Abstract—This paper discusses the prominent and efficient method for detecting and counting the number of flowers from the flower images captured by digital camera. The proposed method uses Gaussian low-pass filter and morphological operations for pre-processing the flower images to remove the non-flower region and enhancement of fine details. The flower region from input image is segmented using global thresholding technique using OTSU’s algorithm. Experiment is conducted in MATLAB on two distinct databases of marigold flower images, the results have shown that the accuracy is over 92% to detect and count the number of flowers from flower images.

Keywords—Flower detection and counting, Flower segmentation, Flower recognition.

I. INTRODUCTION

There are about 250,000 named flower species in the world, every day we can see many blooming flowers in the roadside, garden, park, mountain path, wild field, green houses etc. [1]. Now a day the use of technology in the field of agriculture is increasing day by day for reducing the manpower and increasing the production capacity. Generally the flowers production is taken in greenhouses and fields for the revenue purpose by farmers. Produced flowers sold in market by the farmers in the form of bunch. But in the market these flowers sold in the form of units; hence the profit gain by the agent is more than the farmer; because a farmer doesn’t know how many (in units) flowers are there in his greenhouse. So to overcome this problem, image processing application can be used to automatically detect and count the number of flowers available in the greenhouse.

This paper gives a novel approach to automatically detect and count the number of flowers in an image of greenhouse captured by digital cameras. The digital image of flowers in greenhouse can be taken by either high resolution smart phone or digital cameras. This input flower image is pre-processed using Gaussian low-pass filter and morphological operations for noise removal and image enhancement. The global thresholding approach is used for region segmentation of individual flower and counts the number of flowers in a given input image.

II. RELATED WORK

Recently the flower recognition system based on image processing was proposed by Tanakorn et.al [1]. Author used the edge and color characteristics of flower images to classify the flowers and deployed Hu’s-seven-moment algorithm to acquire edge characteristics. The k-nearest neighbour is used to classify the flowers.

The interactive flower image recognition system was proposed by Tzu-Hsiang et.al [2], the proposed system draw an appropriate bounding window that contains the interested flower region, depending on that the boundary tracking method is developed to extract flower regions as accurately as possible.

In [5], Das et al. proposed a new approach for indexing a specialized database by utilizing the colour and spatial domain knowledge available for the database; and provided the solution to the problem of indexing images of flowers.

In [6], Asma et al. used a novel method to isolate the flower region from the background using OTSU’s thresholding on lab color space for segmenting flower region. Thresholding was performed, separately, on the three component L, a and b, and the best result is selected.

In [7], Yuri et.al used Graph cut method which provides the technique to identify certain pixels as background or object as segment part using contrast dependent prior Markov random field (MRF) cost function.

In [9], John et.al proposed a method for identification of ROI using the edges in the images depends on the natural uncertainty principle. Author used C-Means algorithm avoid ambiguity to decide the flower type to categorize the flowers as flowers with many petals, flowers with clear one petal and rounded flowers.

In [10], Hong et.al has done the segmentation based on color clustering and domain knowledge to extract flower regions from flower images. He also used the color histogram of flower region to characterize the color feature of flower and two shape-based features set.

III. METHODOLOGY

The methodology used for detecting and counting the number of flowers from greenhouse image taken by digital camera is described in following steps.

The interactive flower image recognition system was proposed by Tzu-Hsiang et.al [2], the proposed system draw an appropriate bounding window that contains the interested flower region, depending on that the boundary tracking method is developed to extract flower regions as accurately as possible.

In [5], Das et al. proposed a new approach for indexing a specialized database by utilizing the colour and spatial domain knowledge available for the database; and provided the solution to the problem of indexing images of flowers.

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In [10], Hong et.al has done the segmentation based on color clustering and domain knowledge to extract flower regions from flower images. He also used the color histogram of flower region to characterize the color feature of flower and two shape-based features set.
A. Image Acquisition

The flower image from greenhouse is captured from top side of flowers in greenhouses with one to two meter distance using Sony Cyber shot W810 20.1MP camera in overcast environment. The captured image of marigold flower is in size 1200X1600 in a jpeg format.

B. Pre-processing

After taking the marigold flower image, pre-processing is done on the input image to remove noise and to extract only the flower region. In the discussed method, the Gaussian low-pass filter is used with the predefined size and standard deviation. Input image is converted into binary form based on thresholding level. The Otsu's method is used to choose the threshold to minimize the intra class variance of the black and white pixels.

\[ h_x(n_1,n_2) = \frac{1}{\sqrt{2\pi \sigma^2}} e^{-\frac{(n_1-\mu_x)^2}{2\sigma^2}} \]  
\[ h(n_1,n_2) = h_x(n_1,n_2) \frac{1}{2^{n_2-n_1/2}} \]  
\[ I_1 = I + h \]  
\[ I_2 = \text{binary}(I_1, \text{level}) \]

Where,
- \( n_1=15, n_2=15, \sigma =7. \)
- \( h = \) pre-defined Gaussian low-pass filter.
- \( I = \) original image.
- \( I_1 = \) result image (after applying \( h \)) i.e. filtered image.
- \( I_2 = \) binary image.
- \( \text{level} = \) threshold value calculated using Otsu method.

C. Flower Region Segmentation

The canny method is used to find out the regions of the flowers in an image, because in the binary image white pixels indicate the area of the flowers. After that the mask is created depending on the edge and put that mask on original image

\[ e = \text{edge of} \ I_2 \text{ using canny method.} \]
\[ I_3 = I + m \]

Where,
- \( m = \) coloured edge mask.
- \( I_3 = \) flower region segmented image.

D. Flower Count

To count the number of flower in an image firstly the bounding boxes are created for every connected edge in an image; after that the total number of bounding boxes are counted and stored. Finally the count in stored variable is the number of flowers detected and counted.

IV. EXPERIMENTAL RESULTS

A. Flower Image Database

In this paper, two distinct marigold flower image databases are used to evaluate the performance of the proposed method. First is the primary database (DB1), the images of the marigold flowers are captured manually from the greenhouses using Sony Cybershot W810 20.1MP digital camera from the top side, the distance between surface of the flowers and camera is 1 to 2 meter. This primary database contains 50 marigold flower images of 1200X1600 sizes. The Second database is the secondary database (DB2), in which the marigold flower images are collected from the standard and authorized websites, such as www.shutterstock.com and www.burpee.com, these images were in different sizes. Before doing experiment, the flower images are resized into 500x500 pixels of both the databases to get the prominent results. Finally the experiment is carried out on 50 samples of each primary (DB1) and secondary (DB2) database images in MATLAB.

B. Experiments

Experiment is carried out on 50 marigold flower images of primary database and 50 marigold flower images of secondary database. The results of Flower Detection and Count using proposed method are given in the Table 1.

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43 | MF43 | 9 | 6 | 3 | 0 | 66.67 | 33.33 | 0
44 | MF44 | 40 | 37 | 3 | 0 | 92.5 | 7.5 | 0
45 | MF45 | 5 | 5 | 0 | 0 | 100 | 0 | 0
46 | MF46 | 9 | 9 | 0 | 0 | 100 | 0 | 0
47 | MF47 | 8 | 6 | 2 | 0 | 75 | 25 | 0
48 | MF48 | 6 | 6 | 0 | 0 | 100 | 0 | 0
49 | MF49 | 12 | 12 | 0 | 0 | 100 | 0 | 0
50 | MF50 | 14 | 12 | 2 | 0 | 85.71 | 14.29 | 0
51 | MF51 | 5 | 5 | 0 | 0 | 100 | 0 | 0
52 | MF52 | 17 | 17 | 0 | 0 | 100 | 0 | 0
53 | MF53 | 32 | 32 | 0 | 0 | 100 | 0 | 0
54 | MF54 | 25 | 24 | 1 | 0 | 96 | 4 | 0
55 | MF55 | 30 | 30 | 0 | 0 | 100 | 0 | 0
56 | MF56 | 9 | 9 | 0 | 0 | 100 | 0 | 0
57 | MF57 | 17 | 13 | 4 | 0 | 76.47 | 23.53 | 0
58 | MF58 | 32 | 30 | 2 | 0 | 93.75 | 6.25 | 0
59 | MF59 | 40 | 39 | 1 | 0 | 97.5 | 2.5 | 0
60 | MF60 | 25 | 22 | 3 | 0 | 88 | 12 | 0
61 | MF61 | 50 | 52 | 0 | 2 | 100 | 0 | 3.85
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65 | MF65 | 50 | 50 | 0 | 0 | 100 | 0 | 0
66 | MF66 | 32 | 32 | 0 | 0 | 100 | 0 | 0
67 | MF67 | 40 | 38 | 2 | 0 | 95 | 5 | 0
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90 | MF90 | 23 | 21 | 2 | 0 | 91.3 | 8.7 | 0
91 | MF91 | 40 | 36 | 4 | 0 | 90 | 10 | 0
92 | MF92 | 5 | 5 | 0 | 0 | 100 | 0 | 0
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94 | MF94 | 7 | 7 | 0 | 0 | 100 | 0 | 0
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96 | MF96 | 14 | 14 | 0 | 0 | 100 | 0 | 0

DB2

Sr. No. | Image Name | TNF | D&CF | NDF | FDF | POD | PND | PFD
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98 | MF98 | 8 | 8 | 0 | 0 | 100 | 0 | 0
99 | MF99 | 27 | 27 | 0 | 0 | 100 | 0 | 0
100 | MF100 | 27 | 22 | 5 | 0 | 81.48 | 18.52 | 0

Average = 92.30 7.69 3.72

Where:
- TNF = Total Number of Flowers.
- D&CF = Detected & Counted Flowers.
- NDF = Non Detected Flowers.
- POD = Percentage Of Detection.
- PND = Percentage of Non Detection.
- FDF = False Detection of Flowers.
- PFD = Percentage of False Detection.

Where:
- POD = (D&CF) / (TNF)*100.
- PND = (NDF) / (TNF)*100.
- FDF = MOD(TNF-D&CF).
- MF1- MF100: Marigold Flower 100 samples.

V. Conclusions and Future Work

This paper has presented a novel method for detecting and counting the number of flowers from flower images of a greenhouse. The proposed method for automatic detection and counting of marigold flowers is an efficient and robust with accuracy of 92%. The farmer and agents can use this application to count and verify the number of flowers available in the greenhouse easily and quickly with affordable cost.

This work is extended in future for removing flowers overlapping, classification between the buds and flowers for accurate estimation of production. Also this application can be extended towards the detecting and counting the mixed category flowers in a greenhouse by detecting and recognizing each flower category and its count.

ACKNOWLEDGMENT

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