Pimpri Chinchwad Education Trust's

Pimpri Chinchwad College of Engineering (PCCoE)

Affiliated to Savitribai Phule Pune University(SPPU)

Department of Information Technology

Third Year

(2025-26 Sem – V)

DIP for Detecting Gas Leaks using Infrared Camera Images

Course Name-Fundamentals of Digital Image Processing

Formative Assessment II

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Aim:

To develop an efficient system for detection of gas leaks using infrared (IR) camera images by integrating Digital Image Processing (DIP) techniques and YOLO model.

Motivation:

- **Industrial Safety:** Prevent explosions (e.g., 2014 GAIL pipeline disaster).
- **Environmental Protection:** Reduce methane's 30% contribution to global warming.
- **Economic Effects:** Minimize billions in annual energy sector losses.
- **Public Health:** Early detection to avoid respiratory diseases and cancer risks.

Objectives:

- To use classical DIP (Gaussian, bilateral, adaptive histogram) to improve gas plume contrast.
- To use YOLO for precise detection of gas leaks.
- To enhance detection accuracy through optimized DIP preprocessing.

Literature Survey:

Author	Features	Methodology	Research Gaps
Nie, X. et al. (2021)	Enhanced detection of faint plumes	Gaussian filtering with adaptive histogram	Limited applicability to static images due to focus on video enhancement
Zhao, Q. et al. (2023)	Improved clarity of low-contrast gas images	Denoising, contrast stretching, sharpening	Insufficient adaptability to diverse static image conditions.
Dong, K. et al. (2025)	High accuracy separating leak regions	Bilateral filtering with U-Net	Requires high computing power
Al Hosani, A. et al. (2019)	Detects and locates leaks in real-time	SWIR cameras, GPS, IMU sensors	Expensive, weather-sensitive
Huang, E., Chen, L., Lv, T., Cao, X. (2022)	Reliable in dynamic environments	Compares still vs. changed frames	Difficult to set up, needs annotated video

Methodology:

Approach: System using DIP and YOLO for gas leak detection.

Steps:

1. Data Acquisition: Gas leak images from the Roboflow "Gas-Leak" dataset, containing 163 images of 640x640 resolution.

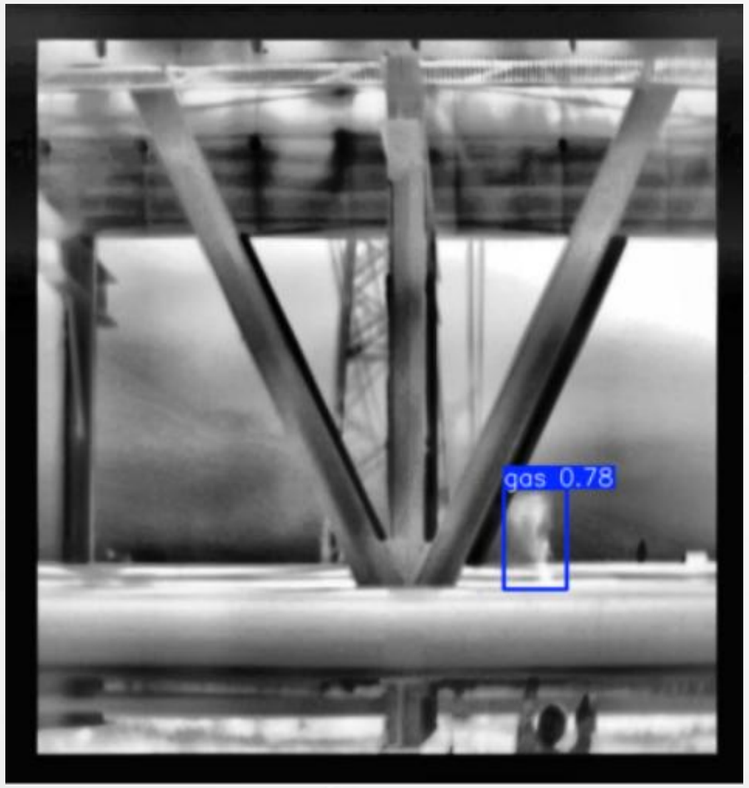
2. Preprocessing: Grayscale conversion, Gaussian & bilateral filtering, CLAHE.

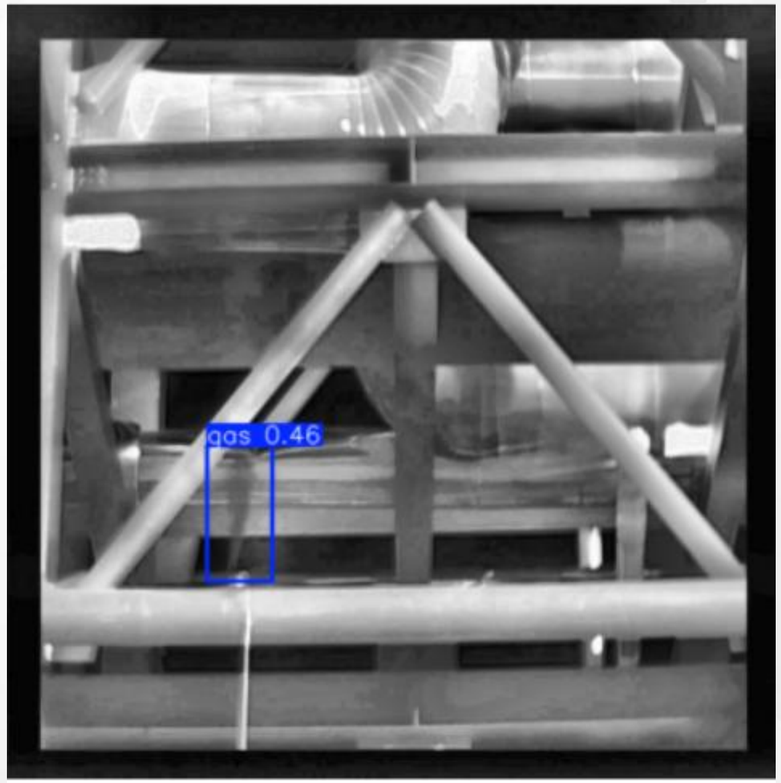
3. Detection: Fine-tune YOLOv8 on preprocessed images with bounding box annotations.

4. Validation: mAP for detection accuracy.

Results and Discussion:

- YOLO detects gas plumes
- DIP enhances contrast, reducing noise
- mAP > 0.7 after 50 epochs





Conclusion:

The integration of Digital Image Processing (DIP) techniques and the YOLO model offers a robust solution for gas leak detection, effectively addressing critical safety, economic, and environmental concerns in industrial settings. Overall, this methodology enhances monitoring efficiency, paving the way for improved leak detection and management in real-world applications.