



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 11, November 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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A Survey on Gas Leakage Detection and Protection Using IOT and AI

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ABSTRACT : This project focuses on developing a robust gas leakage detection and protection system by integrating Internet of Things (IoT) and Artificial Intelligence (AI) technologies. The system employs sensors to detect gas leaks and utilizes IoT for real-time data transmission to a central server. AI algorithms analyse the data to identify potential hazards and trigger timely alerts. Additionally, the system can autonomously activate protective measures, such as shutting off gas valves or activating ventilation systems, ensuring swift response to mitigate risks and enhance safety in residential or industrial settings. YOLOv3, known for its real-time object detection capabilities, is used as the initial stage of the system. It efficiently identifies potential fire objects within images or video frames. The detected regions are then passed to a two-step classification process, where SVM and CNN are employed. The SVM model serves as a feature-based classifier, leveraging handcrafted features from the detected regions. It provides an initial decision on whether a detected region contains a fire or not. This decision helps reduce false positives and enhances the accuracy of the system.

KEYWORDS: Internet of Things , MQ6 Sensor , YOLO algorithm for fire Detection ,Artificial Intelligence

I. INTRODUCTION

In The research discusses gas leakage detection systems that are critical for avoiding disastrous accidents and economic losses. Gas pipelines are ubiquitous in cities for heating and cooking, while various toxic and combustible gases are integral to industries. However, leakages from these pipelines and industrial gases can be extremely hazardous. Conventional manual methods of checking for leaks are tedious, cover only a limited portion of pipelines, and are prone to human errors. Therefore, intelligent and automated systems for continuous monitoring, fire detection and quick response to gas leaks are needed. Fire detection using YOLOv3, algorithms is an advanced approach to identify and alert the presence of fire in images or video streams. YOLO (You Only Look Once) is an object detection algorithm that can be used to detect various objects, including fire, within images or video frames. YOLOv3 (You Only Look Once): YOLOv3 is a state-of-the-art object detection algorithm that divides an image into a grid and predicts bounding boxes and class probabilities for objects within each grid cell. It can be trained to recognize fire in images or video frames. YOLOv3 is known for its real-time processing capability, making it suitable for video-based fire detection.

II. LITERATURE SURVEY

1.Paper Name: Intelligent Urban Sensing for gas Leakage Risk Assessment

Author: TAO TAO , ZERONG DENG, ZHUO CHEN,etc..

Abstract : This paper presents an intelligent gas leakage risk assessment system for utility networks, aiming to address challenges in conventional leakage detection systems. Leveraging large-scale multi-source data, including gas pipeline, Point of Interests (POIs), and human mobility data, the system utilizes a novel urban sensing technique to extract environmental features. A joint learning neural network integrates both internal and external features for comprehensive risk assessment. The proposed system, implemented and tested in real-world scenarios, demonstrates

effectiveness in citywide gas leakage risk assessment, potentially aiding timely detection of potential leakage sites in urban areas.

2.Paper Name: Prompt Sapper: A LLM-Empowered Production Tool for Building AI Chains.

Author: YU CHENG, JIESHAN CHEN etc..

Abstract : The paper "Prompt Sapper: A LLM-Empowered Production Tool for Building AI Chains" introduces the concept of AI chains, leveraging large language models (LLMs) like GPT-4 for natural language interaction. Recognizing the limitations of chat-based approaches, the authors propose an AI chain engineering methodology, incorporating software engineering principles. They present Prompt Sapper, a no-code integrated development environment, facilitating the construction of prompt-based AI services through visual programming. The paper emphasizes the efficiency and correctness of Prompt Sapper, validated through a user study. Keywords include AI Chain Engineering, Visual Programming, Large Language Models, and No/Low Code.

3.Paper Name: IOT based system for detection of gas leakage and house fire in smart kitchen environments.

Author: Marjan Ralevski, Bijana Risteska Stojkoska etc..

Abstract : The future holds a broader range of available technologies that will offer more innovative ways for solving everyday issues. By combining small processing units with artificial intelligence and machine learning, one can expand the horizon of new concepts and ideas to increase everyday safety. In this paper we have designed a cheap Internet of Things based system which enables the early detection of house fire and gas leaks. We are simulating a scenario where we detect the rising possibility of house fire in a kitchen environment, by measuring temperature and the gases concentration. To optimize the communication process and reduce the number of sent packets from the measuring node to the system gateway, we applied time series forecasting approach based on moving average prediction scheme.

4.Paper Name: Design and development of an IoT based LPG gas leakage detector for households and Industries.

Author: Saad Ahmed , Md. Jubayer Rahman etc...

Abstract : Since accidents are occurring more regularly and everyone wants to take the proper steps to prevent tragedy, home security has become a serious problem. Leaks of Liquid petroleum gas (LPG) now pose a threat to both commercial and residential use. The increase in natural gas production over the past 10 years has had a significant negative impact on the gas industry in Bangladesh. Explosions caused by gas leaks are becoming a major hindrance to living in our country. Utilizing technology wherever possible is crucial because it is now transforming the globe. In recent years, home fires have become more frequent, posing a rising risk to both human lives and property. LPG, which is very flammable, can burn even some distance from the spill. The two main causes of fire occurrences are a rubber tube of poor quality or a regulator that is not turned off while not in use. Therefore, developing a system to alert people of gas leakage is essential. By employing LPG gas detectors, we can stop mishaps from occurring in the future. The proposed system, which is based on a microcontroller, uses gas sensors, GSM, a display, and a buzzer. As part of a monitoring and warning system for LPG gas leaks, it makes use of an Arduino UNO and a NODEMCU module with a MQ6 sensor. A solenoid valve and an exhaust fan, respectively, allow the system to prevent excessive leakage and remove the leaked LPG gas from the region where it has leaked after leak detection. With all these characteristics, the system intends to boost home security against gas leaks and fires. The system also contains a feature that allows data from the sensors to be sent to a web server.

5.Paper Name: Gas leakage with Auto Ventilation and smart management system using IOT.

Author: Afsana Mim Anika , Ms. Nasarin Akter, Md. Niamul Hasan etc..

Abstract: In the evolving smart home architectures, the issue of gas spillage and fire is still remaining as a significant hindrance for designing a comprehensive, safe and sustainable kitchen model. On the other hand, security has also been significant challenge in this digital era. In urban areas, most of the kitchens are very small and it doesn't contain proper ventilation system. In such case, Spillage of gas increases the risk of fire accident, suffocation or a blast. To eradicate this challenge, smart management system viz. gas leakage detection and fire detection system should be developed. In this paper, Arduino UNO microcontroller was utilized to build a smart gas detection system with many usable sensors (MQ2, IR Fire Sensor) and actuators (air fan, buzzer). When gas spillage is recognized, the client will be intimated through SMS and at the same time they will receive notification via blynk application. The proposed system can detect fire, gas leakage and it also has the ability to take further steps and decrease gas concentration via auto air ventilation and extinguish fire with water. The proposed method will help to improve the safety and reduce the death toll and reduce the damages that occur to the surrounding environment.

6.paper Name: Research on Image Fire Detection Based on Support Vector Machine .

Author: Ke Chen, Yanying Cheng,

Abstract: In order to detect and alarm early fire timely and effectively, traditional temperature and smoke fire detectors are vulnerable to environmental factors such as the height of monitoring space, air velocity, dust. An image fire detection algorithm based on support vector machine is proposed by studying the features of fire in digital image. Firstly, the motion region is extracted by the inter-frame difference method and regarded as the Suspected fire area. Then, the uniform size is sampled again. Finally, the flame color moment feature and texture feature are extracted and input into the support vector machine for classification and recognition. Data sets were formed by collecting Internet resources and fire videos taken by oneself and the trained support vector machine was tested. The test results showed that the algorithm can detect early fire more accurately.

7. Paper Name: Using Popular Object Detection Methods for Real Time Forest Fire Detection .

Author: Shixiao Wu, Libing Zhang

Abstract: In this paper, we focus on three problems that surrounded fire detection, real-time, early fire detection, and false detection. For the first time, we use classical objective detection methods to detect forest fire: Faster R-CNN, YOLO (tiny-yolo-voc, tiny-yolo-voc1, yolo-voc.2.0, and yolov3), and SSD, among them SSD has better real-time property, higher detection accuracy and early fire detection ability. We make the fire and smoke benchmark, utilize the new added smoke class and fire area changes to minimize the wrong detection. Meanwhile, we adjust YOLO's tiny-yolo-voc structure and propose a new structure tiny-yolo-voc1, the experiments proves that this improves the fire detection accuracy rate. This paper is very practical for safety and real time monitor.

8.Paper Name: A Mobile Robot for Hazardous Gas Sensing .

Author: HUANG HONGYU1 , KUANG PING1 , LI FAN1 , SHI HUAXIN1

Abstract: This paper reports development of a robot that can sense the presence of hazardous gases in the environment. The robot aims at detection of hazardous gases and mapping global positioning system (GPS) locations of the detected gases to the navigation terrain in real-time. These information was transmitted to a hand-held device in a remote location for exploration of gas types, which holds promise for disaster management. The robot was equipped with a module of gas sensors, human detection sensor, GPS module and obstacle detection sensors in a coherent system. While navigating with collision avoidance to obstacles, the robot can transmit information about the presence of

hazardous gases and human being in the area of navigation. It was tested in an uneven terrain to recognize the presence of hazardous gases like carbon dioxide, liquefied petroleum gas, vaporized alcohol gas vis-a-vis ambient gases in real-time. A neural network-based classifier was implemented to recognize the gases with an average accuracy of 98 .

9.Paper Name: Sensor network with energy efficient and low-cost gas sensor nodes for the detection of hazardous substances in the event of a disaster .

Author: Oxsy Giandi,Riyanarto Sarno

Abstract: This paper reports on energy efficient and lowcost gas sensor nodes for spatially resolved, accurate gas measurements in the event of a disaster. This is achieved by the integration of various low-cost and low-power sensors for gas, temperature and humidity combined with intelligent signal processing and information fusion. The relative position of the sensor nodes are needed to perform a spatially resolved gas measurement. For this, a low-cost localization system for the relative positioning of the sensor nodes is implemented. A map can be created, where spatially resolved gas concentrations and the gas sources can be displayed.

10. Paper Name: Design and experimental research of video detection system for ship fire.

Author: Jiang Feng, Yang Feng

Abstract: In order to make up for the shortcomings of traditional fire detectors and improve the reliability of fire alarm, based on the Raspberry Pi hardware conditions and the Keras deep learning framework, this paper uses the lightweight direct regression detection algorithm YOLO v3- tiny to implement a small local video identification system for ship fire. Based on video test and fire simulation, the RpiFire system has achieved high accuracy in high recall rate and can meet the needs of ship fire detection.

III. CONCLUSION

By harnessing the power of AI for data analysis and predictive modeling, and leveraging IoT for remote monitoring and control, we can create a safer environment for individuals. The integration of AI and IoT in gas leakage detection and protection represents a significant advancement in safety and efficiency.

In summary, an aerial based fire detection method has been examined through a large database of videos fires of various scene conditions. To enhance the detection rate, at first the chromatic and motion features of forest fire are extracted and then corrected using rule to point out the fire area. Secondly, to overcome the challenge of heavy smoke that covers almost the fire, smoke is also extracted using our proposed algorithm. Our framework proves its robustness with high accuracy rate of detection and low false alarm rate in practical application of aerial fire surveillance. The synergy between these technologies not only enhances safety but also reduces the economic and environmental impacts of gas leaks. Embracing this innovative approach is a vital step toward a safer and more sustainable future. This technology offers real-time monitoring, immediate alerting, and automated response mechanisms, minimizing the risks associated with gas leaks.

ACKNOWLEDGMENTS

It gives us great pleasure in presenting the preliminary project report on 'LPG Gas Leakage Detection and protection using IOT and AI'.

We would like to take this opportunity to thank our internal guide Prof. Harsha Jain for giving us all the help and guidance that we needed. We really grateful to them for their kind support. Their valuable suggestions were very helpful.



We also grateful to Dr. Nikita Kulkarni, Head of Computer Engineering Department, KJCOEMR for his indispensable support, suggestions.

At the end our special thanks to computer department for providing various resources such as laboratory with all needed software platforms, continuous Internet connection, for Our Project.

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INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
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