



How can toxic gas exposure be assessed as a health risk, not just detected?

PROBLEM STATEMENT

Air becomes dangerous when multiple toxic gases coexist at sub-threshold levels, where combined effects pose health risks even though no single gas triggers an alarm. Exposure is cumulative, yet most detection systems assess gases independently, allowing hazardous environments to appear safe. This results in the following limitations:



New methods explore real-time monitoring and intelligent evaluation to better capture cumulative toxic risks. By combining multiple sensors and adaptive analysis, these approaches aim to provide a clearer, more actionable understanding of hazardous environments than traditional alarms.

INTRODUCING

AEROVANT

A UAV-Integrated Multi-Sensor Platform for Hazardous Gas Detection, Threat Level Classification, and Environmental Monitoring Using Machine Learning

A PROJECT DEVELOPED BY:



RESEARCH OVERVIEW

This study presents AEROVANT, a UAV-integrated electronic nose system for hazardous gas detection and cumulative health risk assessment in environments unsafe for direct human monitoring. The platform employs MQ-series metal oxide semiconductor sensors (MQ-2, MQ-3, MQ-6, MQ-9, and MQ-135) with a DHT11 for environmental sensing, coupled with machine learning-based risk classification. The system was designed and validated in controlled and simulated environments, with applications in industrial, urban, and emergency response settings in Cagayan de Oro.

OBJECTIVES

To develop AEROVANT, a portable AI-powered electronic nose for toxic gas detection and cumulative health risk assessment, validated in controlled settings for future industrial and emergency use in Cagayan de Oro.



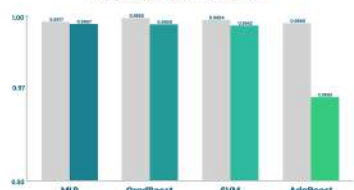
By incorporating ACGIH and OSHA standards, this system lays the groundwork for a more intelligent approach to assessing toxic gas exposure.



$$M = \sum \frac{C_i}{TLV_i}$$

MODEL EVALUATION UPON DEPLOYMENT

ACCURACY VS. F1 SCORE



Although the MLP achieved the highest Test F1 and the lowest accuracy gap, indicating optimal generalization, most other models including Gradient Boosting, XGBoost, and SVM also performed exceptionally well, showing that the dataset's complex patterns are effectively captured by a variety of non-linear algorithms.

BEST OPTIMIZED MODEL

MLP MULTI-LAYER PERCEPTRON
Classification Performance

CRITICAL F1
99.57%

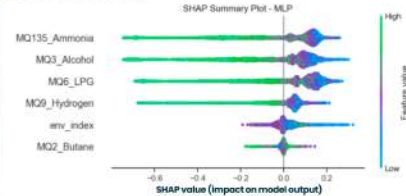
STABLE F1
99.70%

OVERALL ACCURACY

97.53%

CONFUSION MATRIX & SHAP

True Label \ Predicted Label	Critical	Stable
Critical	4891	131
Stable	115	4863



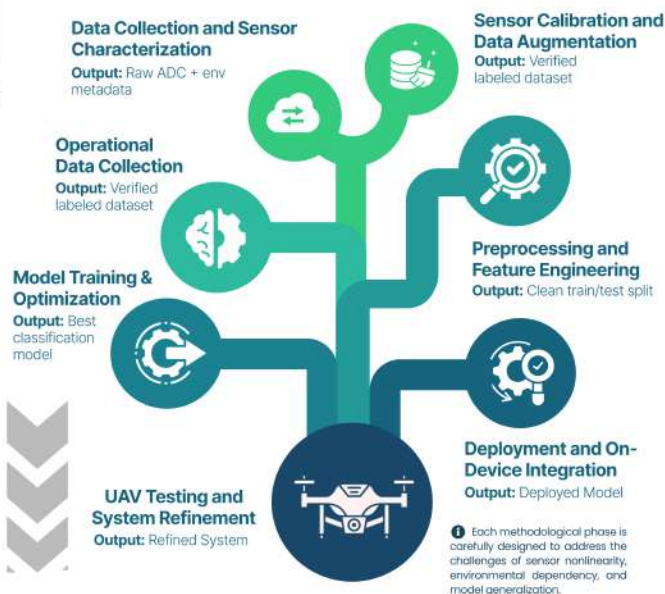
The MLP confusion matrix shows near-perfect, balanced detection of "Critical" and "Stable" events in real-world field data. SHAP confirms the model's decisions are physically meaningful and adaptively focus on the most relevant gases. Together, they demonstrate that the model is accurate, robust, and generalizable.

DASHBOARD

The AEROVANT Citizen Dashboard presents real-time gas readings and AI hazard predictions in an intuitive, color-coded format. An interactive map shows UAV flight paths, sampling points, and reported hazards, while users can view detailed readings and contribute community reports.



METHODOLOGY FRAMEWORK OVERVIEW



CONCLUSION & TAKEAWAY

This project shows that the apparent "instability" of low-cost MQ-series sensors can be leveraged by non-linear models for robust hazard detection. MQ3 and MQ9 required calibration, while MQ2, MQ6, and MQ135 were stable, yet all contributed effectively. The MLP achieved 97.5% accuracy and adapted to real-world gas mixtures, with SHAP confirming physically meaningful and generalizable decisions. This provides a blueprint for intelligent, field-deployable environmental monitoring in disaster and public safety applications.



Don't Send People. Send **AEROVANT**.

This project advances the following SDGs:

