

A UAV Platform for Rapid, Remote Detection of Toxic Gases and Radiation in Crisis Response

Husam Mohsen Alrehaili, Talal Atallah Alamrani, Shaker Sulaiman Alatawi and Ahmed Shabaan Alkathiri

Department of Mechanical Engineering
University of Tabuk
Tabuk, Saudi Arabia

hmalrehaili@ut.edu.sa, 411002747@stu.ut.edu.sa, 411007800@stu.ut.edu.sa,
411001861@stu.ut.edu.sa

Abstract

In recent years, unmanned aerial vehicles (UAVs) and their use in crisis management have advanced significantly from delivering medical supplies to searching for missing people. During crises, hazmat teams face substantial risk and life-threatening situations when surveying toxic gas leaks and radiation incidents. Fixed monitors are sparse, and manual measurements are slow and dangerous. The aim of this study is to enhance safety and prevent humans from being exposed to these hazards while providing a safe and reliable approach to detect gas leaks and radiation. To address these challenges and leverage new technologies and recent advancements in UAVs, this study presents the design and fabrication of a UAV-mounted sensing system for detecting and mapping hazardous gases and radiation safely. The UAV was integrated with a modular payload that serves as a deployment bay for the sensor systems. The sensing system contains single-use sensors, electrochemical gas sensors, and Geiger radiation detectors. Real-time data transmission from these sensors to a ground station was facilitated through an Internet of Things (IoT) application using a Lon Range Low Power (LoRa) communication module. The experimental results showed that the integrated UAV system achieved a flight duration of 15 minutes and an operation range of 12 kilometers, respectively, with an extended communication range of the sensors that can reach up to 20 kilometers. In conclusion, the results of this study confirm that this study enhances the safety, speed, and efficiency of detecting these hazards, providing accurate and dependable readings for crisis response.

Keywords

Unmanned Aerial Vehicles (UAVs), Autonomous Sensing Systems, Internet of Things (IoT), LoRa Communication, Real-time Data Transmission, Crisis Management

Biographies

Husam Alrehaili is the Head of the Department of Mechanical Engineering at the University of Tabuk, Saudi Arabia. He earned his Ph.D. in Mechanical Engineering from Wayne State University (Detroit, USA) in 2024, an M.Sc. in 2018, and a B.Sc. from King Abdulaziz University in 2012. His professional background blends industry and academia: he worked with Saudi Aramco's Berri Gas Plant in mechanical engineering roles and completed training with SABIC (Hadeed) and the Saudi Electricity Company before transitioning to university service. His research interests center on additive manufacturing and alloy development, including laser metal deposition, high-throughput alloy screening, and Ni/Co/Al-based systems; he has developed toolpaths for robotic deposition, designed new alloys, and led experimental campaigns in microstructure-property optimization. In teaching, he has contributed across design and manufacturing—senior capstone, design of machine elements, manufacturing processes, advanced manufacturing, and engineering workshops—while mentoring students in Arduino/controls, CAD/CAM/CAE, and laboratory practice.

Talal Alamrani is a Mechanical Engineering Student at the University of Tabuk, Saudi Arabia.

Shaker Alatawi is a Mechanical Engineering Student at the University of Tabuk, Saudi Arabia

Ahmed Alkathiri is a Mechanical Engineering Student at the University of Tabuk, Saudi Arabia.