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IoT based Smoke Detection with Air Temperature and Air Humidity; High Accuracy with Machine Learning

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Abstract: In the present technologically advanced society, new innovations are being developed constantly. An ever-expanding network that constantly works to exchange and acquire information on the newest trends in the industrial IoT Platform is the source of these new developments in IoT communications-based projects. Home automation is a way to remotely or automatically control household equipment from the tip of your finger. The user will then be able to afford solutions, improve energy conservation, and make the best use of energy. The development of IoT home automation has been greatly aided by the detection of fire in this next technology. A sudden destructive event like fire has the potential to quickly spread, resulting in significant losses of both societal goods and human lives. Preventive actions are essential necessary since, in the event of a fire, prevention is always preferable to cure. This necessitates the need to develop a fire safety equipment in both home and workplace. More attention has been given to an IoT-based automatic smoke detection system to detect smoke in a room and even keep track of it. Additionally, it enables us to notify users and the Fire and Rescue Department when a gas sensor detects a particular amount of smoke. These smoke detectors can emit an audible and visual signal locally in a home smoke detector or smoke alarm, or they send a signal to a fire alarm control panel as part of a building's central fire alarm system. Utilizing an automatic smoke detection system. The Internet of Things (IoT) is used in this automatic smoke detection system to operate all the devices, and a Wi-Fi shield serves as a bridge to connect the devices to the network so that the data from the smoke sensor can be read. The smoke situation in a home that the user can access via the Favoriot platform is continuously monitored by this system.

Keywords: Internet of Things (IoT), Smoke Detection, Machine Learning (ML), Home Automation.

I.INTRODUCTION

The internet of things is used to link the physical world's network to computer-based systems. The expansion of the Internet through the consideration of physical objects combined with the ability to provide more perceptive services to nature as more information becomes available are what drive the Internet of Things [1] are shown in figure 1. The newly introduced fire alarm system is a real-time monitoring system that tests for the presence of smoke up to a predetermined threshold; if the threshold is crossed, the smoke sensor detects a fire, the buzzer turns on, and a message is sent. To detect fire or smoke, a variety of instruments and technologies have been employed. The majority of conventional techniques employ equipment with sensors. The biggest drawback of such sensors is that they often only have the ability to detect fire or smoke in the immediate area where they are positioned. This limits their utility in sizable covered spaces [2]. The direction, position, or size of the fire cannot be accurately determined by fire or smoke detection equipment. The purpose of a gas or smoke detector is to identify the presence of a specific amount of gas or smoke at a predetermined concentration level. These detectors are employed in both household and commercial settings to alert people to potentially hazardous levels of gas and/or smoke concentration. These sensors' sensitivity can be altered, allowing users to choose the concentration levels at which they can react. Despite the fact that they can be employed in challenging environments and circumstances where it may be impossible to deploy humans owing to the risk involved, gas and smoke detectors are often known for their inexpensive cost [3].

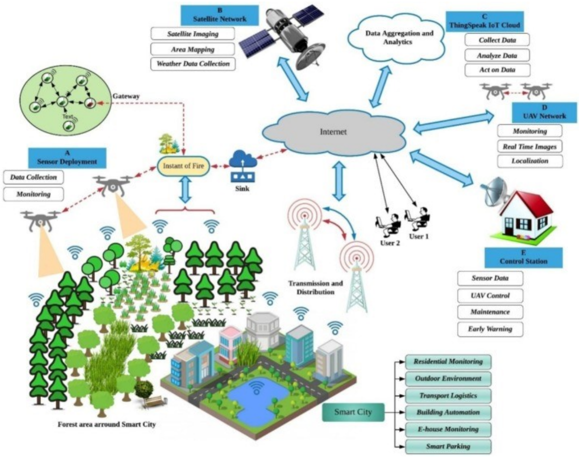

Figure 1. IoT Based Smoke Detection System with Machine Learning.

II.LITERATURE SURVEY

Numerous authors have conducted research and written about the efficacy of various types of gas and smoke detectors in detecting potentially hazardous gas leaks and/or smoke discharges into the atmosphere. These writers have examined the findings of their own research and written about their findings. These writers come from a variety of backgrounds, including academia and business. In order to identify potentially hazardous gases like methane and carbon monoxide, Patle and his co-workers developed a gas detection system that makes use of three different gas sensors. [4] Zampioglou et al came up with an olfactory system that was based on a to differentiate the smell of ascomycete tuber on a metal oxide sensor array [5]. The foundation of their method was a. This technique of detection was designed expressly with truffles in mind when it was invented. In this research that has been conducted, one of the topics that has been brought up for debate is how a gas and smoke detection system might be improved. The system makes use of a MQ-5 gas sensor, which is able to identify whether or not there is LPG, natural gas, or coal gas present in the environment. This may be accomplished by comparing the sensor's readings to a database. The existence of a signal amplifier within the system will allow for the output signal to be amplified in response to the detection of the presence of gas inside the system. This will take place at any moment when the system is operational. The impact that is meant to follow is that the alarm system of the gas detection system that has been presented will begin to operate whenever it detects the presence of gas. This is the effect that is supposed to follow. This is the result that was anticipated. Because of its low cost, broad availability, and high degree of reliability, the Arduino mega 2560 microcontroller was selected to serve as the "brain" of the gadget system [6]. This decision was made for a number of reasons.

This research project should:
1. Count the amount of gas and smoke that were discovered;
2. Notifies the user when smoke, LPG, butane, methane, or propane is present;
3. All gathered information is communicated to the IOT module [7].

Smoke and gas detectors have a wide range of uses and are continuously being researched. The work done in the field of gas detector is highlighted in the following subsections. Choosing the right gas sensor type for a given application is one of the first obstacles in selecting a gas detection product or sensor. Sensor technologies have various drawbacks and are not appropriate for all applications using gases or gas kinds. Our choice of products will be aided by knowledge of the characteristics of the various sensor technologies used to detect gas [8]. For gas monitoring, selecting the appropriate sensor type necessitates an evaluation of a variety of variables, including target gas, price, sensor placement, temperature and humidity of the surroundings, oxygen content, power usage, and cross interference. The possibilities and difficulties of various fog system applications in the context of smart cities are examined [9]. The presentation of a smart parking application utilising WSN and IoT. In this application, the importance of data security, privacy, dependability, and design challenges is highlighted. With the efficient deployment of WSN, the lifetime of the smart city network can be increased. It is crucial to continuously monitor and save the data that the sensors collect. The sensors regularly gather and store information, and this data is analysed in a cloud environment [10]. Due to the abundance of sensor data, efficient processing of all of it is necessary. Big data analytics satisfies the demands of real-time data processing. By developing effective protocols for data exchange, the power required to handle this massive amount of data can be decreased [11].

III.PROPOSED WORK

In this automated smoke detection system, every piece of equipment is controlled by the Internet of Things (IoT), and a Wi-Fi shield acts as a bridge to connect the devices to the network so that the data from the smoke sensor can be read. This allows the system to detect and respond to fires more quickly. Because of this, the system is now able to automatically detect smoke. The information obtained from the smoke detectors may then be employed to help identify the appropriate next step to take. This technology performs continuous monitoring of the smoke situation inside a home and then makes that information accessible to users via the Favoriot platform. Using the ESP8266 Wi-Fi shield, which is used to link the devices together and connect them to the network

[12], the data from the smoke sensor may be maintained up to date on the Favoriot platform. This is possible because the shield is used to connect the devices to the network. If the smoke detector is able to interact with the Arduino Uno by way of the transmission of a signal indicating the presence of smoke, then the alarm will be activated. In the case that a fire is found, a notice will be issued to the Fire and Rescue Department, and concurrently, an update about the current state of the smoke level will be provided on the Favoriot platform. A buzzer will ring and an LCD display will show the phrase "Leakage detected" when a gas leak is found. When a gas leak is found, the buzzer will sound. This investigation's primary emphasis is on locating and verifying the source of any flames that may have been present [13]. [Further citation is required] When it comes to the vast majority of fire detection systems, the confirmation stage of the process is often when customers run into the greatest problems. In order to prove beyond a shadow of a doubt that there was a fire, this approach uses image processing on the photographs that were acquired from the region that was hit by the fire. Figure 2 depicts the Smart Fire Detection System (SFDS), which is essential for both the collection of data and the detection of fires. Both of these tasks are shown in the figure. This figure presents an overview of the SFDS for your perusal. In addition to that, the components of the SFDS are emphasized in bold type throughout the document. Leveraging this technology enables demonstrations of applications like the Internet of Things and wireless sensor networks [14]. The information that can be gained from sensors and other components of the Internet of Things (IoT) can be put to use in the creation of a wide variety of applications by a wide number of users, including commercial corporations, public agencies, and individual consumers. This information can be put to use in the creation of a broad variety of applications by a wide number of users. The technology that has been suggested for use in the context of a smart city has the potential to be utilized for the detection of fires, and this is an important prospective use. It is possible to improve the effectiveness of the system by basing decision-making not only on the data obtained from the sensors but also on the results of image processing. This will allow for a more comprehensive analysis of the situation. Because of this, a more comprehensive analysis of the circumstance will be possible. The integration of intelligent gadgets, sensors for the internet of things, and photo processing in real time makes smart cities much more effective [15]. A cloud gateway is used so that the information that has been acquired from the sensors may be sent. In the beginning of the process, data on the environment is acquired by randomly positioning sensors for smoke, light, humidity, and temperature. These sensors measure temperature, humidity, and light. These installations are located in a variety of different locations. The data that is gathered from each of the sensor nodes is stored and analysed by the sink node, which is a component of the Thing Speak cloud platform. This node is responsible for the storage and processing of the data. In order to make it feasible for the program to carry out activities that are specific to it, the data are analysed [16].

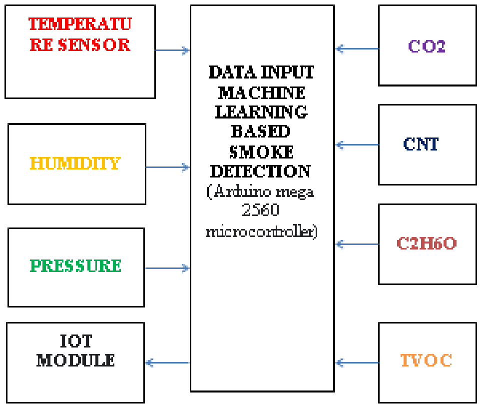

Figure 2. IOT based data analysis for smoke detection.

The positioning of the sensor nodes that are used during the sensing stage enables continuous monitoring of the environmental conditions that have been linked to the start of fires [17]. Because the information that is obtained from the sensors is routinely updated on the cloud platform, it is feasible to undertake constant monitoring and analysis of the situation. In the event that anomalies are discovered during the processing phase, the data from the sensor are examined, and a decision is made about what should be done with them. Users at faraway locations are able to access the data that is kept in the cloud by logging in with the credentials that have been provided to them. If information is monitored on a consistent basis, the user is able to discover any potential dangers or fire occurrences at an earlier stage. Even in the scenario when both occurrences take place at the same time, this remains the case. The presence of the fire may be verified by the use of an image processing approach that makes use of an unmanned aerial vehicle (UAV) [18]. The unmanned aerial vehicle (UAV) travels to the site of the accident and gathers visual information in real time, which is then sent to a distant location. It is possible for an endless number of controllers and users to be located in a distant location and yet still have access to the data that is kept in the cloud. This is made possible by cloud computing. The control station is in charge of monitoring and directing all communication and is responsible for keeping track of it. Image processing methods are used in order to zero down on the particular areas of the forest where the fire is taking place. When it is determined that there is a fire, an alarm is triggered, and a notification is sent to the management team in order to give them with the chance to take the proper following actions [19]. At the distant location, there might be any number of controllers and users, and each of them would be accessing the cloud-based data that was being kept there. The control station is in charge of monitoring and directing all communication and is responsible for keeping track of it. Image processing methods are used in order to zero down on the particular areas of the forest where the fire is taking place. As soon as it is determined that someone ignited a fire, an alarm will be triggered, and a notification will be sent to the management team so that they may take the necessary precautions.

A. Temperature

A temperature sensor is a term used to refer to an electrical device that may record temperatures, monitor temperatures, or signal changes in temperature. A temperature sensor is able to do this by taking readings of the temperature in its immediate environment and then converting those readings into digital form for further analysis. Using temperature sensors allows for another method of conveying information on changes in temperature. Temperature sensors may be found in a mind-boggling variety of configurations, both in terms of their dimensions and their forms. Figure 3 illustrates the fact that some temperature sensors, which are referred to as contact temperature sensors, need physical contact with the object whose temperature is being monitored in order to provide an accurate reading of that object's temperature. On the other hand, certain temperature sensors are able to determine an object's temperature by using a method that is indirect (non-contact temperature sensors).

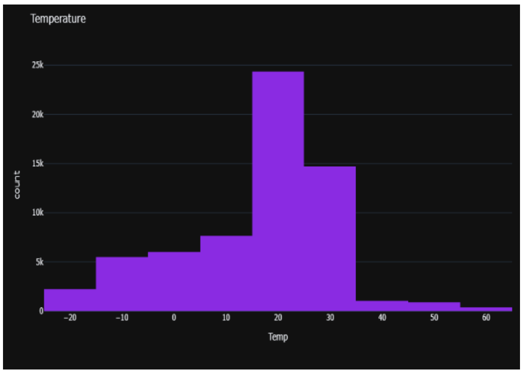

Figure 3. Measured temperature in the given environment.

B. Humidity

A humidity sensor, often known as a hygrometer, detects, gauges, and reports both air temperature and moisture content. Relative humidity is the ratio of the amount of moisture in the air to the maximum amount of moisture at a specific air temperature. Figure 4, The relative humidity becomes crucial for determining comfort. In order to function, humidity sensors must be able to detect changes in electrical currents or air temperature.

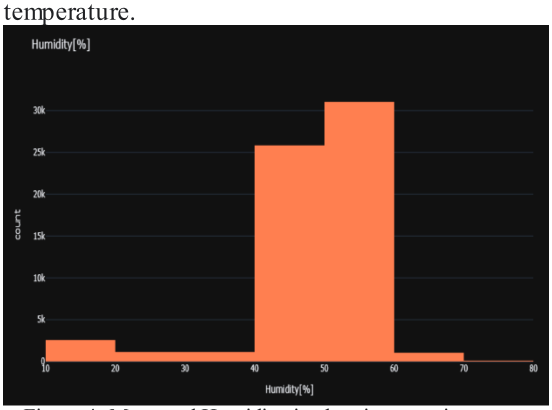

Figure 4. Measured Humidity in the given environment.

C. TVOC detection (Total Volatile Organic Compounds)

To make reporting when these are present in ambient air or emissions easier, a wide spectrum of organic chemical compounds is grouped together as TVOCs. Many things could be categorised as volatile organic compounds, including natural gas (VOCs). VOCs are used to describe these pollutants in contaminated air which is represented in figure 5; in other words, they often refer to the gaseous vapours that compounds emit as opposed to their liquid form [23].

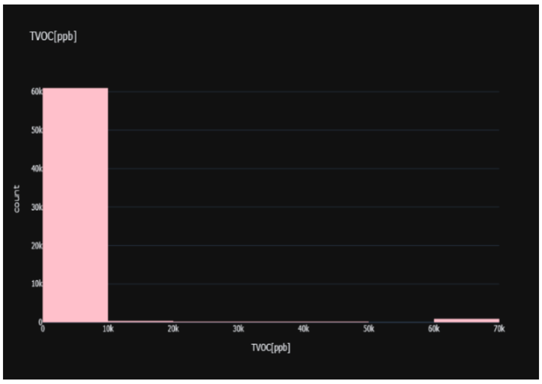

Figure 5. Measured TVOC in the given environment.

D. Co2

Carbon dioxide (CO_2) is a gas that is created as a by-product of respiration, combustion, and the breakdown of organic matter. These three processes all contribute to the production of carbon dioxide. To put it another way, it is a gas that is produced as a by-product of the decomposition of organic materials. Every one of these three processes has an effect, whether little or significant, on the production of carbon dioxide. This gas is odourless and transparent to the human eye, and it does not give off any discernible colour. In addition to this, it is a highly valuable process gas, which means that it can be utilized in a broad range of enterprises and vocations that fall under a number of different categories of the economy. The measurement of carbon dioxide is needed for a wide range of applications in a vast number of various kinds of manufacturing fields. These industries include, but are not limited to, the brewing business, the beverage industry, the pharmaceutical industry, and the refrigeration industry, among others. Figure 6, which may be seen on this page, provides a convenient visual representation of the plotted measurement. Applications that could benefit from using this technology include monitoring combustion processes, environmental CO2 emission levels, indoor air quality, the function of the lungs during surgical procedures, and indoor air quality. These are only a few examples of the many potential applications that could be feasible.

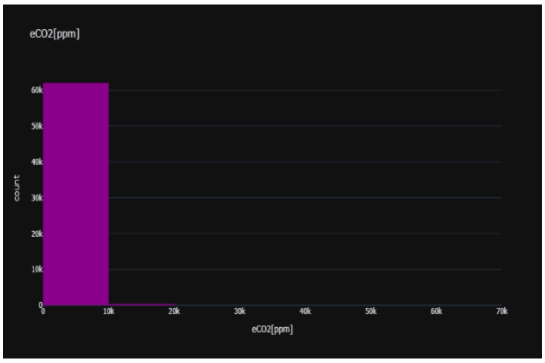

Figure 6. Measured CO2 in the given environment.

E. Carbon Nanotube Chemical Sensors (CNT)

It is possible for charge transfer to be induced either directly or indirectly through analyte interactions, and this might be used to modulate the conductance of the CNT. This would be the case if the concentration of the majority charge carriers was changed (increased or reduced), which would then produce a fluctuation in the conductance of the CNT. In other words, the concentration of the majority charge carriers would determine the outcome. Figure 7, which may be seen by clicking this link, demonstrates the potential financial worth of the CNTs that may be located there. When exposed to their natural environment, some types of CNTs undergo a transformation that causes them to become p-doped. This transformation is caused by the physical adsorption of oxygen molecules onto the surface of the CNTs. Because of this, the presence of extra p-type dopants will have the effect of increasing the hole conduction while simultaneously lowering the resistance, but the presence of additional n-type dopants would have the reverse effect. It has been shown that a sensing technology that involves a direct charge transfer between polar analytes and carbon nanotubes is one that has the potential to be useful for detecting this kind of analyte. Depending on the specifics of the situation to which this approach is used, it is possible that it will take on a more constrained aspect.

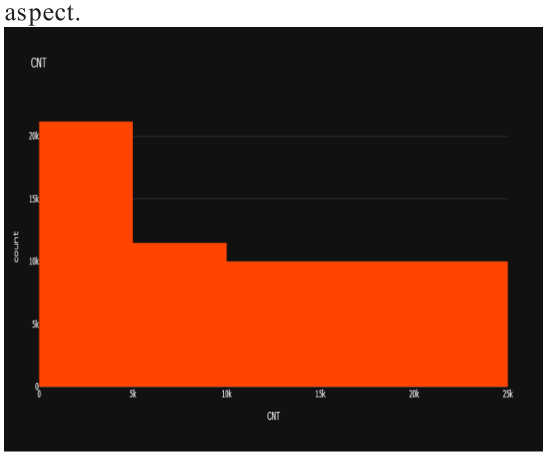

Figure 7. Measured CNT in the given environment.

F. RAW ETHANOL

This article provides details on the properties of ethanol (C_2H_6O), also known as ethylic alcohol, as well as its effects on human health. It also discusses ethanol gas detectors and respiratory protective gear (such as a gas mask or powered air purifying respirator with a gas filter) that can be used to protect against these vapours. One of the earliest biotechnologies used to make alcoholic beverages is the fermentation of sugar to produce ethanol (C_2H_6O), often known as ethylic alcohol or alcohol. It is a raw ingredient used to create a variety of compounds and is utilised in industries as a disinfectant or solvent. Ethanol can be converted into bioethanol, a biofuel (European E85), by being concentrated and hydrated. Any sector can benefit from the technologically advanced, creative products offered by RC Systems, which offer dependable, affordable combustible gas detection solutions. You can customise our single and dual sensor ethanol gas detection sensors based on your application requirements which is shown in figure 8. Pure ethanol is highly flammable and can make you cough and get headaches if you breathe it in. Additionally irritating to the eyes, ethanol can enter the body through the skin. Exposure can result in respiratory paralysis in the worst of circumstances. Effective gas monitoring procedures lessen the risk of fire and other catastrophic occurrences while preventing health problems. Use ethanol detection tools in any application where there is a chance of exposure, such as when producing food and beverages or checking gas levels at tank farms. Depending on your needs, use our high-performance ethanol sensors to monitor one or more gases. Colourless and volatile, ethanol (C_2H_6O) has a sweet aroma that may be detected at 84 parts per million. It is easily absorbed through the skin or breathed.

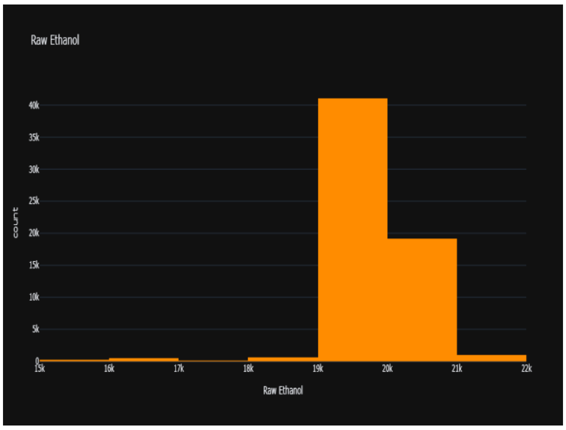

Figure 8. Measured Raw Ethanol in the given environment.

There are several well-known and primarily neuropsychic acute intoxication symptoms caused by ingesting alcohol, including excitement of the mind and body, poor coordination, alcohol coma, and even respiratory paralysis.

G. PRESSURE

When it comes to the science of measuring pressure, there is a kind of instrument called a pressure sensor that is a form of gadget that may be used with either gases or liquids. One way to think about the pressure of a fluid, which is commonly referred to as the amount of force that is exerted in proportion to the volume of the fluid, is the quantity of force that is required to stop the fluid from growing in volume. This is one way to think about pressure. Another way to think about pressure is as the amount of force that is necessary to prevent the fluid from growing in volume. Because it will produce a signal in reaction to the pressure that has been applied to it, a pressure sensor will almost always function as a transducer. This is because pressure sensors create signals in response to the pressure that is applied to them. According to the data that was provided in this article, a signal of this sort may be considered to be electrical. In order to keep track of and maintain command over the many different activities that take place on a daily basis, pressure sensors are used in a wide variety of different contexts. Pressure sensors may also be used to produce indirect measurements of a wide number of other parameters, such as the flow of fluids or gases, speed, water level, and height, to name just a few examples of these types of measurements. In addition, there is a category of pressure sensors that are designed to measure in a dynamic manner so that they can record extremely fast changes in pressure. These sensors may be found in certain pressure monitors. These kinds of pressure sensors are referred to as "dynamic pressure sensors." The term "dynamic pressure sensors" refers to these particular kinds of pressure sensors. Using this kind of sensor, which is versatile and can be put to use in a variety of contexts, one is able to detect the pressure of the combustion taking place inside of an engine cylinder or inside of a gas turbine. The next paragraph will list two of these applications: Quartz and many other forms of piezoelectric materials are the kinds of materials that are used the vast majority of the time in the process of fabricating these sensors. It is more difficult than it first appears to gather training data for this system. To guarantee a good dataset for training, a variety of habitats and fire sources must be sampled. Several such circumstances that are recorded include the following: ordinary outside. Given that our smoke detector relies on battery power, it makes reasonable to consider ways to streamline the model's calculations and simplify it while maintaining high model accuracy shown in figure 9. To achieve all requirements might be a very challenging procedure. This experiment demonstrates that adding more metadata alone can effectively solve complicated problems using sensor fusion. Metadata addition to the "smoke sensor" helps lessen false warnings. Such inexpensive sensor systems can prevent fatalities because they can be trained to recognise fire gases that cause dizziness.

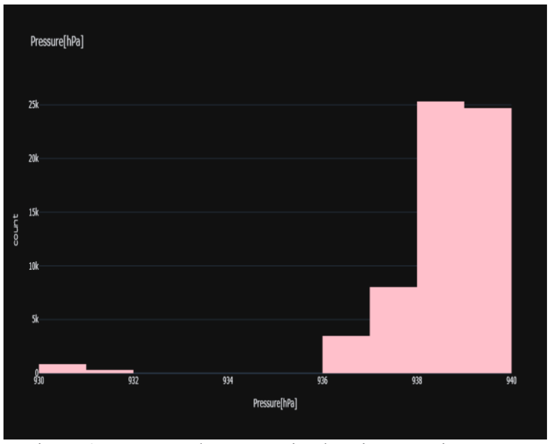

Figure 9. Measured Pressure in the given environment.

H. CROSS MATRIX

Positive is denoted by yellow, and negative by violet. The correlation magnitude increases as the colour intensity does. Observe how weak connections visually vanish, and how your eyes are pulled to areas with high correlation right away. Also, the negative and positive values (lighter violet vs. lighter yellow) are compared. In figure 10, a cross matrix has been created and found the relation between individual parameter and the rest of all the parameters. The yellow colour shows that there is a strong relationship with the two parameters and violet is the least.it can be viewed there is a more correlation between PH and NC. Also, from the plot we can understand that there is a least correlation with other all parameters.

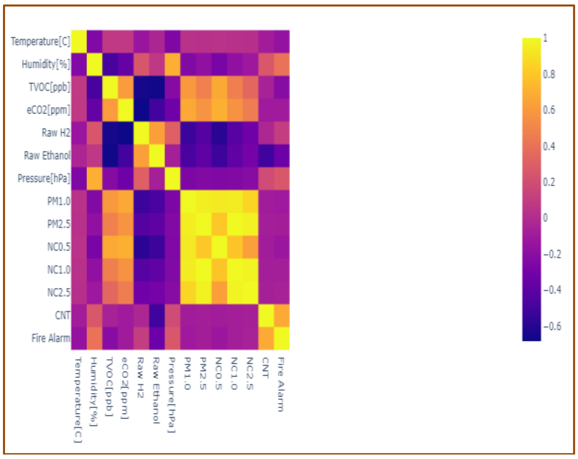

Figure 10. CROSS MATRIX of Correlation Between Other Parameters

IV. Conclusion

Due to various infrastructure upgrades and the adoption of smart cities, all nations have serious worries regarding fire detection and extinguishing. Effective technologies can operate at their best when these worldwide calamities are avoided. With the help of the WSN platform and IoT sensors, early fire detection is made possible. The World Social Network is hosted on the Sense nuts platform. Using the deployed sensor nodes, real-time data is gathered and examined both internally and externally. The whole data collection is maintained in cloud storage for future analysis. The Thing Speak cloud application is used to evaluate factors such as light intensity, humidity, temperature, smoke, and other elements. On the basis of precise fire detection and environmental sensor inputs, real-time data is analysed. This research shows how an IoT and cloud-based fire detection system may be effective. Real-time data can be monitored and gathered with this method in a practical and economical manner. A further efficiency boost comes from the incorporation of an image processing approach. Making several rules improves detection precision. Tests are conducted using example photos to see how well the system detects fire in its early stages. The method yields remarkably precise categorization results. Future research will concentrate on sensor network adaptation and hardware optimization for fire detection in different situations.

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