Project 4_4 Autonomous Drone Vision for Crop Health Monitoring in Indoor and Outdoor Environments

PC Hub Theme (see list here)
Theme 4: Digital Agriculture and Machine Learning
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Monitoring crop health and stress across both greenhouse and open-field environments is critical for achieving precision agriculture and sustainable production. However, while drones (UAVs) are well established in outdoor phenotyping, their deployment in indoor or GPS-denied conditions remains a major challenge. Factors such as low lighting, reflective surfaces, and constrained spaces limit traditional navigation and image acquisition methods.

This PhD project will develop an **AI-driven drone vision platform** capable of real-time, multimodal crop health monitoring in both controlled and open environments. Leveraging advances in visual–inertial simultaneous localisation and mapping (SLAM), ultrawideband (UWB) localisation, and lightweight deep learning architectures, the project will integrate navigation, sensing, and analysis within a unified framework. The goal is to enable adaptive and scalable phenotyping that complements fixed and handheld sensing platforms such as *MacroHand*.

Research aims

- **Multimodal drone sensing and data fusion.** Design a lightweight UAV system equipped with RGB–multispectral sensors and adaptive exposure control to maintain image quality across varying light and canopy conditions.
- **Navigation and mapping in GPS-denied environments.** Develop self-adaptive SLAM and UWB-based localisation algorithms for robust navigation inside greenhouses, targeting sub-decimetre positioning accuracy.
- **Cross-domain learning for plant trait estimation.** Implement domain randomisation and self-supervised learning to transfer models between indoor and outdoor conditions, enabling consistent inference of physiological and stress-related traits.

Methodology

The project will build and customise small UAV platforms equipped with RGB–multispectral cameras and edge computing modules such as NVIDIA Jetson Orin. Navigation algorithms will integrate visual–inertial odometry, optical flow, and UWB anchor signals. Reinforcement learning will be explored to optimise flight paths dynamically based on environmental feedback.

On the perception side, the PhD candidate will train and evaluate deep spectral–spatial models (e.g., U-Net, DeepLabV3+, SAM2) for plant segmentation, stress detection, and canopy reconstruction using datasets collected from both indoor and outdoor trials. Domain adaptation and self-supervised pretraining will support generalisation between varying crop types and environments.

The system will be validated across multiple plant species (wheat, tomato, lettuce) through experiments linking drone-based measurements to physiological and agronomic traits obtained from field trials. Integration with handheld (MacroHand) and fixed sensor systems will enable continuous, multi-scale monitoring of crop health.

Expected outcomes

- A unified UAV-based phenotyping and monitoring system for both indoor and outdoor agriculture.
- A FAIR-compliant dataset for multimodal drone imagery and plant stress monitoring.
- Demonstrated advances in early stress detection, canopy structure mapping, and autonomous navigation under variable conditions.
- Publications targeting *IEEE Transactions on Robotics* and *Computers and Electronics in Agriculture*.
- Technical contributions to La Trobe's LISAF and Cisco–La Trobe IoT Centre projects, supporting industry translation in protected cropping systems.

How to apply

The PC Hub offers a limited number of competitive scholarships.
To apply, please email the following documents to pchub@latrobe.edu.au by **15 February 2026:**

- Application form completed
- Up-to-date CV
- University transcripts

Only shortlisted applicants will be contacted.