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Image Processing Based Silkworm Egg Counting Methods

Rupali Kawade[1], Triveni Dhamale[2], Dipali Dhake[3]
[1](Department of E&TC Engineering, PCCOE&R, Ravet, Pune,India)
[2](Department of E&TC Engineering, PCCOE&R, Ravet, Pune,India)
[3](Department of E&TC Engineering, PCCOE&R, Ravet, Pune,India)

Abstract: *The silkworm seed production is an important activity of sericulture. This involves the rearing of parent seed crop for the production of seed of silkworm known as Disease Free Lyings (DFLs). In order to find out the laying capability of moth and hatching percentage, counting of silkworm eggs is essential during silkworm rearing. Similarly it is important to count silkworm eggs accurately so that farmers can pay accordingly and they will not suffer any loss while buying. The manual counting of silkworm eggs invoves ink or skectch pen which is used to count the eggs by remembering the number. As this is manual method which can be errornous and time consuming.therefore there is a need to develop some fast and automatic methods to count the number of silkworm eggs. This paper presents image processing based two methods of counting and also compares the results of the same.*

I. Introduction

Sericulture is essentially a village-based industry which provides and employment for major section of population. It is an art of silkworm rearing for the production of cocoons. The silkworm seed production is one of the important activity of sericulture. The DFLs are prepared in their granages and supplied to farmers for rearing.The demand of eggs for rearing silkworms is not uniform throughout the year. In Silk production, number of silkworms required for plantation of mulberry trees should be approximate for good yield of silk. It will not waste mulberry leaves. For this farmers need to purchase approximate number of silkworm eggs . The DFLs prepared in grainages have variability in egg quantities laid on sheets. This can cause economic losses and the control measures to monitor the eggs numbers is tedious and laborious. Counting of silkworm eggs is necessary during selling of eggs to farmers for rearing, So that they can pau accordingly and should not suffer any economic lossSericulture is essentially a village-based industry providing employment to a sizable section of the population. It is an art of silkworm rearing for cocoon production. In order to sustain sericulture as a commercial crop in competition with other cash crops, production and timely supply of superior quality silkworm seed is necessary. In India sericulture is practiced in temperate as well as tropical area. Due to different seasons and varying rearing conditions silkworm breeds differ in various zones[1].

The silkworm seed production is one of the important activity of sericulture. The silkworm seed known as Disease Free Laying (DFLs) are prepared in their centers and supplied to the farmers for rearing. Both Government and private sector grainages are involved in this activity. In sericulture , the demand of eggs for rearing silkworms is not uniform throughout the year. When seed cocoons are available in plenty of favorable seasons, surplus quantity of eggs will have to be prepared and stored in cold storage to be released at the time of demand.

In silk production, the number of silkworms required for a particular plantation of mulberry trees, should be approximate one for good yield of silk,so that mulberry leaves will not be wasted. For this farmers must purchase approximate number of eggs from grainages. Disease Free Layings (DFLs) are prepared in grainages and supplied to the farmers for rearing. Variability of egg quantities laid on sheets during production can cause economic losses. In addition quality control measures to monitor the egg numbers is tedious and laborious. While selling the silkworm eggs for rearing it is necessary to count the silkworm eggs accurately, So that farmers can pay accordingly and they should not suffer a loss. Also this counting determines the laying capability of moth and hatching percentage of silkworm rearing.

The conventional method for the silkworm egg counting is by using ink/sketch pen. The transparent paper is put on the egg sheet and eggs from one DFL are counted by marking it using sketch pen. This is usually performed in a manual, visual and non-automatic form which is erroneous and time consuming. This project work approaches the development of automatic methods to count the number of silkworm eggs using image processing, particularly color segmentation and mathematical morphology-based non-linear filters. The system is intended to replace a manual, visual and non-automatic method of counting.

Karnataka State Sericulture Research and Development Institute , Bangalore has implemented a calculator for egg counting to reduce the error and to increase the efficiency of egg counting. In this probe is attached to a pen, which will be pressed gently against each egg. As a result, the counted number will be marked and at the same time calculator will record the number. This avoids remembering of the counted egg number and concentrate only on marking. This improves the accuracy of counting and efficiency. This modification does not affect the normal functions of the calculator. This technology can be adopted in grainages, CRCs and seed multiplication centers which reduce the error during the egg counting and increase the quality parameters. The main disadvantage is that it puts the pressure on eggs because of which h the embryo in an egg may get harm, and because of it the hatching efficiency decreases. Also it is time consuming [3].

The egg detection and counting is done using MATLAB. With a typical digital camera device and a laptop, we can create the detection and counting device. The system will be created in the form of software which consists of input and output parts. The input part is accepts the image file from camera and the output part is responsible for reporting the result in terms of egg count to the user using GUI. Few image processing key methodologies have been applied to implement.

Now a, days the methods used for the counting of silkworm eggs are manual counting method with sketch pen or marker and counting of eggs by calculator. The conventional method for the silkworm egg counting is by using ink or sketch pen. The transparent paper is put on the egg sheet and eggs from one DFL is counted by marking it using sketch pen. Each DFL approximately contains 400-500 eggs. Then Eggs from all DFLs on sheet is calculated by multiplying number of eggs from one DFL by total no. of DFLs on sheet. This is usually performed in a manual, visual and non-automatic form which is erroneous and time consuming. So, it is not good method for counting eggs since it does not give the correct result.

Image processing techniques are being used frequently to count objects, orient pieces ,or discriminate between objects with different visual characteristics. Most automated image systems perform counting by segmenting the object to be counted from background by applying a threshold based on the pixel intensity and/or intensity slope(or rate of change of intensities). Using this methodology, automated imaging systems have been developed to count mosquito eggs[4][5],to count the objects in a video[6], to count number of feeder fish[7].In addition there are several commercial software programs that use this methodology to count objects given a digitized image.

T.C. Pearson, R.H. Edwards, A.P.Mossman, D.F. Wood, P.C. Yu, E.L.Miller has proposed method for counting insect eggs by image analysis [8]. A. Haouari & J.M. Chassery proposes a method to detect schistosome eggs in a microscopic environment connected to a computer. The advantage of this method is the use of a simple two pass algorithm. The first pass detects and analyses the elementary cases of isolated objects. The second pass introduces an enhancement process to improve the classification ratio [8]. Qingmin LIAO , Kacem CHEHDI , Xinggang LIN, Yujin ZHANG have presented pelagic egg identification system by image analysis. Some efficient techniques have been developed such as the edge detection method using human visual characteristics, the improved Hough method for circle extraction and the embryo segmentation method [9]. These object counting systems can work well if the objects are only one layer thick and have good contrast from background. These algorithms are experimented for counting the silkworm eggs for sericulture.

II. Material And Methods

A digital camera with is used to prepare database of images which is connected to computer. A digital image captured from camera of size 1600X1200 pixels is processed in MATLAB. The actual count of eggs are estimated from each DFL by visual inspection to compare it with count obtained from image processing algorithms explored here. Image processing algorithms and GUI implemented to display the results to user in MATLAB.

The explored algorithm evaluated is based on color segmentation, mathematical morphology and Circular hough Transform. Fig.1 shows the sample image of one DFL which actually consist of 585 eggs. A color digital image of size 1600 X 1200 is converted to gray image as RGB color models are not well suited for describing the colors it terms that are not well suited for human interpretation[15]. The first method is based on color segmentation and mathematical morphology. The algorithm is given in following fig. 1[12].

Second method explored for silkworm egg counting is based on Circular Hough Transform. This feature extractiontechnique is essentially used to find imperfect instances of objects within a particular class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform. Circular hough transform is performed after edge detection which isolates the curves of a givenshape. Classical Hough Transform can locate regular curves like straight lines, circles, parabolas, ellipses, etc. It requires that the curve be specified in some parametric form. Generalized Hough Transform can be used where a simple analytic description of feature is not possible.

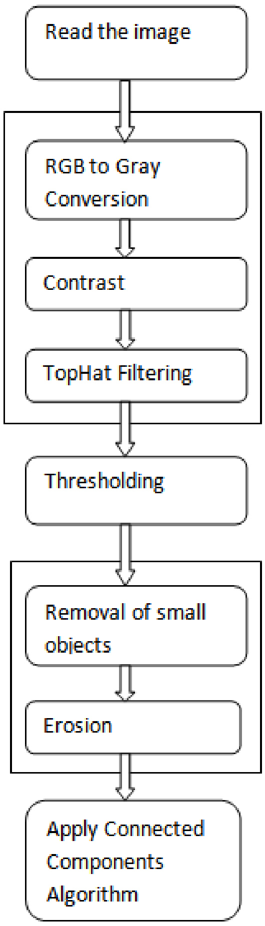

Fig. 1 Algorithm flow for first method

The first step is validation of image parameter which validate the filtered image parameters in order to ensure that the subsequent algorithms used can be applied. The different parameters that need to be considered for validation are 2-D Dimension, size and type of image. Second step is building the accumulation array.To build the accumulation array, the first step is to compute the gradient and the gradient magnitude of the rough silkworm egg sheet image region. It is the first derivative of two-dimensional image. The accumulation array of the image consists of the gradient magnitude of the image and its linear indices. From the segmentation process of the accumulator, the segmented accumulator is smoothened to get better segmented value using averaging filter. To obtain the area of interest, local maxima mapping on the image region is generated by locating every local maximum on the segmented region. Local maximum filter is built by thresholding the local maxima mapping with the lower bound value. There are two steps to be done separately. First, the segmented accumulator is threshold with the non-segmented accumulator and filtered by the local maximum filter. Next step is to label the generated local maximum mapping by eight connected component as in Fig. and then threshold by the gradient component. The threshold process is known here by gradient threshold and basically takes the adaptive threshold method which threshold value varies across the entire image. The output from the second step is known as mask.

Hough transform is a technique which can be used to isolate features of a particular shape within an image. Because it requires the desired features to be specified in some parametric form, the classical Hough transform is most commonly used for the detection of regular curves such as lines, circles and ellipses. The main advantage of the Hough transform technique is that it is tolerant to gaps in feature boundary descriptions and is relatively unaffected by image noise.

The detection process starts with the local maxima in the group of the area of interest is assumed as the centre of the circle. If the linear indices among the minimum value of qualified pixel forming the circular shape, then that area is the eye region detected on the image. Every area of interest is tested with this process for it occurs as an element of the circle component which is the egg region identified in the image.

This method is robust to partial deformation in shape, tolerant to noise and can detect multiple occurrences of a shape in the same pass but lots of memory and computation is required

Fig. 2 Original Image

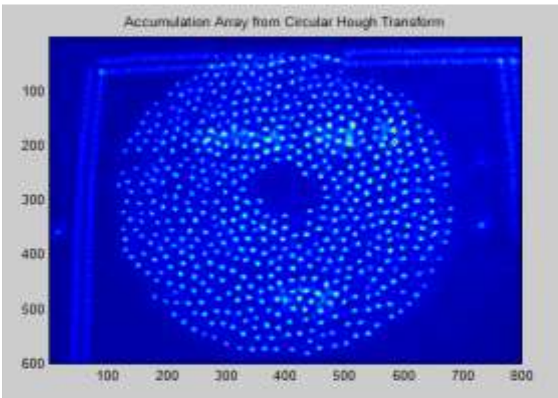

Fig. 3 Accumulation array

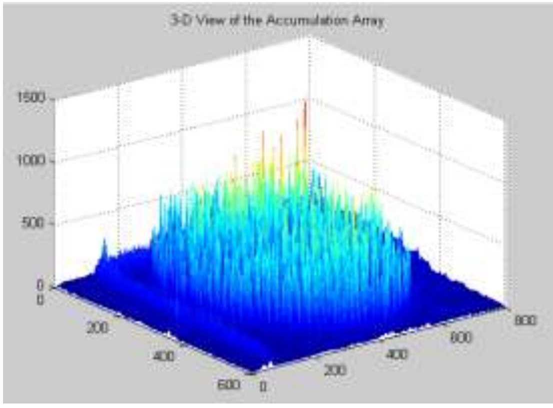

Fig. 4 3-D view of accumulation array

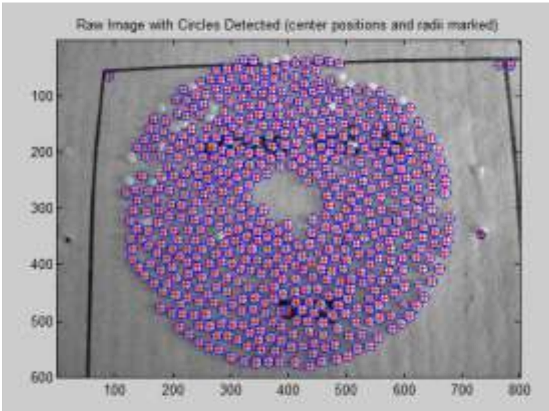

Fig. 5 Image with circles marked

III. Result & Discussion

From the results given in Table 1 the overall accuracy for method 1 is 93.31 % and for method 2 is 97.69 %. So we can conclude that second method is more accurate than method 1. Also method 2 which is based on hough transform is noise tolerant. These algorithms were tested for 19 different images.

Table I Results of Proposed Algorithms

Image	Correct Amount of Eggs	Count with Proposed Methods			
		Method 1	Accuracy	Method 2	Accuracy
1.jpg	585	582	99.48	568	97.09
2.jpg	524	486	92.74	534	101.90
3.jpg	622	627	100.8	533	85.69
4.jpg	525	522	99.42	457	87.04
5.jpg	475	404	85.05	486	102.3
6.jpg	542	540	99.81	525	97.04
7.jpg	518	536	103.46	527	101.73
8.jpg	536	421	78.54	465	86.75
9.jpg	587	545	92.84	568	96.76
10.jpg	527	538	102.08	518	98.29

IV. Conclusion

This paper explores two algorithms for counting of silkworm eggs. The first method based on morphology is simple, efficient and it requires less memory but sensitive to the non-uniform illumination. The second method based on hough transform is noise tolerant, so it gives better results with greater accuracy but requires large memory for the computation of parameters. Transform based method detects only circular objects. Due to illumination this method also detects some unwanted circles in addition to actual eggs. So in some cases we get the count more than actual count.The present work can be further extended to implement many imaging applications for detection of circular objects like eye detection, mosquito egg counting, detection of car wheels and blood cells detection. A dedicated hardware can be implemented using programmable logic devices which can give rise to higher speed of operation. Web based counting system can be implemented using proposed method.

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