Individual Lab Report #8

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Wholesome Robotics (Team E)

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Individual Progress

In the past few weeks I have continued worked on the visualizer tool for the monitoring pipeline. A key part of our deliverables is a tool for the farmers to understand the data that we collect and generate. For that reason, I have been focusing on adding features, as requested by the farmers, to the visualization tool. The main parts of my effort have been focused on implementing data clustering. Specifically, the farmers are not interested in seeing a close up of each plant, rather they are interested in understanding the field as a whole, and for this reason, the previous gui, which plotted each image at its GPS coordinates, was very cumbersome. Further, the robot takes pictures at a constant speed but moves at an inconsistent velocity, meaning some plants are in multiple images, and others are only in one. Rather than attempt to match multiple images of the same plant, we decided, with the farmers' approval to merely cluster multiple images into single data points. To accomplish this, I use least squares line fitting to generate a line through the true locations, and then generated cluster points at regular intervals along the line (interval length is handled by a tunable parameter). Finally, I assign each image to the closest cluster location. While the premise of this clustering is fairly simple, its implementation was difficult for a few reasons. Most notably, data needs to be preserved on the image level so the individual clusters need to maintain connections to the data they draw from (the benefit of this is that we can easily implement a color scaling system by averaging the health score of each image). This also means that the gui needed to be updated to accommodate multiple images, and the ease with which the farmers can access them. This meant redesigning the gui's data structure so that it can load multiple images. Then including navigation and additional control buttons was a natural and straigthforward implementation. Another concern was clustering on saved data. When the user reloads the data, the software should run using the old clusters, rather than reclustering the data. This saves computational effort and also keeps the data consistent from use to use. Enforcing this requires minor programattic effort (instead of running the clustering function, it reconstitutes the clusters based on their saved positions, and reassigns each image to the correct cluster) however, because of the way saving is implemented, it has caused a bit of integration difficulty and has remained one of the few hurdles left to finishing our mvp.

Another key feature I implemented is the save functionality of the visualizer tool. This is important to the farmers because their main use of the visualizer is to track trends from dataset to dataset. More practically, if they review a dataset, they want their review and input to be reflected and saved. The current save functionality is fairly simple, it merely overwrites the previous pickle file with the updated data. However, we have begun to discuss how to create a more robust and integrated saving protocol,

that is consistent across all the parts of the pipeline. Again, I have accomplished the base version, and the final integration steps towards the mvp are reflected in my goals for the next sprint.

The final progress I made on the visualizer was another integration task. This was a refactoring of the data structures shared between the different portions of the visualizer pipeline. Specifically, we switched the primary data container from a dictionary to a list of objects. By creating a custom object, we have added modularity for any future values (we can add another subobject to the class). This change actually made my code much more readable, and will help make future feature development easier. It did however take time to update my code to reflect this change, and to debug the minor issues that arose.

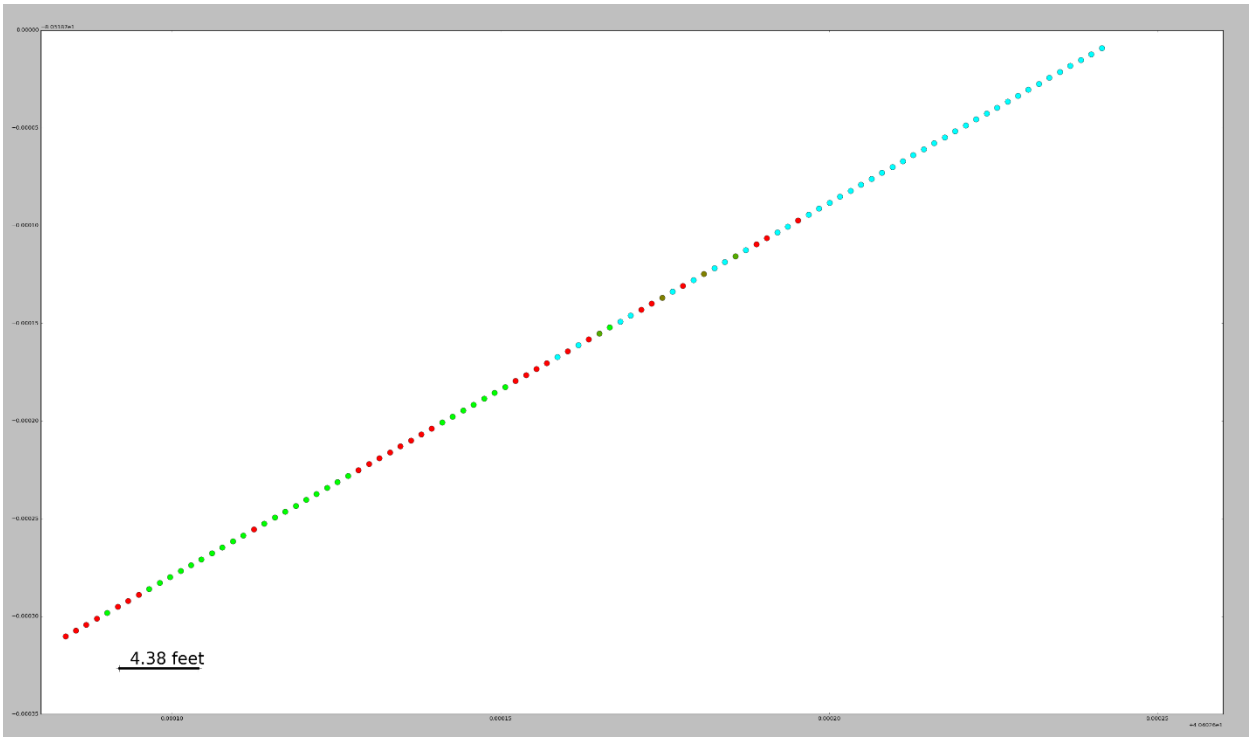

Figure 1 Clustered version of a single row of plants. Green demonstrates healthy, Red unhealthy, and blue uninferenced (this was run on a test set, that was not actually run through the inferencing pipeline).

Figure 2 Updated Gui includes navigation buttons on either side of the image, as well as new, "Mark All" (within a cluster) buttons.

I also began prototyping the wheel guards for the robotanist, to protect the crops from the robot's wheels. This is an important task because it reduces risk from navigational errors, and also certain crops overhang the traversable rows and would be hit by the robot regardless of the nevigation system's success. To do this I ordered acrylic sheets, to bend to form (we want a low cost, low weight solution that is corrosion resistant – plastics are a natural choice). After bending the first acrylic sheet to shape and confirming its fit on the robot, I learned that most adhesives do not work on acrylic. Since machining acrylic is generally difficult and I cannot machine any mounting points onto our robot, I researched other materials, and will be making the future wheel guards out of PETG. I will use heavy duty velcro to attach the wheel guards (this adds a certain amount of "worst-case" mechanical compliance and also makes maintenance easier).

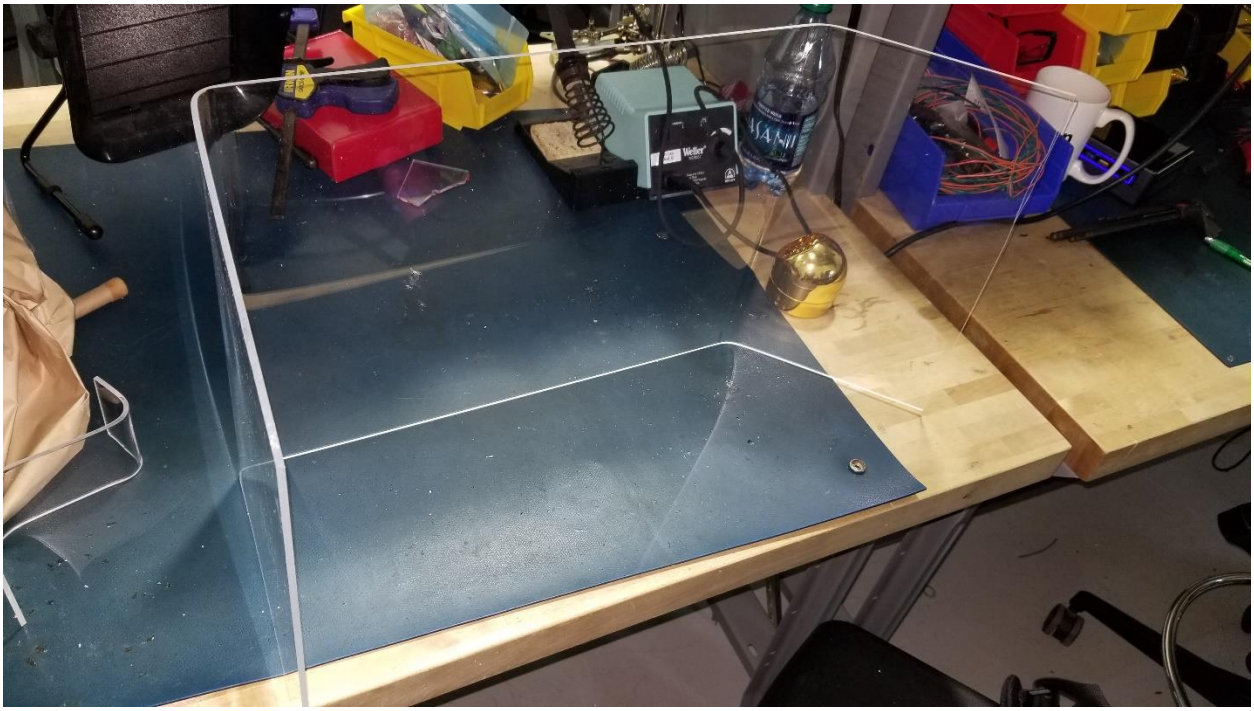

Figure 3 Completed first prototype of the wheel guard, made of acrylic.

Team Progress

We went on another field visit. This one went much better in that we encountered only typical setup problems, and by the end of the day were able to collect data. We have continued to evaluate our field testing setup and have begun to hone in on a more efficient routine. We have also had many integration meeting to discuss the interoperability of the various parts of the system.

Challenges

The biggest challenge I have faced has been time management. Because of the jewish holidays I have been unable to work or even communicate with my team for more than 6 days over the course of the past two weeks. Fortunately, the team has been very understanding about coordinating meetings to accommodate my availability, and I have taken deliberate actions to manage my remaining time.

Another major challenge we faced was managing our field visits. Due to constraints on drivers, team availability, weather, etc. we have had continuing issues with our tests. We have spent many meetings planning our visits, and creating contingencies for all sorts of scenarios.

Teamwork

Aman has worked on map building and managing the robot platform.

Aaditya has been working on visualizer integration and researching auto-exposure methods for the camera.

Dung Han has been working on evaluating the plant health model and fine tuning it.

John has been working on the localization and navigation nodes.

Future Plans

Wholesome Robotics

In the coming weeks my plan is to finish integration of the visualizer mvp. This mostly involves debugging compatibility and interfaces between the different parts of the pipeline. Time depending, I may try to implement the requested comment bar in the visualizer tool.

We have deprioritized the wheel guards due to my limited availability again during the next two weeks (as fabrication tasks often take many hours), and will likely look into it again after the next progress review (after the visualizer mvp deadline, and when I will have more time).