CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1501

Project Title

Machine Learning Based Citrus Orchard Health Analysis with Autonomous Drone Technology

Abstract

Objectives/Goals

Our goal is to build an algorithm that can detect an orange disease with an accuracy of more than 90% and have a processing time of less than 10 seconds per tree. The solution should present data in a graphical and intuitive manner to the farmer. The drone should also be able to map out a whole orchard autonomously. Our algorithm (written in python using TensorFlow) should begin by location oranges on trees, and then classifying these oranges as normal or deformed.

Methods/Materials

We used a DJI Phantom 3 drone, and developed our own application to autonomously control it. We also used a laptop to process the algorithm. Our algorithm consists of two parts, locating oranges, and classifying the oranges as normal or deformed. To locate oranges, we developed a custom OpenCV (image processing library) based color algorithm to locate oranges on a tree and feed that information to our machine learning algorithm. We also created a custom convolutional neural network trained with 10,000 oranges (5,000 normal oranges and 5,000 rotten oranges) to classify each orange. To present the data, we developed a Tkinter (Python UI library) based interface to display a heatmap of the orchard to help visualize its health. Each tree is represented by a square grid where the color of the square is indicative of the ratio of deformed oranges.

Results

After training our network, we tested the classification accuracy of our model with 2000 images. Our algorithm achieved 98.8 percent accuracy. We also tested our network over different training data sizes of 2000, 4000, 6000, 8000, and 10000 oranges. After plotting the accuracies, there is a trend of increasing accuracy with a bigger dataset. This process shows that with an even larger dataset of 20,000 oranges, the accuracy can reach above 99%. We also tested classification time with sets of 200 test oranges. Our algorithm was able to process 200 oranges in 12 seconds. In our test cases, each orange tree had around 50 visible oranges, which took three seconds for our network to process.

Conclusions/Discussion

Our solution provides comprehensive data to the farmer in a cost-effective and accurate manner. This method helps identify outbreaks such as citrus greening, citrus canker, or any disease that affects the fruit with 98.8 percent accuracy. This method can also be trained to analyze the health of other fruit orchards such as apple and lime.

Summary Statement

We created an algorithm that can count the number of diseased and normal oranges on each orchard tree, and created a drone application to map out a whole orchard.

Help Received

We wrote all of the code and designed the entire algorithm ourself. However, we got in contact with Professor Won Suk Lee from the University of Florida to get an idea of existing technologies.