A New Method for Tangerine Tree Flower Recognition

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Abstract. Different machine vision strategies are adapted for performing automated real time agricultural tasks in order to increase more productivity with less cost. Based on this notion, a new method is developed and implemented for detecting white color flowers in Tangerine tree and counting Tangerine fruit flowers to yield better outputs with regard to the existing schemes. Gaussian filter is employed to reduce unwanted noise in Tangerine tree flower recognition for Tangerine yield mapping system. It is observed that the newly developed method gives better valid output for tangerine tree flower detection in natural outdoor lighting, with different lighting condition without any alternative lighting source to control the luminance. The simulation result reveals that the new method is reliable, feasible and efficient compared to other existing methods.

Keywords: Tangerine tree flower, yield estimation, color detection, Gaussian smoothing, counting algorithm, machine vision.

1 Introduction

From literature study, it is noticed that related research is still being carried out in diversified areas but not in Tangerine tree flower recognition. It is observed that, lot of potential applications for automated agricultural tasks are found using machine vision system; therefore, we introduced new method for new Tangerine tree flower recognition. But, recently, many researchers are engaged in fruit recognition system for automated harvesting and for educational purpose to enhanced learning. Lak et al. [1] used edge detection and combination of color and shape analysis to segment images of red apples obtained under natural lighting using machine vision, Arivazhagan et al. [2] proposed fusion of color and texture features for fruit recognition by color and texture feature, Jun Zhao et al. [3] studied ways of locating both red and green apples in a single image frame. Song Wan-Gan et al. [4] studied a method of fruits recognition based on SIFT characteristics, Gabriel Gatica et al. [5] presented a model for the recognition of the diameter of olives, Yang et al. [6] presented a method to detect and recognize mature tomato fruit clusters on a complex-structured tomato for

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automatic harvesting purpose using stereo vision camera. Libing Zhang et al. [7] studied a method for cucumber fruit recognition in greenhouse using neural network and Wan Ishak Wan Ismail et al. [8] presented the development of outdoor image analysis for oil palm fruit fresh bunches (FFB). Also, Urena et al. [9] presented an automatic system for monitoring seed germination by means of a software tool incorporating an artificial vision system and a fuzzy logic-based classifier. Jingtao Lei et al. [10] presented a method used for fruit category recognition based on machine vision and total matching degree of fruit's multi characteristics. Arguenon, et.al. [11] proposed a multiagents system for the simulation of prototypes for different agriculture robots that can be employed in the harvesting of a vineyard. Patel et al. [12] presented automatic segmentation and yield calculation of fruit based on shape analysis. Palaniappan Annamalai [13] presented a machine vision algorithm to identify and count the number of citrus fruits in an image and finally to estimate the yield of citrus fruits in a tree.

The yield potential of a tangerine field depends on a number of factors, such as 1) the numbers of trees in the field; 2) weather conditions in both the sprout and crop years; 3) insect and disease incidence; 4) soil fertility; 5) soil moisture, as well as 6) the number of flowers which result in a fruit. There are a few methods for determining the percent fruit set. One such method is counting number of flowers of tangerine tree. It is important to point out that, Tangerine trees bloom on May, and during that time one can estimate yield. If there are too many blooms in one tangerine tree, it is not suitable for high quality yield, because tangerine can be too small. Also, if take too much yield, price can be down, because tangerines market is not too large. Therefore one can count the tangerine tree flowers and control yield of the tangerine every year by manually. In order to overcome the existing problems a new method has been introduced and executed to obtain better solution. The paper is arranged as follows. Section 2 discusses about the objectives and newly proposed methodology. Results and discussion is presented in section 3. Finally, conclusion and future work is given in section 4.

2 Objectives and New Methodology

The aim is to develop an image analysis system which is able to identify flowers in natural tangerine tree with the following needs:

1. The system should be able to recognize tangerine tree flowers.
2. Pictures should be taken on May, when flowers of tangerine tree are blooming.

A flow diagram for Tangerine tree processing is shown in Figure 1 which gives a better idea on the new methodology to be incorporated to obtain better output. For developing a Tangerine tree flower recognition algorithm, images were taken in the Tangerine tree field, which is in Jeju Island. A total of 21 tree images were taken on May during Tangerine tree flower blooming season. The Tangerine tree images were taken in natural outdoor lighting condition. Each tree picture was taken from four sides. The tree images were noisy and different lighting conditions. Flowers in some images were under the shadow of the leaves and branches. Also, there were too many flowers in the one tree for counting. So the input image was first removed noise, divided many sections (from ten into thirty five) before image processing steps. Figure 2 shows the input / original image of a Tangerine tree with background noise and figure 3 illustrates the ground noises are removed manually i.e. output image of a Tangerine tree without blurred noise.

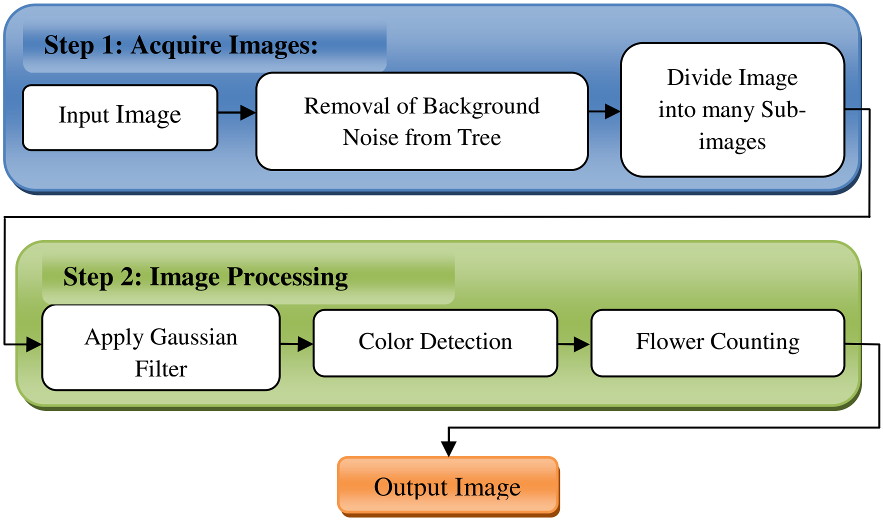


Fig. 1. Flow Diagram for Tangerine tree Processing

Fig. 2. Original image of Tangerine tree with background noise

Fig. 3. Output image of Tangerine tree without background noise

Image processing was carried out using 28 calibration images and tested on the 172 images. Also, the preprocessing of the input image was performed first. A Gaussian Filter was used to reduce the noise as much as possible. Input image of Tangerine tree flower is presented in figure 4, which is divided into sections. Filtering of an image cause blurring (noise) therefore, Gaussian 2x2 Filter is employed to reduce noise as shown in figure 5.

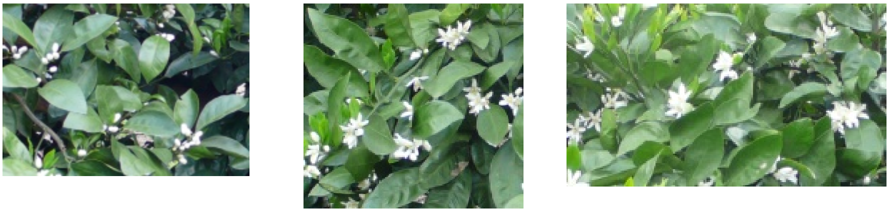


Fig. 4. Input Image of Tangerine Tree Flower

Fig. 5. Blurred Image using Gaussian 2x2 Filter

One of the most fundamental aspects of an image is the colors. Based on the principle, the end user can use colors to differentiate between different objects from others. Further, it is possible to isolate the white color pixels from the image and find out the number of white flowers. In this paper we isolated white color pixels of the image and counted a number of white color pixels and also, counted a number of white color pixels of the one flower. However, flower counting was performed by dividing a total number of white color pixels of the image to a total number of white color pixels of the one flower as following

$$N_{\text{flowers}} = \frac{N_{\text{total flower pixels}}}{N_{\text{one flower pixels}}} \tag{1}$$

where

N_{flowers} – a total number of flowers of the input image
$N_{\text{total flower pixels}}$ - a total number of white color pixels of the image
$N_{\text{one flower pixels}}$ - a total number of white color pixels of the one flower.

Input picture was included with different kinds of flowers, like small, bloomed and mixed (small and bloomed). Accordingly, white color pixels of the one flower were calculated by using 10 images for two kinds of flower images: small and bloomed. In order to perform optimal counting of flowers, flower counting algorithm was employed as follows:

- Input image was checked by manually and was classified for three types: small (s), bloomed (b), mixed (m)
- White color pixels of the one small type flowers were calculated by 253 pixels

- White color pixels of the one bloomed type flowers were calculated by 601 pixels
- Almost all mixed type flower images were included 50% small and 50% bloomed flowers. Then mixed input image flowers were counted by 50% white color pixels of the one small type flowers and 50% white color pixels of the one bloomed type flowers and tested on the 28 calibration images.

In order to evaluate the performance of the algorithm, flowers were counted by the flower counting algorithm should have been compared with the actual number of flowers. The flowers were counted manually from an input image by two different persons for three times. The percentage error of images was defined as percentage error between the number of flowers counted by the machine vision algorithm, and the average number of flowers counted by manually as carried out by Palaniappan Annamalai [2].

$$\text{Error}_{\text{image}}(\%) = \frac{\text{MV}-\text{MC}}{\text{MC}} \times 100 \quad (2)$$

where

MV - number of fruits counted by the machine vision algorithm

MC – average number of fruits counted manually

3 Results and Discussion

The aim of this paper was to develop color detection and counting algorithm of the tangerine fruit flowers under various natural lighting conditions. As a result, total of 200 images of tangerine tree flowers was detected by this algorithm. White flowers of tangerine tree were presented in the resultant image by black color. A snapshot of window program implementation is presented in figure 6.

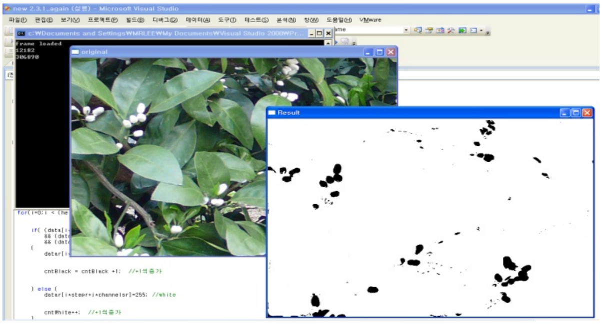
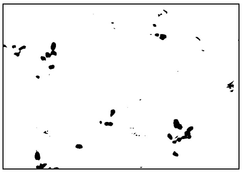


Fig. 6. Program Implementation Window

A sub-module of program source code as shown below. We used RGB color code from 190 to 220.

```
if( (data[i*step+j*channels+2]>190)  //R
          && (data[i*step+j*channels+1]>190)  //G
          && (data[i*step+j*channels]>190) ) //B
     {          datar[i*stepr+j*channelsr]=0;  //black
          cntBlack = cntBlack +1;
     } else {
          datar[i*stepr+j*channelsr]=255; //white
          cntWhite++;
     }
```

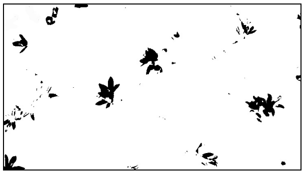


(a)

Counted Flower Pixels: 7048
Flower Type: Small (s) Total
Number of Flowers: 28

(b)

Counted Flower Pixels: 10241
Flower Type: Mixed (m)
Total Number of Flowers: 29



(c)

Counted Flower Pixels: 11825
Flower Type: Bloomed (b)
Total Number of Flowers: 20

Fig. 7. Output image of Tangerine tree using Color Detection Algorithm

In specific, color detection algorithm was performed and the output image of a Tangerine tree is presented in figures 7(a)-7(c) for better understanding. Patel et al. [12] presented automatic segmentation and yield calculation of fruit based on shape analysis. They applied Guassian Low Pass Filter, converted RGB to L*a*b space, selected the range of “a” for coarse detection, extracted the fruit regions by adding the input image with the binary mask, used morphological operations for remove noise, generated a binary image, labeled the pixels, applied Sobel Edge Detection, for each labeled region edge points are used for fitting of appropriate circle. A total of 100 images of different fruit were collected from internet. Finally, a minimum error of 0%, maximum error of 72%, mean absolute error of 31.4% and the Regression analysis value (R^2)= 0.79 is obtained.

A machine vision algorithm to identify and count the number of citrus fruits in an image and finally to estimate the yield of citrus fruits in a tree was discussed by Palaniappan Annamalai [13]. They Converted RGB to HIS, binarizated of color image in hue-saturation color plane, pre-processing (threshold using area, dilation, erosion, extracted features of fruits) to remove noise and to fill gaps, and, finally, counting the number of fruits. The fruit counting algorithm was applied to the 329 images. Finally, a minimum error of 0%, maximum error of 100%, mean absolute error of 29.33% and the Regression analysis value (R^2)= 0.79 is obtained.

It is noticed from above discussion that Patel et al. [12], and Palaniappan Annamalai [13] methods gives less significant results. Therefore, in order to yield better results we introduced our new machine vision method, there by percentage error was as low 0% and as high as 55% for all input images. The mean of absolute error was determined to be 17% for all input images. The main reason for this error was due to the fact that there were many and, small flowers or were in a shaded place and clear to the human eye. The algorithm would have treated them as noise or would not recognize well and left them while counting the flowers.

A regression analysis is performed between the number of flowers counted by flower recognition algorithm and the number of flowers counted by human observation for 200 images as shown in figure 8. Regression analysis value was R^2=0.94.

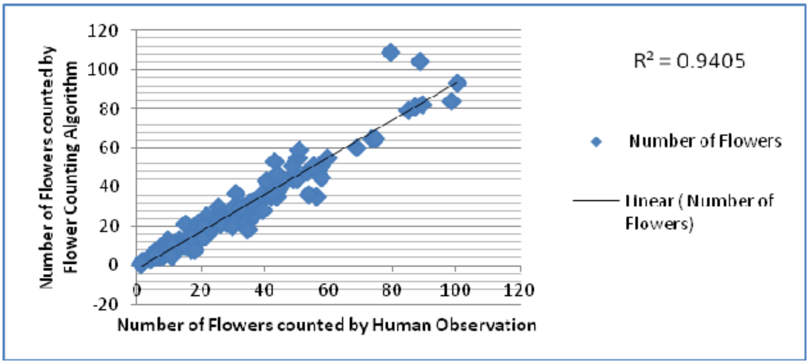


Fig. 8. Regression analysis between the number of flowers counted by flower recognition algorithm and the number of flowers counted by human observation

The white color pixels of the one small and bloomed type flowers were calculated to the 10 images and tested 28 calibration images. The white color pixels of the one small type flowers were calculated by 253 pixels. The percentage error was as low 4% and as high as 27% for all images. The mean of absolute error was determined to be 27%. The white color pixels of the one bloomed type flowers were calculated by 601 pixels. The percentage error was as low 1% and as high as 63% for all images. The mean of absolute error was determined to be 30%.

4 Conclusions and Future Work

The goal of this paper is to propose a general algorithm under different natural lighting conditions without any additional lighting source to control the luminance. A new method for tangerine tree flower recognition by computer vision using Tangerine yield mapping system is introduced to obtain better results in comparison with other existing methods. It is important to point out that the newly introduced method gives better output of tangerine tree flower detection in natural outdoor lighting, in different lighting condition and found to be efficient and effective. Future work is to develop yield prediction model for estimation yield information of the Tangerine grove and mobile system for counting Tangerine fruit, and its related applications.

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