ElectroCap Project Proposal

Sensor ecosystem for controlling agriculture - SECA

Filipe Piçarra
Francisco Apolinário
Guilherme Barros
Hugo Dezerto
Matilde Sardinha
Nuno Abreu

Challenge ID: 16

TÉCNICO LISBOA

1. Advisors and Mentor

Scientific Advisor:

Prof. Marcelino Santos

Monitor:

Francisco Simplício

2. Problem definition

Controlling the environment and growth level of agricultural products is carried out periodically and inefficiently. Additionally, diverse plantations require a diverse list of checkmarks for each crop, different levels of light exposure, soil moisture, etc. This all leads to late and less productive harvests due to problems identified too late in environments ranging from urban to rural agriculture. The key words are Modular and Scalable.

The existing methods to monitor plantations can't account for a diverse agricultural environment or are specifically designed for industrial production.

3. Solution beneficiaries

Small and medium producers in both rural and urban environments.

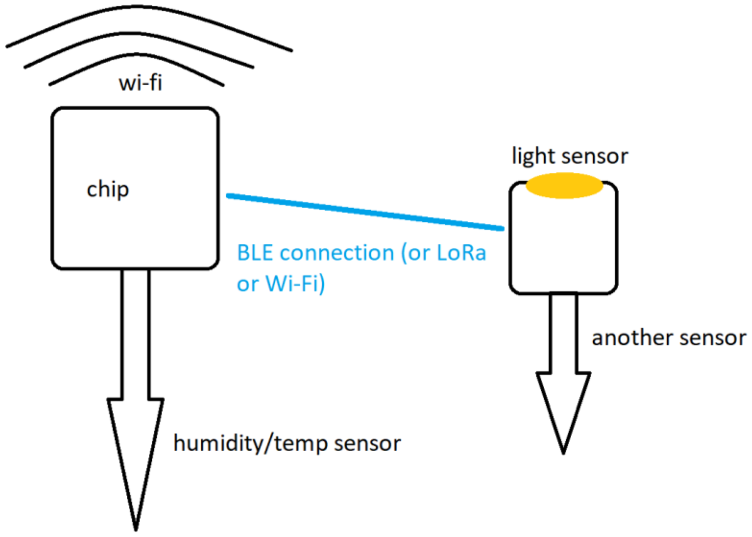
In recent years, the number of urban plantations, either on private balconies or terraces, has increased substantially; thus, a system like this would help monitor and manage said micro-productions in between every-day tasks.

In rural environments, medium-sized producers can have their workload lifted at a lower cost and with higher customizability.

A product like this might lower the barrier of entry for small productions, leading to an increase in small personal urban farms.

4. Technological solution

The solution would be a grid of wireless sensors that would stick to the soil, be water-proof, and be solar-powered, each with a unique set of sensors and presets to measure the environmental conditions. They would all be connected to a central processing node, which would be the main controller. The entire system would work like a hive, with all the data being processed and shown to the user so that he could decide on how to act or even define rules that would allow the user to interact with one of the nodes, which could be a relay module controlling irrigation systems, for example.



Illustrative image, does not represent the final design.

4. Technological solution

Like we said before, the simple nodes would stick to the ground, measuring the following parameters: **soil humidity**, **ambient humidity**, **ambient temperature**, and **ambient light levels**. Due to the nature of the environment and the data fluctuation, we only needed to measure these values on an hourly basis, thus producing sufficient data for the producers to understand and diagnose possible crop problems.

When it comes to analysing crop footage, this process would only be done once a day.

The system could also cross the sensor data with a database to notify the users of ideal values of light, humidity, etc.

4. Technological solution

Thus, we would require the following components to start our prototypes:

Ambient Temperature/Humidity Sensor

Soil Humidity Sensor

Main Processing Node Node

Main Processing Node Camera

5. Competitors and previous work

- Competitors:

-Pycno is the competitor with the product most similar to what we propose to develop, also having a node structure. Despite this, it has some features that we do not intend to build, such as 2G communication. It also belongs to a higher price range.

-micro:bit Smart Agriculture Kit by ELECFREAKS is a more similar competitor in price range, although it does not have a node structure.

6. Solution requirements

This device should ideally be solar-powered to be able to last for an entire day since we are only measuring data a few times.

It should be able to accurately measure the environment a plant is in (temperature, soil humidity, light levels, etc.) and cross-reference with some database that would tell the user the ideal conditions for said plantation.

Since the data is coming from anywhere in the plantation, the different nodes need to be able to work and interact in a mesh, changing data and interacting via direct connections or via a central node. One of the nodes could be able to take a photo and process the image, for example, the number of tomatoes ready to be picked.

7. Technical challenges

Hardware:

The small solar panels that feed each node will require optimisation on behalf of the electronics (energy consumption), and each device, while simple on paper, will need to be compact, resilient, and complete to provide every significant information about the growth environment of a crop.

Software:

Each node will communicate wirelessly, so we will need to develop a network system that allows the exchange of information between them while maintaining the possibility of scalability if another sensor is added. All this while the power consumed by each node must be minimum.

The central node will need to recognise the crops via a camera, identifying growth stages and other useful information, so a computer vision algorithm will have to be trained to accomplish said task.

8. Partners

As project partners, we are supported by Torriba, an organization of agricultural producers focusing on horticulture and fruit cultivation. Through this collaboration, we will meet with technicians and producers, making it easier to identify area-specific challenges. This allows us to explore viable solutions and acquire more profound technical knowledge.

9. Testing and validation metrics

To test the system's viability, the prototype will be tested on a small crop. During the tests, it's important to assure that for each technological area, the device's functionality gets validated in our tests.

First Testing:

This test will serve to evaluate sensor architecture and node network performance. It is expected that a single device can be able to accurately read soil and air humidity levels, ambient temperature, luminosity levels, and other useful field data while also communicating with the central node and sending data when needed, while the network should be able to handle an arbitrary number of nodes collecting data that will be stored and processed by the central node.

Second Testing:

Evaluation of the solar panels and computer vision performance. The device should be energy efficient enough to work during the day and last the night with minimal data acquisition without going offline. If this step works, it means that the solar panels are ready to work as a reliable solution for powering our network.

As for the computer vision algorithm, it must be able to easily differentiate between crops and growth stages (at least between a single species).

The final tests will be made in a real scenario and not in a controlled crop by us; this means that the device, now with some new and improved features, must provide valuable data to the farmers in a custom UI, withstand different climate conditions, and be self-sufficient.

10. Different areas of labor

Hardware – Responsible for designing and assembling the devices, including hardware acquisition, sensor testing/configuration and energy management.

Software – Microcontrollers setup and configuration, wireless communication network, crop databases.

Solar Panels – Subdivision of hardware but focused on assuring the devices have an efficient power source during the day and night.

Computer Vision Model – Subdivision of software but focused on integrating a computer vision algorithm capable of recognizing different growth stages of a crop and other useful information.

Communication – Responsible making periodic reports on the work, talking to outside partners, arranging field tests, designing the website, videos and poster.

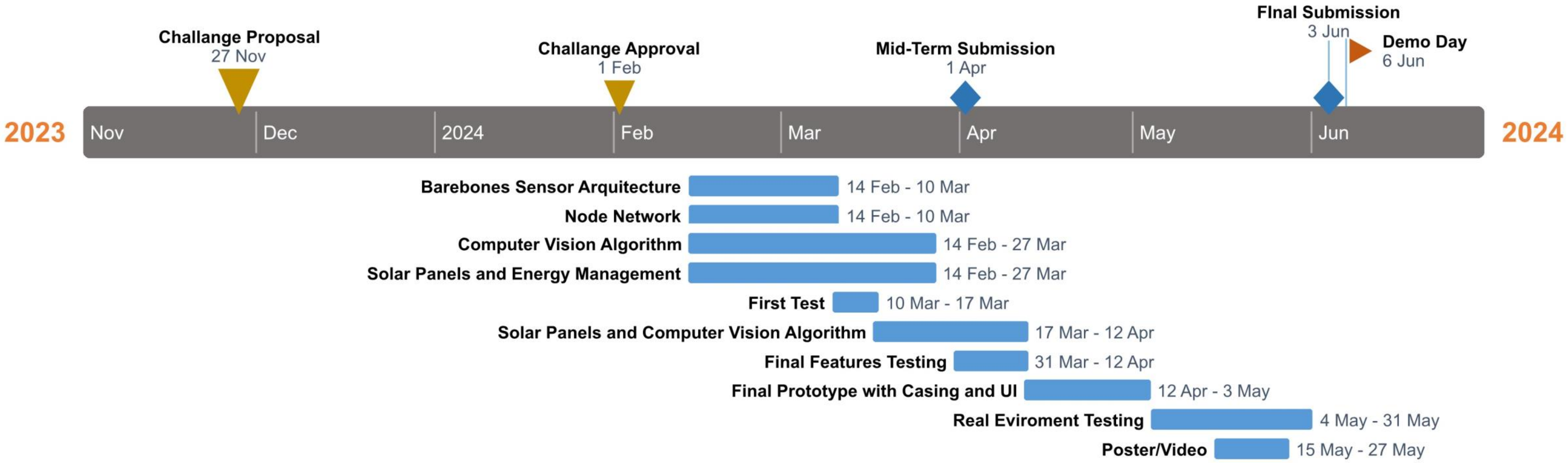
10. Division of labor (I)

Filipe Piçarra	Francisco Apolinário	Guilherme Barros
Hardware/Software Interface	**Communication**	**Solar Panels**
Crop Monitoring System	Computer Vision Model	Energy Management
Sensor Configuration	Video/Poster	Sensors
Node Network	Testing	
Computer Vision Model		

11. Division of labor (II)

Hugo Dezerto	Matilde Sardinha	Nuno Abreu
Communication	**Hardware**	**Computer Vision Model**
Energy Management	Energy Management	Node Network
Node Network	Sensors	Sensor Configuration
CAD	CAD	
Website		

12. Schedule



Challange Proposal
27 Nov
Challange Approval
1 Feb
Mid-Term Submission
1 Apr
FInal Submission
3 Jun
Demo Day
6 Jun
2023
Nov
Dec
2024
Feb
Mar
Apr
May
Jun
2024
Barebones Sensor Arquitecture
14 Feb - 10 Mar
Node Network
14 Feb - 10 Mar
Computer Vision Algorithm
14 Feb - 27 Mar
Solar Panels and Energy Management
14 Feb - 27 Mar
First Test
10 Mar - 17 Mar
Solar Panels and Computer Vision Algorithm
17 Mar - 12 Apr
Final Features Testing
31 Mar - 12 Apr
Final Prototype with Casing and UI
12 Apr - 3 May
Real Eviroment Testing
4 May - 31 May
Poster/Video
15 May - 27 May