Project 61: Plant monitoring system to estimate harvesting timing

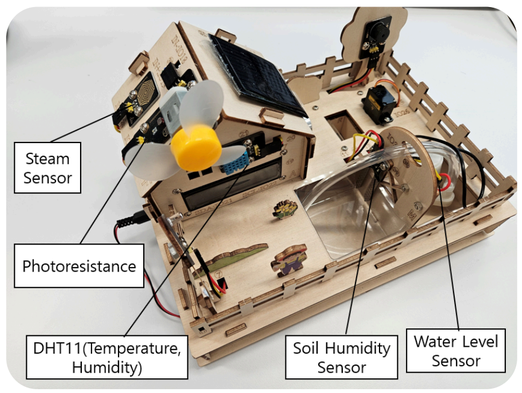
Authors: Kim Zuo & Do Jun Kwon **Supervisors: Ho Seok Ahn & Trevor Gee**

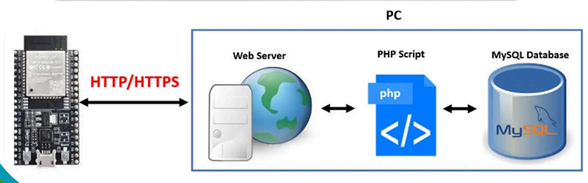
= 109,800 Tomatoes in a building

Problem Statement

Our project aims to research and develop whole integrated system which can work in the real environment for furture SMART Farm System [1]

Environent Monitoring

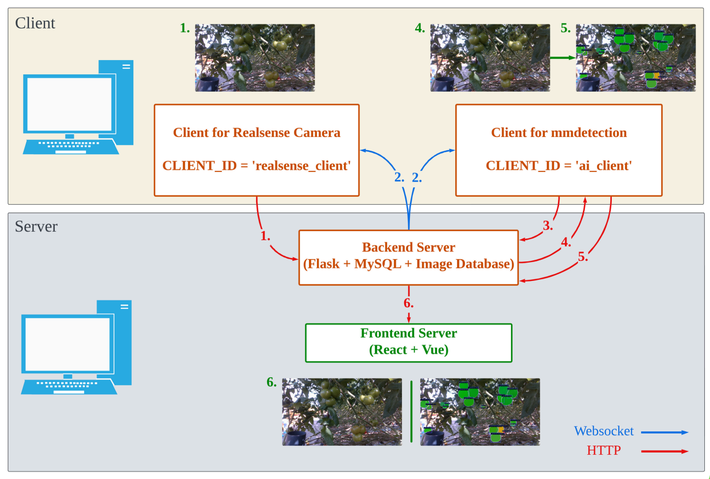




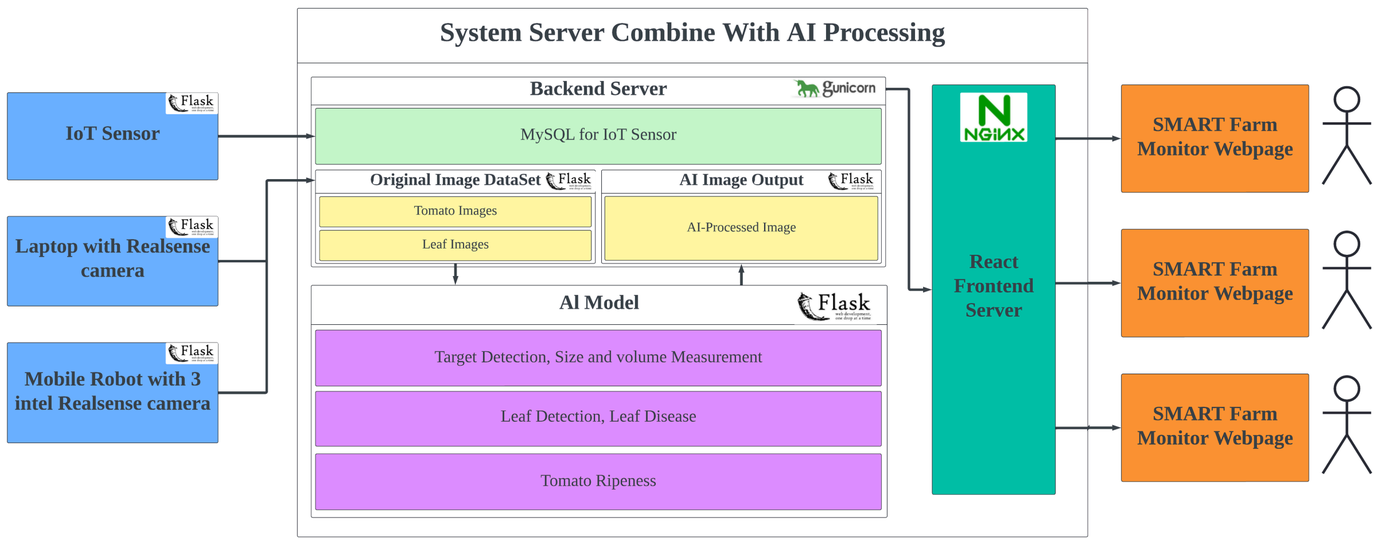
- Central processing unit: ESP32 microcontroller [2] with low power consumption and built-in WiFi.
- Interfaces with various sensors for continuous data collection.
- Data sent to MySQL database via WiFi using HTTP protocol.
- PHP backend handles data transmission and storage, ensuring each entry is timestamped.

Plant Growth Monitoring

1. RealSense Camera [3] Client uploads the image taken to the Backend Server via HTTP.
2. Backend Server notifies all of the Clients via WebSocket.
3. AI Client gets notification and found another client upload image
4. AI Client requests the image from the Backend Server via HTTP.
5. AI Client processes the image and uploads the result back via HTTP.
6. Backend Server sends both original and processed images to the Frontend for display.



System Architecture



Input Devices (left):

- IoT Sensor for environmental data collection
- Laptop with RealSense camera for stationary image capture
- Mobile Robot with 3 Intel RealSense cameras for dynamic image collection

AI Powered Server (center):

Backend Server, which includes:

- MySQL database for IoT Sensor data storage
- Original Image Dataset for storing Tomato and Leaf images
- AI Image Output for processed images

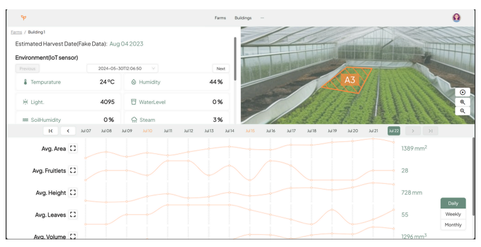
AI Model, performing:

- Target Detection, Size and Volume Measurement
- Leaf Detection and Disease Identification
- Tomato Ripeness Analysis

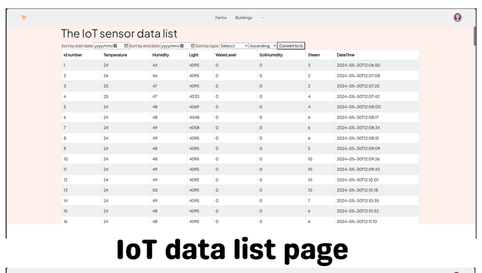
User Interface (right):

- SMART Farm Monitor Webpage, accessible by multiple users simultaneously

Web Interface



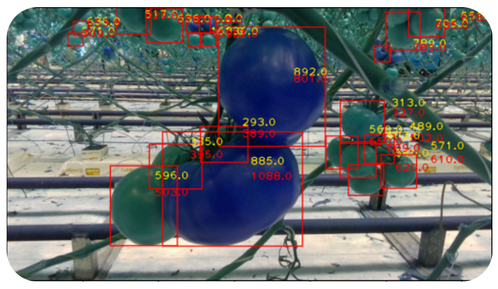
Environment Result Page



IoT data list page

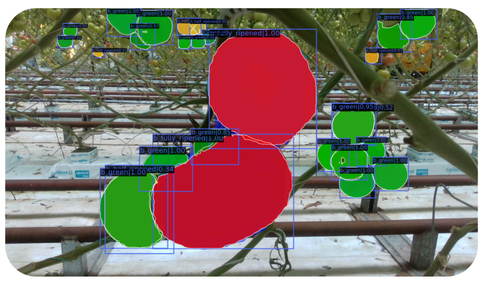
Ripeness Result Page

AI-Processing Result



Size Measurement Result

Original Image



Ripeness Measurement Result

When provided with an input image of a tomato, Size Measurement model performs the following tasks:
- Automatically estimates the actual size of the tomato,
- Superimposes the size information directly onto the image,
- Generates a new image with the size annotation,
- Returns this processed image to the server.

This capability allows for non-invasive, automated size tracking of tomatoes throughout their growth cycle, providing valuable data on crop development without manual measurements.

Ripeness Measurement model processes tomato images and performs the following actions:
- Identifies and outlines the approximate position of each tomato in the image,
- Analyzes the visual characteristics of the tomatoes to assess their ripeness,
- Classifies the tomatoes according to their maturity levels,
- Annotates the image with ripeness information for each identified tomato,
- Returns the annotated image to the server.

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

ENGINEERING
DEPARTMENT OF ELECTRICAL, COMPUTER, AND SOFTWARE ENGINEERING

Reference
[1] Faid A, Sadik M, Sabir E. An Agile AI and IoT-Augmented Smart Farming: A Cost-Effective Cognitive Weather Station. Agriculture. 2022; 12(1):35. https://doi.org/10.3390/agriculture12010035
[2] Espressif Systems. (n.d.). ESP32 series of chips. Espressif Systems. https://www.espressif.com/en/products/socs/esp32
[3]Intel. (n.d.). Intel® RealSense™ depth camera D435i. Intel Corporation. https://www.intelrealsense.com/depth-camera-d435i/

CENTRE FOR AUTOMATION AND ROBOTIC ENGINEERING SCIENCE