Harvest Time Alert

1. Aim

To be able to make the harvest decision automatically so that the fruits in a garden can be picked just in time.

2. Introduction

Software technologies are tried to be integrated into many areas in daily life due to their advantages such as working continuously for a long time and processing faster than humans. Due to the high sensitivity of the results, it is frequently preferred especially in fields such as medicine and space. Especially after the 1980s, with the development and cheapening of integrated circuits, it has found a place in all sectors. One of these sectors is agriculture. Its applications in the field of agriculture are especially focused on precision agriculture.

Its applications in the field of agriculture are especially focused on precision agriculture. Fruits and vegetables show significant quality differences relative to each other due to their genetic and environmental conditions. Although classification according to this difference is still often done by workers, some systems that assist in image-oriented classification are also increasingly used. Software technologies and image processing, which have started to be used in areas such as crop forecasting and harvesting, are mostly done at the prototype stage. Serial production of the studies is not carried out due to the high cost. The main ones of these works are:

Kondo conducted research on the location of the fruit with the robotic vision method he had done in 1988. In this research, it was determined that it would be necessary to use the visual sensor attached to the structure to find the three-dimensional position of the fruit via a stereo camera.It has been stated that this method will be used to find relatively low plants such as tomatoes. It has been seen that the process of recognizing the fruits of tall trees and measuring their location accurately is difficult. It has been determined that the reason for this is that the sensor is at a longer distance from the fruits.

Kataoka, in 2001, conducted a study on an automatic detection system for locating apples for robotic apple harvesting. Farmers decide when the harvest time has come by looking at the color of the apple. They stated that the color of the fruit is the most important criterion for deciding the harvest time. In the study, apple colors in the harvest season and previous apple colors were separated according to the Munsell color system, L*a*b* color space and XYZ

color system. According to this color system, the harvest time was determined according to the apple color.

Flemmer and his friends aimed at remote controlled kiwi harvest in the design they made in 2007. With this design, they were able to collect 14,000 kiwis per hour. After taking the image with the camera system attached to the arms of the robot and processing it, they defined the fruit as. They harvested the fruit by rotating the fruit on its own axis according to the fruit firmness determined as a result of the hardness measurement and by means of arms with 360 degree mobility.

3. Materials and Methods

3.1. Image Acquisition System

A camera system was installed, positioned where the plant would be least affected by the light and the correct shooting angle could be captured. Photographs were taken from the camera system at regular intervals and transferred to the system. Then the image transferred to the system was processed.

Camera system

Figure 1

3.2. Image Processing

Image processing is a set of operations that allow us to extract meaningful expressions from the image we have. These operations are performed by means of mathematical operations to be performed on the pixels that make up the image. After the image is obtained, an algorithm is designed according to the task to be done, and the image passes through these stages and fulfills the desired task. In this project, MATLAB, one of the frequently used programming languages for image processing, was used.

The main matlab functions which can be used to manipulate the objects within the image are:

rgb2gray: converts RGB color image to gray.

im2bw: Converts image to binary image, based on threshold.

imfill: Fill image regions and holes.

bwareaopen: removes small objects from the image.

bwlabel: Label connected components in 2-D binary image.

regionprops: Measure properties of image regions such as area and coordinates.

The methodology of manipulating objects within a digital image can be implemented applying the following steps:

1. Get the original input image.
2. If the image is color image, convert it to gray image, then to binary image.
3. Remove noise from the image by removing small objects.
4. Apply the function bwlabel for Label connected components to retrieve the number of objects and a label matrix which points to the objects.
5. Measure properties of image regions to get objects information such as area and coordinates.
6. Extract objects or individual objects.

The following matlab code can be used to implement this methodology and it can be executed in various forms.

Appropriately taken photos were processed using MATLABR2020b by going through the following stages.

First of all, in order not to mislead the code, non-product elements were deleted and the roughness in the picture was removed. With the help of the written function, the pictures filtered using RGB channels were separated into their colors. The fruit and vegetable images that were separated with the appropriate filter were automatically combined and saved.

(a) Original Tomato Image

(b) Processed Image

(c) Original Banana Images

(d) Processed Images

(e) Original Strawberry Image

(f) Processed Image

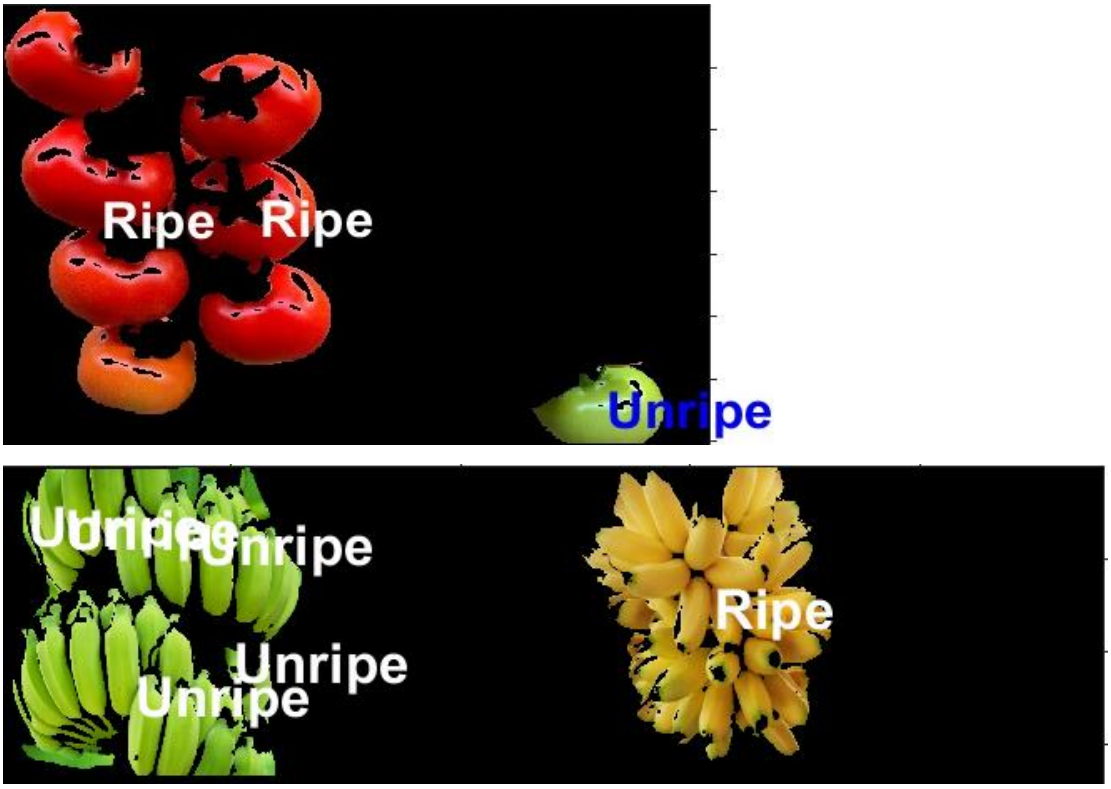
Figure 2

In the next step, the code giving information about the type of fruit and vegetable was written by looking at the color of the fruit and vegetable. The two processed images were combined and differentiated into their types.

Stages of Distinguishing

Figure 3

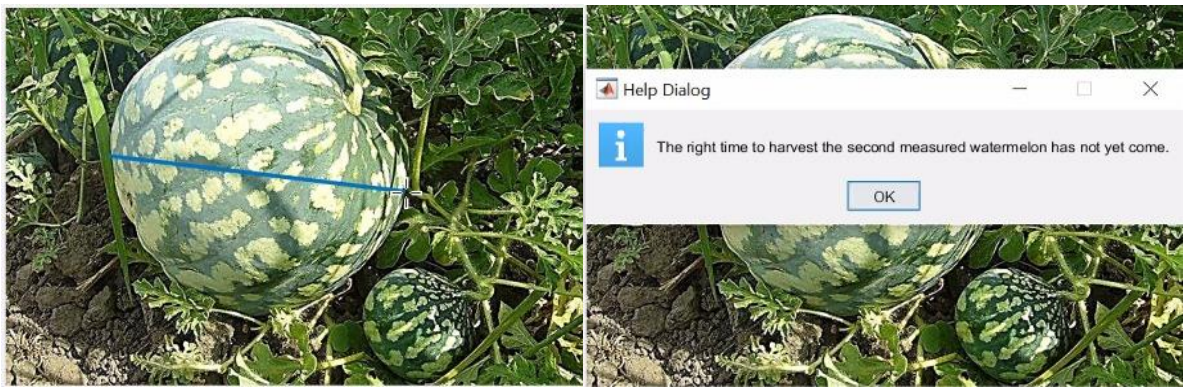
In line with the distinction made, information about the mature and immature colors of the product was obtained.



Ripeness Decision by Color

Figure 4

Finally, a code that can be applied for products whose diameter is highly dependent on whether they are mature enough or not has been written. The applied code output is below.



Detection of Ripeness by Diameter

Figure 5

4. Conclusion and Recommendations

The angle of incidence of light is one of the main factors affecting the result of image processing. The difference in the angles of incidence of light on the fruit results in different perception of existing colors. When the fruit is viewed from different angles, the perception of the existing original color in different color tones arises due to these reflection values of the light. The main reason for this is that the light does not come from the same direction in every photograph. Hayashi et al. developed a lighting unit to harvest at night to overcome the unstable lighting problem in their robot strawberry harvest research in 2010.

In the Harvest Time Stimulator project, after the stages of identifying the fruit and vegetable, determining its color and diameter, it was interpreted whether it would be suitable for harvesting. In addition, it was ensured that the farmer had an idea about the average suitability of the entire garden for harvest based on a single plant.

Some suggestions for the development of the project are as follows: For fruits and vegetables of the same color, distinctiveness should be high in terms of color, size, shape and texture; minimizing the deception of non-plant elements such as leaves, soil and branches in the plant and adding automatic product counting feature etc.

AYSU ARDA 090170335 ZEYNEP AKKOÇ 090170336

References

Feng, J., Zeng, L., & He, L. (2019). Apple Fruit Recognition Algorithm Based on Multi-Spectral Dynamic Image Analysis. Sensors (Basel, Switzerland), 19(4), 949. https://doi.org/10.3390/s19040949

Kondo, N., & Ting, K. C. (1998). Robotics for plant production. Artificial intelligence review, 12(1), 227-243.

Scarfe, A. J., Flemmer, R. C., Bakker, H. H., & Flemmer, C. L. (2009, February). Development of an autonomous kiwifruit picking robot. In *2009 4th International Conference on Autonomous Robots and Agents* (pp. 380-384). IEEE.

https://www.mathworks.com/help/images/color-based-segmentation-using-k-means-clustering.html