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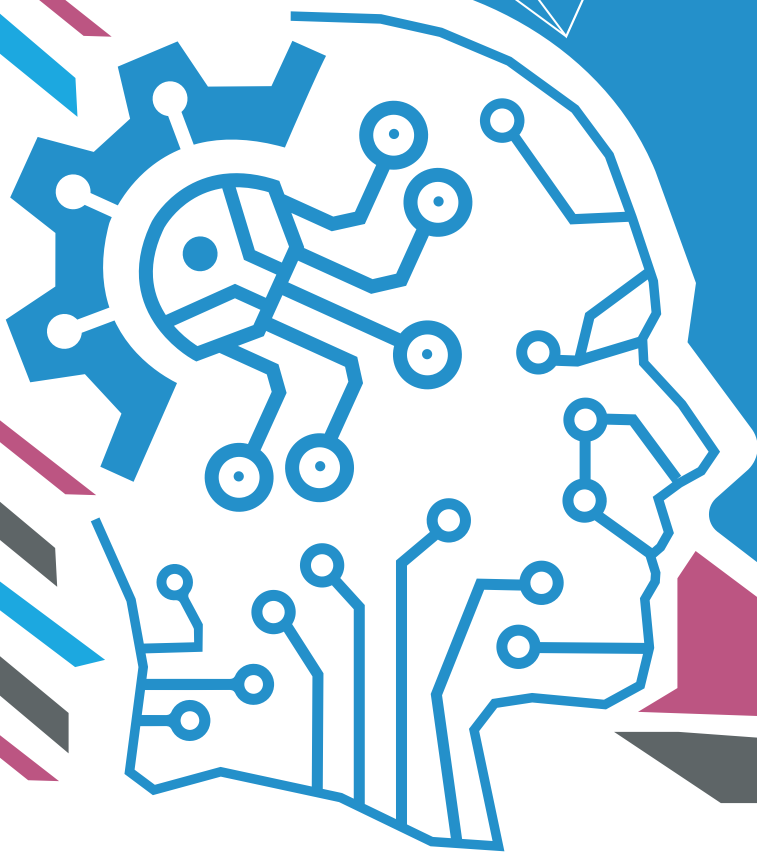
THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025



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DEVELOPMENT OF A SMART DASHBOARD FOR MONITORING FUNGAL GROWTH IN BUILDING STRUCTURES USING UAV AND GIS INTEGRATION

Suriani Ngah Abdul Wahab, Munirah Radin Mohd Mokhtar, Nor Amin Mohd Radzuan, Md Yusof Hamid

Department of Built Environment Studies and Technology,
Faculty of Built Environment, Universiti Teknologi MARA, Perak Branch,
Seri Iskandar Campus.

suria275@uitm.edu.my, munirah@uitm.edu.my, noram185@uitm.edu.my, yusof344@uitm.edu.my

ABSTRACT

This innovation introduces the development of a smart dashboard that integrates Unmanned Aerial Vehicle (UAV) imagery and Geographic Information System (GIS) data to monitor and visualise fungal growth patterns in building structures. Fungal growth in building structures carries significant pressures on structural integrity, indoor air quality, and human health, especially in humid and poorly ventilated environments. Early detection and continuous monitoring are critical to prevent widespread contamination and costly remediation. The significance of this project lies in its ability to provide building managers, maintenance teams, and researchers with real-time, location-based insights into potential fungal infestations. The objective is to create a centralised digital platform that collects, processes, and displays spatial and environmental data to support timely decision-making and risk justifications. The methodology involves deploying the UAV equipped with high-resolution cameras and RGB sensors to capture imagery of building surfaces, especially in hard-to-reach areas. These images are then georeferenced and analysed using GIS tools to identify moisture-prone zones and early fungal growth indicators. Environmental parameters such as humidity, temperature, and material condition are also incorporated through sensor integration. The processed data is visualised through an interactive dashboard that displays fungal risk levels, spatial distribution maps, and temporal trends. The expected outcome is an intelligent, user-friendly dashboard system that enhances proactive building maintenance, reduces health risks, and supports sustainable facility management. This innovation not only improves monitoring efficiency but also sets a new benchmark for integrating spatial technologies in building diagnostics and environmental health investigations.

Keywords: dashboard, Unmanned Aerial Vehicle (UAV), Geographic Information System (GIS), spatial, monitoring.

1. INTRODUCTION

Mould growth in building environments is a critical issue that affects structural integrity, indoor air quality, and occupant health. Traditional inspection methods are often limited in scope, time-consuming, and lack spatial precision. In recent years, the integration of Geographic Information Systems (GIS) with dashboard mapping technologies has emerged as an effective approach for real-time monitoring and spatial analysis of mould-prone areas in buildings. GIS enables the visualisation of environmental variables like humidity, temperature, and material susceptibility, allowing the early identification of high-risk zones (Jin et al., 2021). When combined with smart dashboards, this integration provides dynamic data representation, facilitating timely interventions and informed decision-making (Wang et al., 2022). Moreover, the incorporation of UAV imagery enhances data accuracy, especially in inaccessible areas (Ahmed et al., 2020). This spatially enabled monitoring system is increasingly recognised as a proactive tool in building management and environmental health monitoring.

2. METHODOLOGY

2.1 Data Collection

The data collection process for this innovation integrates advanced UAV imagery and spatial data from Geographic Information Systems (GIS) to effectively monitor fungal growth in building structures. UAVs equipped with high-resolution RGB cameras capture detailed images of the building's exterior and interior surfaces, focusing on areas prone to moisture accumulation and fungal development. These UAV flights enable rapid, non-intrusive inspections, particularly in hard-to-reach areas that are otherwise difficult to assess manually. The captured imagery undertakes pre-processing and analysis to detect visible signs of mould, moisture stains, and surface degradation. Spatial data layers from GIS provide critical environmental and structural context by integrating information such as building layout, material types, ventilation pathways, and environmental parameters such as humidity and temperature. GIS also enables georeferencing of UAV images, aligning them with real-world coordinates to produce accurate spatial maps of fungal risk zones.

This spatial integration facilitates comprehensive analysis by linking visual indicators with environmental conditions, allowing for precise localisation of potential fungal outbreaks. Together, UAV imagery and GIS spatial data form a robust dataset that underpins the development of a smart, interactive dashboard. This enables real-time visualisation and monitoring, empowering building managers to make informed, proactive decisions to mitigate fungal growth and preserve building health. Figure 1 refers to the data collection by the UAV on-site investigation.

Figure 1 Mould growth from an image taken by UAV

2.2 Development of Dashboard

The primary purpose of developing the dashboard is to provide a centralised, user-friendly platform that enables real-time monitoring and visualisation of fungal growth within building structures. With integrated data from UAV imagery and GIS spatial analysis, the dashboard aims to present complex environmental and structural information in an easily interpretable format. This facilitates early detection of mould-prone areas, allowing building managers and maintenance teams to take timely preventive or corrective actions.

Additionally, the dashboard supports informed decision-making by providing spatially accurate risk maps, trend analyses, and alert notifications related to moisture and fungal development. It enhances communication among staff by merging various data sources into a single interactive interface, improving overall building health management. Consequently, the dashboard leads to reduced maintenance costs, prevents structural damage, and safeguards occupant health through proactive and efficient fungal monitoring.

2.3 Findings of the Research

The findings of this research highlight the successful integration of UAV and GIS technologies in the development of a smart dashboard for monitoring fungal growth in building structures. This method proved to be efficient, time-saving, and non-intrusive compared to conventional manual inspections. GIS spatial analysis significantly enhanced the detection process by mapping the distribution of fungal activity and correlating it with environmental parameters of temperature, humidity, and building orientation.

The geospatial data facilitated the generation of risk maps, enabling the identification of hotspots and vulnerable zones within the surveyed structures. These maps were validated through ground truthing, which confirmed the accuracy of UAV observations and GIS-based classification. A major output of the research was the development of a smart dashboard that integrates UAV imagery, GIS analysis, and real-time environmental data into a centralised system. The dashboard features include spatial visualisation, time-series monitoring, risk level categorisation, and automated alert systems. Users can interact with the data intuitively, view fungal growth over time, and make informed decisions about maintenance planning. Generally, the integration of UAV, GIS, and a smart dashboard offers a scalable, data-driven solution for proactive fungal monitoring in buildings. The findings support the use of such systems in modern building maintenance strategies, particularly in environments where early detection and continuous monitoring are crucial to ensure structural health and occupant safety.

3. CONCLUSION

The development of a smart dashboard integrating UAV imagery and GIS spatial data presents a powerful and innovative solution for the effective monitoring of fungal growth in building structures. This system enables real-time visualisation and spatial analysis of environmental conditions and fungal risk zones, enhancing early detection and suitable involvement. The dashboard allows building managers, maintenance teams, and researchers to make informed decisions that moderate structural damage and protect occupant health. The incorporation of UAV technology allows complete coverage of inaccessible areas, while GIS provides precise spatial context for targeted monitoring. Overall, this innovation not only improves the efficiency and accuracy of fungal growth assessment but also supports sustainable building maintenance and environmental health management. Future enhancements may include integration with sensors to provide automated detection and predictive analysis, making the dashboard a necessary tool for proactive facility management.

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