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Gas sensor implementation for detecting hazardous gas leakage in Hospitals

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ABSTRACT

The goal of the study is to create a state-of-the-artgas detection system that will improve hospital patients' safety and wellbeing, especially that of newborns. Modern sensors andreal-time monitoring technologies will be used by this system toidentify and notify medical professionals when dangerous gaseslike methane, carbon monoxide, and volatile organic compounds are present in hospital rooms. The research aims todecrease health difficulties and establish a safer environment forpatients, particularly infants who are more susceptible to airborne toxins, by rapidly recognizing and minimizing the hazards associated with these gases. This approach raises the standard of care and safety in medical facilities, ultimatelysaving lives and expenses.

KEYWORDS

Node-MCU
Arduino UNO
Buzzer
Data Analytics
GSM
Sensors

1. INTRODUCTION

Hospitals are essential to protecting the public's health, yet inside their gates lurks a silent, frequently invisible danger: toxic gasses. The integration of Internet of Things technology has emerged as a revolutionary option to guarantee the safety and well-being of patients, healthcare workers, and visitors. Hospital hazardous gas detectors have progressed from manual, recurring inspections to real-time, data-driven monitoring systems with Internet of Things sensors. These sensors, which are positioned thoughtfully across healthcare facilities, monitor and analyze the air quality continually for a variety of dangerous chemicals, such as volatile organic compounds, methane, and carbon monoxide. These detectorsuse the power of the Internet of Things to facilitate proactivemaintenance and preventive measures, in addition to offeringprompt alerts in the event of gas leaks or abnormal levels. This innovative technology ensures a safer and better environment for all parties involved, which not only improves hospital safety but also advances the larger goal ofproviding high-quality treatment. IoT- powered hazardous gas detectors are a monument to the union of healthcare withcutting-edge technology in this era of connectivity and automation, promoting a safer and more robust healthcare environment. Hospitals are essential institutions in charge ofthe health and care of their patients. But they also use and store other gases, like nitrogen, oxygen, and anesthetic gases,which can be extremely dangerous for your health and safetyif they leak. Hazardous gas leaks can endanger patients, employees, and the environment by causing respiratory distress, fires, or even explosions.

Gas sensors must thereforebe installed to monitor gas levels, identify leaks, and prompt appropriate action to guarantee safety.

2. LITERATURE SURVEY

Jikai Dong et.al. proposed the optimization of sensor layouts in chemical factory environments with variable wind conditions and multiple possible leakage sources is the focus of this work. To help prioritize sensors, it presents a way to compute the risk information (RI) at each grid node using normalized concentrations of leakage scenarios and occurrence probability. According to the study, leakage monitoring and source term estimation (STE) efficiency can be improved by using an optimized sensor layout with fewer sensors, which can perform better than standard layouts.

Liwen Wu et.al. to improve emergency response and risk assessment, this paper investigates the diffusion behaviour and leakage of natural gas in underground pipelines. Factors influencing gas diffusion, including pressure, leak size, soil temperature, moisture content, and type, are found through the analysis of exploratory data. The study simulates multi-source leakage scenarios and looks at the effects of transporting natural gas mixed with hydrogen, offering insights for risk assessment and emergency preparation.

Dongdong Yang et.al. proposed a novel approach to classify hazardous areas by considering dynamic factors like emergency evacuation and temporal-spatial variations of toxic gas profiles. It focuses on toxic gas leakage on offshore facilities. When used in a fictitious H2S leakage scenario, the method enhances the precision of identifying hazardous areas and facilitates the optimization of emergency planning.

Jikai Dong et.al. improve source term estimation accuracy, this study suggests a dual-layer sensor deployment scheme to address sensor layout in hazardous material monitoring. It uses computational fluid dynamics simulations to compare the efficacy of various sensor schemes and investigates how sensor height and leak source location affect estimation results. The study emphasizes how effective the suggested dual-layer sensor deployment strategy is in turbulence.

Yuexing Zhang et.al. proposed a two-line oxygen tunable diode laser absorption spectroscopy (TDLAS) optimized leakage detection system for vials is introduced. The system is made to precisely identify the processes of instantaneous leakage of sealed vials, overcoming the difficulties caused by medicine absorption in water. The enhanced system exhibits non-invasive, quick response, and high-accuracy leakage detection capabilities through tests and measurements, highlighting its potential for useful applications.

Chenyang Li et.al. proposed the development and application of a small single-fiber photoacoustic (PA) sensor for the detection of methane gas traces is presented in this paper. The sensor achieves efficiency and compactness by means of a wavelength division multiplexer (WDM) and Fabry-Perot interferometric cantilever. The sensor's viability is confirmed by the experimental results, which show that it has a high sensitivity to methane gas leakage and responds in real time. This makes it a promising option for gas detection applications.

Jinbiao Liu et.al proposed presents an integrated urban risk assessment (IURA) method for assessing population vulnerability and evaluating the effects of chemical leakage accidents, with a focus on chemical parks and urban infrastructure. The proposed approach, which uses the Grey Correlation-TOPSIS method for vulnerability ranking and ALOHA software for hazard mapping, creates integrated risk maps that help with safety enhancement and emergency planning for urban areas that face chemical hazards.

Yung Liu focuses on Remote Area Modular Monitoring for Canister Surface Temperature Measurement (RAMM-TM) device, intended to detect gas leakage from canisters containing spent nuclear fuel, is developed and demonstrated in this paper. The device efficiently detects air and helium gas leaks through tests with a scaled model cask, offering early alerts for risk mitigation and consequence management in nuclear fuel storage facilities.

Di Zhang et.al. study addresses safety issues related to chemical industrial parks by analyzing how best to locate emergency shelters and routes for occupant evacuation in the event of a gas leak. Based on the shortest paths with the least amount of toxic gas impact, the study creates evacuation plans using the Floyd algorithm and dynamic gas diffusion analysis. The results provide technical advice for safe evacuation procedures in chemical industrial parks, reducing the likelihood of hazardous gas leaks.

Ran Ye focused on the non-adaptive psychology of crowd evacuation in chemical parks in the event of hazardous gas leaks. The psychological guidelines for evacuation are determined through a questionnaire survey, and the impact of panic is quantified in terms of weight. Using simulation experiments based on the social force model and Anylogic software, personnel evacuation is examined under various panic influence factors. The purpose of the proposed safety criteria for toxic gas leak evacuation while taking panic influence into account is to offer practical direction for emergency evacuation in chemical parks.

Xiangyu Zhao proposed the Regression-enhanced Entrotaxis, a hybrid autonomous source searching method, is proposed in this paper to locate sources of hazardous gas leaks. By combining regression techniques with the Entrotaxis algorithm, the method requires less prior knowledge about source strength and accelerates computation. Monte Carlo simulations show that it is effective and flexible enough to cover larger search areas, providing a viable way to quickly locate the sources of gas leaks.

Shuaiqi Yuan et.al. integrated method for evaluating the effectiveness of safety barriers and modeling evacuation in the event of toxic gas leakage in chemical plants is presented in this paper. The suggested approach takes into account synergistic interventions from technical safety barriers and evacuations by combining event tree analysis (ETA), computational fluid dynamics (CFD) simulation, and evacuation modeling (EM). The case study results emphasize the value of taking safety barrier failures into account when assessing risks, and they also highlight the potential of timely gas detection and alarm systems in reducing risks.

Jitao Caigas et.al. drainage pipeline diffusion and leakage in underground coal mines is presented in this paper. Based on the OpenFOAM platform, a multi-factors gas drainage pipeline leakage and diffusion (GDPLD) model is suggested and validated using field measurement data. In order to provide insights for monitoring system design and safety management in underground coal mines, scenario analysis assesses the properties of gas leakage and diffusion inside pipelines under various conditions.

Kang Zhou focused on study suggests techniques for utilizing the adjoint method and CFD simulation to estimate the sources of natural gas leaks in subterranean utility tunnels. Accurate source location identification is achieved by analyzing and comparing various monitoring sensor networks. The outcomes demonstrate how well the suggested sensor networks perform long-distance leakage source identification, offering important information for improving energy security and optimizing gas-monitoring systems in utility tunnels.

Mingshu B et.al. uses experimental simulation to study the behaviour of liquefied gas leakage through various hole shapes. The discharge coefficient (Cd) is examined and multiple nozzle shapes are used to replicate various hole shapes. It is suggested to use an empirical formula to predict Cd for holes that are not circular. The study provides insights into the dynamics of liquefied gas leakage by revealing asymmetries in temperature regions and spray cone angles among various hole shapes.

Lixin Cheng et.al. proposed the numerical model for examining the quasi-elliptical sealing anomaly noise distribution pattern in pipelines is presented in this paper. The model predicts the distribution of sound pressure levels by using large eddy simulation to solve the gas leakage flow field and computational fluid dynamics (CFD) to compute the near-field noise distribution. The model's accuracy is validated experimentally, and this makes it a useful tool for assessing noise pressure levels in the vicinity of pipeline leaks.

Chengyou Wang proposed to increase the precision of gas pipeline leak detection, particularly in the identification of weak leaks, this paper presents EMDet, a hybrid deep learning model. To improve feature representation and detection accuracy, EMDet incorporates multi-link parallel feature enhancement algorithms and entropy blending. Assessment using data from actual urban environments shows better performance than the latest models, with possible uses in gas pipeline safety management.

Jinpeng Zhao et.al. suggests a method for detecting leaks in natural gas pipelines using the Markov chain Monte Carlo approach and a modified Gaussian plume model. Pipeline leak location and rate can be simultaneously determined by combining unmanned aerial vehicle inspection technology with Bayesian inference. Its accuracy and viability are validated using simulated data, providing technical support for emergency management of natural gas pipeline leakage incidents.

Weibing Gan et.al. works to investigates the detection and localization of gas pipeline leaks using Ultra Weak Fiber Bragg Grating (UWFBG) array sensing technology. The efficacy of the suggested detection algorithm, which combines wavelet transform and spectral Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN), is demonstrated through experimental simulation on a real pipeline model. The technique is a promising method for pipeline condition monitoring because it has a high degree of accuracy in identifying and pinpointing pipeline leaks.

3. SYSTEM DESIGN

Hospital gas detector systems that use the Internet of Things (IoT) make use of a network of gas sensors that are positioned strategically throughout the building to continuously monitorthe quality of the air. These sensors are linked to an Internet of Things gateway, which gathers and analyzes data to find any irregularities in the gas levels. After that, the gateway sends real-time data to a cloud-based platform so that it can beexamined for gas leaks. In case of a gas leak, the system promptly notifies hospital staff via SMS alerts or mobile apps,guaranteeing prompt action and patient and staff safety. he system can be remotely accessed by authorized personnel for monitoring and control purposes, enabling proactive management of possible gas-related emergencies. This Internet of Thing provides improved accuracy, scalability, andremote accessibility

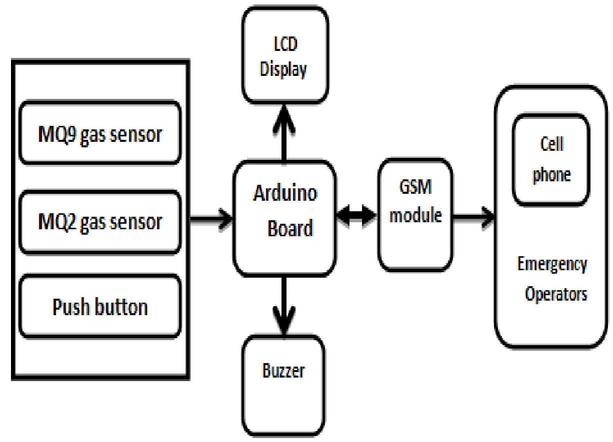

Fig .1. Gas Sensor Selection

Gases such as nitrogen dioxide (NO2) and carbon monoxide (CO) can be detected using electrochemical sensors. Infrared Sensors: These sensors provide good specificity and are effective in detecting hydrocarbons and methane (CH4). Semiconductor sensors: These are employed in the detection of gases, such as ammonia (NH3) and hydrogen (H2). Catalytic sensors are excellent for identifying flammable gases, such as propane (C3H8) and natural gas (CH4).

Installation of a Gas Sensor

Correct sensor installation is crucial for reliable gas detection. The most common locations for gas leaks include supply lines, gas storage areas, and regions near gas-powered medical equipment. Gas sensors should be positioned strategically in these regions. The sensors must undergo routine calibration and maintenance in order to ensure their accuracy.

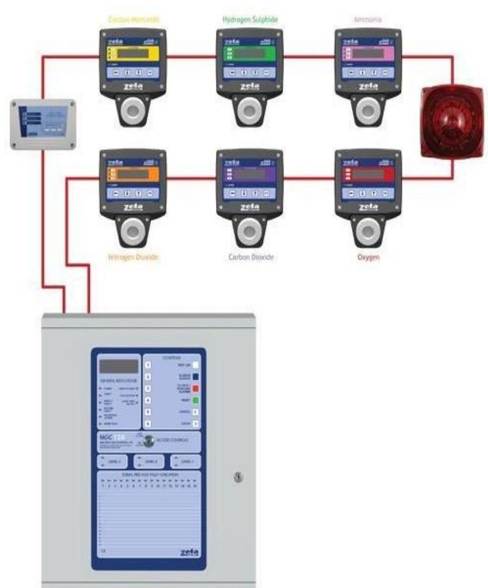

Fig.2. Analyzing data

It is necessary to continuously monitor and assess data from gas sensors. Hospitals can install data analysis systems to provide real-time alerts and monitoring. Setting preset criteria for gas concentrations can help hospital staff react swiftly to gas leaks by triggering an immediate alarm system for any aberrant readings. Reaction System For the safety of their patients and the public, hospitals must have well-defined procedures in place in event of a gas leak. These devices are crucial for lowering the risks associated with gas leaks. Firstly, hospitals should have appropriate evacuation plans for the type and amount of gas involved. They should also provide staff and patients with training on what to do in the event of a gas leak. In addition, the construction of emergency shut-off devices could be crucial since they enable the prompt cutting off of the gas supply in the impacted region, preventing further leaks. Furthermore, effective ventilation systems are required to lessen the effects of gas leaks and facilitate their dispersal. Establishing clear lines of communication and protocols for alerting the appropriate authorities is crucial, too.

4. IMPLEMENTATION

Gas Sensor: These are the main parts in charge of identifying dangerous gases in the surrounding air. Depending on the gases to be detected, such as carbon monoxide (CO), carbon dioxide (CO2), oxygen (O2), and volatile organic compounds (VOCs), different types of gas sensors can be utilized.

Arduino Board: Select an Arduino board, such as the Uno, Nano, or Mega, that is appropriate for the project. To gathering data from the gas sensors and sending it to the IoT platform, the board will act as the central processing unit.

Programming: To read, process, and send sensor data to the IoT platform, write code for an Arduino board. Use data transmission protocols (such as MQTT or HTTP) and algorithms for gas detection and threshold monitoring for Internet of Things (IoT) connectivity.

Gas Sensor Interface: Make sure the selected Arduino model is compatible with the gas sensors before connecting them to the Arduino board using the proper interfaces (digital or analog).

GSM Module: Hospital gas detection systems benefit from proactive maintenance and improved operational efficiency thanks to the remote accessibility and monitoring provided by GSM-enabled gas detectors. All things considered, the incorporation of GSM modules into gas detectors connected to Internet of Things networks strengthens safety protocols, speeds up response times, and raises the bar for general safety in medical facilities.

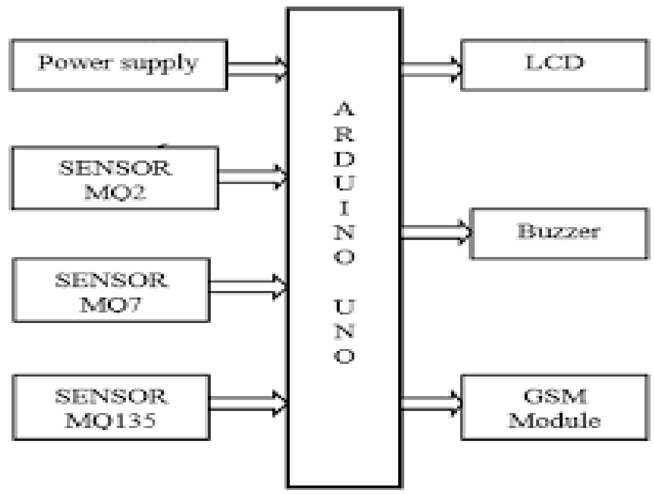

Fig.3. Flow Chart

V COMPONENTS

Fig.4.MQ 9 Sensor

Fig. 5 . GSM Module

Fig. 6. LCD Display

Fig. 7. Arduino Board

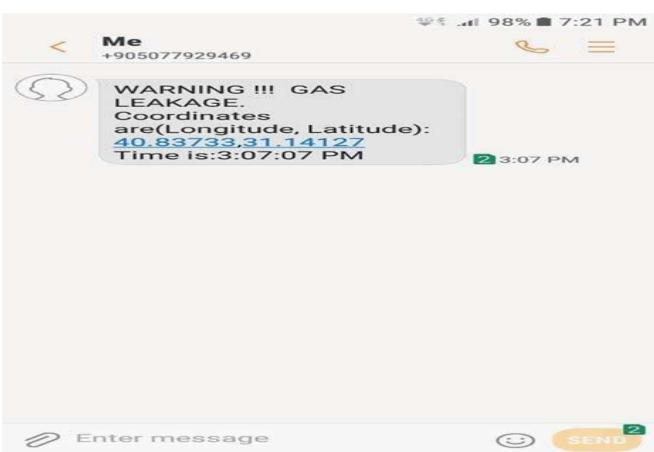

Fig. 8. Alert Message

5. PROPOSED SYSTEM

The recommended smart system for hospitals includes a central microcontroller, a network of gas sensors, and a comprehensive notification system for more efficient gas leak detection and response. Gas sensors that are positioned strategically throughout the hospital are outfitted to continuously monitor for gas leaks in accordance with predetermined thresholds. When the microcontroller detects a gas leak, it triggers a warning system that sends alerts to pre-stored phone numbers of responsible staff via a GSM module, an LCD display for visual alerts, and a buzzer for audio alerts. With this mechanism in place, gas leaks will always be swiftly addressed—even in the unlikely case that human involvement is not feasible. Additionally, it gives medical staff members the freedom to activate via a mobile alert system, enabling them to take preventative action as needed.

6. INFERENCE FROM THE LITERATURE SURVEY

The survey paper offers a thorough summary of the various aspects of hazardous gas leak detection, monitoring, and response strategies that have been the subject of research efforts and advancements. In a variety of settings, including chemical plants, natural gas pipelines, offshore installations, urban areas, and nuclear fuel storage, it emphasizes the growing significance of chemical safety and the requirement for efficient monitoring and mitigation strategies. Numerous strategies are covered in the paper, such as planning evacuation routes, risk assessment techniques, remote monitoring technologies, sensor deployment optimization, and computational fluid dynamics simulations. It emphasizes how important it is to consider a variety of factors when creating effective strategies for hazard detection, risk assessment, and emergency response. Some of these factors include wind conditions, sensor placement, population vulnerability, and dynamic gas diffusion patterns. Overall, the survey offers insightful information for improving safety procedures and emergency preparedness, advancing our understanding of the difficulties and solutions involved in handling hazardous gas leakage incidents in a variety of industrial and urban settings. With the goal of enhancing the precision, effectiveness, and safety of gas leak detection and evacuation protocols, it includes a broad spectrum of approaches, such as sensor technologies, numerical models, simulation software, and experimental setups. These studies explore the human factors involved in evacuation procedures during such emergencies, in addition to the technical aspects of detecting and localizing gas leaks. They stress the significance of comprehending panic behavior and crowd psychology in evacuation situations, and they offer safety standards and models to evaluate evacuation effectiveness under various panic influence factors. Furthermore, the incorporation of cutting-edge technologies like semi-supervised anomaly diagnosis, acoustic sensors, and deep learning shows a forward-thinking approach to tackling the difficulties associated with gas leak detection in diverse contexts. The survey's overall findings point to a concentrated effort to improve gas leak detection, localization, and response, with the ultimate objective of reducing risks to human life and financial losses.

7. RESULT

One of the most important steps in guaranteeing patient and staff safety in hospitals is the installation of gas sensors to detect hazardous gas leaks. These sensors, which are usually built into the infrastructure of the hospital, keep an eye on the air quality and identify dangerous gases like methane, carbon monoxide, and other volatile organic compounds. The sensors identify leaks and set off an instant alert system that can include ventilation system activation to reduce gas concentration, automated notifications to maintenance staff, and audible alarms. A central monitoring system frequently receives the data gathered from these sensors, enabling real-time analysis and prompt decision-making. By taking a proactive stance, the risk of gas exposure is reduced, potential health risks are avoided, and safety regulations are followed. Furthermore, routine upkeep and calibration to preserve their accuracy and dependability, these sensors are necessary, improving the general safety procedures in the hospital setting.

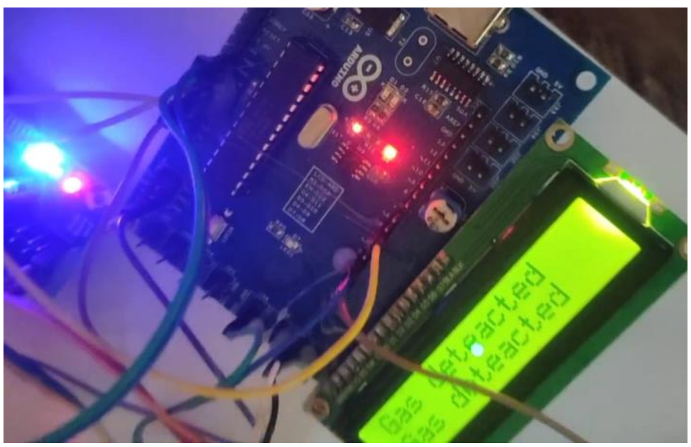

Fig. 9. Gas detector kit

Fig. 10. Alert Message

8. CONCLUSION

The literature analysis highlights how critical it is becoming to integrate Internet of Things (IoT) technology into safety procedures and gas monitoring across a range of environments. Using Internet of Things (IoT) sensors and devices for proactive alarm mechanisms, early gas leak detection, and real-time gas monitoring—many of which are made possible by smartphone notifications—is a prevalent theme among the projects that are showcased. This Internet of Things application aims to enhance safety and security, as well as environmental conditions and resource management. The combined findings demonstrate the revolutionary impact of technology in lowering the risks connected with gas-related catastrophes and the crucial role that IoT will play in fostering a safer and more sustainable future in residential, industrial, and urban contexts. Gas sensors are a vital piece of equipment that hospitals need to detect and immediately contain hazardous gases. emphasize the revolutionary impact of technology in lowering the dangers connected with gas-related catastrophes and the crucial role that IoT will play in fostering a safer and more sustainable future in residential, industrial, and urban contexts. Hospitals need to have gas sensors in order to detect and swiftly contain hazardous gas leaks. By carefully selecting the appropriate sensors, positioning them in key locations, routinely monitoring data, and implementing string reaction mechanisms, hospitals can lower the danger of gas leaks. As technology advances, sensor-based smart hospital systems can further enhance safety and reduce the potential damage that gas leaks in medical facilities may cause. Safety of patients and healthcare personnel should always come first, and gas sensors are crucial to achieving this for the sake of the hospitals' well-being.

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