be used to determine the path and rate at which a fire spreads.

A method for detecting, confirming, and putting out forest fires is provided in the work numbered [10]. This method makes use of the Internet of Things (IoT) in conjunction with unmanned aerial vehicles. In the subnet-based approach, different sensors are believed to be present. Sensors will detect the fire and relay that information to the control room through gateways. In order to put out the fire and verify the information about the fire that was gathered by sensors, unmanned aerial vehicles (UAVs) will be deployed. When the algorithm has been built using the conceptual architecture of the system, it is next transformed into a suitable formal model using the Vienna Development Method Specification Language (VDM-SL). By making use of several tools provided by the VDM-SL toolbox, the accuracy of the model is ensured.

### III. METHODOLOGY

#### EXISTING SYSTEM

##### Fire lookout towers using Osborne fire finder

In order to determine whether or not there has been a forest fire accident, certain locations have lookout towers installed, each of which is staffed by a person. This method requires manual labor.

##### Satellite imagery fire detection

While using this technology, satellite photos are analyzed to determine whether or not a fire has occurred. Nevertheless, in order for the photos to detect fire, the fire must have spread across a large region and be moving slowly.

### PROPOSED SYSTEM

The functionality of the entire system is dependent on a dispersed network of sensor nodes that are connected to both one another and the server. Sensors have the ability to determine the levels of smoke, fire, and temperature in their immediate surroundings. The overall architecture of the system that is being suggested is comprised of three distinct components, which include internet of things devices, user applications, and online interfaces or services. The Internet of Things devices that are connected to the surveillance network may sense and monitor data coming from their surroundings, and this information is analyzed in real time. Block Figure 2 presents a diagram of the model that has been presented.

### BLOCK DIAGRAM:

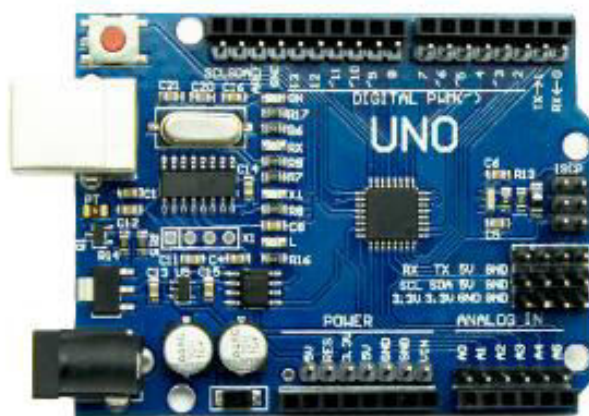
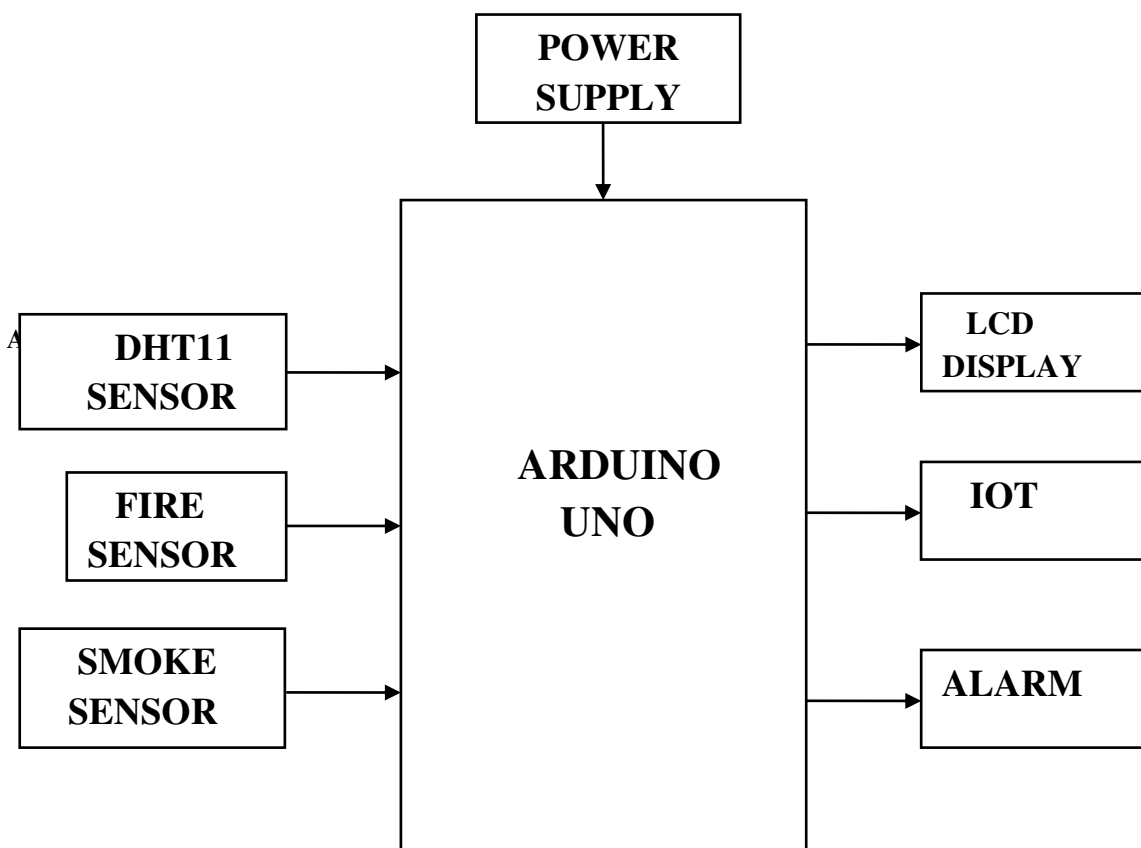


Figure 3: Arduino Uno

The Uno R3 CH340G ATmega328p Development Board is the popular Uno R3 Arduino board that comes in a more budget-friendly form. Instead of an Atmega16U2 chip, it is constructed with a CH340 USB to Serial converter chip. This chip is used during assembly. We have put quite a few of these inexpensive Arduino boards with CH340 chips to use, and we have discovered that they perform faultlessly. Programming and making use of the serial output of the USB port are the only times in which the CH340 chip is really put to use. Whenever this board is functioning normally, it is the same as the more costly variant that does not have the CH340 chip. Figure 3 illustrates an Arduino Uno board.

## FIRESENSOR

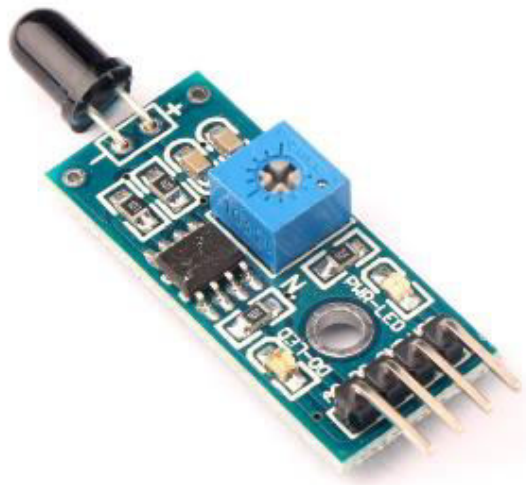


Figure 4: Fire Sensor

One kind of detector is known as a flame sensor, and its primary purpose is to detect and react to the presence of a fire or flame. Its primary design goal is to protect people and property. The responsiveness of the flame detector might be affected by how it is fitted. An alarm system, a line for natural gas, propane, and a fire suppression system are all included in this package. This sensor finds application in commercial and industrial boilers. The primary purpose of this is to provide verification of the condition of the boiler and whether or not it is operating correctly. Because of the technique that these sensors employ when they are detecting a flame, their reaction time is far faster than that of a heat/smoke detector, and their accuracy is also significantly higher. The Fire Sensor is seen in Figure 4.

## SMOKE SENSOR

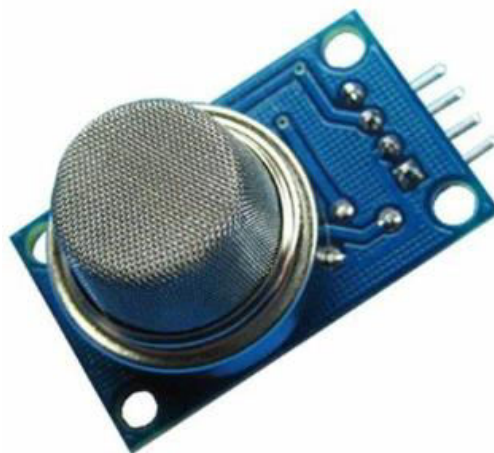


Figure 5: Smoke Sensor

The output reading of this Carbon Monoxide (CO) gas sensor is provided in the form of an analog voltage. It is able to detect the concentrations of CO that are present in the air. The sensor is able to monitor concentrations ranging from 10 parts per million (ppm) to 10,000 ppm. At 5 volts, the sensor draws less than 150 mA of current. Figure 5 depicts the Smoke Detection Sensor.

#### DHT11 TEMPERATURE SENSOR

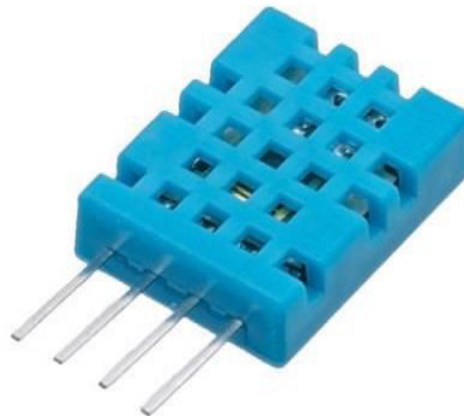


Figure 6: DHT11 Temperature Sensor

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

#### ADVANTAGES:

In comparison to the system that is already in place, the system that has been proposed can identify forest fires far more quickly. It offers improved capabilities for the collecting of data. Because there are a variety of sensors available, it not only has precision but also decreases false alarms, which is the most important component. Because it operates without the need for human intervention, it saves time and money. As a result of both of these factors, this may be obtained in an uncomplicated manner.

#### IV. RESULTS AND DISCUSSIONS

In the event that a forest fire breaks out, a message will first be transmitted to the relevant authorities, and then the information that has been gathered will be posted into a database on an internet website using the computer at the base station. As a consequence of this, the Forest Fire Unit would have access to statistics and would be able to monitor live feeds from each forest. These sensors have a sleep mode that allows them to reduce their energy consumption while not in use. They take readings of the parameters that relate to them once per minute and then send those readings as a string to the base station unit. It should come as no surprise that it is not possible to power these wireless sensors using either energy or batteries in a realistic setting. As a result of this, it is recommended that these devices include a sustainable source of energy that can charge the battery, such as a solar energy system. The information that is recognized and gathered by the temperature sensor and the gas sensor is obtained by the microcontroller that is placed into the Arduino stage display that is located in the transmitter circuit. At that moment, the controller will carry out the individualized action that it was assigned to, after which it will give those details on to the transmitter so that it may send them to the accepting station. Figure 7 depicts some of the sample data that has been saved in the database.



	Temperature	Humidity	Smoke	Fire	DateTime
0	38	53	163	N	4/3/2023 8:57
1	38	53	169	N	4/3/2023 8:57
2	38	52	175	N	4/3/2023 8:57
3	39	51	184	N	4/3/2023 8:56
4	39	50	201	N	4/3/2023 8:56
5	39	49	248	N	4/3/2023 8:56
6	40	48	355	N	4/3/2023 8:56
7	40	47	411	N	4/3/2023 8:56
8	40	46	421	N	4/3/2023 8:56
9	41	45	117	N	4/3/2023 8:56
10	42	44	118	N	4/3/2023 8:56
11	42	43	119	N	4/3/2023 8:56
12	43	42	121	N	4/3/2023 8:56
13	47	35	117	N	4/3/2023 8:55
14	50	25	111	N	4/3/2023 8:55

Figure 7: Sample Dataset

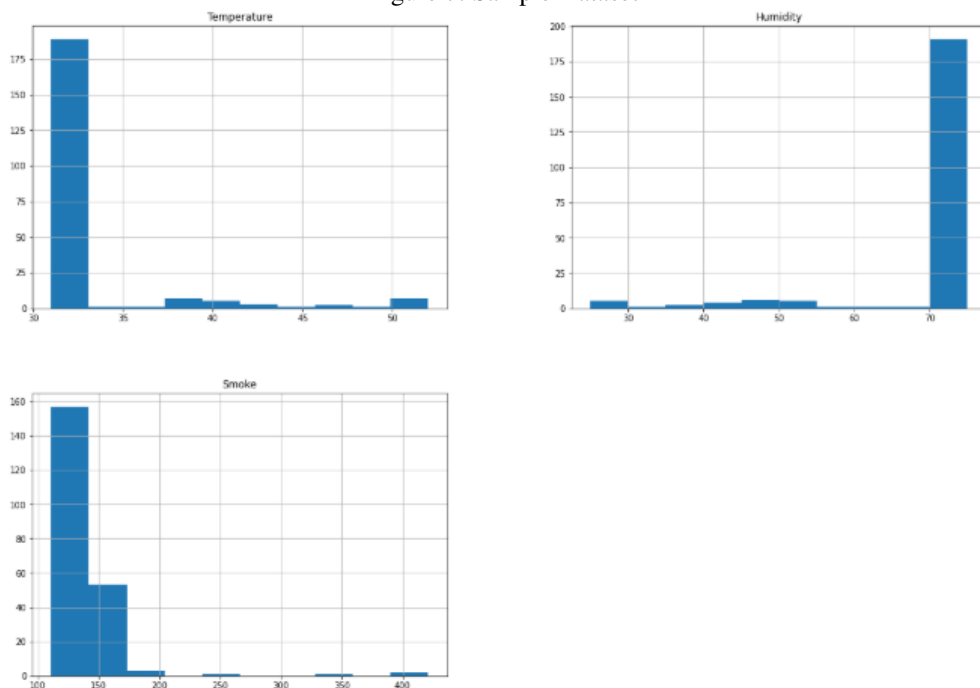


Figure 8: Histogram based Sensor Datas

The information that is kept in the database is made up of values obtained from a variety of sensors, including temperature sensor, humidity sensor, and smoke sensor, in addition to datetime information. Figure 8 presents a





histogram of the sensor values, which may be found here. The date-wise sensor data that were acquired are displayed in Figure 9.

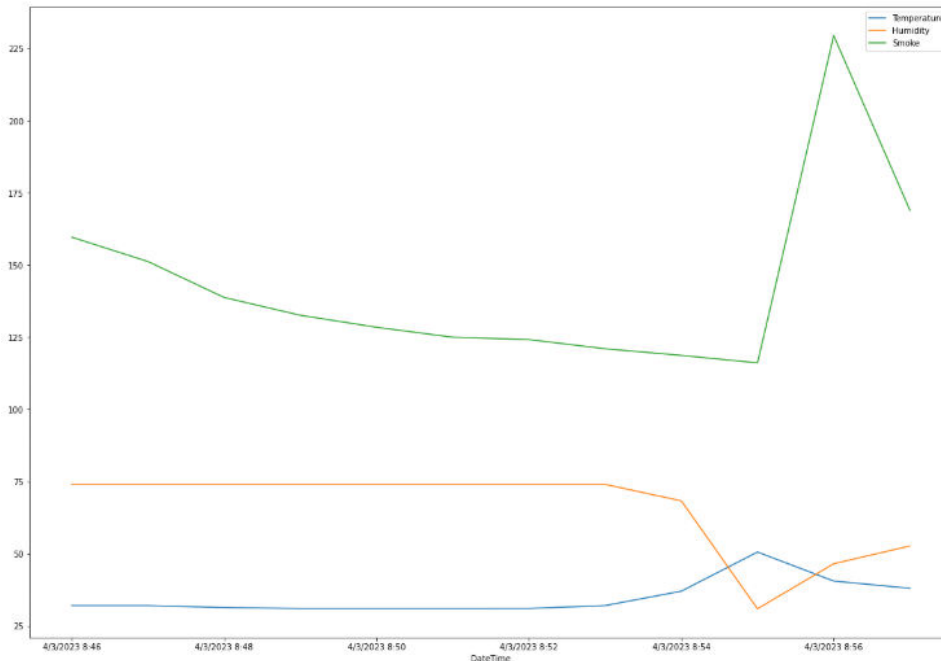


Figure 9: Datewise Sensor variables

An artificial neural network, often known as an ANN, is a computer program or piece of hardware that mimics the way neurons in the human brain communicate with one another. ANNs, or just neural networks, are a subset of the category of technology known as deep learning. Both of these categories are subsumed under the umbrella term artificial intelligence, abbreviated as AI. The initial layer of any neural network is known as the input layer, and it is responsible for representing the data that is fed into the network. In the picture that can be seen above, each neuron corresponds to one characteristic of the dataset and is represented as a little circular node (x1, x2,..., xn). It is essential to have a solid understanding of the input layer and its function inside the neural network in order to develop and train effective models. The output layer of a neural network is where the complete predictions that have been created by the network are stored. The required number of outputs for a particular input determines the number of neurons that should be present in this layer of the network. When a single output value is anticipated in a regression issue, there will only be one neuron in the output layer of the neural network. When doing classification tasks, on the other hand, if there is the possibility of several output classes, there will be many neurons, one for each class. Sometimes the links between the input and output pairs might be rather complicated, and in order to decode these interactions, there are hidden layers placed in between the input and output layers. Neurons are also present in the hidden layers, and each neuron in an adjacent layer is connected to its neighboring neurons. As an illustration, all of the neurons in the input layer as well as the neurons in the hidden layer 2 will be connected to the neurons in the hidden layer 1. The accuracy of the proposed ANN model was determined to be 92%. Figures 10 and 11 present the Classification report and Confusion Matrix for the Proposed Model, respectively.

	precision	recall	f1-score	support
0.0	1.00	0.88	0.93	24
1.0	0.75	1.00	0.86	9
accuracy			0.91	33
macro avg	0.88	0.94	0.90	33
weighted avg	0.93	0.91	0.91	33

Figure 10: Classification Report of ANN

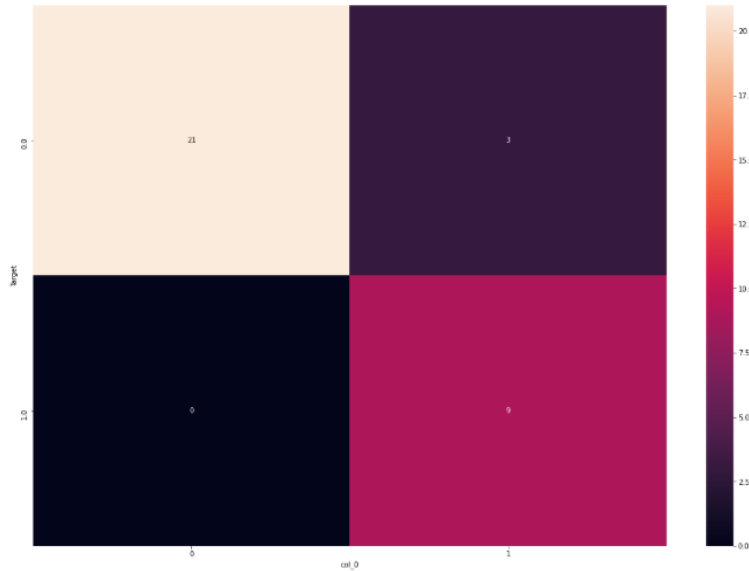


Figure 11: Confusion Matrix of ANN

## V. CONCLUSION

The most important things to take to prevent catastrophic losses and damage to one's natural and social heritage are to be alerted in a timely manner and to respond quickly in the event of a fire outbreak. As a result, the most important goals in flame observation are to quickly and accurately identify the fire and to contain it. When the origin of a fire can be located, together with the fact that it is still in its early stages, putting out the blaze is a lot less difficult. While fighting a fire at whichever stage it may be in, having information about how the fire spreads is also quite helpful. In light of these findings, the personnel charged with fighting fires might be directed to concentrate on putting a stop to the blaze before it reaches any social legacy locations and doing so as quickly as possible by making use of the necessary firefighting equipment and vehicles.

## REFERENCES

- [1] N. Tripathi, D. Obulesu, A. S. S. Murugan, V. Mittal, B. Ravindra Babu and S. Sharma, "IOT Based Surveillance System for Fire and Smoke Detection," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), Uttar Pradesh, India, 2022, pp. 1557-1563, doi: 10.1109/IC3I56241.2022.10072509.
- [2] V. r. Karumanchi, S. H. Raju, S. Kavitha, V. L. Lalitha and S. V. Krishna, "Fully Smart fire detection and prevention in the authorized forests," 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), Coimbatore, India, 2021, pp. 573-579, doi: 10.1109/ICAIS50930.2021.9395969.
- [3] V. Venkataramanan, G. Kavitha, M. R. Joel and J. Lenin, "Forest Fire Detection and Temperature Monitoring Alert using IoT and Machine Learning Algorithm," 2023 5th International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2023, pp. 1150-1156, doi: 10.1109/ICSSIT55814.2023.10061086.
- [4] R. Vega-Rodríguez, S. Sendra, J. Lloret, P. Romero-Díaz and J. L. Garcia-Navas, "Low Cost LoRa based Network for Forest Fire Detection," 2019 Sixth International Conference on Internet of Things: Systems, Management and Security (IOTSMS), Granada, Spain, 2019, pp. 177-184, doi: 10.1109/IOTSMS48152.2019.8939193.
- [5] K. Sood, M. R. Nosouhi, N. Kumar, A. Gaddam, B. Feng and S. Yu, "Accurate Detection of IoT Sensor Behaviors in Legitimate, Faulty and Compromised Scenarios," in IEEE Transactions on Dependable and Secure Computing, vol. 20, no. 1, pp. 288-300, 1 Jan.-Feb. 2023, doi: 10.1109/TDSC.2021.3131991.
- [6] K. Jayaram, K. Janani, R. Jeyaguru, R. Kumaresh and N. Muralidharan, "Forest Fire Alerting System With GPS Co-ordinates Using IoT," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 2019, pp. 488-491, doi: 10.1109/ICACCS.2019.8728383.
- [7] M. Antunes, L. M. Ferreira, C. Viegas, A. P. Coimbra and A. T. de Almeida, "Low-Cost System for Early Detection and Deployment of Countermeasures Against Wild Fires," 2019 IEEE 5th World Forum on Internet of Things (WF-IoT), Limerick, Ireland, 2019, pp. 418-423, doi: 10.1109/WF-IoT.2019.8767331.



- [8] A. Tehseen, N. A. Zafar and T. Ali, "Graph Theory-Based Formal Modeling of Forest Fire Management System using IoT and Drone," 2021 International Conference on Communication Technologies (ComTech), Rawalpindi, Pakistan, 2021, pp. 132-137, doi: 10.1109/ComTech52583.2021.9616876.
- [9] G. Pettorru, M. Fadda, R. Girau, M. Anedda and D. Giusto, "An IoT-based electronic sniffing for forest fire detection," 2023 IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, 2023, pp. 1-5, doi: 10.1109/ICCE56470.2023.10043411.
- [10] A. Tehseen, N. A. Zafar and T. Ali, "Algorithm-based Dynamic Formal Model for Forest Fire Detection & Extinguishment System," 2021 International Conference on Frontiers of Information Technology (FIT), Islamabad, Pakistan, 2021, pp. 170-175, doi: 10.1109/FIT53504.2021.00040.



Impact Factor: 8.423



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details