Natural Gas Leakage Recognition By Thermal Images Using Artificial Intelligence

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ABSTRACT

Natural gas leakage poses serious risks including fire hazards, explosions, and environmental pollution. Traditional gas detection techniques often fail to provide early and accurate leakage localization, especially in large-scale industrial environments. This project proposes an Artificial Intelligence–based natural gas leakage recognition system using thermal images. Thermal cameras capture infrared radiation differences caused by leaking gas, and deep learning models analyze these patterns for accurate detection. The system enhances safety by enabling real-time monitoring and automated alerts. Experimental results demonstrate improved accuracy and faster response compared to conventional methods. This approach ensures non-contact, continuous, and reliable gas leakage detection in real-world conditions.

INTRODUCTION

Natural gas is widely used in industries, power plants, and residential areas due to its efficiency and low carbon emissions. However, gas leakage remains a major safety concern as it is often invisible and odorless in open environments. Conventional detection systems rely on point sensors that cover limited areas and are prone to failure. Thermal imaging technology offers a promising alternative by visualizing temperature variations caused by gas flow. With the integration of Artificial Intelligence, these thermal images can be intelligently analyzed for leakage recognition. This project focuses on developing a robust AI-driven system capable of detecting gas leaks in real time. The system improves safety, reduces human intervention, and minimizes economic losses.

LITERATURE SURVEY

Several studies have explored gas detection using sensor-based and vision-based techniques. Early research primarily relied on semiconductor gas sensors, which suffer from slow response and environmental interference. Recent advancements introduced infrared and thermal imaging for gas visualization. Researchers have applied machine learning algorithms such as SVM and Random Forest for gas pattern recognition. Deep learning models like CNNs have shown superior performance in extracting thermal features automatically. However, many existing studies lack real-time deployment and robustness in complex environments. This literature survey highlights the need for an integrated AI-based thermal imaging system for reliable gas leakage detection.

RELATED WORK

Previous works have demonstrated gas leakage detection using infrared cameras combined with image processing techniques. Edge detection, background subtraction, and temperature thresholding methods were initially used but produced high false alarms. Some researchers applied convolutional neural networks to classify thermal images into leak and non-leak categories. Others focused on UAV-mounted thermal cameras for pipeline inspection. While these approaches improved detection accuracy, they often required controlled conditions and expensive hardware. Limited datasets and lack of real-time inference remain major challenges. This project addresses these gaps by implementing an optimized AI model suitable for real-time industrial environments.

EXISTING SYSTEM

Existing gas leakage detection systems mainly use gas sensors, pressure monitoring, and manual inspection methods. These systems provide limited coverage and require physical contact with the environment. Sensor-based approaches are highly sensitive to temperature, humidity, and aging effects. Manual inspections are time-consuming, costly, and unsafe in hazardous areas. Vision-based systems without AI rely on fixed thresholds, leading to poor accuracy. Moreover, most existing systems fail to provide precise leakage localization. These limitations highlight the need for an intelligent, automated, and scalable detection system.

PROPOSED SYSTEM

The proposed system utilizes thermal cameras to capture infrared images of gas pipelines and industrial zones. These images are processed using deep learning

models to identify leakage patterns. A Convolutional Neural Network (CNN) is trained on real-time thermal datasets to distinguish gas leaks from background noise. The system operates continuously and triggers alerts upon detecting abnormal thermal signatures. It supports real-time monitoring with minimal human intervention. The proposed approach offers higher accuracy, faster response, and improved safety. It is suitable for industrial, residential, and pipeline monitoring applications.
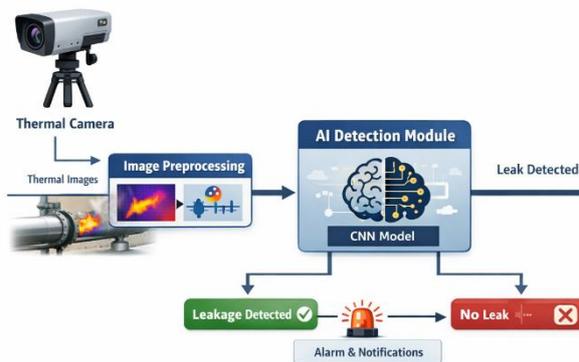
SYSTEM ARCHITECTURE

Fig 1: Gas leakage detection system

METHODOLOGY DESCRIPTION

Initially, thermal images are collected under normal and leakage conditions to create a dataset. Image preprocessing is performed to remove noise and enhance thermal contrast. The dataset is then labeled and split into training and testing sets. A CNN model is trained to learn spatial and thermal patterns associated with gas

leakage. The trained model is deployed for real-time inference on incoming thermal frames. Detected leak regions are highlighted using bounding boxes. The system continuously updates results and triggers alerts for safety respo
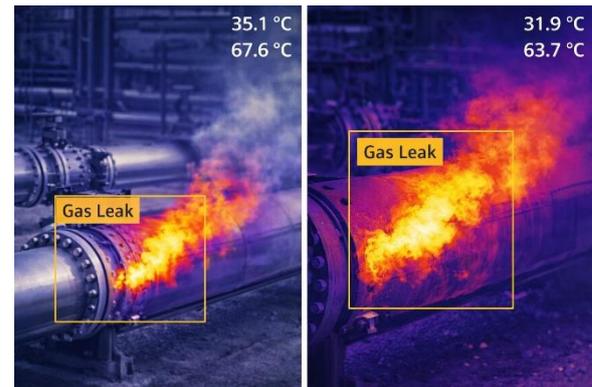
RESULTS AND DISCUSSION

Fig 2:Gas leakages detection

The proposed system was tested using real-time thermal images captured from gas pipeline environments. Experimental results show high detection accuracy with reduced false positives. The AI model successfully identified leakage regions even under varying environmental conditions. Compared to traditional sensor-based systems, the response time was significantly faster. Thermal image analysis proved effective for non-contact detection. The results confirm the robustness and reliability of the proposed approach. Real-time visualization further enhances situational awareness for operators.

CONCLUSION

This project presented an AI-based natural gas leakage recognition system using thermal imaging. The integration of deep learning enables accurate and real-time detection of gas leaks. The proposed system overcomes the limitations of traditional sensor-based methods. It provides wide-area coverage, improved safety, and automated monitoring. Experimental results validate the effectiveness of the approach. The system can be deployed in industrial plants, pipelines, and residential areas. Overall, this solution contributes to enhanced safety and environmental protection.

FUTURE SCOPE

Future work can focus on integrating UAV-mounted thermal cameras for large-scale pipeline inspection. Advanced deep learning models such as YOLO and Transformers can be explored for faster detection. Multi-sensor fusion with gas sensors and acoustic sensors can improve accuracy. Cloud-based monitoring systems can enable remote surveillance. The system can be extended to detect other hazardous gases. Dataset expansion will enhance model generalization. Edge AI deployment can further reduce latency and power consumption.

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