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Detection of Flower Using Watershed Algorithm (Plucking Robot)

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Abstract*--*Detection of color and separation of flower from background is important step toward detection of flower and it done with a fully automated system. Capturing of image and detection of flowers is done in single frame. After detection in the frame co-ordinate of every flower will be calculated. After detection of all flowers each flower is labeled on the bases of their centroid value. The co-ordinates of every flower are given to the robotic arm and the motors of the arm make the required movement for reaching to the flower. After that jaw hold and cut the stem of the flower and dropped it in the collection box.

I. Introduction

Indian economical system is highly based on agriculture. It contributes about 17% of the total GDP. So, automation in agricultural industry plays a vital role. Use of technology is increasing day by day in agriculture for reducing manpower and increasing production. Recently the interest in automatic flower detection and plucking is increased and production of flower requires labour and this process is time consuming [2]. The cost of the labors reduces the overall profit of the farmer and the time required for plucking the flowers using only manpower is considerably high [1]. To solve these issues plucking robot is introduced. For the plucking robot it is extremely important to detect the flower successfully in the outdoor conditions. The most important thing in the plucking robot is to detect and locate the flower on the plant or tree. This paper focuses on detection of the flower by acquiring image and then processing image using image processing algorithm.

II. Methodology

From acquiring image till detection of flowers many image processing algorithms can be used to obtained best results. To detect the object various techniques can be used such as shape recognition, size of object and the color detection etc. In case of flower detection, the shape recognition algorithm does not give accurate results because the shape of each flower is irregular. Same is the case with detection of flower using size, as each flower on the tree may grow in different sizes. The algorithm which gave most accurate result is object detection using color detection. This algorithm detects the flower using the color specified by the user. In case of this project as the flowers which are to be detected are nearly uniform in color, this algorithm provides best possible results.

The only problem with the color detection algorithm is with overlapping flowers. If the flowers are overlapped on each other then the algorithm will treat both of those overlapping flowers as a single one, which is not ideal output. To nullify this problem watershed algorithm is used which will differentiate two overlapping flowers and treat them as two separate objects. Considering the outputs of various algorithms, to obtain the best results following flowchart is developed.

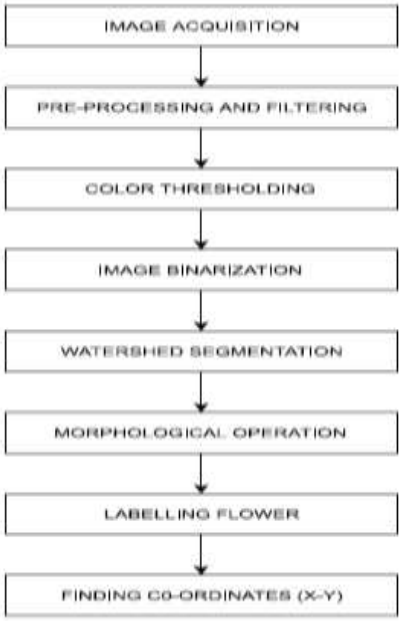


Fig 1: Flowchart for flower detection

1. Image Acquisition

In image processing image acquisition is defined as acquiring images from hardware-based source for image processing. It is the very first step of any work flow. Image acquisition can be done using tools such as Webcam, IP camera.

2. Pre-processing and Image Filtering

Pre-processing is used for operations with images at the low level of abstraction. The aim is to improve the image data by suppressing unwanted distortion and enhancing certain features for further processing. Here we have averaged the intensity of the acquired image using Gaussian low pass filtering [3].

3. Color Thresholding

Image thresholding is the simplest and the most effective way of bifurcating an image foreground and background. Segmentation make group of pixel's sharing similar pixel attributes. It makes the image meaningful and easier for image analysis and interpretation. The color thresholding lets your threshold color images by manipulating the color components of images, depending on different color spaces. The color threshold value is selected based on the color space. Here the color threshold is used for detecting the red color component in the image.

4. Image Binarization and Region Filling.

Binarization is a process of converting RBG image or grey scale image into a binary image [1]. Binary images have on two possible values for each pixel either black or white. Region filling is used to fill small holes.

5. Watershed Segmentation

The key factor in recognizing the flowers is that the touching or the overlapping flowers needs to be separated from each other [4]. The output of commonly used image processing algorithm is that it considers the touching flowers as a single flower. These algorithms are not able to extract the features of single flower at a time. To overcome the difficulty of extracting the features of single flower at a time, different algorithms were tested.Watershed algorithm is the best-known algorithm. The watershed algorithm is most suitable for circular objects [2]. Due to this, the watershed algorithm was used for the separation of touching or overlapping flowers in our project. Even though the watershed algorithm detects and separate touching flowers, sometimes it can generate incorrect results. To overcome this difficulty, Watershed Improvement Process (WIP) is used. Watershed Improvement Process (WIP) includes calculating 2-D Euclidean distance of binary images, calculating extended minima transform, modifying the intensity of image using morphological reconstruction.

6. Morphological Operations

Morphology is `a set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image. The most basic morphological operations are dilation and erosion. The binary image is morphologically opened using opening function from MATLAB. In the opening operation a threshold value is set in order to detect the flower. If the number of pixels in the region is less than the threshold value, then it states that the flower is present. Also using this method unwanted region can be turned black so it is neglected.

7. Labelling the detected flowers

After detection each flower is labelled in sequence from left to right so that total number of detected flowers can be identified, and each flower can be located separately. The labelling of flowers is done based on centroid value of the object in acquired image.

8. Finding X-Y Co-ordinates of the flowers

In the previous step we have computed the centroid and labelled the flowers. In this step individual flower is taken in ascending order of their labels at a time and their X-Y co-ordinates are superimposed as a text string on top of the flower image at the centroid location.

III. Results Obtained

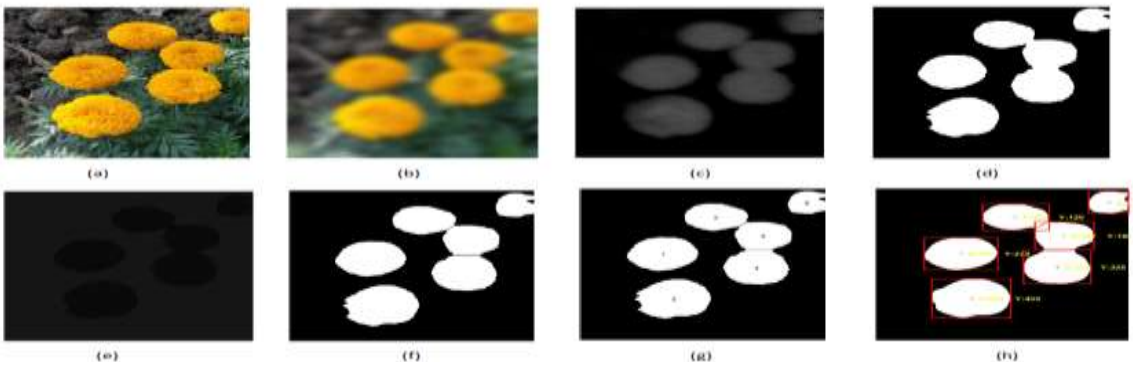
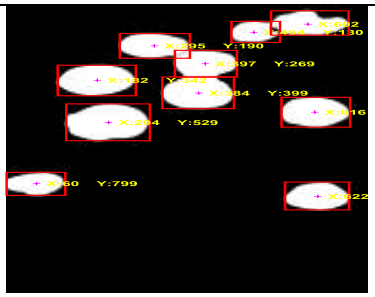
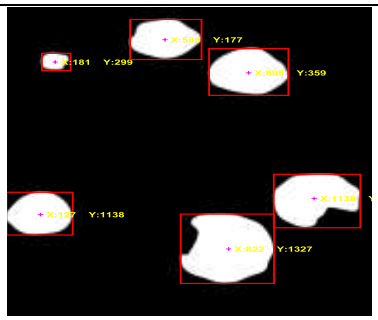


Figure 2. Results of flower detection. a) Acquired image. b) Average filtered image. c) Color threshold image. d) Binarized image e) Segmented image using watershed transform. f) Morphological processing on image. g) Labelled image. h) Co-ordinates obtained.

Table no 1: Manual and automatic results comparison for marigold flower.

Acquired image	Processed image	Actual number of flowers	Detected number of flowers
		10	10
		6	6

If the acquired image is directly processed, then the edges of the petals of each flower is considered as an individual flower. Thus, to overcome this drawback we need to smoothen the edges of the petals. Thus, we use the Gaussian Averaging Low Pass Filter to smoothen the acquired image. The color-based detection technique is efficient technique for detecting the colored objects. Therefore, the color thresholding algorithm is used to detect the red flowers. In order to improve the efficiency of the thresholding operation the region filling operation is performed. The 'catchment basins' and 'watershed rigid lines' are present in between the overlapping flowers. Thus, to separate overlapping flowers watershed segmentation is performed. In color-based algorithm, when detection of flowers takes place, sometimes it detects bud as a flower which is not appropriate. Also, if the background color is same as color of flower then false detection will take place which is major challenge of this algorithm.

IV. Conclusion

In this paper, using segmentation and watershed algorithm, the program successfully detects flower regions in the image. Using color thresholding and segmentation we can detect flowers with 80-90% accuracy. For the accurate results the averaging filtering operation must be adaptive. It is observed that by using IP camera better accuracy and precision is obtained as compared to the webcam.

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