Project Proposal

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1 Project Title

Fruit Recognition

2 Project Team Members

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3 Project Goals

The goal of the project is to create a program that can segment fruit from their background in a "natural environment", and then be able to identify 4 different classes of fruit. Natural environment in this context means that the photos given to the program for recognition will be of fruit still on the trees or plants that they get harvested from. These 4 classes would be apples (granny smith), oranges, bananas, and lemons. These 4 were chosen based on some of the similar textures (oranges and lemons), similar colors (bananas and lemons), and similar shapes (oranges and apples) that the fruit have in order to make the program more robust. Additionally, if pictures of the fruit in their "natural environment" proves to be too difficult, there are databases with the fruit on a plain background. An extended objective would be to have the program be able to identify how ripe the fruit is, but that would very likely be outside the scope of the project.

Additionally, because of their similarities, the fruit portion could also be replaced with vegetables, flowers, or any other agriculture type fairly easily while using the same process, should the subject need to be changed for any reason.

4 Related Work

The following are some pieces of related work that has been done by others.

DeepFruits: A Fruit Detection System Using a Deep Neural Networks.

This project created an "accurate, fast, and reliable fruit detection system" for an autonomous agricultural robotic platform. It used a Faster Region-based CNN (Faster R-CNN) architecture for object detection. This project used RGB as well as Near-Infrared too. This project delt with fruit in their "natural environment" as well.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5017387/#B5-sensors-16-0122

Automatic Fruit Recognition from Natural Images Using Color and Texture Features.

This project was also created for a robot-assisted harvesting device. This project focused more on finding new approaches for classifying fruits in order to separate them from the background. Texture features form Gray-level Co-occurred Matrix (GLCM) and statistical color features were used together to try to identify the fruit. Lastly, this project was geared toward embedded systems and streamlined devices.

https://ieeexplore.ieee.org/document/8074025

5 Methodology

There will be two main steps of the program that will use two separate neural networks. The first step will be the segmentation step, and will remove the fruit from the background. The second step will be the classification step, which will be used to identify the segmented fruit from the image. The first step will use **AlexNet** for texture feature extraction. The output of this network will be cropped images of fruit from the original image. This network will only have 2 classes (fruit and not a fruit). The second step will use **Faster R-CNN** to identify the object. This will utilize 4 different classes, (apple, orange, banana, lemon). This step will receive the output, cropped images from the first step and output what fruit/class the object is.

AlexNet https://papers.nips.cc/paper/4824-imagenet-classification -with-deep-convolutional-neural-networks **Faster R-CNN** https://arxiv.org/abs/1506.01497

6 Data Sets/Anticipated Results

Fruits 360 Dataset Fruits 360 data set has over 65429 images of over 95 fruits. These images have a combination of fruit in their natural environment as well as in miscellaneous environments. The only issue with this data set is that the images of the fruit in their natural environment will need to be selected and used over the others. This data set also has all 4 classes (granny smith, orange, lemon, banana) https://www.kaggle.com/moltean/fruits

Hyperspectral Database of Fruits and Vegetable's (white background) This data base has 42 different fruits and vegetable classes. This data set is different in that all of the fruit are on white backgrounds and not in their natural environment. This can be used if separating the fruit

from their background becomes unfeasible. https://www.osapublishing.org/josaa/abstract.cfm?uri=josaa-35-4-B256#articleReferences

The anticipated results will come in two fold. First, the program will have to identify if there are any fruit in a given image. As stated from before, these results come from the first step and from AlexNet. The next results will be what fruit each identified object is. These results come from the second step with Faster R-CNN.

7 Time Table with Milestones and Work Assigned

Time Table

- Set up the deep learning architecture (Faster R-CNN)
- Solidify the two data sets that will be used
- Based on the data sets, determine how many classes there should be
- Determine the classifier for the network
- Begin developing the network where needed
- Begin training the network
- Analyze and test training results
- Debug and retrain as necessary
- Compare results to other to different architectures
- Complete the report

The work will be divided in such a way that each team member will have an understanding of each section but will be able to work on different sections in parallel. For example, the initialization of the network can be set up by one member while the other finalizes the data base. One member can run the test while the other begins to compare the results already goatherd. One member can debug while the other begins writing the final report.