Overlapped Sunflower Weighted Crop Yield Estimation Based on Edge Detection

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Abstract. Today agriculture field's demands to develop such an intelligent system those provide accurate and timely information for an estimation of crop productivity. This paper designed an automated decision support system to estimate sunflower crop productivity information with interface between camera and computer software. The earlier steps of system generate overlapped flower yield information and latter steps count the seed from the flower head. Some beautiful flowers in the nature have Fibonacci relationship in their seeds pattern, i.e. sunflower, pineapple etc. The implementation parts based on two color model RGB and HSV. HSV provide better results for overlapped flower. The technique use image segmentation, morphological operation for overlapped flower count and edge detection for seed count.

Keywords: Edge detection · Morphological operation · Segmentation Filters

1 Introduction

Study of flowers is done in Floriculture [1]. The study of modern flower crops comes under the floriculture which is sub-branch of horticulture [1]. Yield estimation is the main part of the agriculture's accuracy. The precision agriculture has main application of the yield estimation. Precision agriculture is the early estimation of the crop for preplanning and decision of every stage of crop. The entire problem in every stage of flowers can be solved by precision agriculture using computer & machine vision based decision with full automation. This paper presented the sunflower yield calculation of crop from flowers shape analysis [2]. The man made estimation system gives better results even if there is variation in fields or weather conditions [3–7]. For developing a new computing algorithm basic yield estimation model is inferred in Fig. 1 below.

Object detection, shape detection and texture detection are the three main parts of counting algorithm [8–11]. It is easy to estimate the object from binary image in matlab. Hence, firstly it is important to use segmentation technique for extracting flower form the background and convert in to binary image [12]. In the fifteenth century scientist Leonardo discovered Fibonacci series [13]. The sun magic flower known as sunflower. It has clockwise and anticlockwise spires. These spires have

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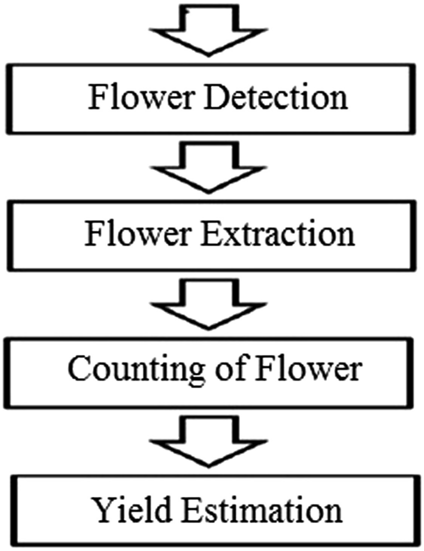


Fig. 1. Basic model for yield estimation

number relationship (i.e. 34 anticlockwise and 55 clockwise or 55 anticlockwise and 89 clockwise). For any size of sunflower they come with Fibonacci number, even if head size of sunflower very. It is very complex to count number of seeds from a sunflower because many seeds presented in both spires and they intersect. In Fig. 2 show the algorithm steps of sunflower yield estimation.

2 Development Algorithm

The Development steps of proposed algorithm are divided into two parts, first for flower count and second for seed count:

The flower count step includes 6 steps, in which input is taken as RGB image and output is generated in the form of flower count. In next seed count steps includes the cropping the sunflower head followed by seed count operation.

2.1 For Flower Count

Step 1: First of all Capture RGB images from the field of the sunflower
The first step of yield estimation of sunflower is capturing the image of sunflowers from the sunflower field. The sunflower image is captured by the high-quality camera which is stationary. The image captured by camera is the RGB image. The RGB image has the basic color of any object like Red, Green, and Blue. Future this RGB image to pass to next step which remove the noise from the RGB image.

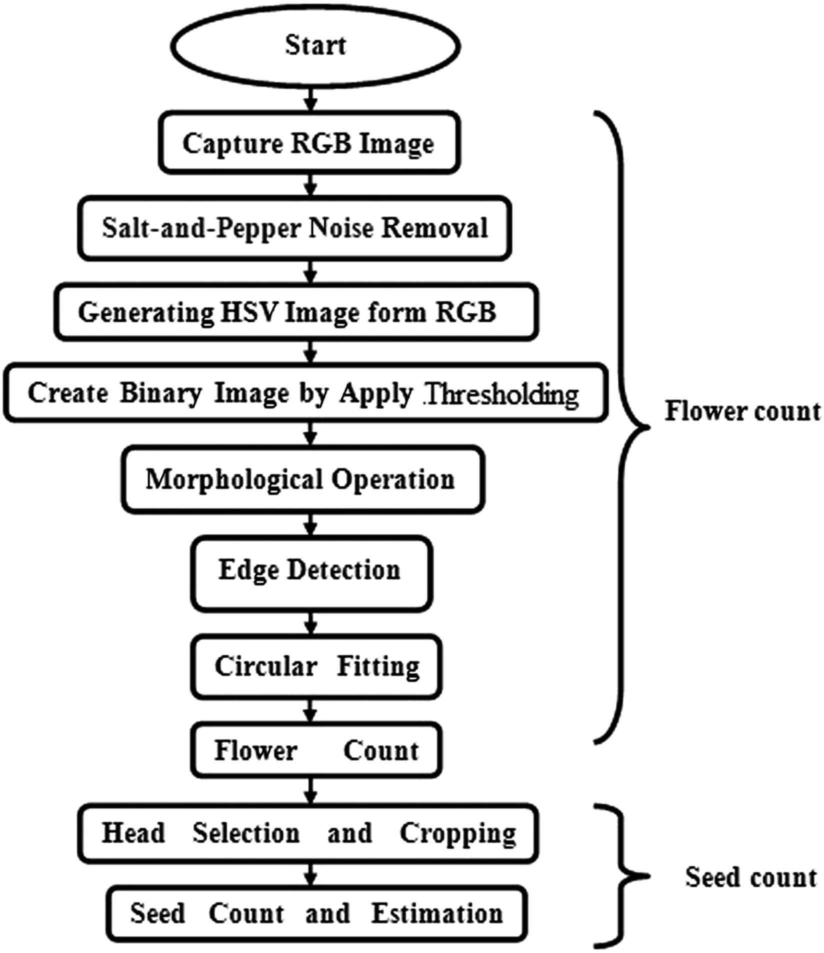


Fig. 2. Development algorithm's process flowchart

Step 2: Remove the noise from the captured image
Salt and pepper noise is common in captured image by camera. So remove the Salt and pepper noise by the Median filter. The output pixels of the image are determined by calculating the median of the neighborhood pixels and replace the pixel by the calculated median pixel. In this filter, the median value is placed on image pixel value.

Step 3: Convert the RGB capture image to HSV image
Different flowers have the different color. The color extraction has a range of hues value because the flowers contain shades of color. After the color transformation, the hue range is calculated. The HSV color model used for flower extraction. The transformation of RGB image gives better segmentation. The segmentation of the flowers is better using HSV color model then compared to RGB color model.

Step 4: Generate the binary image
After detection of flowers, they are extracted from the background using Otsu thresholding technique segmentation process. After the segmented image is called the binary image in which flower region is white and the background is black and vice versa. It is easy to count objects from the binary image.

Step 5: Apply Morphological operation on the binary image
The image is reconstructed using the finite number of time operation i.e. Dilation, Erosion, Opening, and Closing after the morphological operation.

Step 6: Apply edge detection process followed by circular fitting and flower count
The basic process of detection detects the boundaries of different object and outline of an object and background of the image and indicates the overlapping object boundaries. The image segmentation using the canny edge. Find the number of circles and their radius by using the imfindcircles commands. The number of circles is equal to the number of the flower head and the size of each flower is calculated in inch from the radius.

2.2 For Seeds Count

Step 1: Head selection after all steps of Flower Count Steps then cropping
After the circular fitting, the circle marks on the head of the sunflower then count the sunflower head and find an estimation of the sunflower cropping. Heads of the sunflowers are not the same size. Different sunflower has different head size then select the different sunflower head for next step seed count.

Step 2: Seed Counting and estimation of the crop of sunflower
After the head count, then select the sunflower head of different size. After head selection, the seeds are count form different heads of sunflower and find the average weight of the seeds which give the crop estimation of sunflower.

3 Experimental Results

During the image capturing process there is some chance to add the noise due to any regions like environment condition etc. Hence here is need to remove such kind of noise [14–16]. RGB to HSV conversion is necessary because the flower area can be detected on the basis of hue value [17, 18]. It is easy to extract the different regions by using segmentation technique [19]. The circular fitting or curve fitting tool box used to count the number of flower [20–22]. It provides the facility to create, modify and access the fitting objects [20–22]. The methods command of MATLAB results the curve fitting objects.

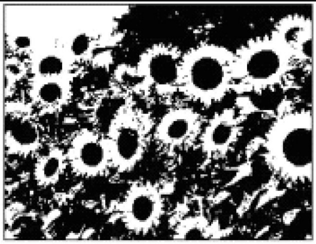
For example,

f = fittype (‘a * x^2 + b * exp (n * x)’); methods (f)

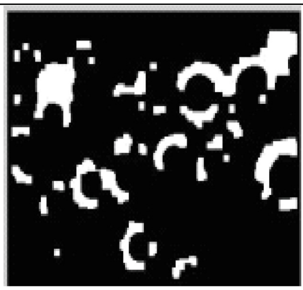
The number of objects or circles gives the result Flower yield calculation.

Figure 3 infers the results obtained after execution of flower count steps. From the results it is clear that accuracy of flower count is near about 92%.

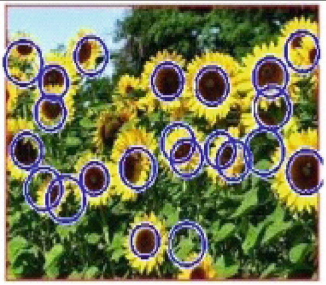
(a) Input Sunflower Image



(b) Generated Binary Image



(c)Image after Morphological Operation and Hole Filling



(d) Output Sunflower Image

Fig. 3. Obtained result of proposed technique

4 Accuracy of Flower Count Steps

The number of flower count is equal to the result of the length function of MATLAB.
For example:

length (centers);

The accuracy of proposed flower count steps can be computed by comparing it with the manual count.

$$\text{Accuracy} = (\text{AFC} / \text{MC}) * 100 \tag{1}$$

Here,

AFC = Algorithmic flower count
MC = Manual count

In Table 1 shows the Summary for the accuracy of different kinds of flowers.

From above table it can be concluded that the flower count steps of proposed algorithm provides the 89.896% or 90% accuracy. For sunflower it results accuracy approximately 92%. Input and output image from figure no 2 it is clear that head count is 22 out of 24, here the accuracy is 91.67%.

Table 1. Development algorithm accuracy

S. No.	No of image processed	Type of flowers	Accuracy
1	18	Yellow gerbera	92.31%
2	22	White marigold	87.53%
3	8	Water lily	82.48%
4	18	Yellow marigold	95.50%
5	15	Common yellow sunflower	91.66%
Development algorithms over all accuracy			89.896%

5 Head Size Based on Circular Fitting

Figure 2 shows overlapped flower count or flower head count. Sunflower is found in many verities but yellow sunflower is common. In agriculture the head size is normally measured in inch. It very from 4 inch to 12 inch. The maximum head size exists up to 27 inch. Table 2 shows the radius of sunflowers reflected as result, from the output image in Fig. 2 and its equivalent full head size in inch.

Table 2. Details head size of each sunflower of flower counting algorithm.

Flower count	Radius	Head size = 2*radius	Head size in inch
1	13.615	27.23	10.7205
2	13.2777	26.5554	10.4549
3	15.1792	30.3584	11.9521
4	14.6327	29.2654	11.5218
5	11.4672	22.9344	9.0293
6	13.9376	27.8752	10.9745
7	13.5606	27.1212	10.6776
8	10.0707	20.1414	7.92969
9	12.1582	24.3164	9.57339
10	11.1913	22.3826	8.81205
11	8.5658	17.1316	6.74473
12	8.1214	16.2428	6.39481
13	15.224	30.448	11.9874
14	15.9961	31.9922	12.5954
15	13.0219	26.0438	10.2535
16	13.6835	27.367	10.7744
17	12.4706	24.9412	9.81938
18	14.5105	29.021	11.4256
19	14.5679	29.1358	11.4708
20	12.2001	24.4002	9.60638
21	12.0045	24.009	9.45237
22	15.5084	31.0168	12.2113

1 inch = 2.54 cm or 1 cm = (1/2.54 = 0.393701) inch

In this paper we categorize three kinds of sunflower heads; these are Large, Medium and Small [23].

So close picture of such kind of head is taken and count the seed of individual head using edge detection.

Apply the following Mathematical formula to seed estimation:

$$SE = FC((SH_L + SH_M + SH_S)/3) \tag{2}$$

Here,

SE: Total seed count
FC: flower count
SH_L: Number of seed in large head (greater than 10″).
SH_M: Number of seed in medium head (7″ >= and <=10″).
SH_S: Number of seed in small head (less than 7″).

Here we can categorize the head in more, according to size which give more accurate yield results.

Following Fig. 4 infer the edge detection.

Table 3 shows the Results of average weight yield. From the Pearson Education, "Data analysis on the Web" the average weight of a seed is 142 mg [24].

So yield estimated weight can be derived from it.

$$\text{Yield weight} = SE * \text{seed average Weight} \tag{3}$$

6 Accuracy of Crop Estimation

The accuracy of crop estimation of sunflower can be computed by comparing with the manual count average weight

$$\text{Accuracy} = (ACW / MCW) * 100 \tag{4}$$

Here,

ACW = Algorithmic Count Weight
MCW = Manual Count Weight

In the Table 4, the input image has 24 head and output image has 22 head, then the weight accuracy of 22 head out of 24 is 92.28%.

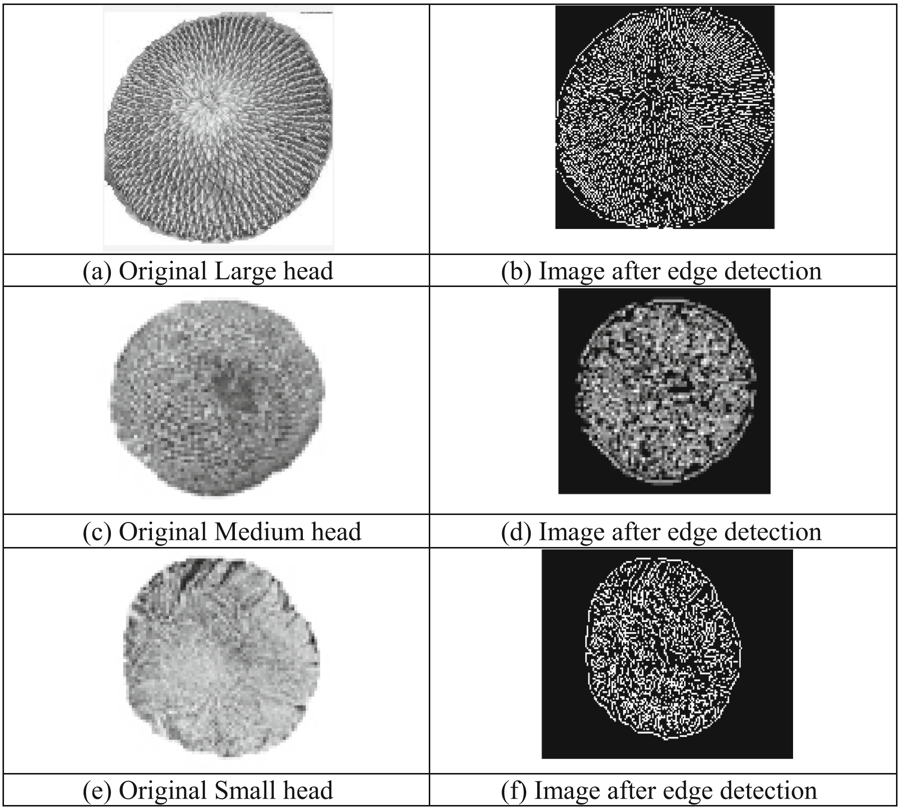


Fig. 4. The edge detection of sunflower heads

Table 3. Shows the results of average weight yield

No. of flower	SH_L	SH_M	SH_S	SE	Total yield weight
22	1224	997	799	22147	3.145 kg
25	1182	951	862	24958	3.544 kg
30	1190	961	878	30290	4.301 kg
18	1235	1020	828	18498	2.627 kg
23	1169	905	858	22479	3.192 kg

Table 4. Shows the results of crop estimation of sunflower

Manual flower count	Algorithmic flower count	Weight of sunflowers by manual	Weight of sunflowers by proposed technique	Accuracy
24	22	3.408 kg	3.145 kg	92.28%
27	25	3.834 kg	3.544 kg	92.44%
33	30	4.686 kg	4.301 kg	91.78%
20	18	2.840 kg	2.627 kg	92.50%
25	23	3.550 kg	3.192 kg	89.91%

7 Conclusion

This paper presents the sunflower crop yield estimation technology with the help of the application of image processing. To comparing our results on the basis of seed weight [24]. Our results meet the accurate crop productivity. it can be concluded that the technique provides the accurate estimation of sunflower weighted crop. The proposed technique is used for precise agriculture. In future scope, we will focus on other types of crop.

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