GAS LEAKAGE SENSOR

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Abstract*—The issue of the day The compressed gas system leaks cost the world industrial energy. There is an increasing need for dependable and reasonably priced gas leak detection systems due to the increased emphasis on energy efficiency and indoor air quality. particularly in two-wheelers or automobile wheels. We are introducing the creation of an air leakage sensor intended for Internet of Things (IoT) use. The suggested sensor uses IoT technology to track air leaks in vehicles, bicycles, and gas stations, giving users access to real-time data. Upon detection of a breach, the sensor transmits a signal to a central hub, which subsequently sets off an alert and notifies the homeowner through email or a smartphone application. Real-time monitoring and remote access are features of the system that give homeowners increased security and tranquility of mind. The suggested Internet of Things (IoT)-based gas leak detection system for home security applications is proven to be reliable and effective based on experimental results.

***Keywords*—energy efficiency, gas, leaks, system, sensor.**

I. INTRODUCTION

The project "GAS LEAKAGE SENSOR" Significant improvements in vehicle security and safety have resulted from the incorporation of Internet of Things (IoT) technologies. Tire pressure monitoring, which guarantees ideal tire performance and lowers the possibility of accidents brought on by underinflated tires, is a crucial component of vehicle safety. This introduction describes the drawbacks of the current tire pressure monitoring systems, emphasizes the significance of real-time air leak detection in vehicle wheels, and presents the suggested Internet of Things-based solution.

II. LITERATURE SURVEY

In[1] The focus of this study was societal issues. One of the biggest problems in society is air leakage in wheel-related accidents. The purpose of this project is to build a gas detection product that uses an alcohol sensor MQ4 sensor to detect hydrocarbon gas. By measuring the amount of gas present in the air, it can identify gas. In order to increase the utility of the gas leakage detector, a circuit with an alarm system is installed on the prototype to alert users in the event of a gas leak. Additionally, the GSM modem is activated, allowing the owner of the mobile number to get an alert message. This prototype has a faster gas sensing and is far less expensive than other items on the market.

In[2] The project objective is to construct a completely functional prototype that can detect gas leaks; in this case, though, we planned to utilize air. Furthermore, the prototype should react automatically by activating the GSM modem and an alert system, which will activate the exhaust fan and try to lessen the gas level. A key component of this research is detecting leakage, which is made possible by the sensor capacity to gauge gas concentration. When the gas level is true, a signal is sent to the alarm system to activate.

In[3] The application of Internet of Things (IoT) sensors to mitigate interior fire threats in smart buildings has garnered increasing attention in recent years. This study looked on the possible use of IoT sensors in indoor fire hazard contingency by conducting a systematic assessment of 54 articles from interdisciplinary databases over the previous ten years using certain keywords. Twenty-four sub-themes and five major themes—including vision-based sensing, smart automation, evacuation and indoor navigation, early fire detection, intervention and prevention, and BIM-related—were found through thematic analysis. The review findings show that there are several aspects of indoor fire dangers where IoT sensor utilization could be advantageous.

In[4] After a protracted ten years, technology is evolving at a swift pace. In order to measure and show the amount of gasoline in a gas cylinder and to facilitate the automatic booking of new gas cylinders, this article presents a wide-area application of the Internet of Things to gas booking. This is accomplished through the use of an integrated gas sensor. Up until recently, a weight machine has been used to assess gas level. However, in this case, a transducer-developed i-sensor (integrated sensor) is used to monitor the level. After connecting to the NODE MCU to read the output, it is Internet of Things (IoT) monitored. It is designed to be installed on cylinders, measuring the fuel level and automatically alerting the connected distributor to refill the cylinder via Internet of Things and a registered gas booking number

In[5] The growth of machine learning and the Internet of Things (IoT) has increased interest in flexible gas sensing. In this article, we describe the development of a foldable, flexible, high-performance hydrogen (H2) sensor on any textile substrate using reduced graphene oxide (GO) inkjet printing, and its use in wearable environmental monitoring. The benefits of inkjet printing include cost-effectiveness, non-contact patterning capability, and compatibility with a wide range of substrates. Palladium (Pd) nanoparticles (NPs) have a catalytic impact on wide bandgap GO, making it easy for nonpolar H2 molecules to adsorb and desorb. This effect is the basis of the sensing mechanism.

In[6] Because of its demanding operating conditions, the gas monitoring sensor is prone to failure, and identifying the type of fault is challenging. This paper proposes a novel sensor failure detection approach for gas leakage monitoring, based on the Probabilistic Neural Network (PNN) and Naive Bayes Classifier (NBC). First, the aberrant safety monitoring data is found using NBC. Next, PNN is used to classify sensor faults. This method's viability and efficacy are confirmed by using it with the urban gas pipeline leakage monitoring system. It is demonstrated that the type of sensor defect can be accurately identified and that anomalous monitoring data may be differentiated online. It is possible to achieve 85% and 95% global accuracy for aberrant data detection and sensor malfunction diagnosis, respectively.

In[7] Fueled mostly by hydrocarbons like propane and butane, liquefied petroleum gas (LPG) is a flammable gas that is regarded as a clean energy source. Due to leaks, the widespread use of LPG as fuel in automobiles, homes, and industries has resulted in a number of catastrophes and fatalities worldwide. Therefore, it is essential to detect LPG correctly. To do this, gas-sensing instruments that can quickly and precisely monitor this gas at room temperature are needed.

In[8] Growing numbers of people living in cities as a result of immigration and more pleasant living conditions have created megacities out of once self-sufficient traditional cities and brought up a number of new environmental issues. The old urban view of these issues is inadequate to address the needs of the contemporary population. The idea of a "smart city" emerged from using science and technology to address the primary issues that cities face. In order to manage the efficient and responsible use of resources and to guarantee a sustainable environment for high welfare/public health, it is now necessary to provide citizen-oriented solutions to urban challenges.

In[9] Stretchable substrate, electrode, and sensing material optimization have gained attention as a result of wearable electronics for the Internet of Things (IoT). In particular, wearable gas sensors are useful for tracking dangerous substances in real time. Stable operation under mechanical deformation is necessary for wearable gas sensors. Here, we present strain-insensitive Kirigami-structured gas sensors for NO2 detection that are adorned with functionalized carbon nanotubes (CNTs) made of titanium dioxide (TiO2). The substrate is fashioned like a kirigami to guarantee mechanical stability when stretched.

In[10] The incorporation of flexible nanocomposite materials to create lightweight, pleasant, and skin-irritating wearable sensors is the main topic of this chapter. Additionally discussed are a variety of biofluids and exhaled breath vapor that include pertinent biomarkers that can be utilized in wearable sensors to diagnose various illnesses. The ease of incorporating the Internet of Things (IoT) has also caused an increase in the need for next-generation wearable sensing technologies across a range of industries, including the security, defense, and healthcare sectors. The purpose of this chapter is to discuss and examine the recent advancements in flexible wearable gas sensor fabrication technologies. The methods for creating and utilizing flexible wearable gas sensors based on nanocomposite materials, as well as the difficulties associated with current gas sensors and future possibilities for wearable nanocomposite sensors.

In[11]Because of its demanding operating conditions, the gas monitoring sensor is prone to failure, and identifying the type of fault is challenging. This paper proposes a novel sensor failure detection approach for gas leakage monitoring, based on the Probabilistic Neural Network (PNN) and Naive Bayes Classifier (NBC). First, the aberrant safety monitoring data is found using NBC. Next, PNN is used to classify sensor faults. This method's viability and efficacy are confirmed by using it with the urban gas pipeline leakage monitoring system. It is demonstrated that the type of sensor defect can be accurately identified and that anomalous monitoring data may be differentiated online. It is possible to achieve 85% and 95% global accuracy for aberrant data detection and sensor malfunction diagnosis, respectively. The outcomes of this investigation may serve as guidelines for enhancing the urban gas pipeline monitoring systems' dependability.

In[12]Fueled mostly by hydrocarbons like propane and butane, liquefied petroleum gas (LPG) is a flammable gas that is regarded as a clean energy source. Due to leaks, the widespread use of LPG as fuel in automobiles, homes, and industries has resulted in a number of catastrophes and fatalities worldwide. Therefore, it is essential to detect LPG correctly. To do this, gas-sensing instruments that can quickly and precisely monitor this gas at room temperature are needed. This study examines the most recent developments in room-temperature LPG gas sensors. The effects of doping, catalyst use, and synthesis factors and procedures on sensing performance are explored. Future trends, difficulties encountered in the development of LPG room temperature operational gas sensors, and important concepts for the development of LPG gas sensors in the future are discussed. Furthermore reviewed are the developments in next-generation gas sensors, including wireless LPG leak detection, self-powered sensors powered by triboelectric/piezoelectric processes, and artificial intelligence systems. This review also looks at how cellphones can be used to monitor LPG more affordably and conveniently by eliminating the need for expensive equipment. Lastly, it has also been discussed how to use the Internet of Things (IoT) to identify and monitor LPG leaks. This method will limit the effects of leaks by giving users better alerts.

In[13]Growing numbers of people living in cities as a result of immigration and more pleasant living conditions have created megacities out of once self-sufficient traditional cities and brought up a number of new environmental issues. The old urban view of these issues is inadequate to address the needs of the contemporary population. The idea of a "smart city" emerged from using science and technology to address the primary issues that cities face. In order to manage the efficient and responsible use of resources and to guarantee a sustainable environment for high welfare/public health, it is now necessary to provide citizen-oriented solutions to urban challenges. Water, waste, air, and traffic are the four main headings under which environmental problems that can arise in any city are categorized in this review. By taking into consideration the primary environmental issues that arise in cities, approaches that can be used in smart city management to address these issues in traditional cities are highlighted in light of studies in the literature. As a result, clever approaches based solutions are offered to address common issues like waste management, air pollution control, water and wastewater management, and efficient city transportation.

In[14] Stretchable substrate, electrode, and sensing material optimization have gained attention as a result of wearable electronics for the Internet of Things (IoT). In particular, wearable gas sensors are useful for tracking dangerous substances in real time. Stable operation under mechanical deformation is necessary for wearable gas sensors. Here, we present strain-insensitive Kirigami-structured gas sensors for NO2 detection that are adorned with functionalized carbon nanotubes (CNTs) made of titanium dioxide (TiO2). The substrate is fashioned like a kirigami to guarantee mechanical stability when stretched. Under 80% strain, the designed device only exhibits3% the hange in base resistance. Furthermore, the influence of electro-thermal characteristics at different strain levels is examined to facilitate comprehension of the device's functionality. When compared to a bare CNT sensor, the CNT-TiO2 composite improved the measurement sensitivity by about 250% via causing changes in p-n heterojunctions. Additionally, because of TiO2's improved photocatalytic action under UV exposure, the sensors showed a 10-fold quicker desorption rate. Surprisingly, even under 80% strain, the Kirigami-structured gas sensors continued to function steadily and repeatedly, which would be sufficient for usage in a variety of wearable applications.

In[15]The incorporation of flexible nanocomposite materials to create lightweight, pleasant, and skin-irritating wearable sensors is the main topic of this chapter. Additionally discussed are a variety of biofluids and exhaled breath vapor that include pertinent biomarkers that can be utilized in wearable sensors to diagnose various illnesses. The ease of incorporating the Internet of Things (IoT) has also caused an increase in the need for next-generation wearable sensing technologies across a range of industries, including the security, defense, and healthcare sectors. The purpose of this chapter is to discuss and examine the recent advancements in flexible wearable gas sensor fabrication technologies. The methods for creating and utilizing flexible wearable gas sensors based on nanocomposite materials, as well as the difficulties associated with current gas sensors and future possibilities for wearable nanocomposite sensors.

In[16] To lessen the chance of environmental harm, proper attention to the levels of various gases of concern—especially the poisonous ones—is essential. This increases the need for extremely precise and sufficient gas-sensing devices, which are needed but not currently in use. Fifth-generation nano-enabled gas sensors, which have the following advantages: they can operate independently, provide room-temperature detection, flexibility, good selectivity, cheap cost, resistance to dampness, and portable size. The main prerequisites for incorporating gas sensors into contemporary Internet-of-things systems are these characteristics. This view focuses on developments and trends (2020–2023) in the field of designing customized nanomaterials to create state-of-the-art gas sensors that operate well under specified circumstances, such as point-of-care and point-of-location testing. The difficulties in using these materials and the efforts made by science to discussed.

[17] This work proposes a micro-electro-mechanical systems (MEMS)-based heating platform equipped with chemiresistive gas sensors to serve as a portable multi-gas sensing module. With an operating power of just 6 mW per heater, MEMS gas sensors are made up of four microheaters mounting heterogeneous sensing nanomaterials (ZnO nanowires and SnO_2 nanotubes with or without a Pt catalyst). Analog/digital signal processing combined with a highly reconfigurable circuit structure is used to provide a complete method of controlling heaters and reading out many resistive sensors on a printed circuit board. An adaptive trans-impedance amplifier can be used to read a wide range of sensor resistance (1 kΩ-100 MΩ) with a relative error of less than 1%. The goal power is maintained at a consistent value to maintain a steady temperature state, and heater controller circuits are operated to provide the best possible power for each heater. Principle component analysis (PCA) can be used to enhance selectivity because of the module's multiple gas sensing capacity. It is easily possible to reprogramme the operation mode to enter a repetitive sleep state, and it has been shown that the manufactured sensors respond and recover reasonably well to repeated on/off cycles of the heater. An RF-microcontroller combo system-on-chip (SoC) is used to enable Bluetooth Low Energy and Wi-Fi connection for both portable and stationary applications

[18] A threat to humans, the development of industry and the acceleration of urbanization have resulted in major issues related to the release of numerous deadly and hazardous gases. It is therefore desirable to fabricate extremely selective and sensitive sensors for the purpose of monitoring these gasses. Indium oxide (In_2O_3) has gained a lot of attention in the gas sensing field because of its stability, sensitivity, and selectivity in the general environment. As a result, the current study covers the most recent findings on In_2O_3-based gas sensors conducted during the last five years. There was discussion of the effects of environmental pollutants on the ecosystem and human life, including VOCs, NOX, CO, O_3, NH_3, and SO_2. For the fabrication of In_2O_3-based sensors, the hydrothermal technique has been the most popular synthesis method. The shortcomings and difficulties associated with In_2O_3 sensors over the previous five years have demonstrated that the majority of the sensors have been operating at higher temperatures. Due to reliability concerns brought on by the long-term stability drift, this has prevented commercialization. Noble metals doped-In_2O_3 sensors have so far demonstrated encouraging advantages for room temperature operation. These could be helpful in advancing intelligent gas sensors from micro/nanomaterials to the next generation of artificially intelligent systems that run on their own power and are integrated into smartphones. It may be possible to wirelessly monitor the concentration of various gases without the use of an external power source and to send data via a smartphone using In_2O_3 gas sensors equipped with Bluetooth modules. In addition, this would be useful for gas sensing through wireless signal detection, the Internet of Things, and data processing, especially machine learning.

[19] Light emitting diode (LED) based gas sensors are becoming more and more important in various applications. Outstanding stability, selectivity, and sensitivity are offered by LED-based sensing techniques based on absorption, transmission, and fluorescence spectroscopy for the diverse range of applications that sensors integrated into mobile and wearable technology are expected to find. Additionally, the efficiency of semiconductor gas sensors is increased by using UV-LEDs to activate metal oxide semiconductors. A few recent advancements in the integration and reduction of optical gas sensors are highlighted, with a focus on low-cost and low-power devices.

III. ARCHITECTURE

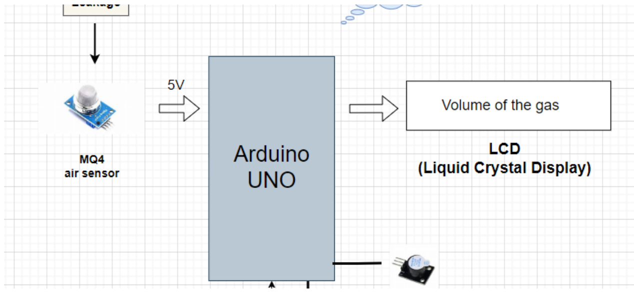

Fig 1:Architecture

A.Arduino Uno

This is microcontroller setup for the air leakage sensor which acts as the CPU of the whole system. This takes inputs from the Sensors and triggers the actuators.

B.MQ4- Sensor

An MQ4 sensor is a type of gas sensor that is specifically designed to detect methane (CH_4) and natural gas. It is widely used in gas leakage detection systems for homes and industries.

C.LCD Module

This module is used to notify about the volume of gas in the wheel.

D. BUZZAR

A buzzer serves as an audible alarm to alert users of a detected gas presence or air leakage. This setup is crucial for ensuring safety in environments where gas leaks can pose significant hazards.

E. I2C Module

This is used as a communication medium between the LCD module and Controller just utilizing 4 pins from the controller whereas to connect LCD directly it needs more pins.

CONCLUSION AND FUTURE ENHANCEMENT

In conclusion, integrating an gas leakage sensor within an IoT framework significantly enhances safety and operational efficiency. These sensors, combined with IoT capabilities, enable real-time monitoring and immediate alerts for gas leaks, crucial for preventing hazardous incidents in residential, commercial, and industrial environments. The use of components like the MQ4 sensor and a buzzer for audible alarms ensures that gas leaks are detected and communicated promptly. IoT connectivity allows for remote monitoring, data logging, and advanced analytics, providing insights into gas leak patterns and system performance. Overall, IoT-enabled air leakage sensors are a pivotal advancement in smart safety systems, offering enhanced protection, convenience, and peace of mind.

Future enhancements for air leakage sensors in IoT will likely focus on improving sensitivity, accuracy, and integration capabilities. Advanced sensor materials and technologies could detect a wider range of gases at lower concentrations. Incorporating AI and machine learning will enable predictive maintenance and anomaly detection, providing preemptive alerts before leaks become critical. Enhanced connectivity options, such as 5G and edge computing, will facilitate faster data processing and real-time decision-making.

REFERENCE

[1] R. Naresh Naik et al.Arduino Based LPG gas Monitoring & Automatic Cylinder booking with Alert System OSR J. Electron. Commun. Eng. (IOSR-JECE) (2016).

[2] Jena, B., Pradhan, S. K., Jha, R., Goel, S., & Sharma, R. (2023, January 1). LPG gas leakage detection system using IoT. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2022.11.172

[3] Shaharuddin, S., Maulud, K. N. A., Rahman, S. A. F. S. A., Ani, A. I. C., & Pradhan, B.(2023, July 1). The role of IoT sensor in smart building context for indoor fire hazard scenario:A systematic review of interdisciplinary articles. Internet of Things. https://doi.org/10.1016/j.iot.2023.100803

[4] Mariselvam, V., & Dharshini, M. (2021, January 1). IoT based level detection of gas for booking management using integrated sensor. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2020.05.825

[5] Shaharuddin, S., Maulud, K. N. A., Rahman, S. A. F. S. A., Ani, A. I. C., & Pradhan, B.(2023, July 1). The role of IoT sensor in smart building context for indoor fire hazard scenario:A systematic review of interdisciplinary articles. Internet of Things. https://doi.org/10.1016/j.iot.2023.100803

[6]Tan, Q., Mu, X., Fu, M., Yuan, H., Sun, J., Liang, G., & Sun, L. (2022, May 1). *A new sensor fault diagnosis method for gas leakage monitoring based on the naive Bayes and probabilistic neural network classifier*. Measurement. https://doi.org/10.1016/j.measurement.2022.111037

[7] Tladi, B., Kroon, R., Swart, H., & Motaung, D. E. (2023, May 1). *A holistic review on the recent trends, advances, and challenges for high-precision room temperature liquefied petroleum gas sensors*. Analytica Chimica Acta. https://doi.org/10.1016/j.aca.2023.341033

[8] Salman, M. Y., & Hasar, H. (2023, July 1). *Review on environmental aspects in smart city concept: Water, waste, air pollution and transportation smart applications using IoT techniques*. Sustainable Cities and Society. https://doi.org/10.1016/j.scs.2023.104567

[9] Park, J., Lim, H., Yea, J., Ryu, C., Jung, S. I., Jana, R., Jang, K., Keum, H., & Kim, H. J. (2024, March 1). *Kirigami-inspired gas sensors for strain-insensitive operation*. Results in Engineering. https://doi.org/10.1016/j.rineng.2024.101805

[10] Motsoeneng, R. G., Tladi, B. C., Swart, H., Kroon, R., & Motaung, D. E. (2024, January 1). *Wearable and flexible nanocomposite-based gas sensors*. Elsevier eBooks. https://doi.org/10.1016/b978-0-323-95476-1.00009-5