

Design and Implementation of Autonomous Flower Harvester using Image Processing



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Abstract In this paper to design and implementation of fully autonomous system which can harvest flowers. The flowers will be able to cut from the plant by using the device proposed in this paper in a perfect condition which will take lesser time for harvesting as compared to the manual harvesting by humans. In recent days, automated flower harvesting is available only for large flowers like tulip. Thus there will be a requirement for harvesting smaller flowers like rose. This procedure will solve this problem and also it is cost efficient than manual harvesting. In this procedure the watershed algorithm is used to detect the flowers. By the histogram distance calculation, the detected flower is compared to the flowers which are already present in the database. If the detected flower matches 70-80%, then there will be the calculation of centroid of the flower and the distance from the centroid at which the stem is to be cut. The robotic arm is provided that will cut the matched flower when the signal has received to it via microcontroller. The project has to establish a cost effective harvesting systems for agricultural purpose.

I. INTRODUCTION

Image processing is a technique to analysing and manipulating the image, in charge to get the required in sequence of the picture or to enhance it. In the image processing input is given as a picture and the simulation output might be a picture or some specified characteristics or feature of that image. It is narrowly connected to the vision and graphics of the computer in which forms main research area in computer graphics, engineering, etc. The most common is digital image processing, but there is a possibility of analog and optical image processing. In the hard copies like photographs the analog technologies are used. Digital image is nothing but the spatial co-ordinates (say x,y) are having discrete values. Digital images are cost effective and faster to process. Image processing is a vast area in which the various interpretations are used. The image processing tool is an important role is association through visual techniques. Thus the image processing analysts apply the collateral data along with the personal knowledge for processing the image.

The systems that monitors are react or manage an outer environment which are connected through physical sensors, Interfaces between input and output, actuators that can have biological or physical objects of any structure and form is a real time embedded system. It should meet some timing and various constrains due to the real time application as it going to interface with external world. This autonomous system will allow the harvesting of smaller flowers with higher feasibility. This system consists of a sequence of elements for harvesting flowers at right time with collision avoidance. They are motors, sensors, collision avoidance along with the gripper and the robotic arm.

II. SYSTEM DESCRIPTION

In this procedure the water shed algorithm is implemented for detecting the flower. According to the algorithm the description is given below.

1. Replicate filtering:

The input array value external the limits of the array are supposed to be same nearest array limit values in the duplicate filter. The data types are handled as the image arithmetic functions by IM filter function. This IM filter is used to reduce the null padding artifacts in the picture around their edges. It offers the border replication which is nothing but the boundary padding method. To attain this, additional argument „replicate” is used to IM filter.
`13=imfilter(I,h,„replicate”);`
`figure; imshow(13), title(„filtered with border replication”)`

III. CALCULATION OF GRADIENT:

A directional change in the colour or strength of a picture is called as the image gradient. The image gradient is the essential structure building block used in the image processing.

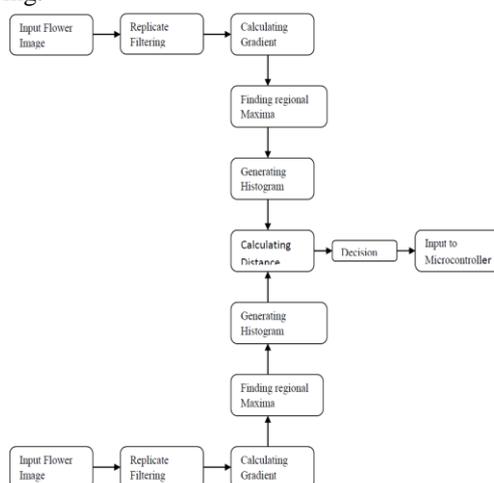


Fig.2.1: System description

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Using this image gradient, vertical and horizontal edges are detected. Horizontal gradient is used to detect the vertical edges, and then the extreme values of the image gradient are used to find the threshold values. The calculation of horizontal gradient was given by the differences in the image gradient between each column. Thus the image with the above two processes can be given as the combination of result of each gradient calculation. This resultant image combining horizontal and vertical gradient images is called gradient image.

IV. FINDING REGION MAXIMA:

There will be chances of having many regional minima or maxima but the global minima or maxima should be a single one. In morphological reconstruction, the marker images are used which is determined by using the image valleys or peaks. Here, $BW = \text{imregional}(I)$, which proceeds the binary picture that particularly identifies the area maxima in I . The connected component of pixels that having constant intensity value, t is the regional maxima, where the values of external boundary pixels are lesser than t . Here the function imregionalmax will accept the black and white picture as input as arrival a binary image as output. In the output image, the area minima or maxima is set to be 1 and expect this all other pixels are set to be zero.

In this procedure, grayscale image dilation is used which is simply a max filter that gives the single pixel peak.

V. GENERATING HISTOGRAM:

In a digital image, a graphical representation of the tonal distribution is referred to as the image histogram. In this graph for each tonal value, the numbers of pixels are plotted. The function imhist is used to calculate the histogram for the intensity image (I) and displays the histogram plot. The image type is used to determine the number of bins in the histogram.

$n = \text{hist}(Y)$

$n = \text{hist}(Y, X)$

$n = \text{hist}(Y, \text{nbins})$

$[n, xout] = \text{hist}(\dots)$

It shows the distribution of data values.

$n = \text{hist}(Y)$ is the function used to bin the elements in the Y vector into 10 equally spaced containers and it will return the number of elements in each container as a row vector.

$n = \text{hist}(Y, X)$ where x is a vector.

It is created with the patch graphics object where the patch properties are used to alter the colour of the graph.

VI. DISTANCE CALCULATION:

The below formula is used to calculate the difference between both the histograms,

$\text{Distance} = \sqrt{\text{mean}((\text{hist1} - \text{hist2})^2)}$

where, hist1 and hist2 are the histograms of input and image in the database respectively. Here the root mean square error metric of minimum value is the best match from all samples of histograms (hist1 and hist2) which we are going to compare.

VII. SYSTEM HARDWARE ARCHITECTURE

The hardware used here is ATmega microcontroller- ARDUINO UNO. The diagrammatic representation of system hardware is given in fig. 3.1.

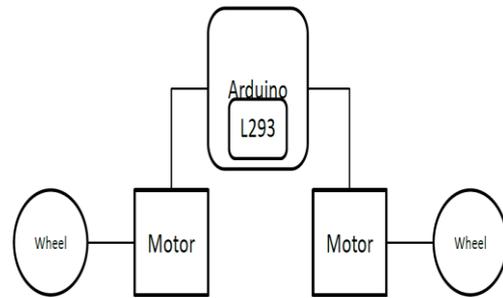


Fig.3.1: Structure of hardware process

Robotic cutter arm:

The robotic arm cutter has movable blades is controlled by the motor. The blade cuts the stem when the motor moves 180° .

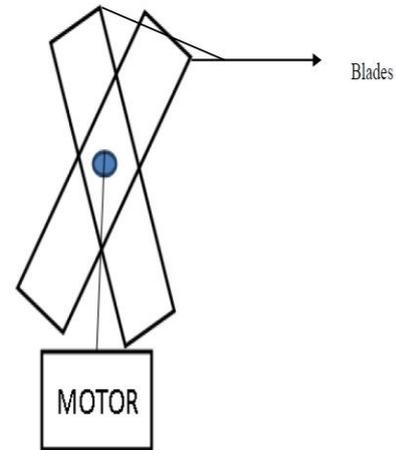


Fig.3.2: Robotic cutter arm with motor

VIII. WATERSHED ALGORITHM:

Watershed refers to the ridge that divides areas drained by different river systems where catchment basin is the geographical area that drains into a river. These ideas are used in image processing to overcome many image segmentation problems. There are two popular methods for computing watershed transformation and they are discussed below.

1. Watershed segmentation using distance transforms:

The distance transform is a commonly used tool for conjunction with the watershed transform for segmentation. This technique deals with the distance between every pixel to the nearest non zero valued pixel. The function bwdist is used for computing distance transform and its syntax is given by, $D = \text{bwdist}(f)$. Similarly, the function watershed is used for computing the watershed transform of the negative of distance transform and its syntax is given by, $L = \text{watershed}(f)$

2. Watershed segmentation using gradients:

In this method, pre-processing a gray-scale image uses gradient magnitude which is prior to the watershed transform for segmentation. This image has high pixel values in the edges and low pixel values everywhere else. To superimpose the watershed ridgelines as white lines in the original image the following function is used.

$g2 = \text{imclose}(\text{imopen}(g, \text{ones}(3,3)), \text{ones}(3,3));$

$l2 = \text{watershed}(g2);$

IX. ALGORITHM

- Step 1:** Input image is get and convert the rgb image into gray-scale image.
- Step 2:** Create a 2-dimensional filter (sobel),hy.
- Step 3:** Using replicate create IM filter, Iyto filter the image according to the specified value (hy).
- Step 4:** Using replicate create IM filter, Ix to filter the image according to the specified value (hx’’).
- Step 5:** Using the formula given below, the gradient magnitude of the filtered image is calculated,
 $gradmag = \sqrt{Ix2.^2 + Iy2.^2}$;
- Step 6:** The region maxima is calculated and superimposed on original image.
- Step 7:** The histogram is plotted for the image obtained in above step.
- Step 8:** All the above steps are repeated on the images in database.
- Step 9:** The histograms of both input image and images in database are compared and the distance between samples are then calculated.
- Step 10:** The centroid of the image is calculated if there occurs a match of 60% or above and then the position to be cut is calculated.

X. RESULTS AND DISCUSSION

The simulation result for the same flowers are given by,



Fig.6.1 :Gray-scale image of the original picture

In the fig. 6.1 the RGB image has been converted into gray-scale image for making the processing easier.

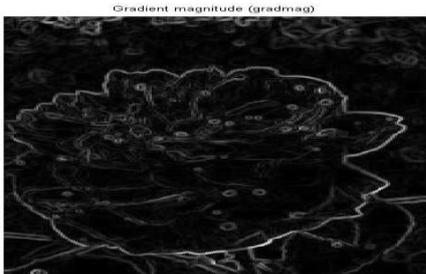


Fig. 6.2: Gradient magnitude of the gray-scale image

In the fig. 6.2, using the below formula the gradient magnitude of gray-scale image has been found.

$$\text{Gradient magnitude} = \sqrt{Ix2.^2 + Iy2.^2}$$



Fig. 6.3: Area maximum of opening-closing by rebuilding

In the figure 6.3, using the function imregional() the regional maxima of the image for which the gradient magnitude is computed is found. The external boundary pixels have value less than the constant intensity in the regional maxima.



Fig. 6.4: area maximum superimpose on original picture

In original image (fig. 6.1), the image in fig. 6.3 is superimposed and the above result is obtained.

1. Histogram of similar images:

For the similar images the histogram plots are given below.

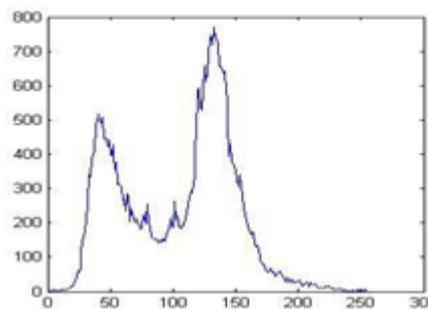


Fig. 6.5: Picture Histogram 1

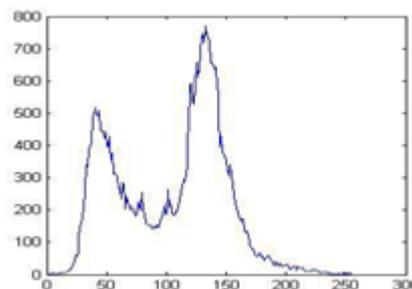


Fig. 6.6: Picture Histogram 2

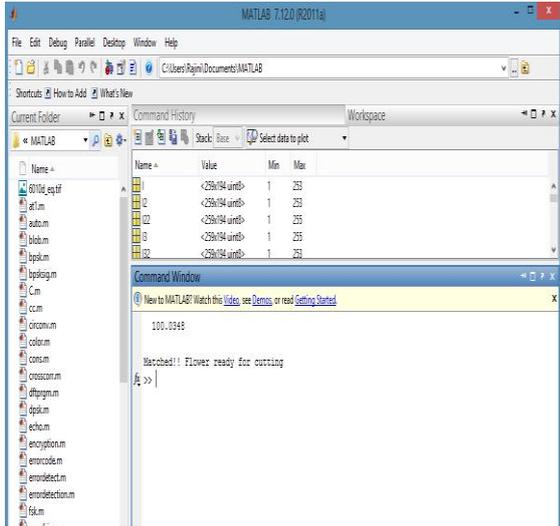


Fig. 6.7: Percentage of matching of same flowers

The simulation result for exact match in flowers is given in below figures. Here the flower which is not present in the database is given as input and compared with the flower in database and the result is as follows.



Fig. 6.8.1: Black and white image

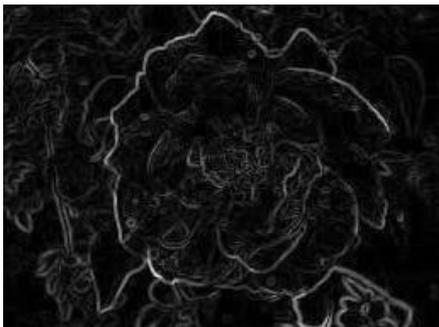


Fig. 6.8.2: Black and white image for gradient magnitude



Fig. 6.8.3: Area maximum of opening-closing by rebuilding



Fig. 6.8.4: Area maximum superimpose on original picture

2. Histogram for different images:

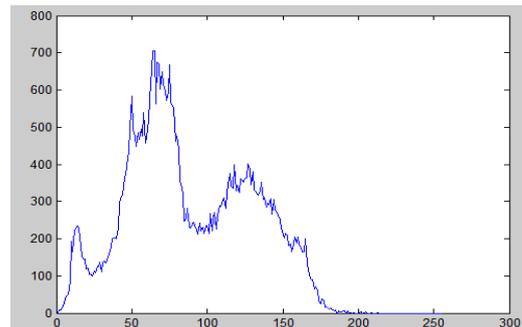


Fig. 6.8.5: Histogram image for different flowers

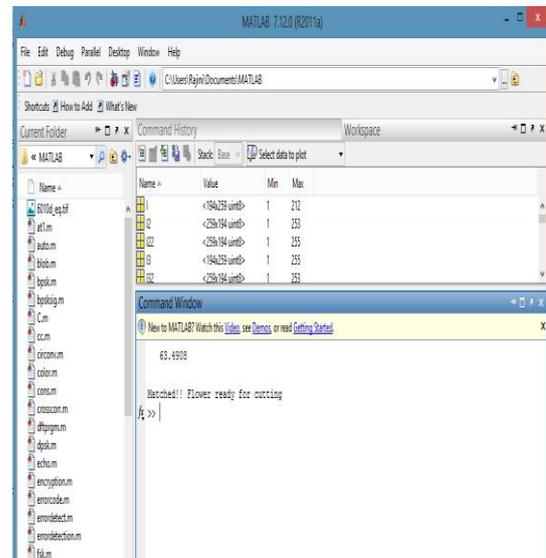


Fig. 6.8.6: Percentage matching for different flowers

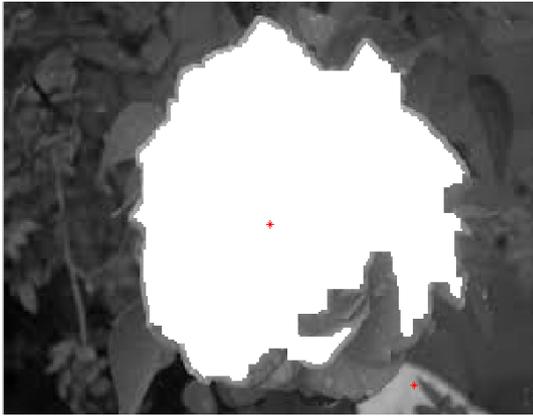


Fig. 6.8.7: Centroid of the detected image

The centroid of the superimposed figure is detected and a distance of 70mm from the centroid is marked. At this marked position the flower will be cut.

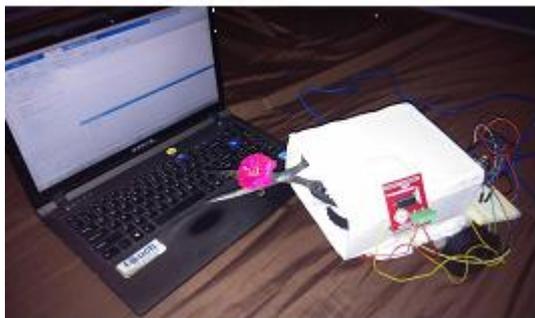


Fig. 6.9.1: Hardware setup for flower cutting



Fig. 6.9.2: Hardware setup after flower cutting

XI. CONCLUSION

The proposed system in this paper can harvest the rose flower in lesser time compared to manual harvesting. Here the system is demonstrated in a simpler way with a robotic arm. This can be developed to further extend with advanced hardware. The future scope for this proposed system is very vast. This can be enhanced to detect and classify different colours of flowers and different kind of flowers to be harvested with some specifications given by the user. Also, the robotic arm can be made fully automated by using Bluetooth. This robot can be used in irregular fields by making the base sturdy. The electronic arm covering various heights can be used to increase the degree of freedom. It allows cutting the flowers at different locations with more feasibility.

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