AI Salad

An Internet-of-Things (IoT) Enabled Smart Indoor Vertical Farming Monitoring Technology

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Problem Statement

Our land and resource-scarce Singapore produces only a small amount of food for its population, leaving the country vulnerable to disruptions in the global food supply chain.

We have always been heavily reliant on food imports, and the current COVID-19 situation has further emphasised the importance of local food production, as part of Singapore's long-term strategy to ensure food security.

For this Capstone Project, we **explored into how we can leverage on innovative farming technologies to boost the nation's self-sufficiency for food**.

Project Objectives

Partnered with Norgren, a firm specialising in motion control and fluid technology, we aim to develop an Internet-of-Things (IoT) enabled smart indoor vertical farming monitoring technology. The **main objectives are to reduce cost of production and improve crop yield** for Norgren's client, Indoor Farm Factory Innovation (I.F.F.I), a local agri-food enterprise. Hence, we focused on these features:

Analysis on Varying Evaporation Rate

Irrigation Automation

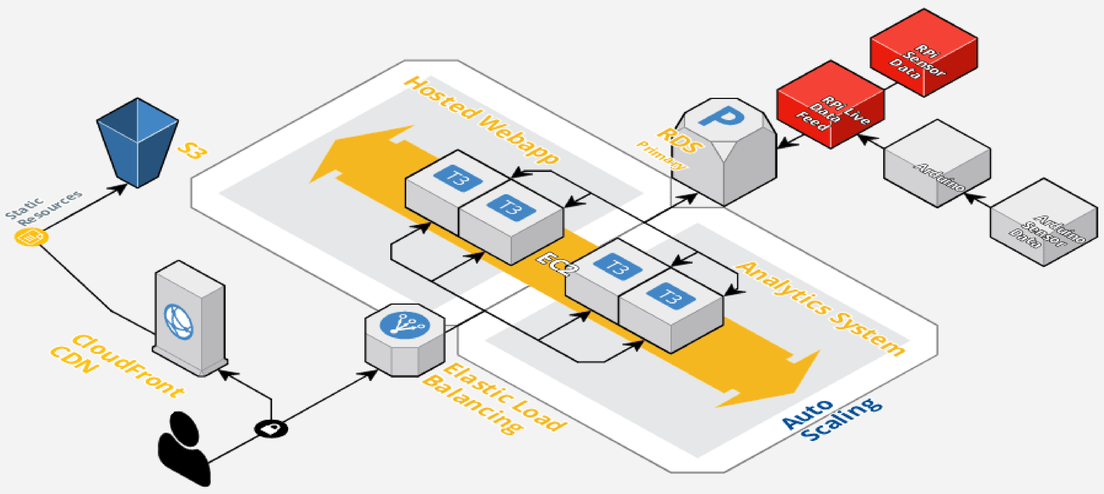
Nutrient Optimisation

Proposed Solution

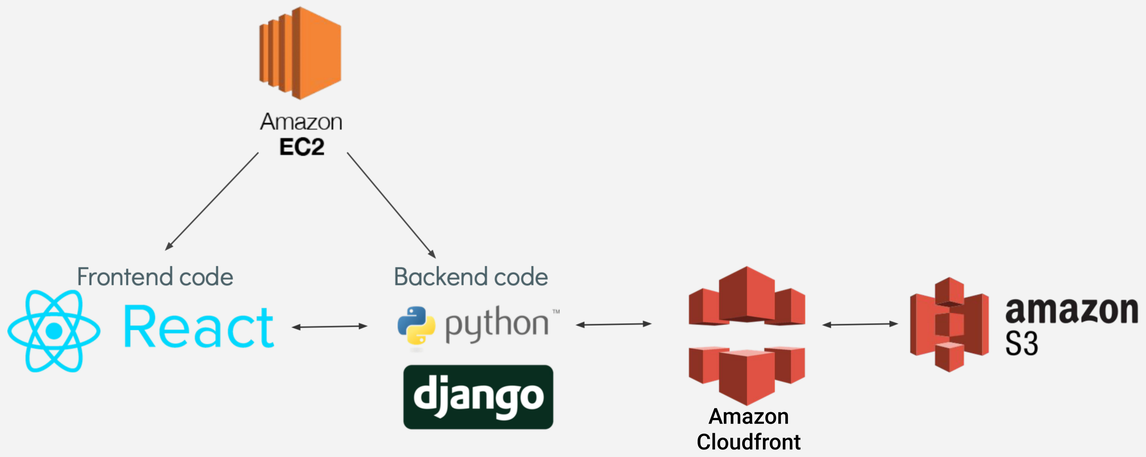
Based on the client's needs, our group proposed a solution that includes the use of **hardware sensors** to measure the plant growth conditions, and the development of a **web-based dynamic dashboard.**

The purpose of the sensors is to obtain the relevant parameters required to **predict optimal conditions for plant growth**. The data collected would then be transmitted to a cloud database, which can then be extracted to be analysed and visualised on the dashboard. The purpose of the web-based dashboard is to provide our client with **real-time monitoring and analytics on the plant growth conditions** based on the sensors installed at the indoor farm facility. It will also display a Growth Degree Days (GDD) Analysis feature to predict plants' growth based on daily temperatures.

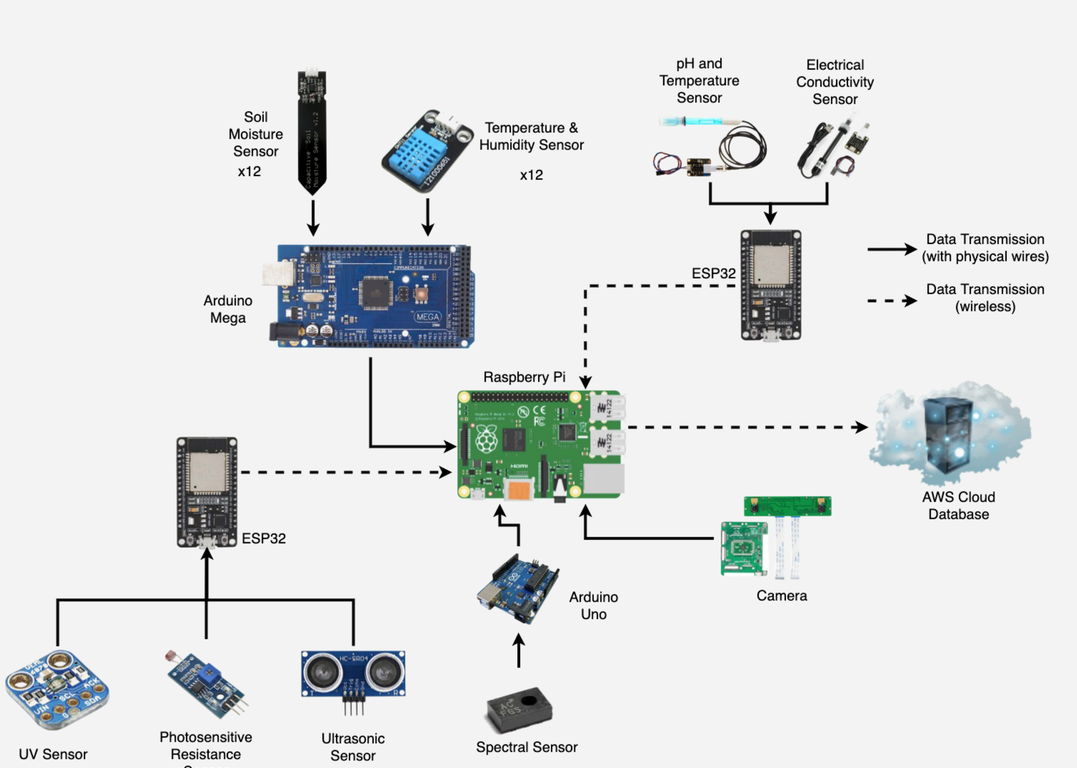
Overall System Architecture



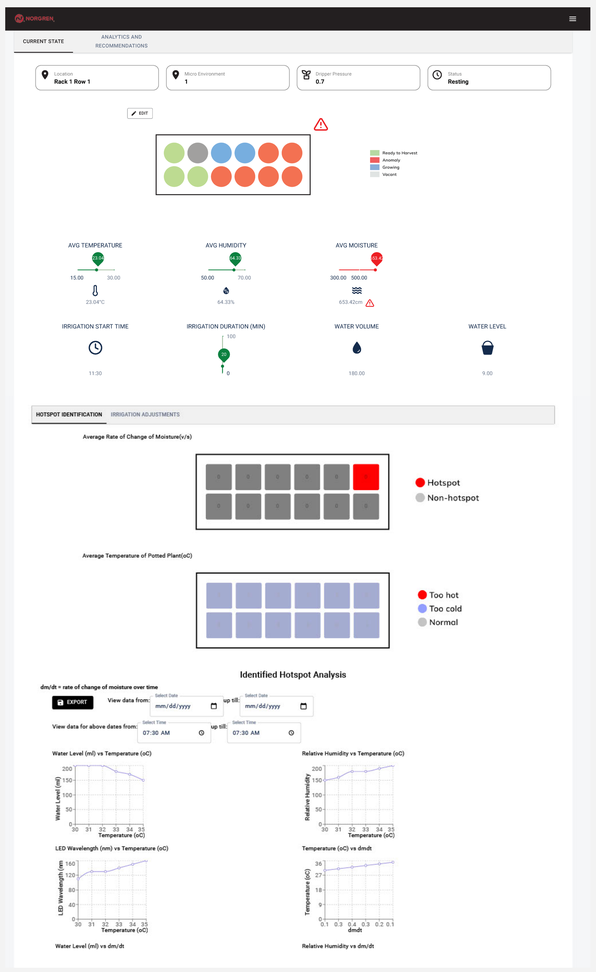
Technology Stack



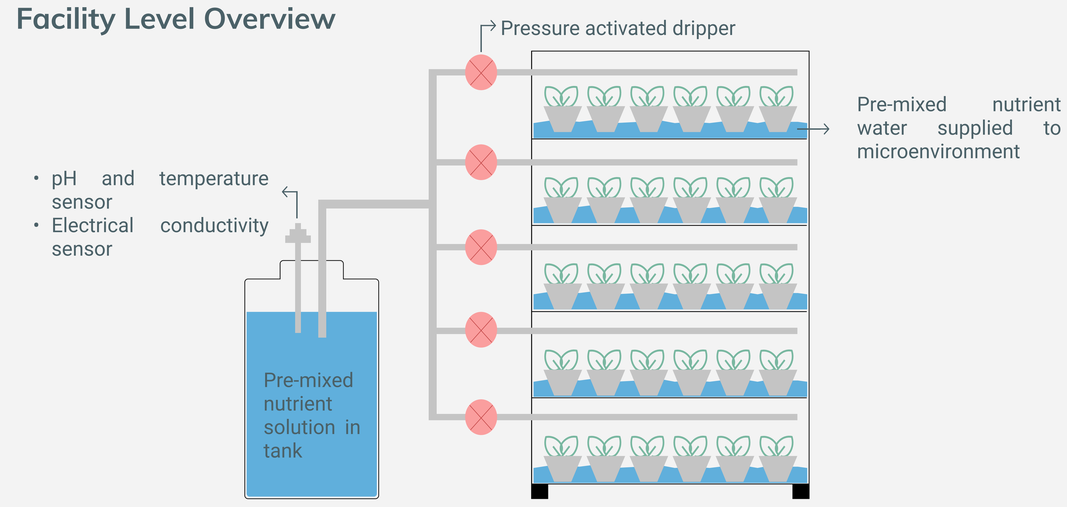
Hardware Architecture



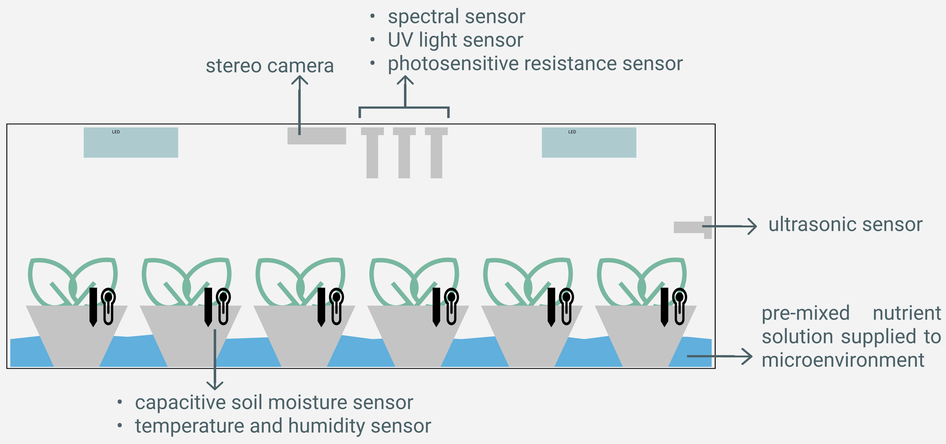
Dashboard Website



Facility Level Overview



Microenvironment Level Overview



Monitoring

- Status of crops in each rack or microenvironment
- Real-time sensor data
- Anomalies in plant growth
- Irrigation settings
- Resource consumption statistics

Analysis and Recommendations

- Anomaly detection
- Sensor data visualisation
- Irrigation analytics
- Hotspot identification
- Irrigation recommendations

Management

- Different user access levels
- User input for threshold values
- User control to edit plant status

Growth Degree Days (GDD) Analysis

The primary modelling task performed by our system is GDD analysis, in which the **growth of the plant is modelled as a function of the average daily temperature**. After analyzing a real dataset with large variability in the data, we found that **Linear Regression model delivered the best performance** for this task.

Our project timeline prioritized the development and delivery of the software and hardware, which meant that there was not enough time for data collection from real plants in the real setting. However, our testing and observation of the data in indoor conditions reveals to us that **there is much less variance in indoor data, and consequently less noise**. This means that our model will most probably be able to capture the trend with less noise in the indoor environment.

Our comprehensive database design combined with our django backend framework ensures that it is easy to expand the capabilities of the analytics system for other use cases, such as Irrigation Automation and Varying Evaporation Rate Modelling.