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IOT BASED GAS LEAKAGE DETECTION IN INDUSTRIES USING CNN

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ABSRACT

IoT-based gas leakage detection in an industrial plant using CNN refers to the use of an Internet of Things (IoT) system to detect gas leaks in industrial plants. The captured images are then analyzed by a Convolutional Neural Network (CNN), which has been trained to recognize the patterns and features of gas leaks. This technology can help prevent accidents and protect workers' safety by providing early warnings to alert personnel and trigger automatic safety systems to mitigate the impact of the gas leak. In an industrial plant, IoT sensors can be used to monitor temperature, humidity, pressure, and other parameters that can indicate the presence of a gas leak. The sensors can be connected to a central control system, which can trigger alarms and initiate safety protocols in the event of a gas leak .A CNN is a type of deep neural network that is designed to analyze visual imagery. It consists of multiple layers of artificial neurons, which are organized into convolutional layers, pooling layers, and fully connected layers.The CNN is trained using a large dataset of gas leak images, which are labeled as gas leak or non-leak. The CNN learns to recognize the patterns and features of gas leaks by adjusting its weights and biases through backpropagation. Once the CNN is trained, it can be used to classify new gas leak images with high accuracy

Keyword: Convolutional Neural Network

1. INTRODUCTION

The number of gas leaks that happen every year on industrial plants is obscure. The majority of these leakages, regardless of whether recognized, go unreported when they do not straight forwardly prompt tangible mishaps. Environmental Protection Agency (EPA) reports evaluate that in the United States alone, these plants discharge close to one. The majority of these misfortunes (around 80%)appear to originate from flawed compressors, valves, seals, and connectors . Gas leaks are one of the major safety hazards in industrial plants, and they can cause severe damage to human life and property. Hence, it is essential to

detect gas leaks as early as possible and takenecessary measures to prevent any disaster. Traditionally, gas leakage detection hasbeen done using various sensors, but withthe advent of IoT, it is now possible to useadvanced technologies like Convolutional Neural Networks (CNNs) to detect gasleaks. CNNs are a class of deep learningmodels that are widely used for image andvideo recognition tasks. They are composedof multiple layers that perform featureextraction and classification of the inputdata. CNNs have been shown to be highlyeffective in detecting patterns in images andvideos, and they can be applied to detect gasleaks as well. In this paper, we present an IoT-based gas leakage detection system thatuses CNNs to detect gas leaks in anindustrial plant. The proposed system

consists of various sensors that collect data about the gas levels and other environmental parameters. The collected data is then sent to a central server, where it is processed using a CNN to detect any gas leaks. The system also includes an alert mechanism that notifies the concerned authorities about the gas leak so that necessary actions can be taken to prevent any disaster The authors reported an accuracy of 95.2% in detecting gas leaks using their system.

The implementation of this project has the potential to significantly enhance gas safety measures in various settings, such as residential buildings, commercial spaces, and industrial facilities. By utilizing CNNs for gas leakage detection, this project can contribute to mitigating the risks associated with gas leaks, protecting lives, and minimizing property damage

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2. EXISTING AND PROPOSED SYSTEM

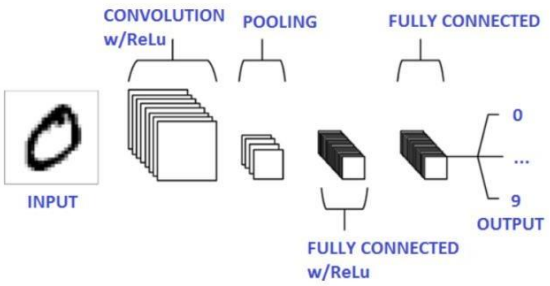
The existing system for gas leakage detection in industrial power plants may involve manual inspection or traditional sensor-based methods. Manual inspection typically requires human operators to visually inspect the power plant premises for gas leaks, which can be time-consuming, labor-intensive, and prone to human error. Traditional sensor-based methods typically use fixed gas sensors installed at specific locations in the power plant to detect gas concentrations. However,terms of accuracy, coverage, and real-time monitoring capabilities.Wireless Gas Sensors: Deploying wireless gas sensors strategically in key locations within the power plant to collect real-time gas concentration data. These sensors may be connected to the IoT network and transmit the gas sensor data to a central server for processing.Wireless Communication: Utilizing wireless communication technologies, such as Wi-Fi, Zigbee, or LoRaWAN, to transmit the gas sensor data from the sensors to the central server. This enables remote and real-time monitoring of gasconcentrations without the need for manual inspectionData Processing: Processing the gas sensor data received from the sensors using a CNN-based gas

leakage detection algorithm. The data may undergo preprocessing steps, such as data cleaning, normalization, and feature extraction, to prepare it for input to the CNN model.CNN-based Gas Leakage Detection Algorithm: Using a CNN model to analyze the gas sensor dataand detect gas leakage events. The CNN model may be trained on a large dataset of gas sensor readings, and it may learn complex patterns and features indicative of gas leaks. The model may output binary or multi-class predictions, indicating the presence or type of gas leakage.Real-time Alerts: Sending real-time alerts to plant operators or relevant stakeholders, such as through email, SMS, or a dashboard, when gas leakage events are detected by the CNN model. These alerts enable prompt actions to be taken to mitigate the risks associated with gas leaks, such as shutting down equipment or evacuating the affected area.Data Storage and Analysis: Storing the gas sensor data and detected gas leakage events for further analysis and reporting. This data may be used for monitoring, trend analysis, and predictive maintenance purposes, to improve the overall safety and efficiency of the power plant.Visualization and Reporting: Providing visualization tools or reports to plant operators or management, summarizing the gas leakage events,their locations, and other relevant information. This can facilitate decision-making, planning, and compliance reporting.Overall, the proposed system combines IoT technology, wireless gas sensors, and CNN- based gas leakage detection algorithm to enable remote, real-time, and accurate gas leakage detection in industrial power plants, enhancing the safety and efficiency of the operation

3. CONVOLUTIONAL NEURAL NETWORK

Convolutional Neural Networks (CNNs) are a sophisticated class of deep learning models that excel at image recognition and processing tasks.A typical CNN architecture comprises convolutional layers that perform convolutions on input images using filters to detect local patterns, pooling layers that downsample feature maps to reduce spatial dimensions, activation functions that

introduce non-linearity, fully connected layers that connect all neurons to the output layer, dropout regularization to prevent overfitting, a loss function to measure discrepancy between predictions and ground truth, optimization algorithms for weight and bias updates, and backpropagation for gradient computation and parameter updates.CNNs are well-suited for applications involving visual data, such as gas leakage detection in industrial power plants, where they can learn patterns from gas sensor data to accurately and rapidly detect gas leaks in real-time. IoT-based gas leakage detection in industrial power plants can be achieved through the utilization of Convolutional Neural Networks (CNNs), a sophisticated deep learning technique. The system involves the deployment of wireless gas sensors at strategic locations within the power plant to collect real-time gas concentration data. The collected data undergoes preprocessing steps, such as data cleansing, normalization, and feature extraction, to prepare it for input to the CNN model. The CNN model is then trained on a large labeled dataset of gas sensor data, encompassing both normal gas concentrations and gas leakage events, to learn intricate patterns and features indicative of gas leaks. The trained CNN model is validated using a separate dataset to ensure its generalizability and accuracy in detecting gas leaks in unseen data. In real-time, the gas sensor data is fed into the trained CNN model for prediction, and binary or multi-class predictions are generated, indicating the presence or type of gas leakage. Real-time alerts can be generated and sent to plant operators or relevant stakeholders through email, SMS, or a dashboard, triggering prompt actions to mitigate the risks associated with gas leaks. The gas sensor data and detected gas leakage events can be stored for further analysis and reporting, aiding in monitoring, trend analysis, and predictive maintenance activities to enhance the safety and efficiency of the power plant operations



4. HARDWARE REQUIREMENTS

Microcontroller- ESP32

LM35 – Temperature Sensor

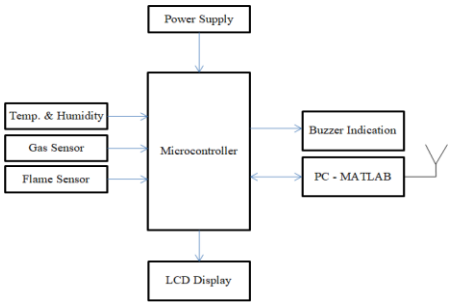
DHT11 – Humidity Sensor

MQ2 – CO2 Gas Sensor

LCD display

Power Supply

PC



MQ SENSORS

MQ sensors, also known as gas sensors, play a crucial role in IoT- based gas leakage detection using Convolutional Neural Networks (CNNs). These sensors are used to measure the concentration levels of different gases in the environment, which is a critical parameter for detecting gas leakage events. The data collected from these sensors is fed as input to the CNN model, which then learns to analyze and interpret the patterns in the data to identify gas leakage events.Sensing Gas Concentration: MQ sensors are designed to detect and measure the concentration of specific gases, such as methane, carbon monoxide, or hydrogen, in the surrounding environment. These sensors typically

work by interacting with the target gas, causing a change in their electrical or chemical properties. The output from the MQ sensors provides information about the gas concentration, which is a crucial parameter for gas leakage detection.Input to CNN Model: The gas concentration data from the MQ sensors is used as input to the CNN model for further processing. The CNN model is trained to analyze the patterns in the input data and learn the features associated with gas leakage events. The gas concentration data serves as the raw input that is processed by the CNN model to identify patterns indicative of gas leakage.Feature Extraction: The CNN model uses convolutional layers to extract relevant features from the input data. These features represent the distinctive patterns in the gas concentration data that are indicative of gas leakage events. The CNN model learns to automatically extract these features from the input data, which are then used for further analysis and classification.

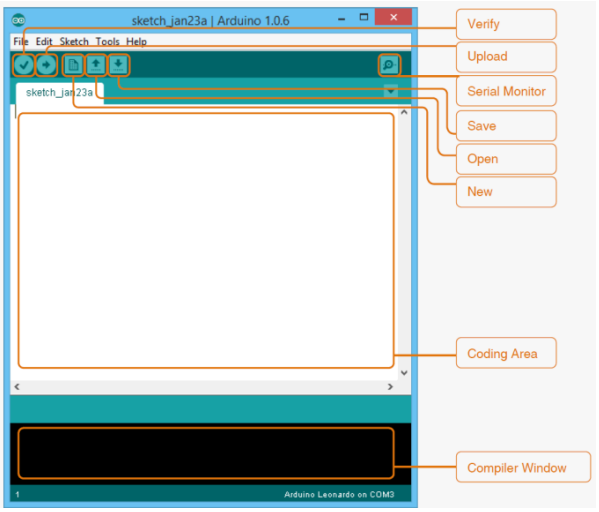
ESP32

ESP32 is a microcontroller platform that can be utilized in IoT-based gas leakage detection systems using Convolutional Neural Networks (CNNs) for gas detection.ESP32 can host the CNN model for gas leakage detection. This may involve deploying a pre-trained CNN model onto the ESP32 or training a CNN model on the microcontroller itself, depending on its computational capabilities. ESP32 can run the CNN model locally, taking the preprocessed sensor data as input and making real-time predictions on gas leakage detection based on the learned patterns.ESP32 can integrate with other components of the IoT-based gas leakage detection system. It can communicate with user interfaces, data storage, and cloud services to exchange data and enable seamless integration and operation of the overall system.

SOFTWARE REQUIREMENTS

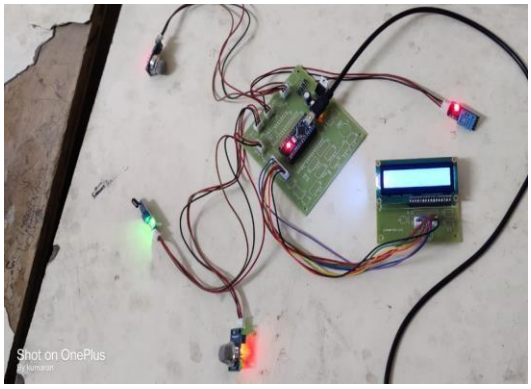
Arduino IDE

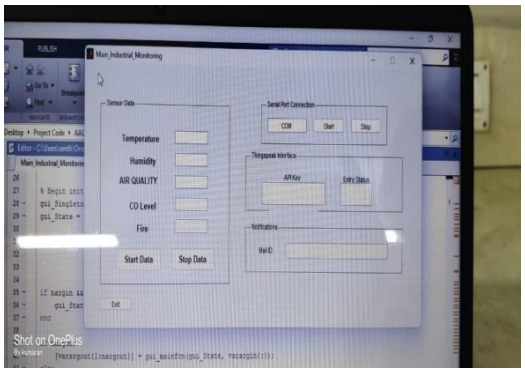
MATLAB R2014A



5. CONCLUSION AND RESULTS

In conclusion, IoT-based gas leakage detection using Convolutional Neural Networks (CNNs) is a promising approach that leverages the power of IoT devices and deep learning algorithms for accurate and real-time gas leakage detection. The use of CNNs allows for the automatic extraction of relevant features from gas sensor data, enabling accurate detection of gas leaks with high precision and low false positive rates





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