UNIVERSITY OF CAMBRIDGE
Department of Engineering

CHURCHILL COLLEGE

Project Title:

Event-driven monitoring of plant growth and stress using low-energy, brain-inspired sensing

Project Summary:

Controlled-environment agriculture is energy intensive, yet most systems rely on simple on/off control with limited feedback from the plants themselves. This project explores a brain-inspired, event-driven approach to monitoring plant growth, where computation is triggered only by meaningful changes rather than continuous sensing.

Using *Arabidopsis* grown in low-cost modular growth chambers, the student will analyse pre-collected image data and have the option to run an additional short experiment to detect growth and stress-related changes over time.

The work connects plant science, data analysis, and energy-aware neuromorphic system design, with relevance to sustainable food production and scalable low-cost sensing technologies.

Host Institution/Company and Supervisors

Primary supervisor: Dr Rachel Thorley (rachel.thorley@chu.cam.ac.uk)
Fellow in Engineering, Churchill College.
Affiliated Assistant Professor, Department of Engineering, University of Cambridge

The project will be hosted at the University of Cambridge, with the primary supervisor based at Churchill College and affiliated with the Department of Engineering.

The nature of the project and field is interdisciplinary, so to facilitate this, we will arrange meetings with researchers, and PhD students working across plant science, hardware and software to support the student both in this specific project and also in interdisciplinary career awareness.

Research Quality:

Indoor and controlled-environment food production is increasingly important but comes with high energy costs. One route to improving efficiency is to supply resources such as light or water only when plants show signs that they need them.

Most automated plant monitoring systems rely on continuous imaging and computation, is energy intensive and difficult to scale. This project takes a different approach: treating plant behaviour itself as a trigger for sensing and computation, inspired by how biological systems allocate resources only when change occurs.

Building on existing published and unpublished work, the focus is on detecting changes over time, rather than estimating absolute growth rates or relying on calibrated multispectral measurements. This avoids fixed baselines, better reflecting real growing environments, where conditions vary between plants and zones.

To ensure feasibility within eight weeks, the student will analyse pre-existing time-lapse image data to develop and test edge-oriented, event-based change-detection methods. , to extract indicators of stress or altered growth conditions. There will also be the option to run an *Arabidopsis* validation experiment with *Arabidopsis thaliana*, a well-established model organism with a fast lifecycle, under controlled environmental changes.

Expected outputs include lightweight algorithms, and a comparison between continuous and event-driven sensing strategies.

Opportunity to Learn Across the Stack:

The project provides structured experience across the stack, exploring how low-level sensing decisions affect system-level energy use and scalability, without requiring prior expertise in all areas.

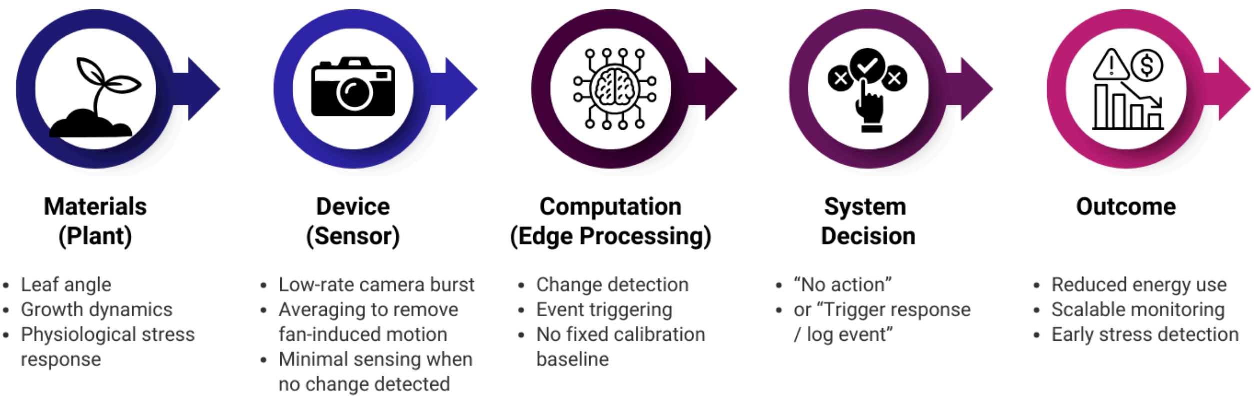
At the materials level, the student will consider how plant tissues interact with light and how growth-related changes are physically expressed, introducing the idea that biological materials themselves act as dynamic sensors.

At the device level, the student will work with camera-based sensing under realistic constraints, including lighting, airflow, and motion caused by fans. They will explore how sensing choices-such as sampling rate or image resolution-affect energy use and data quality.

At the computational level, the student will develop and test event-driven algorithms inspired by neuromorphic principles, focusing on detecting change rather than processing all data continuously.

At the systems level, the focus is on edge-oriented processing: analysing data locally and triggering computation only when behaviour changes. This mirrors how people notice a houseplant needs water because it starts to droop, rather than by continuously measuring soil moisture against a fixed reference.

This project offers an interdisciplinary view of neuromorphic design principles applied to a practical sensing problem, Through discussions with researchers across research fields, the student will gain insight into how ideas translate across disciplines



Research Environment

The project will be primarily based at Churchill College, with links to the Department of Engineering for example for meetings with researchers and PhD students to support interdisciplinary aspects .

Speaking directly here: As a supervisor I’m really engaged and very keen to see this project succeed, so you would have regular meetings for technical guidance and project direction. I have supervised many summer research students before, and it is really important to me that projects are successful and that students have an interesting and fun time with lots of opportunity to develop interests, skills and career awareness. The student will be part of a small cohort of summer project students working on connected but independent projects, providing a supportive peer environment and opportunities to exchange ideas.

If interested, students can use a makerspace to develop practical skills using 3D printers, laser cutting and electronics - I love hands-on projects and very happy to support in this area There is a Makerspace at Churchill College, and at the Department of Engineering.

There is also opportunity to build confidence in communication through outreach, including demonstrating their project at a residential event for UK sixth-formers from underrepresented backgrounds.

Additional Support offered

Subsidised accommodation is available at Churchill College if required, offering a welcoming campus, strong community, and an excellent environment in which to live and work over the summer.