Advanced Air Quality Monitoring System Employing Neural Network and Blockchain Technology

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Abstract- **Due to causes including industries, urbanisation, population growth, and vehicle use, which might have an adverse effect on human health, the level of pollution is rising quickly. Using an internet-based application, an IOT- based air pollution monitoring system is used to track air quality. Due to causes including industries, urbanisation, population growth, and vehicle use, which might have an adverse effect on human health, the level of pollution is rising quickly. An Internet of Things (IoT)-based air pollution monitoring system uses a web server to monitor air quality. The Internet of Things (IoT) links and manages data, while inexpensive sensors gather environmental data. Temperature, humidity, particulate matter, carbon dioxide, carbon mono oxide, and LPG make up the indoor air quality system. The NN decision-making algorithm uses input from five different sensors to estimate the AQI and avert dangerous scenarios. The proposed IoT-based smart block- chain solution contributes significantly by offering dependability, scalability, and privacy. This study will function well in terms of system maintenance, costeffectiveness, and convenience of use.**

Index Terms: **Block chain, Air Quality index, Pollution monitor, Neural Network, Internet of things.**

1.INTRODUCTION

Quite possibly of the most disturbing issue in present day urban communities is the air quality level, where air contamination has caused 120 passings out of 100,000 every year founded on an overall report (Green Vehicle Congress, 2019). The World Wellbeing Association underscored that 97% of urban areas in low-and center pay nations with in excess of 100 000 occupants don't meet World Wellbeing Association (WHO) air quality rules. Because of unfortunate air quality, it will increment potential well-being dangers like gamble of stroke, coronary illness, cellular breakdown in the lungs, asthma and others too

(reference). Subsequently, there is a need to introduce an air quality observing framework in urban communities to guarantee the air isn't tainted. This should be possible by introducing sensors to screen dust particles, carbon dioxide, carbon monoxide, nitrogen dioxide and sulfur dioxide levels and this data can be imparted to general society through cell phones, where the cell phone applications

permits individuals to screen ongoing information of the ongoing air quality level nearby. Subsequently, through these executions, better personal satisfaction can be accomplished. Respiratory issues are extremely normal among many individuals because of air contamination and harmful substance of air. Carbon monoxide, Carbon dioxide, Sulfur dioxide, Nitrogen dioxide, Lead are sure air toxins regularly known as Models poisons. Organisms, molds, Creature skins, pets, bugs are normal among the natural contamination Air contamination is a significant disadvantage of the ongoing climate and it is a deterrent for general wellbeing. Air contamination causes numerous unfriendly wellbeing impacts in people, different organic entities, for climate, varieties in climatic circumstances and changes in life pattern of everything.

Unsafe gases in the air is the justification for every one of the impacts referenced above by which the whole world endures a great deal.

IOT and man- made consciousness-based frameworks will be much useful for the observing of climate. Calculations like ANN, CNN, KNN, SVM, Arbitrary Woods are pre overwhelmingly utilized for the climate checking. The observed information or estimated information is associated with Think Talk. The climate information acquired can be observed from anyplace. Here Indoor Air Quality Check (IAQC) is considered for making a shrewd home with contamination free or contamination less. Air quality in light of toxins level which has the boundaries like Carbon dioxide, Nitrogendioxide, Sulfur dioxide and so forth .

Temperature likewise affects climate. Different sensor hubs incorporated alongside IAQC observing will betterly affect air quality. This paper gives the examination of different strategies included and improved impact in view of the

proposed strategy. Adjusted Navie bayes calculation is proposed here to break down and give the information. The proposed framework has a microcontroller ESP8266 and different sensor hubs for estimation of different boundaries. DHT22 is a mugginess and temperature sensor for estimating the temperature and stickiness of the climate. The information estimated from DHT22 is connected with the regulator. MQ5 is a gas sensor utilized here. MQ5 is delicate to LPG, Hydrogen, and propane. The critical idea of this paper is to give the crisis ready when the air quality isn't satisfactory by individuals are in industry as well as home areas. The paper requested follows covers Air Quality observing framework for its current strategy. Segment III covers the given strategy and contention of the tests accomplished to show the presentation of the different blocks of the AMS.
Area IV has the finish of proposed strategy. Air quality checking framework Certain techniques like AQ forecast based models gives the toxins focus in view of the typical information of the different strategies. The outcome was gotten in view of the mean qualities. Measurable techniques and ML based strategies for investigating the air quality are talked about further. As referenced by S.Ali in [1] minimal expense gadgets are utilized to quantify the different fixation s of gases like CO, NO2 . LORAWAN is involved here for transmission of sensor information. It gives great expectation of information in light of the sensor values.

2.RELATED WORK

Reviewing the landscape of existing IoT-based systems dedicated to monitoring air quality parameters like temperature, humidity, and pollutant levels using sensor networks. Investigating the utilization of blockchain technology in environmental monitoring systems, focusing on enhancing data integrity, security, and transparency. Exploring research on Neural Network (NN) algorithms employed for predicting the Air Quality Index (AQI) based on sensor data, considering factors such as particulate matter, carbon dioxide, and ozone levels.
Studying projects that integrate various sensor types (e.g., gas sensors, dust sensors) to provide comprehensive air quality data for analysis and monitoring. Examining approaches for real-time visualization and analysis of air quality data collected from IoT sensors to provide actionable insights. Reviewing mobile applications designed for air quality monitoring, allowing users to access real-time data, receive alerts, and make informed decisions based on AQI levels. Exploring tools and methodologies used for assessing the environmental impact of pollutants on human health and ecosystems, contributing to better decision-making. Investigating the use of wireless communication protocols (e.g., LoRaWAN, MQTT) for efficient transmission of air quality data from sensors to monitoring systems. Studying machine learning techniques such as Support Vector Machines (SVM), Random Forests, and K-Nearest Neighbors (KNN) for data analysis and prediction of pollutant levels in air quality monitoring. Exploring open data platforms that provide access to air quality data collected from various sources, promoting collaboration and research in the field. Examining community-based initiatives where citizens participate in collecting air quality data using IoT devices, contributing to a shared knowledge base. Analyzing the impact of air quality on public health through studies correlating air quality levels with respiratory illnesses, cardiovascular diseases, and other health outcomes. Discussing the role of environmental regulations and policies in addressing air pollution issues and fostering the adoption of IoT-based monitoring solutions. Investigating data fusion techniques for integrating data from multiple sources like satellite imagery and ground sensors to improve the accuracy of air quality monitoring. Evaluating the scalability and cost-effectiveness of deploying IoT-based air quality monitoring systems, considering factors such as sensor maintenance, data storage, and system upgrades.

3. PROPOSED METHODOLOGY

IAQ is a low-cost AQI monitoring system developed using Arduino, Humidity, Temperature, Carbon monoxide, Particulate Matter, Carbon dioxide, liquefied petroleum gas sensor, which is a gas leakage detection sensor. The solution is accessed by identifying the diversity of different factors such as as Humidity, Temperature, CO2, CO, PM, and LPG leakage. Figure 2 indicates the architecture of the suggested system. Five types of sensors are used that are connected using IoT and the block-chain system that communicates with Neural Network Algorithm(NNA) model that does processing on data taken from the sensor as input and predicts the result. The input data, processed data, and relevant information are continuously stored on a computer system and reported through warnings and indicators through different reports and signals as their confidence in the state of AQI environment to the system's user. This blockchain module was executed in java as blocks contents in a hash that is a distinctive identifier; each block can calculate a block hash, and the SHA- 256 hash is calculated from it. When a threshold is attained, a block is looped over to corroborate a block's hash for the validity of the complete block- chain. **Neural Network Algorithm (NNA) Model Used for Decision Support** Neural networks are widely used in many applications successfully. They act as real word functions/models Thismodel predicts the control of the system.Neural networks have processing elements linked to each other in layers. Usually, two layers connect with the real world. The output from the sensor is provided to the first layer, the input layer, whereas the output is the response to the system provided by the hidden layer that holds the packet of data as a buffer for output(s) of the system. Usually, feed- forward multilayer networks use backpropagation. A multilayer feedforward network used in this paper is shown in Figure 3. Neurons are divided into the input layer, the

output layer and the layers that are hidden. The hidden layers relay feed- forwards from the input layer to the output layer. The training of this network is compulsory in which thresholds and weights are determined. This training is necessary to reduce the error function. The error functions are described by the LMSA
(Least Means Square Algorithm).

$$E = \frac{1}{2}\sum k((T_k - O_k)^2)$$

where *Tk* and *Ok* are objectives and determine the output for output neuron *k* exclusively. Inputs received by the hidden node or layer and output layer are multiplied as *wij* and *wjk*.
The non-linear sigmoid function provides output on the hidden and output layers. Output layer known as *j* layer node input sum is given by Equation (2).

$$Net_j = a_j = \sum w_{ij} S_i + \theta_j$$

where *aj* is *j* neuron's present output state and in *wij*;*I* weight of *j* neuron on connections. The output sum of *j*th layer is given by Equation (3). *sj = f (net j)* (3) The threshold function is *f*, and by Equation (4) the sigmoid function is given. The output of the hidden layer is computed by
Equation

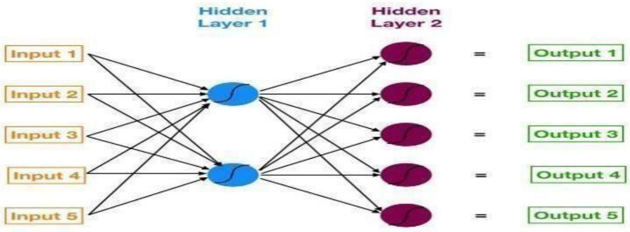
$$f(a_j) = \frac{1}{(1 + exp(-net_j - \theta_j))}$$

Layer-*k* node output is the sum of outputs that are described in

$$f(z) = (1.0 + e^{-z})^{-1}$$

$$S_k = f(a_k) = \frac{1}{(1 + exp(-net_k - \theta_k))}$$

NEURAL NETWORKS:
Neural networks are the workhorses of deep learning. And while they may look like black boxes, deep down (sorry, I will stop the terrible puns) they are trying to accomplish the same thing as any other model — to make good predictions. Neural networks are multi-layer networks of neurons (the blue and magenta nodes in the chart below) that we use to classify things, make predictions, etc. Below is the diagram of a simple neural network with five inputs, 5 outputs, and two hidden layers of neurons.



Starting from the left, we have: The input layer of our model in orange. Our first hidden layer of neurons in blue. Our second hidden layer of neurons in magenta. The output layer (a.k.a. the prediction) of our model in green.

SECURED HASH ALGORITHM: SHA-512 is a
hashing algorithm that performs a hashing function on some data given to it. Hashing algorithms find application in various domains, including blockchain technology, digital certificates, and internet security. This is an easy-to-follow tutorial for the hashing method SHA-512, which includes some fundamental and simple math along with some illustrations, as hashing algorithms are so important to digital security and cryptography. It is a component of the SHA-2 family of hashing algorithms, which also includes SHA-256 and is employed for hashing on the bitcoin blockchain.

HASHING FUNCTIONS
When given some data as input, hash functions generate an output (referred to as a hash digest) for that data that has a set length. For this output to be useful, it must meet a few requirements. Uniform distribution: It is obvious that there will be some output values that can be achieved for varied input values because the input size may vary and the length

of the output hash digest is fixed. Despite this, the hash function should be designed so that every conceivable output value should have the same likelihood for every given input value. In other words, for any given input value, there is an equal chance Of producing any potential result.Fixed Length: This one ought to be quite obvious. Every output value ought to have a set length. Thus, the output size of a hashing function could be, for instance, 20 characters, 12 characters, etc. The output size of SHA512 is 512 bits. The term "collision resistance" refers to the lack of, or the impossibility of, finding two different inputs to the hash function that provide the same output (hash digest).

Components of the IAQ system and their organization

The IAQ (Indoor Air Quality) System utilizes components organized within the Arduino integrated development environment (IDE). Arduino serves as the data collector, with sensors strategically positioned to provide inputs for the neural network decision support system. The sensors employed in this system include the DHT22AM2302 for monitoring temperature and humidity, the MG-811 for carbon dioxide (CO2) levels, the MQ5 for LPG (liquefied petroleum gas) values, the MQ7 for carbon monoxide (CO) concentrations, and the SPS30 for particulate matter data. Each sensor's key features and functionalities are detailed in subsequent sections.

The Temperature and Humidity Sensor DHT22AM2302

The AM2302 DHT22 sensor is utilized to gather humidity and temperature data within the subject program. It's known for being straightforward, widely available, costeffective, and user-friendly. In our current experimental configuration, we specifically chose the AM2302 model of the DHT22 sensor for its precise and calibrated output. Figure 4 illustrates the sensor used for temperature and humidity measurement.

MQ5 Liquified Petroleum Gas Sensor

The MQ5 LPG sensor is capable of detecting concentrations ranging from 0 to 10000 ppm. It operates on a 5 VDC input voltage and consumes 150 mA of power. The sensor produces a digital output voltage between 0.1 V and 5 V, which corresponds to TTL digital signals of 0 and 1. When the analog output voltage is clean, it falls within the range of 0.1 V to 0.3 V; for higher concentrations, the voltage output reaches 4 V. The sensor board measures 32 × 20 × 22 mm and features 4 pins with 0.1 mm spacingMQ5 Liquified Petroleum Gas Sensor.

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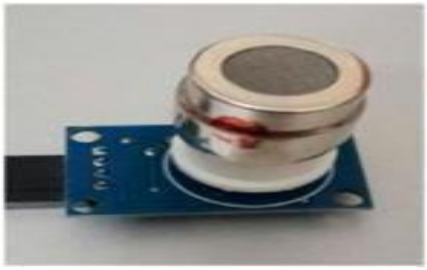
The MQ7 carbon monoxide (CO) sensor depicted in Figure 6 is capable of detecting CO concentrations ranging from 0 to 10000 parts per million (ppm). Its power requirement falls within the range of 2.5 to 5 volts. This sensor generates a digital output voltage between 0.1 and 5 volts, which corresponds to TTL digital signals of 0 and 1. When the analog output voltage is free from interference, it typically ranges from

0.1 to 0.3 volts. However, in cases where thereis a high concentration of CO, the output voltage deviates from this range s a high concentration of CO, the output voltage deviates from this range.

MG-811carbondioxide sensor

The MG-811 carbon dioxide (CO2) sensor offers both analog and digital output options through a straightforward drive circuit. It includes a trigger level configuration potentiometer that allows for adjusting the transition of output levels. The sensor operates at a DC voltage of 6 volts, with a preheatduration of 20 seconds. Refer to Figure 7 for an illustration of the CO2 sensor in use.



SPS30 Particulate matter sensor

The SPS30 Particulate Matter Sensor, depicted in Figure 8, is a compact and top-notch optical particle sensor. It employs laser scattering and advanced technology to resist contamination effectively, ensuring accurate binning and particle measurements. This sensor allows users to compute the mass concentration and count the number of particles measuring 1, 2.5, 4, and 10 micrometers per cubic meter (µg/m³).

Arduino UNO

The Arduino microcontroller features a total of 20 pins, with 6 designated as input/output (I/O) pins and 14 as digital pins, as illustrated in Figure 9. These pins are programmable using the Arduino Integrated Development Environment (IDE) to interface with various sensors and devices.

4.SIMULATION AND EVALUATION

The intelligent Indoor Air Quality (IAQ) system incorporating a neural network decision-making component is innovative and sophisticated. These systems are cutting-edge in their application and design. To evaluate the effectiveness of this system, researchers gathered data from a room on five key metrics: Carbon Monoxide levels, Carbon Dioxide levels, LPG concentration, Particulate Matter levels, as well as temperature and humidity.The temperature and humidity sensor continuously captures temperature readings in real-time, spanning from -40 degrees Celsius to +125 degrees Celsius. In their study, the authors categorized these temperature readings into five distinct levels to train the neural network algorithm effectively.

Table 1: Five Classifications of Temperature for Training Dataset

Temperature (°C)	Class
> 40	Very High
30–40	High
20–30	Normal
10–20	Low
< 10	Very Low

Table 2: Classes of humidity

Humidity (%)	Class
> 80%	Dangerous
70–80%	Threatening
50–70%	Healthy
35–50%	Normal
< 35%	Satisfactory

Table 3: Classes of Carbon Monoxide

CO (PPM)	Class
> 2000	Dangerous
1000–2000	Threatening
250–1000	Healthy
100–250	Normal
< 100	Satisfactory

Table 4: Classes of Carbon Dioxide

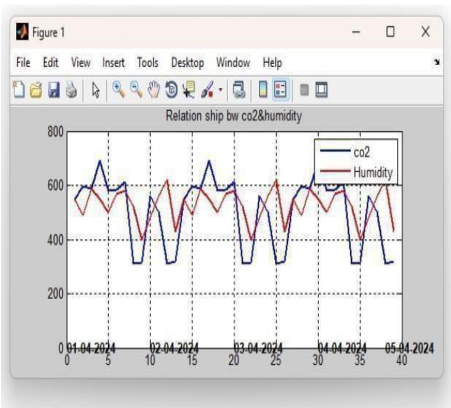
CO2 (PPM)	Class
> 2000	Dangerous
1000–2000	Threatening
250–1000	Healthy
100–250	Normal
< 100	Satisfactory

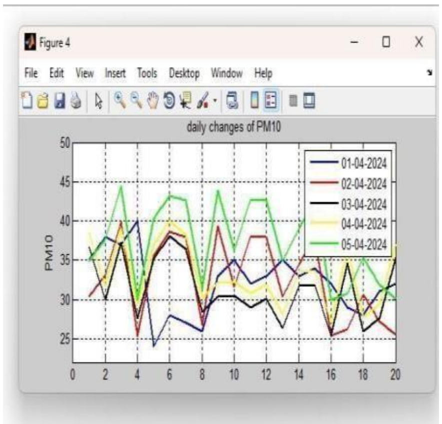
Table 5: Classes of LPG

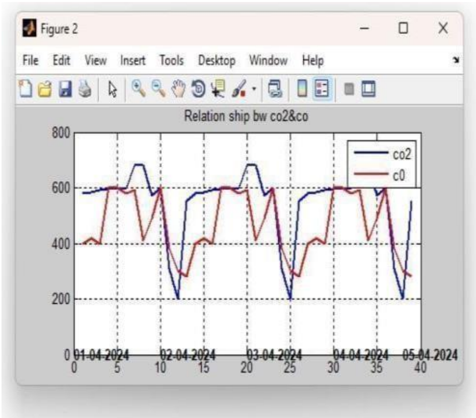
LPG (PPM)	Class
> 3000	Dangerous
1500–3000	Threatening
350–1500	Healthy
100–350	Normal
< 100	Satisfactory

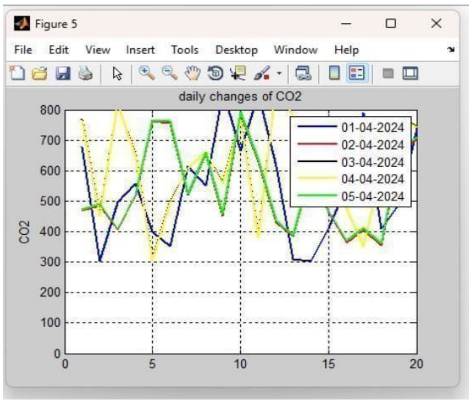
Table 6: Classes of particulate matter

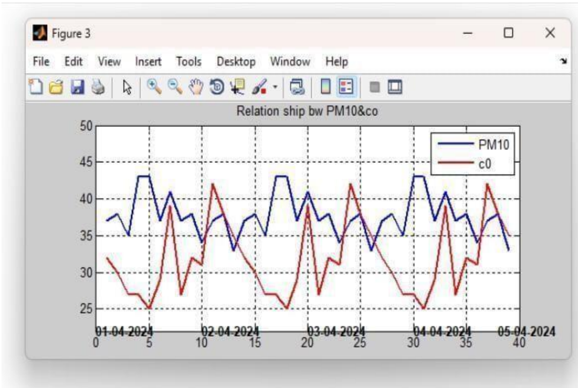
PM (PPM)	Class
> 2000	Dangerous
1000–2000	Threatening
250–1000	Healthy
100–250	Normal
< 100	Satisfactory

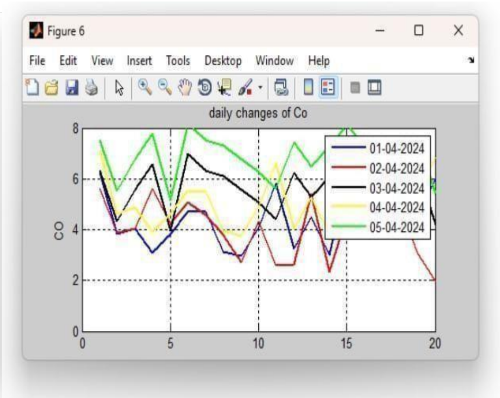












5.CONCLUSION

In An indoor AQI monitoring and prediction system was presented in this research using IoT, block- chain and Neural Network Algorithm. Six measurements (temperature, humidity, CO2, CO, PM and LPG) were collected from three sensors. The Arduino microprocessor is used to collect the information from sensors. Then the secured collected information through the block-chain is used to train a neural network Algorithm to predict the AQI for an indoor home or workplace environment. There were five classification models for the indoor environment for temperature, humidity, carbon monoxide, particulate matter, carbon dioxide and LPG to help the NN model to correctly predict the situation. The system performs equally reasonably for the room, workplace, and kitchen and predicts hazardous situations for users. The proposed system is useful and secure for inhabitants of closed door environments. The future work for this research is to extend for infant care, indoor pet health monitoring; indoor plants care management system, patient care, and management system.

FUTURESCOPE

In future the project can be upgraded in more ways than one. • Interface more no.of sensors to know gases present in air. • Design webpage and upload data on webpage. • Interface SDCARD to store data. Interface GPS module to monitor the pollution.

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