

CS 24-312 - Low-cost Soil Moisture Sensing with Wireless Signals

Team members: Fig Vishton, Anisha Vijaykumar, Stephen Liu | Faculty adviser: Eyuphan Bulut | Sponsor: VCU College of Engineering | Mentor: Eyuphan Bulut

Introduction

Wi-Fi sensing is the process of utilizing Wi-Fi signals to detect physical attributes such as motion, speed, and even biometrics via information in the signals. This project focuses on using Wi-Fi sensing and machine learning to measure soil moisture levels.

One of the biggest advantages of Wi-Fi sensing as opposed to using a traditional sensor for soil moisture sensing is increased cost-effectiveness. The materials used are cheaper, and Wi-Fi sensing allows for data collection over a greater area.

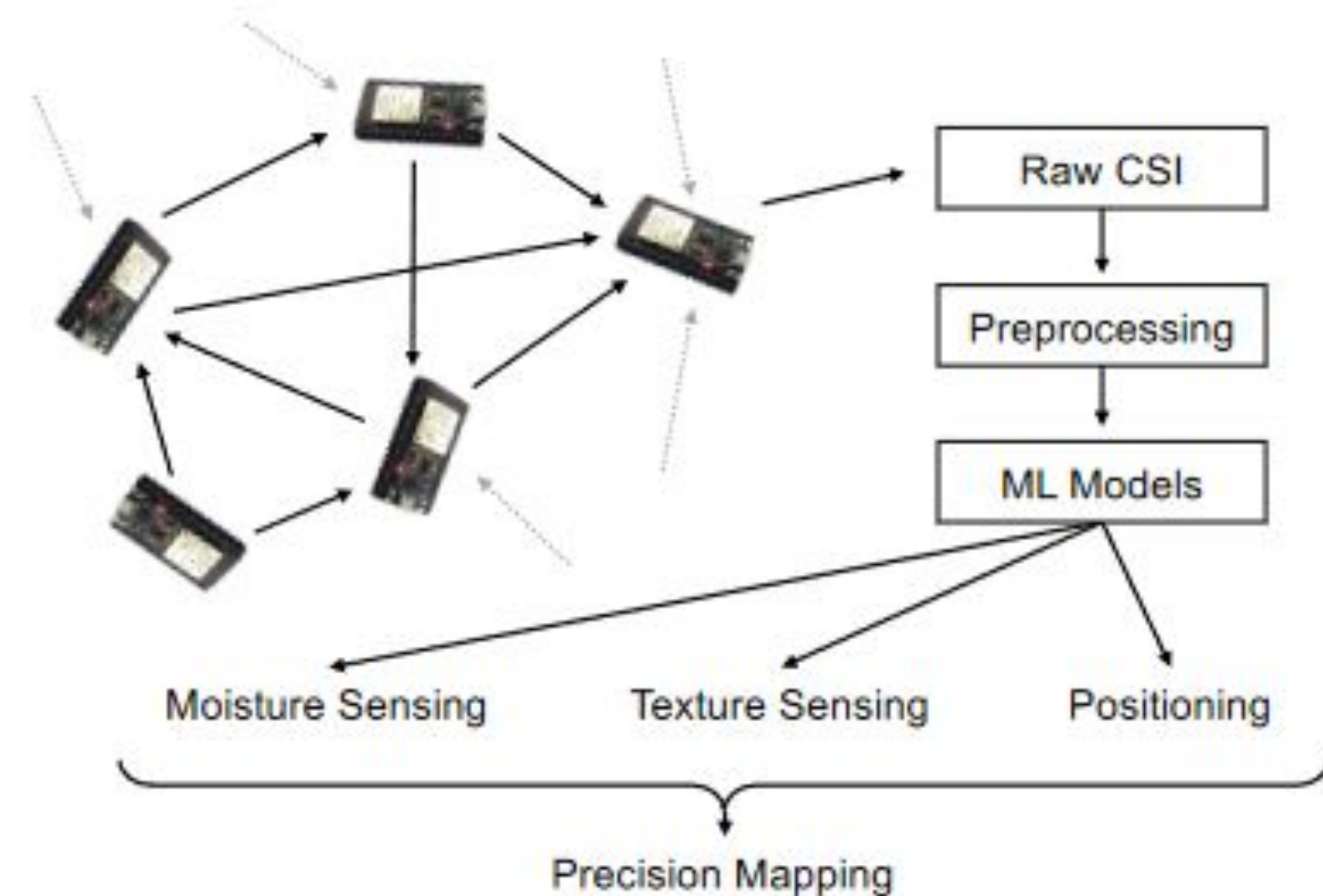
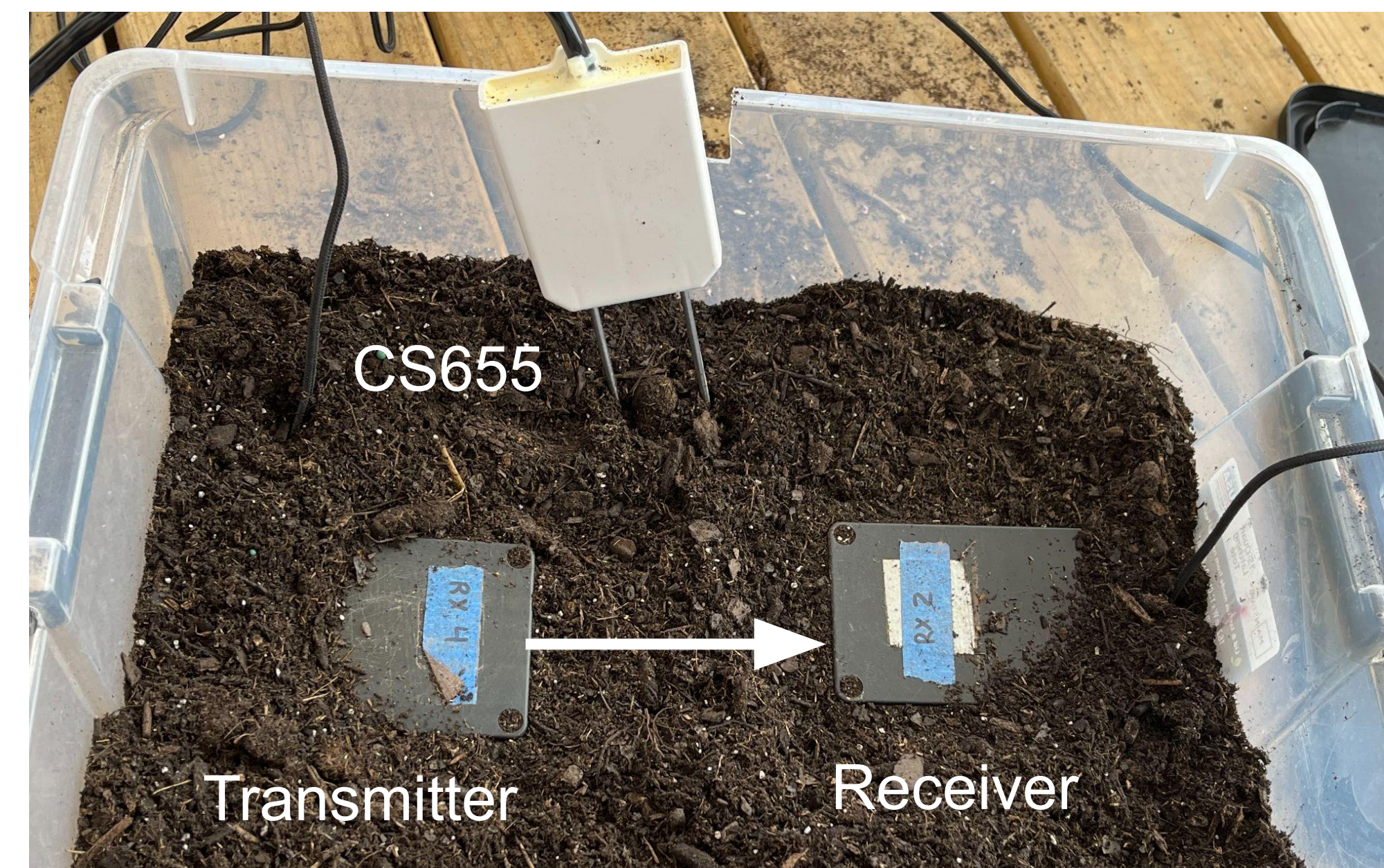


Diagram for ESP32 setup

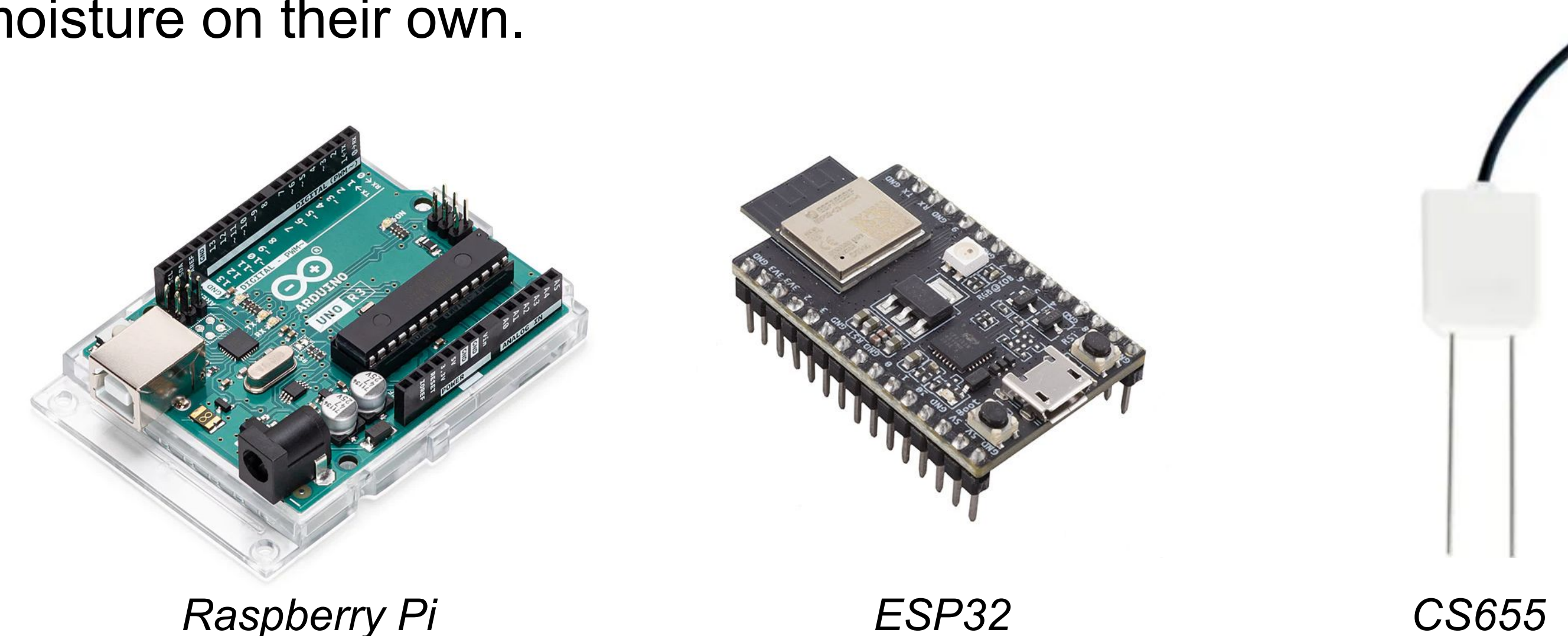


Our Data Collection Setup

Methods

Our soil moisture sensing system utilizes low-cost ESP32 microcontrollers as the Wi-Fi transmitters (TX) and receivers (RX). Wi-Fi signals are sent through the soil from a TX to an RX, and once that signal has been received, the CSI data is extracted, and annotated. At the same time, soil moisture measurements are collected by a reliable soil moisture sensor (in our case, the CS655).

All of this data, along with the time it was collected, is then used to train a machine-learning model. Once the model is adequately trained and paired with a user interface, the ESP32s and Raspberry Pi can reliably measure soil moisture on their own.



Raspberry Pi

ESP32

CS655

Results

Preliminary results were promising, but more data needs to be collected before a working standalone prototype could be produced. Our team worked first on verifying ESP32 measurements manually before moving to working in tandem with the CS655, so much of our data is from that data collection period.

Our team also did work towards making hardware setup easier for future students who will work on this project, including extensive documentation.

Below is a confusion matrix of collected data:

