Final PROJECT TITLE	Grow, Plant. Grow!		
NAME or NAMES	Ryah Carpenter and Jonathan Nguyen	DATE	3/23/23

I. INTRODUCTION Central problem being addressed; Topic of study related to problem [1.0 Points]

- Growing and maintaining healthy Plants and Trees is exponentially complex when trying to maintain multiple plants and trees. Data like moisture, dimensions, and color can be extremely repetitive and strenuous for the user to collect.
- A network of devices that use cameras and sensors to track and optimize plant and tree growth, using image processing and monitoring the plant's soil moisture level and air quality.
- Having a network on devices, we could minimize the amount of work to maintain and collect data on a plant lab and improve accuracy and efficiency.
- Using the cameras, we will be able to calculate the overhead area/size of each plant and, we could do the height of the plant. Using humidity and temperature sensors we will ensure the plant(s) is in the optimal environment. Using moisture sensors we will monitor the water levels of the soil, and with the NPK/pH sensor we will monitor the nutrient and pH levels of the soil.

II. BACKGROUND AND SIGNIFICANCE Problem details; Rationale; Problems addressed; Research methods and sources. [1.0 Points]

Plants essential to keep us and the environment healthy. They improve air quality and reduce CO_2 emissions, and vegetables can increase nutrient diversity in human diets. Everything from farms and forests to gardens and houseplants are essential to the human ecosystem. NASA conducted a study in 1989 that determined plants do have the ability to reduce volatile organic compounds (VOCs) in the air [1]. Diverse diets are important in the fight against malnutrition and obesity [2]. For these benefits to be actualized, plants need to have the tools that keep them healthy and successful. This includes nutritious soil, the appropriate amount of water, soil with optimal pH levels, and an environment with enough light and humidity.

III. LITERATURE REVIEW Cite, Compare, Contrast, Critique, Connect [2.0 Points]

- "Simple Imaging Techniques for Plant Growth Assessment", developed and researched methods of measuring plant size. Using a phone camera to take overhead photos/ canopy photo of cucumber, strawberry, and tomato plants, and using ImageJ software on a window computer to create a canopy cover of the plant. Using the cover find the overall area of each plant. [3]
- "A Raspberry Pi-based camera system and image processing procedure for low cost and long-term monitoring of forest canopy dynamics", Using a Raspberry pi 3 and camera module enclosed in a device placed on the ground level of forest, they developed methods for calculating canopy cover of trees in a forest. Images and canopy covers were processed at specific times throughout the daylight for the span of the year. They were able to find valuable results for the canopy cover throughout different seasons meaning they could have data about the health of trees throughout the seasons. [4]
- "Smart Home Monitoring System Using ESP32 Microcontrollers", Using ESP32 microcontrollers with multiple sensors to monitor an environment. MQTT protocol is used to publish data from sensors to the Raspberry Pi and display data to users on a mobile application. [5]

IV. PROJECT DESIGN AND METHODS Research operations and result interpretation methodology argument; Potential obstacles [1.5 Points]

- **Sensor layer**: Soil moisture sensors, NPK soil sensor, pH sensor, humidity sensor, temperature sensor, camera
  - Lead – **Ryah**
  - Ryah will work with the plant soil sensors.
  - Jon will work with the plant's environment using the camera, humidity, and temperature sensors.
- **Communication layer**: ESP32
  - Lead – **Jonathan**
  - Jon will set up the Wi-Fi hot spot and connect all sensors.
  - Ryah will pitch in especially when connecting the soil sensors.
- **Processing layer**: Raspberry Pi
  - Lead – **Jonathan**
  - Jon will research what processing is necessary and process the plant data.
  - Ryah will pitch in with the soil data processing and research.
- **Information layer**: User app and dweet.io
  - Lead – **Ryah**
  - Ryah will publish sensor data to dweet.io and build user app.
  - Jon will pitch in when incorporating the processed information.
- **Business layer**: Could be scaled up to large scale agriculture, since it is a remote service.
  - Lead – **Jonathan**

V. PRELIMINARY SUPPOSITIONS AND IMPLICATIONS Task division; Identify who is doing what if you are in a team of two [2.0 Points]

- **Sensor layer**: Soil moisture sensors, NPK soil sensor, pH sensor, humidity sensor, temperature sensor, camera
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  - Ryah will pitch in with the soil data processing and research.
- **Information layer**: User app and dweet.io
  - Ryah will publish sensor data to dweet.io and build user app.
  - Jon will pitch in when incorporating the processed information.
- **Business layer**: Could be scaled up to large scale agriculture and forest monitoring, since it is a remote service.

VI. SUMMARY Why is this problem worth addressing; Why this problem is unique and how it advances existing knowledge [1.0 Points]

- Acquiring plant and forest data at high frequency is essential for the study of ecology. While there is processing and equipment for measuring things like population and area, these systems can be expensive. Using a raspberry can make the system cheaper and allows for more data receiving points like doing multiple forest and multiple plant areas. By using a raspberry pi network, the user does not have to be at each individual site to collect data, but anyone can pull data on our application.
- In addition, by adding NPK soil pH sensors, we can not only measure the Forrest and plants as a group, but also the individual health of each plant based on their environment. We will be able to make data and conclusions on optimal conditions for plants growth and health. Furthermore, this project as massive scalability because this system can be put plant Laboratory and forests and the same time which build a network.

VII. CITATIONS References; Bibliography [1.5 Points]

[1] American Lunch Association Editorial Staff, "Getting into the Weeds: Do Houseplants Really Improve Air Quality?" American Lung Association, February 2017.

[2] P. C. Weerasekara, et al., "Understanding Dietary Diversity, Dietary Practices and Changes in Food Patterns in Marginalised Societies in Sri Lanka", *PubMed Central*, National Library of Medicine, November 2020.

[3] A. Shinsuke, "Simple Imaging Techinques for Plant Growth," Univerity of Floria January 2020.

[4] W. Matthew , "A Raspberry Pi-based camera system and image processing procedure for low cost and long-term monitoring of forest canopy dynamics," British Ecological Society, April 2021.

[5] M. Babiuch and J. Postulka, "Smart Home Monitoring System Using ESP32 Microcontrollers," Internet of Things, November 2020.