SAAGE

Sensing and Actuating in Agricultural and Gardening Environments

Motivation for the problem

In agriculture and gardening, there is often one main metric of success: crop yield. How many tomatoes will I have to harvest? At the agricultural level this dictates the success of a farmers business, who needs his/her crop yield to be high for a good harvest to pay back the debt taken on to plant the crop initially. At the gardening level, gardeners often dedicate hours of energy into caring for and raising their plants. They check up on their crops and work towards the healthy growth of the plant. In both contexts, crops must be monitored to determine health and corrective actions, which can help lead to a high crop yield. We aim to automate the previously manual and iterative process of monitoring with an on-site sensing system that can gather useful statistics related to crop growth. These statistics include the soil temperature, soil moisture, air temperature, air humidity, air pressure, and UV light (sunlight estimation). In addition, once data is gathered, linear regression techniques allow us to make predictive estimates as to the conditions the crop face, allowing for pre-emptive action to be taken in the event of unfavorable conditions. Examples of useful preemptive actions involve ensuring plants are receiving enough water and changing the irrigation system after determining dry periods of a day the soil moisture levels, or changing irrigation techniques if the soil temperature indicates it is freezing over. Given a farmer or gardener has the data related to the successful growth of their crop, one issue that still persists are rodents that may consume the crop. To combat these rodents, our system employs three actuated defensive systems triggered when motion is detected by a PIR sensor. A hypersonic emitter emits high frequency noise to repel small pests, while a speaker plays an audible noise of a predator, and a small motor moves a makeshift scarecrow. In addition to the defensive capabilities, the system will also proactively fertilize the crop using an actuated dispenser to release nitrates into the soil.

What’s been done before

Diwenhouse Soil Moisture Meter Test Kit - Waterproof Soil Water Monitor Hygrometer for Indoor Plants Gardening Pot Flowers, Led Lights Instant Detection

by Diwenhouse

38 ratings

Govee Temperature Humidity Monitor, Indoor Bluetooth Thermometer Hygrometer Gauge, Wireless Temp Humidity Sensor with Alert, Data Export Thermometer Humidity for Home Garage Cigar Humidor Greenhouse

by Govee

580 ratings | 127 answered questions

XLUX T10 Soil Moisture Sensor Meter - Soil Water Monitor, Hydrometer for Gardening, Farming, No Batteries Required

by XLUX

3,018 ratings

Plant Monitor, Xiaomi Smart Plant Tracker Soil Moisture Meter Tester Nutrient/Temperature/S Sensor Plant Detector Flower Plant Care for Home Garden Farm (Plant Monitor) (Plant Monitor)

by OLLIVAN

8 ratings

What’s been done before

Dalen 016069000301 OW6 Gardeneer by Natural Enemy Scarecrow Horned Owl

by Dalen

2,604 ratings

Dalen Gardeneer 100055888 Gardeneer by Dalen Solar Action Owl Natural Scarecrow Device, 18in, 18 in, Yellow

by Dalen Gardeneer

1,995 ratings

Bocianelli Ultrasonic Pest Repeller 6 Packs, 2020 Newest Electronic Indoor Plug in for Insects Mice Ant Mosquito Spider Rodent Roach, Best Repellent for Children and Pets' Safe

by Bocianelli

1,326 ratings

133 answered questions

Neatmaster Dual Microchip Ultrasonic Pest Repeller Mice Control Variable Electromagnetic Insect Repellent Reject Rodent Bed Bug Mosquito Ant Fly Cockroach Spider and More, Black

by Neatmaster

2,324 ratings

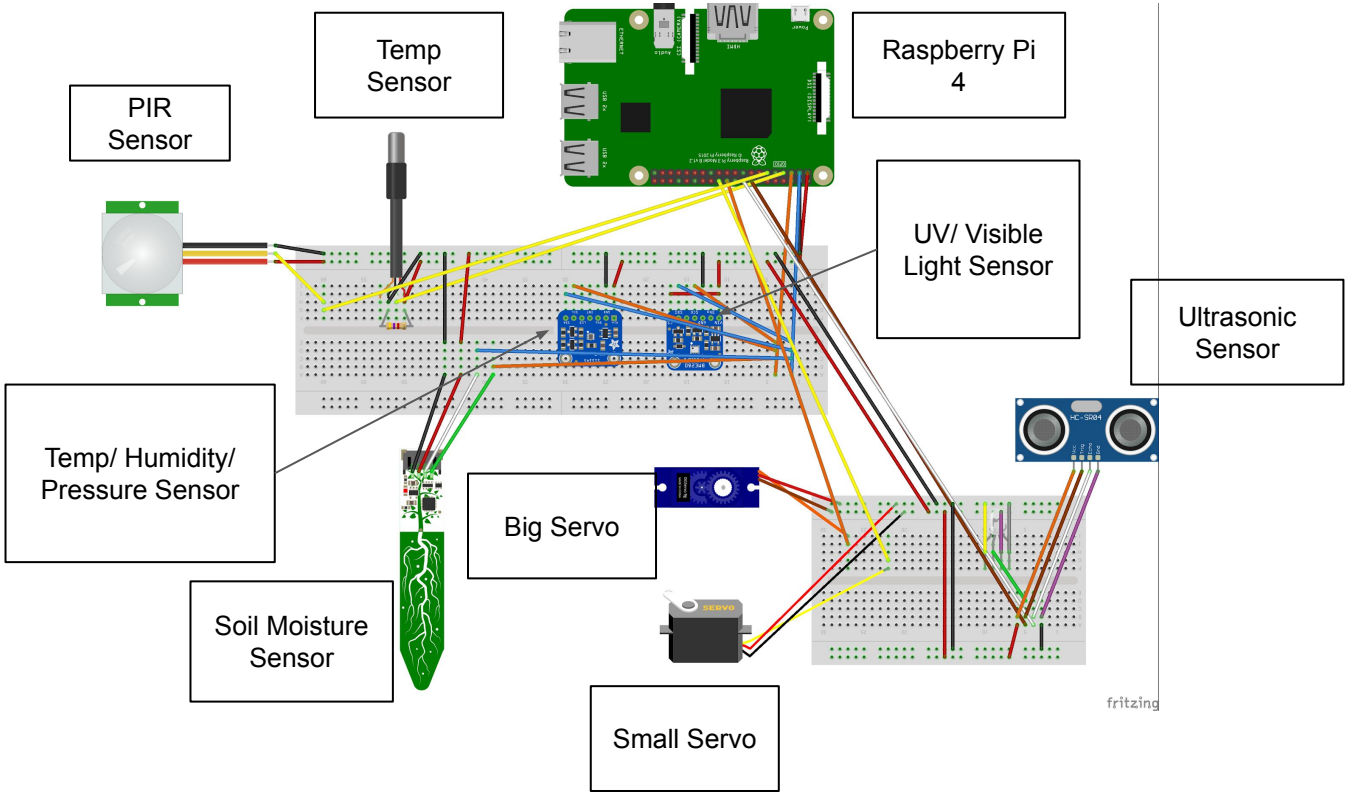
What’s (hasn’t) been done before

Missing integrated system with predictive capabilities

Hardware Components

Component	Communication Protocol	Units sensed
Waterproof temperature Sensor	1-wire	Temperature in ℉
Soil Moisture Sensor	I2C	Moisture level 200(very dry) to 2000 (very wet)
PIR sensor	GPIO	Motion detection
Temp/humidity/pressure sensor	I2C	Temperature in ℉, Humidity in %, Pressure in hPa
UV/Visible light sensor	I2C	UV index
Ultrasonic sensor	GPIO	Emits ultrasound in 40 kHz range
Small servo motor	GPIO	360° rotation
Big servo motor	GPIO	Intermittent rotation

Hardware Integration

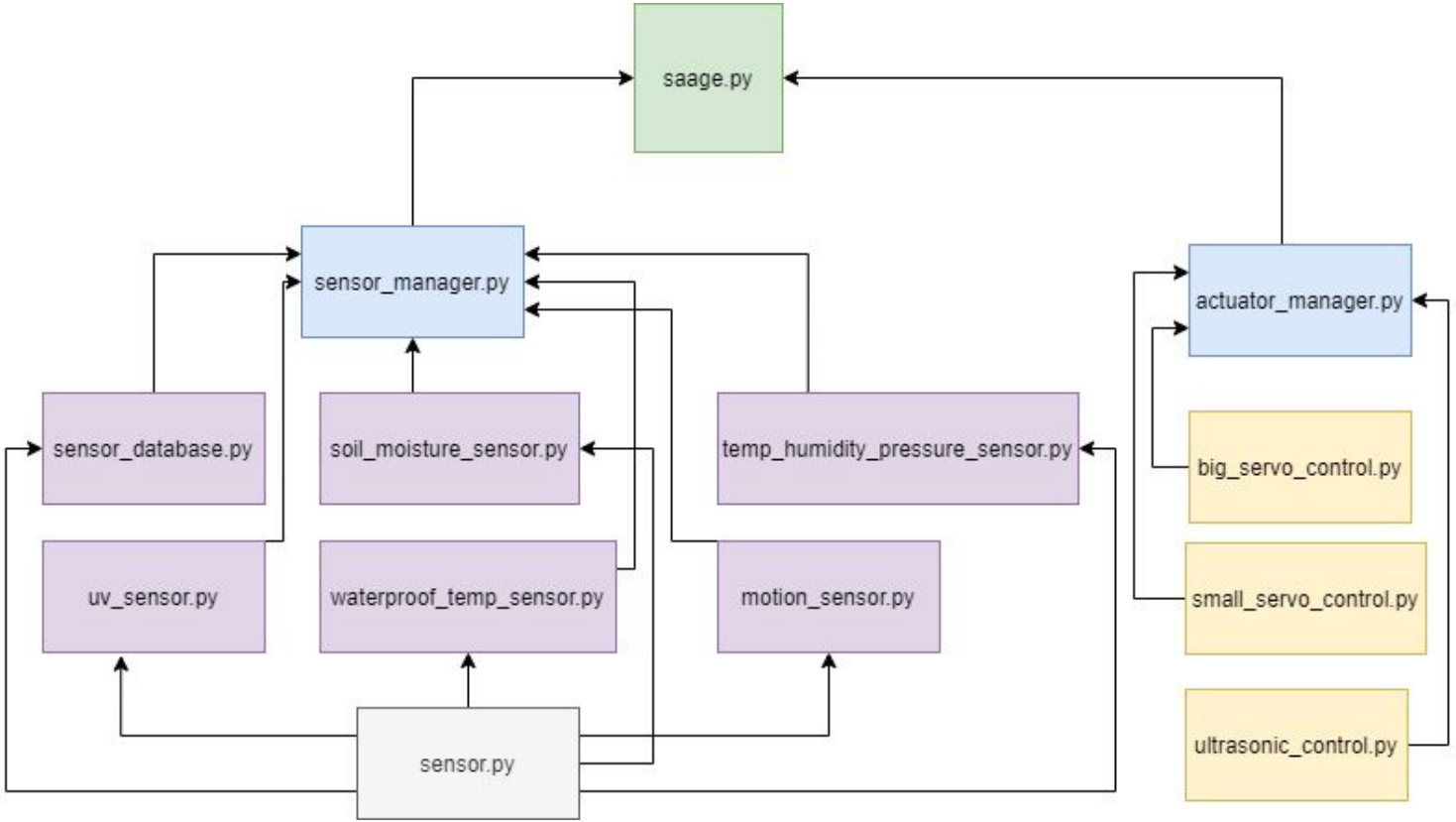


Software Modules

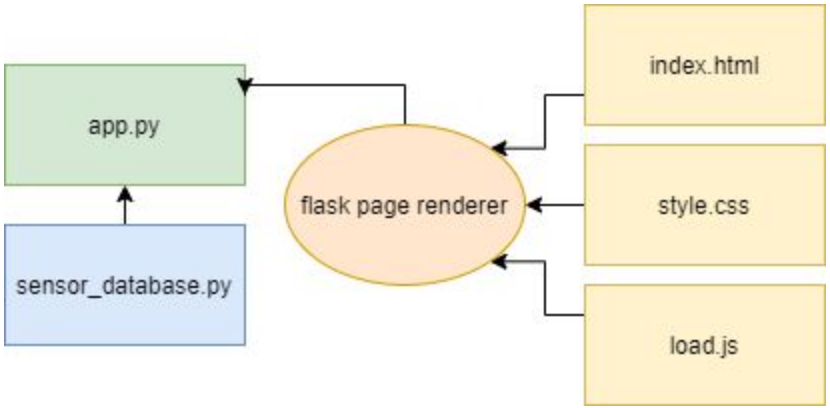
Python Module	Use
RPi.GPIO	GPIO interface, soft PWM for servos
adafruit-blinka (busio, board)	i2c interface access
adafruit_seesaw	Soil moisture sensor interface
adafruit_bme280	Temp/humidity/pressure sensor interface
SI1145	UV sensor interface
sqlite3	Sqlite3 database interface for data storage
flask	Web interface
sklearn	Linear regression prediction model

Additionally Google Charts (javascript) was used for presenting the data.

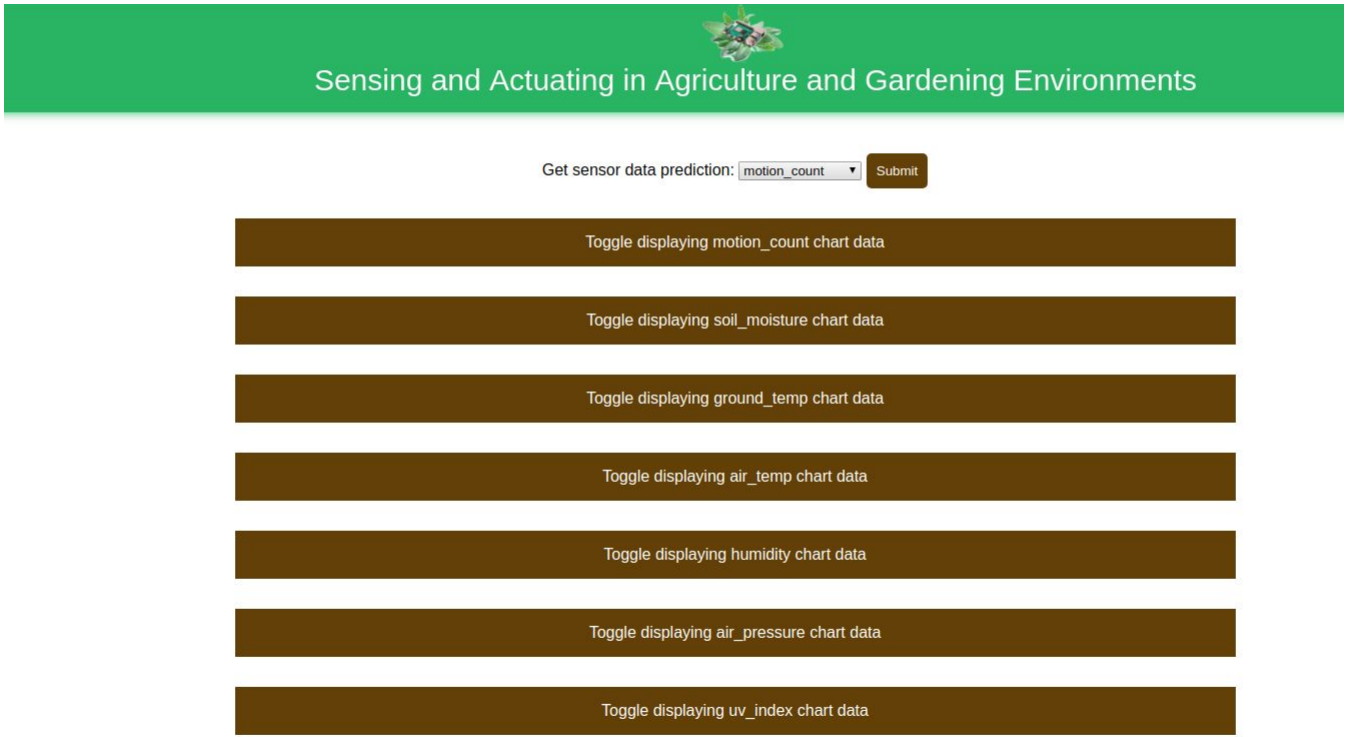
What Software? Controller



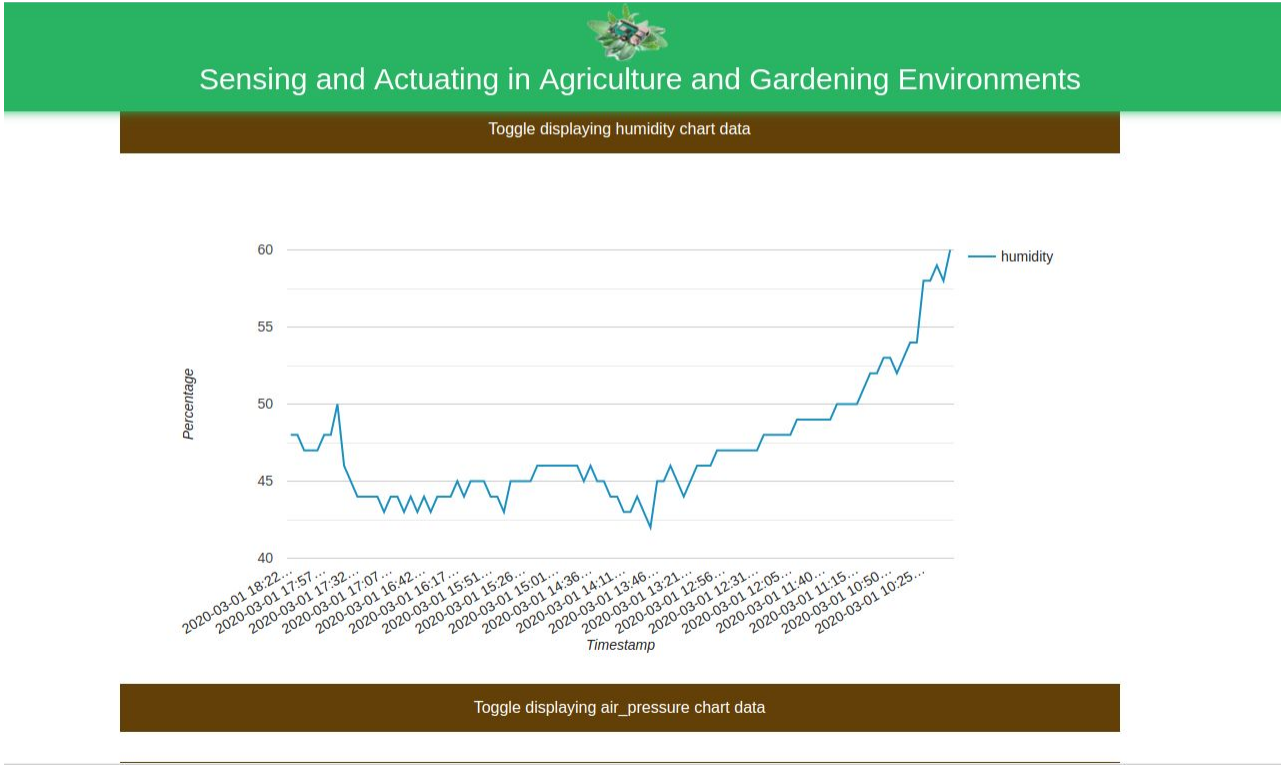
What Software? Web Server



Results


Sensing and Actuating in Agriculture and Gardening Environments
Get sensor data prediction:
motion_count
Submit
Toggle displaying motion_count chart data
Toggle displaying soil_moisture chart data
Toggle displaying ground_temp chart data
Toggle displaying air_temp chart data
Toggle displaying humidity chart data
Toggle displaying air_pressure chart data
Toggle displaying uv_index chart data

Results

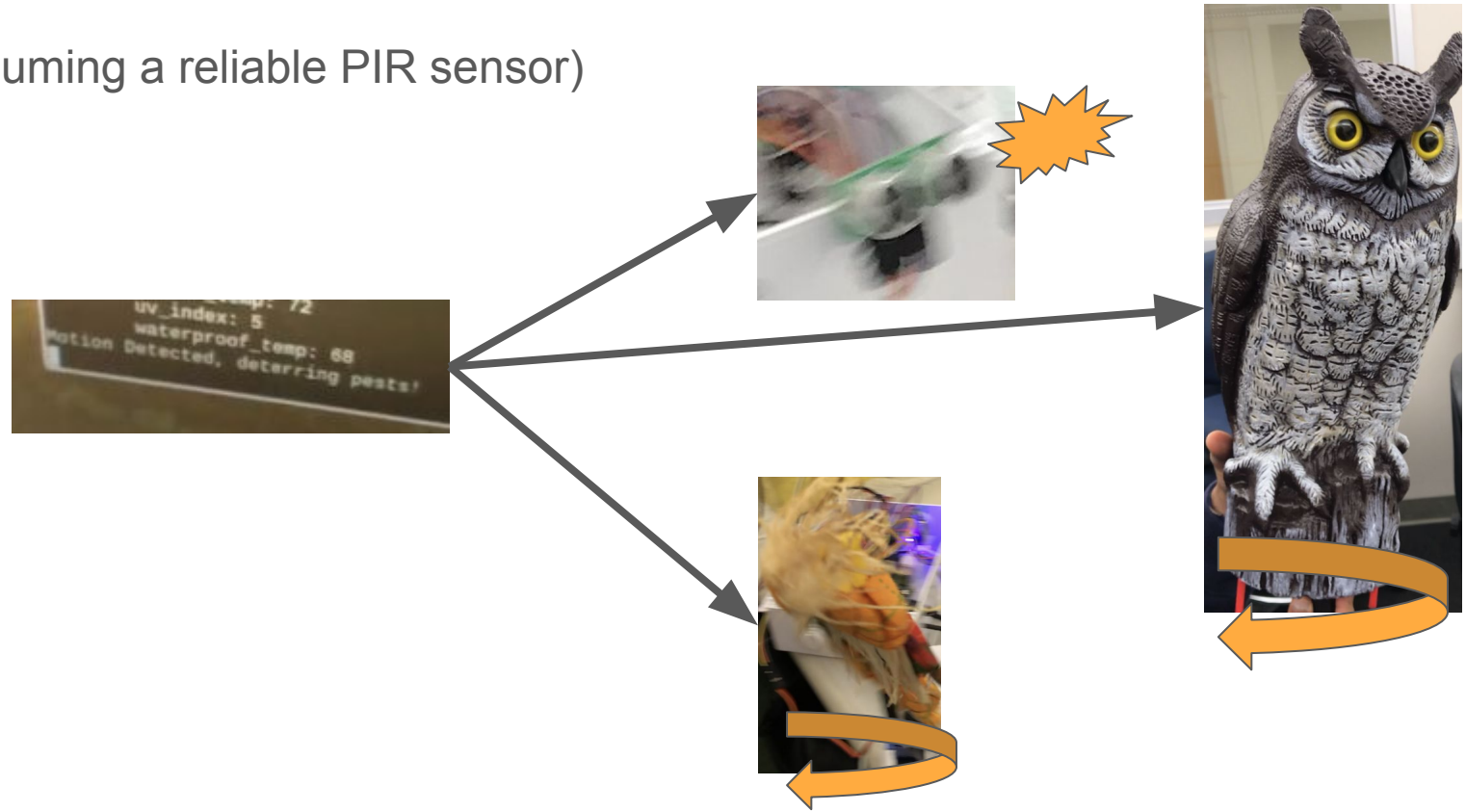

Sensing and Actuating in Agriculture and Gardening Environments
Toggle displaying humidity chart data
humidity
60
55
50
45
40
Percentage
2020-03-01 18:22…
2020-03-01 17:57…
2020-03-01 17:32…
2020-03-01 17:07…
2020-03-01 16:42…
2020-03-01 16:17…
2020-03-01 15:51…
2020-03-01 15:26…
2020-03-01 15:01…
2020-03-01 14:36…
2020-03-01 14:11…
2020-03-01 13:46…
2020-03-01 13:21…
2020-03-01 12:56…
2020-03-01 12:31…
2020-03-01 12:05…
2020-03-01 11:40…
2020-03-01 11:15…
2020-03-01 10:50…
2020-03-01 10:25…
Timestamp
Toggle displaying air_pressure chart data

Results


Sensing and Actuating in Agriculture and Gardening Environments
Get sensor data prediction:
motion_count
Submit
Predicted chart for humidity:
humidity
Percentage
57
56
55
54
53
52
51
5
20
35
50
65
80
95
110
125
140
155
170
185
200
215
230
245
Predicted Minutes in Future

Results

(assuming a reliable PIR sensor)



Live Demo

Two applications to run:

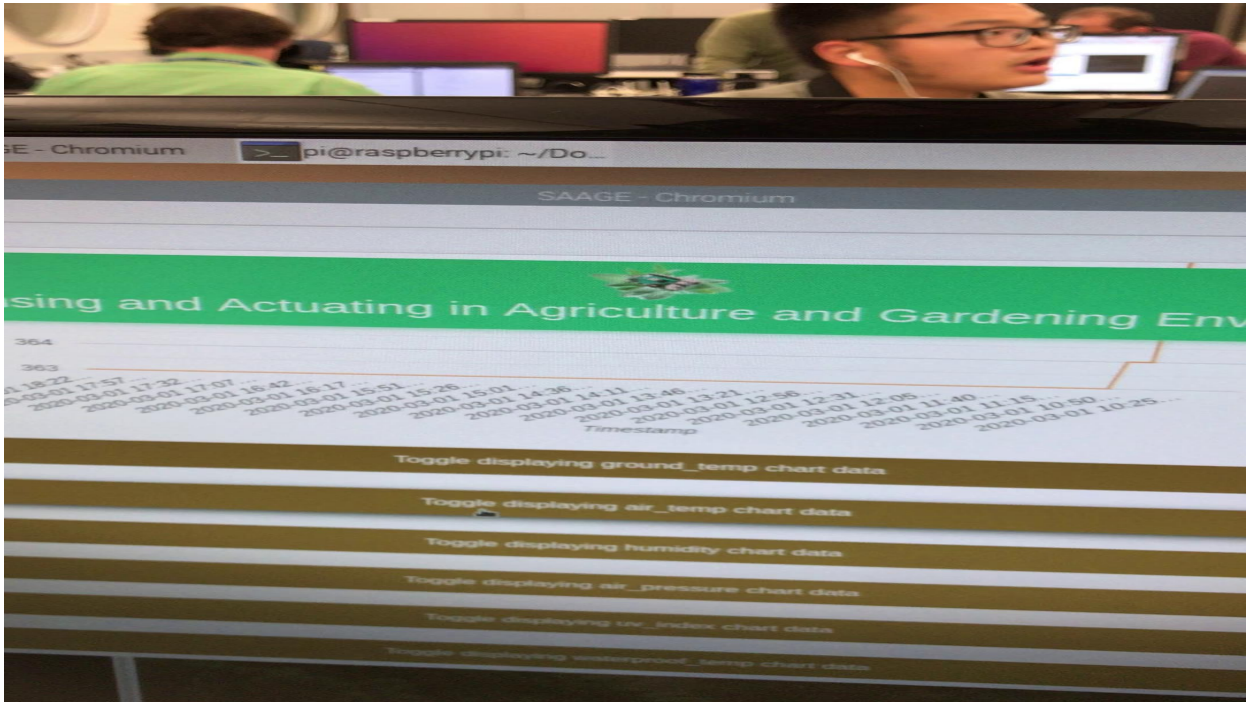
- SAAGE
- Web Server

Demo:

- Actuation (may disconnect PIR sensor)
- Web Server

Recorded Demo

Sensed Data



Recorded Demo

Pest Deterrence