Detection and Counting of On-Tree Citrus Fruit for Crop Yield Estimation

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Overview

There is a great necessity in the citrus fruit industry, at the farming of the fruits to have a clear and relatively precise count of fruits to correctly estimate crop yield, so that at the processing stage the work can be as efficient as possible to maximize profits.

The project aims to get a fruit count by using image processing techniques to process a photograph of a fruit tree.

Goal

Precisely detect citrus fruit count on a fruit tree image.

Specifications

Create a citrus fruit detection and counting system using specific image processing techniques.

Basic Approach

Based on the read documentation, the chosen approach involves a technique that combines several image processing techniques to preprocess the image, remove shadows, separate objects and segment the image to then be able to extract a fruit count.

The strategy:

1. Load an image from a dataset.
2. Preprocess the given image by smoothing it.
3. A shadow reduction technique is created by converting the RGB image to L∗a∗b image, where L is the luminosity layer and a and b represents color-opponent dimensions. After that we increase the luminosity and re-convert to RGB.
4. The object separation step creates a few issues since the fruits can overlap, or be split by a leaf, thus creating an error in the object count. This is corrected by convolving the image with a variance mask. Then the image is converted to grayscale by taking an average of the three color channels and a threshold is applied.
5. The next step regards K-means segmentation and orange extraction. In this step we separate the specific objects to receive the subjects of our goal, the object blobs representing oranges.
6. The final step is blob detection and object counting. Blob detection refers to finding an orange, represented by a blob on the processed end image. We find the connected objects in the binary image using 8-connectivity, after which we count the objects, giving the result for the fruit tree given in the image.

Preprocessing - smoothing:

Smoothing the image is necessary as a first step in processing the image, to ease the rest of the image processing steps and to shrink the margin of error. This is done based on the following equation: $\frac{\partial I}{\partial t} = div(c(x, y, t)\nabla I) = c(x, y, t)\Delta I + \nabla c.\Delta I$, while the diffusivity function in Perona-Malik model is given by the following equation: $c(x, y, t) = g(||\nabla I(x, y, t)||)$.

K-Means Segmentation and Orange Extraction:

K-means segmentation is the most important step in the whole process. We use a k-means clustering algorithm, which is an unsupervised classification technique. The issue introduced by the fact that on the images some of the fruits can be split into smaller visual sections by leaves or branches is corrected by converting the image into a binary image and applying the erosion algorithm. The erosion of image A by the structuring element B is described by the following formula: $A \ominus B = \{z|(B)z \subseteq A\}$,

which means that the output of erosion functions contains all pixels z in A such that B is in A when origin of B = z.

Bibliography

1. Zeeshan Malik, Sheikh Ziauddin, Ahmad R. Shahid, and Asad Safi. “Detection and Counting of On-Tree Citrus Fruit for Crop Yield Estimation” https://thesai.org/Downloads/Volume7No5/Paper_69-Detection_and_Counting_of_On_Tree_Citrus_Fruit.pdf