Report of the Week of March 2nd

This project consists roughly half of image recognition. This part of the problem is to find keypoints of flowers from a bird’s eye view such that the location of those flowers can be found, and a drone swarm can move through them. As mentioned last week, a major challenge in this project is to find a dataset that works for this project. After many hours of searching, I have not been able to find an easily accessible dataset containing bird’s eye view images of flowers with bounding boxes. I found mention of a dataset containing images of apple flowers with bounding boxes already drawn on them in [1]. I attempted to contact both of the authors by the email addresses listed in the paper to see if I could obtain the database. I also contacted someone in the College of Agriculture, Forestry, and Life Sciences regarding creating a manual database. I have not heard back from that contact yet either. However, I have another idea of how to create a dataset for keypoint detection. As outlined in this tutorial, it is possible to create a synthetic dataset for computer vision for keypoint detection [2]. I could use the Oxford 102 dataset as was shown in [3]. I was initially hesitant to use this dataset as shown in this paper, as all of the pictures they used were up close to the flower, with no obstructions. If we are to sweep a large area such as a greenhouse or a farm, the flowers will be far away, and generally will be obstructed by some kind of obstacle. However, by taking some of these close ups of flowers, and semi-randomly (recall that having some known structure to the distribution of the flowers prior to flight, such as where flower beds are, is a crucial component of this problem) distributing them across a bird’s eye view of a field, we can generate an image of a field containing many flowers. We will already have the locations of the bounding boxes for the flowers since the bounding boxes will be placed on the image when the flowers are overlayed on the image. As for the problem of obstruction, we can easily place obstructing images over the images of the flowers. For example, it would not be hard to find an image of a leaf and randomly place that over an image of a sunflower. This would not change the location of the bounding box. While I discovered this technique very late into my research this week, creating this database will be the primary focus of next week.

However, the computer vision side of things is not the only aspect of this research. While I waited to hear back from my multiple contacts regarding the acquiring or formation of a dataset, I continued to look into pathfinding algorithms. As outlined in [4], there is already a fair bit of research done on the blind travelling salesman problem using a particle swarm to optimize the local search. That is, a swarm of particles is used to incrementally move from a random or greedy solution to a more optimal one incrementally. The Fast Local Search algorithm is outlined in [5]. It’s easy to imagine taking this algorithm and replacing the particles put forth in [4] and replace them with UAV drones. However, this still would not exactly be our problem. Again, the problem is that we have a general idea of where the particles are. For example, we know pre-flight where garden beds or planters for the flowers are. We just don’t know the exact position of the flower heads. As such, I’m going to pursue a solution in which large clusters of flowers (or flower beds) are traveled between by swarms of drones, where the individual flowers within those clusters are visited by using the Fast Local Search algorithm. It would be a hybrid of a deterministic and a heuristic approach, where the order of the clusters to be visited would be determined before flight deterministically, whereas the order of flowers to be visited would be determined mid-flight heuristically.

[1] Wenan, Yan. (2021, January 11). UAV-Based Heating Requirement Determination for Frost Management in Apple Orchard. MDPI. https://www.mdpi.com/960608

[2] P, Alex. (2022, January 15). How to Create Synthetic Dataset for Computer Vision (Keypoint Detection). https://medium.com/@alexppppp/how-to-create-synthetic-dataset-for-computer-vision-keypoint-detection-78ba481cdafd

[3] Zhang, Fuquan & Cheng, Zhibin (2020, July 30). Flower https://www.hindawi.com/journals/wcmc/2020/8870649/End-to-End Detection Based on YOLOv4 Using a Mobile Device. Hindawi.

[4] H. S. Lope and L. S. Coelho, "Particle Swarn Optimization with Fast Local Search for the Blind Traveling Salesman Problem," Fifth International Conference on Hybrid Intelligent Systems (HIS'05), Rio de Janeiro, Brazil, 2005, pp. 245-250, doi: 10.1109/ICHIS.2005.86.

[5] Voudouris, Christos & Tsang, Edward (1998, March). Guided Local Search and Its Application to the Traveling Salesman Problem. https://www.bracil.net/csp/papers/voutsa-glstsp-ejor99.pdf