ELECOMP CAPSTONE
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO™

Automated Spectral Data Acquisition and Analyzer

TSRgrow™

Team Members: Robin Hall (ELE), William Guo (CPE), Ruairi Heslin (ELE)

Technical Director: Mikhail Sagal

Project Motivation

Currently, desired data must be manually collected and compiled. Taking this data is time consuming and labor intensive. This is done by an employee collecting each data point with a PLA-30 over increasingly large areas. There is no standard methodology or equipment to perform this testing and data collection automatically. The goal of this project is to eliminate the need for human intervention. Any TSRgrow Employee should be able to set up our prototype/product to start a test and be able to come back once it's finished. The data will also be able to interact and align with TSRs' current data visualization software. The data collection will be automatic and can be used for customer interaction and can represent light/heat maps which show the efficiency of PAR getting to the plant canopy from the fixtures. These advancements in data collection will allow TSRgrow to be more productive and efficient which will lead to more profit.

Key Accomplishments

We created a robot as seen in **Fig. 1** that is capable of following a specified grid and stops to take light or PAR(Photosynthetic Active Radiation) readings at certain predetermined locations. The robot is capable of accurately carrying the PLA-30 light sensor. It stops at desired locations as seen in **Fig. 2** and triggers the PLA to take a light reading. Once the reading is complete, the PLA triggers the robot to move to the next point. This allows for accurate and repeatable measurements.

The Line following robot consists of two arduinos, one UNO and one MKR-1000. They are connected via two cables, these are then connected to the PLA-30 by being physically the platform for the PLA but also via the WiFi page hosted by the MKR-1000 board. The two cables connecting the MKR and UNO allows the two boards to send and receive signals between each other which then can be utilized by their individual program to perform task stop as adjusting the status of robot on webpage. The PLA program **Fig. 3** we've adjusted, waits for signals from our MKR board and takes automated measurements when specified. The program also allows users to input all testing related dimensions, such as positions of LED lights or number of expected data points. The program also allows for all collected data and testing dimensions that were entered by the user to be exported into a .csv file which then can be used to create heat maps or data sheets which represent the PAR and specific wavelengths at each test point.

We tested this grid system on printed mats seen in **Fig. 4** and it proved to be very successful. We were able to make these mats in photoshop and implement 90 degree turns. These printed mats feature ½ inch thick lines for the robot to follow and ½ inch thick lines, which are perpendicular to the pathway, to mark sensor points. The printed grid mats will be placed underneath a light fixture to accurately test the efficiency of the fixture and deliver the correct wavelengths of light to the correct place on the canopy of plants. For smaller fixtures we will need a smaller grid area for our robot to test and a larger fixture calls for a larger grid and so on. The robot will be placed on the grid and powered on, it will then be given initial test info, and then finally follow the path and carry out its test sequence. After it has completed the whole test sequence it will save the data to be examined. We are able to repeat light measurements on the same grid and get high quality results. Printing these grids allows for the whole test set up to be moved, taken down, and manually adjusted. Our system eliminates the need for human interference. Once the robot is started, it can take all the measurements necessary for any given light fixture. This allows TSR employees to work on other tasks instead of manually performing these tests.

Lastly we created a fixture mount prototype. We have both a prototype and cad files representing a desired final product. This was deemed not an essential portion of the test due to the fact that TSR already has a method for mounting light fixtures and fell to the backburner when we encountered the COVID-19 crisis. However this prototype mount would be capable of holding any fixture TSRgrow may need to test and be able to adjust vertically to any desired height. This would be done using a ceiling mounted piece with a guide which allows a sliding portion to be lifted/lowered into place.

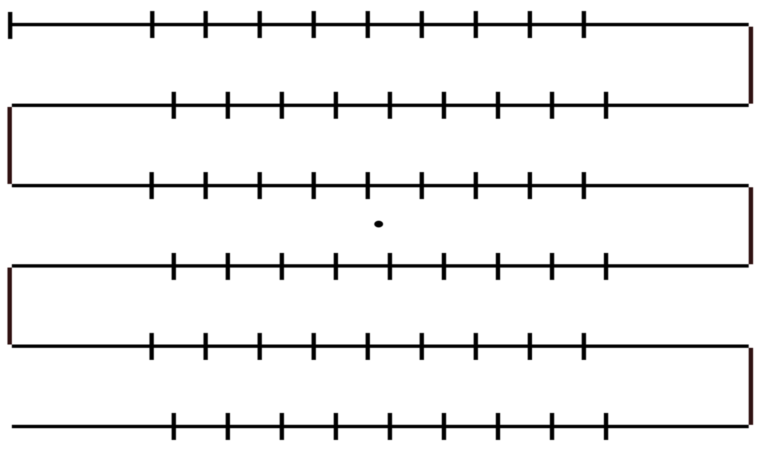

Fig. 4 One of the finalized mats that the Robot will complete a test on.

Anticipated Best Outcome

To have automated data collection of PPF and PPFD from light fixtures. Data collection must happen over a predefined grid area that can vary from 4'x4' to 16'x24' at heights from 6" to 72". A grid set up needed to be created that complements the created system and works in TSRgrows facility. Finally, the creation of an application to aggregate, sort and store the information and create reports based on defined queries. This data will be entered into a GUI interface that controls all aspects of the light testing system. It must aggregate data in a way that can be easily manufactured into lighting reports.

Project Outcome

The Anticipated Best Outcome was Achieved.

We created an automated test apparatus using robotics and a PAR sensor, the PLA-30. Wireless communication between an Arduino Uno and MKR-1000 enabled the robot and PLA to communicate and take light data. We developed printable grids that can be used to test any light fixture.

Figures

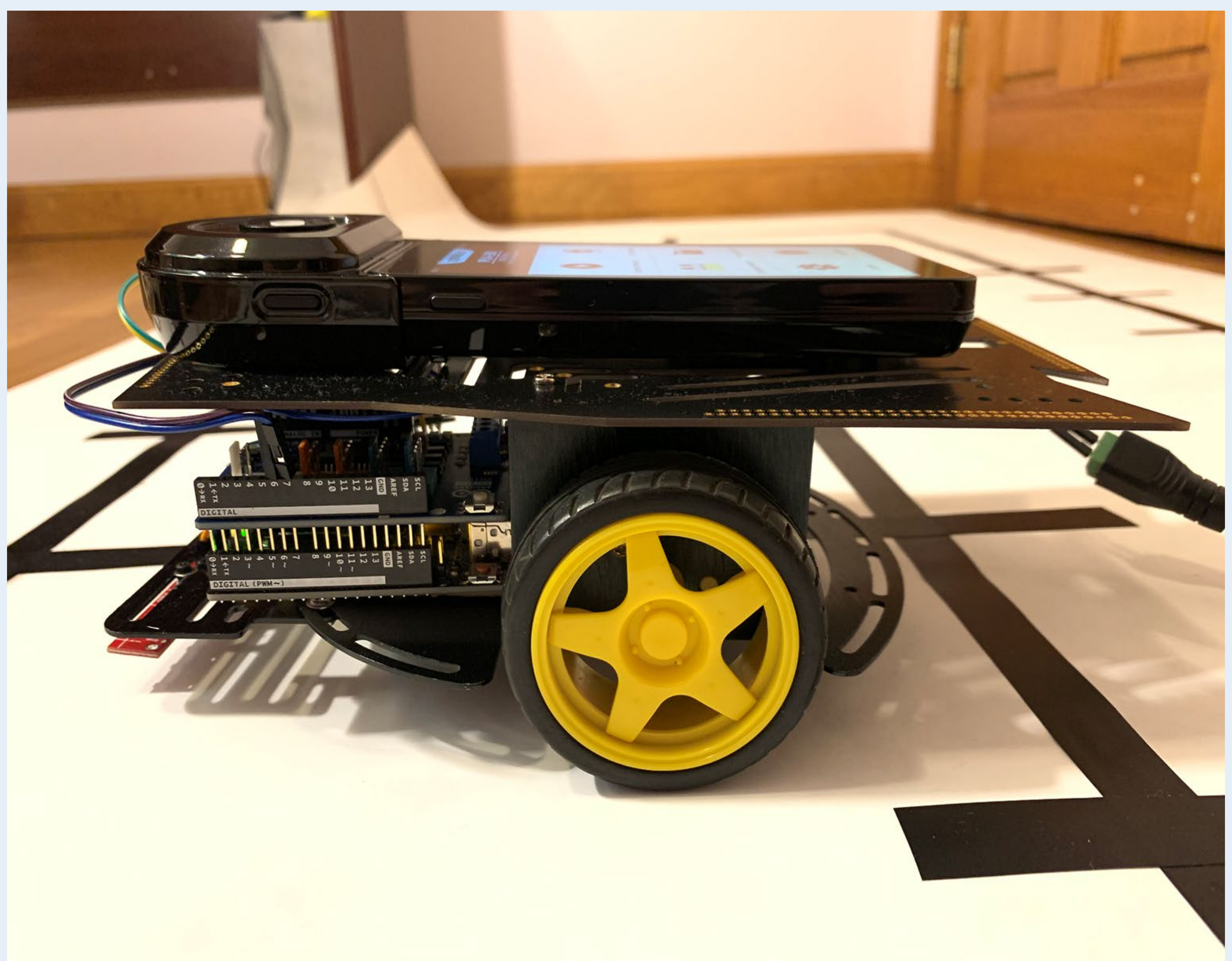

Fig. 1: Completed Robot composed of Arduino Uno, MKR-1000 and an Everfine PLA-30

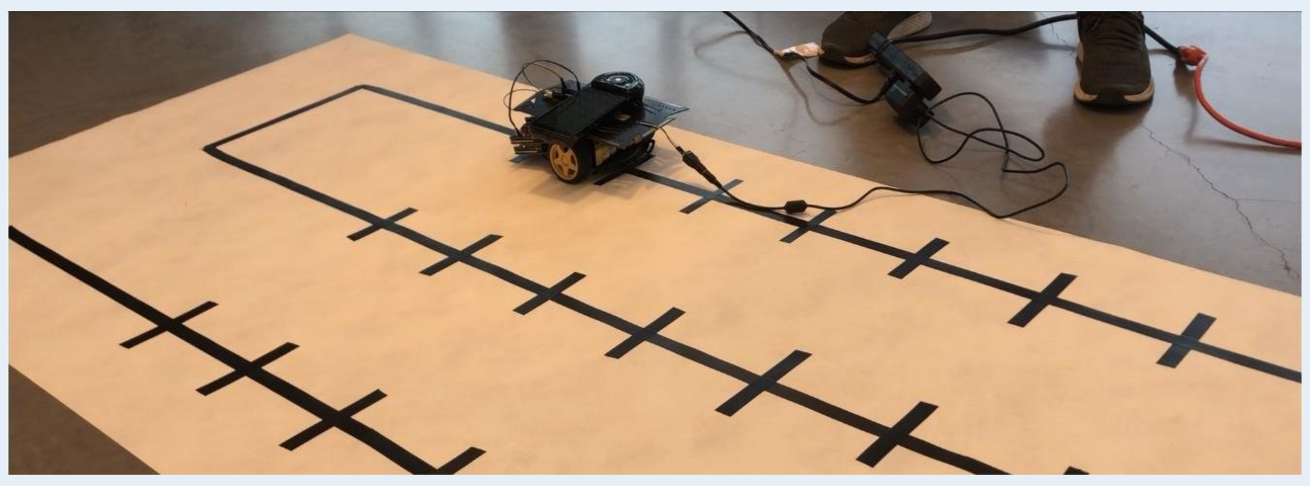

Fig. 2: Robot in middle of a test sequence, Stopped taking a reading at desired data point.

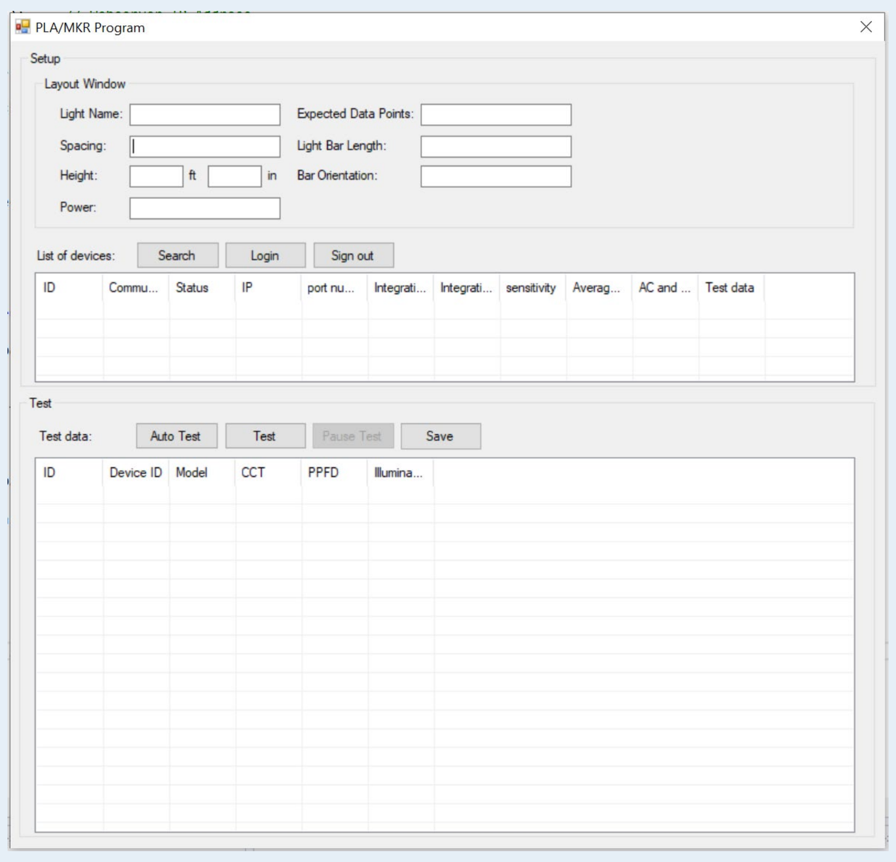

Fig. 3 PLA-30 Program to handle taking PAR readings and stopping/going on path again.