Use of Image Processing Techniques For Detection of Tea Pests from Darjeeling foothills, India

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Abstract: Monitoring and detection of pests in the field is a major challenge for tea planters and it's an important component of IPM programme. Therefore effective measures should be developed to fight the infestation while minimizing the use of pesticides. The techniques of image analysis are recently applied to tea science, and it provides maximum protection to these perennial monoculture crops, which can ultimately lead to better field management and production. Surveillance of tea pests infestation relies on manpower, however automatic monitoring has been advancing in order to minimize human efforts and errors. This study extends the implementation of different image processing techniques to detect and extract insect pests by establishing an automated detection and extraction system for estimating pest densities in tea fields. Experiment results shows that the proposed system provides a simple, efficient and fast solution in detecting pests in the plantation fields.
Index Terms: **Automated major tea pests, image, detection, management, object, extraction.**

INTRODUCTION

North Bengal provides a typical agroclimate for cultivation of tea, *Camellia sinensis* (L) O. Kuntze and the plantations cover a wide area of Darjeeling slopes and its adjoining plains mainly bifurcated by river Teesta into terai and the dooars. Among 300 species of insects and mites that attack tea in India, the pests that are dominant in this region and cause substantial damage to the crop are the red slug caterpillar, looper caterpillar, aphid, jassid, thrips, tea mosquito bug and red spider mite. To overcome the crop loss, the populations of these pests are mostly managed chemically. Increasing dependence on synthetic pesticides has created problems like differential killing of non-target organisms, sinister changes in the natural-enemy complexes of the tea ecosystem, development of pesticide resistance among the tea pests, and secondary pest outbreaks (Das, 1959). In plantation, pest control has always been considered as the most challenging task for planters as it was also evident in case of rice cultivars (Anonymous, 2005). Most of the planters used the traditional pest management methods which is the regular spray program based on schedules rather than the presence of insect pests on the tea fields. These chemicals kill useful insects which eradicate pests in crops. However, tea may lose its quantity and quality when this plantation is attacked by different insect pests. Therefore, it is a top priority to find effective methods to reduce the level of their infestation in the field condition. The inventory of the insect pests from the tea growing area of Darjeeling foothills, terai and the dooars would provide the base line for developing future control and integrated pest management strategies. A proper identification, monitoring, forecasting would enable the planters, researchers and agro-advisory personnel to take decisions. In a similar study, Carino et al (1979) also suggested the several sampling techniques and devices for pest management decision making. Assessing the density of the tea pest population in fields is very important for pest forecasting decisions. Sticky traps are widely used to trap the insect pests. The trapped insects are brought to the laboratory for counting and identify manually. Usually, technicians identify and segregate the insects manually according to their species and count the major pests separately. The resulting counts are used to estimate the pest density in the tea fields. However, multiple site and frequent counting of major tea pests is time consuming and tedious for a planters. This can lead to low count accuracy and delays in obtaining accurate counts that can lead to poor decisions on rice pest management. Due to the rapid development of digital technology, there is an opportunity for image processing technology to be used in the field of tea research which could help the researcher to solve a complex problem. Image analysis provides a realistic opportunity for the automation of insect pest detection (Miranda et al., 2014). This study extends the implementation of image processing techniques to estimate pest densities in tea fields by establishing an automated detection system.

Through this system, planters can easily count the pests from the collected specimens, and right pests' management can be applied to increase both the quantity and quality of tea production. Using the automated system, technicians can make the monitoring process easier. Tea infestation may be easily detected and monitored with the use of a camera.

MATERIALS AND METHODS

A. Acquisition of Image

The experiments on pest detection were carried out in the nearby tea fields. We setup a network of wireless cameras (protected against water projection and direct sun light) together with the sticky traps to capture the insect pests. The cameras used are Wireless Internet Home Monitoring Camera which can capture 10 frames per seconds at 8 megapixel resolution. The captured images were processed using a local machine equipped with Intel i3 processor and 4 GB RAM.

B. Pre-processing Image

Image pre-processing creates an enhanced image that is more useful in processing the still image. In RGB color model, each color appears in its primary spectral components of red, green, and blue. The color of a pixel is made up of three components; red, green, and blue (RGB), described by their corresponding intensities. RGB color image require large space to store and consume much time to process. In image processing it needs to process the three different channels so it consumes large time. In this study, grayscale image is enough for the method so that to convert the RGB image into grayscale image with the following formula:

$$I(x, y) = 0.2989\times R + 0.5870\times G + 0.1140\times B \qquad (1)$$

C. Detection of Pests in the Image

The detection mechanism used to detect the insect pests in the image is simple and yet efficient. We compared the image pixel values of the successive captured images from the camera. Two images are used in detecting the difference. The first image served as the reference image that represents the reference pixel values for comparison purposes, while the second image served as the input image. The two images were compared to each other and the differences in pixel values were determined. If the inputted image pixel values are not equal to the reference image pixel values, the inputted image pixel will be saved as the output image pixel. If the pixel value of the input image is equal to the reference image then the background will be white (pixel value is 150). After determining the difference of the reference and input image, the input image will now be used as the reference image and the output image will be the extract and served as the input on the next phase. To determine the difference of the reference and input image, the following equation will be used:

$$O_{RI}\,(x, y) = \begin{cases} 150, & if \quad R\,(x, y) = I\,(x, y) \\ I\,(x, y), & if \quad R\,(x, y) \neq I\,(x, y) \end{cases} \qquad (2)$$

where I (x, y) is the input image and R (x, y) in the reference image in coordinate (x, y).
To demonstrate the difference between the reference R(x, y) and input image I(x, y), assume that we have two 4x4 grayscale images. The two images are represented in the following matrices:

$$R\,(x, y) = \begin{bmatrix} 120 & 120 & 120 & 120 \\ 120 & 120 & 120 & 120 \\ 120 & 120 & 120 & 120 \\ 120 & 120 & 120 & 120 \end{bmatrix}$$

$$I\,(x, y) = \begin{bmatrix} 120 & 120 & 120 & 120 \\ 120 & 20 & 11 & 120 \\ 120 & 14 & 13 & 120 \\ 120 & 120 & 120 & 120 \end{bmatrix}$$

$$O\,(x, y) = \begin{bmatrix} 150 & 150 & 150 & 150 \\ 150 & 20 & 11 & 150 \\ 150 & 14 & 13 & 150 \\ 150 & 150 & 150 & 150 \end{bmatrix}$$

where the O(x, y) is the output image in coordinate (x, y).

D. Filtering of the Image

Filtering is a process of cleaning up the appearance of the image from noise caused by different lighting conditions. Digital image processing required filtering to yield a usable and attractive end result. There are different techniques available and the best options depend on the image and how it will be used. In this study I have use median filter. Median filter looks at its nearby neighbor's pixel values to decide whether or not it is representative of its surrounding pixels and replaces with the median of those values.

E. Extraction of the Detected Pests

This phase is the extraction of the detected insect pest from the image. The output image which was obtained at the end of the previous phase was used in this phase. The image pixel values of the output image will be scanned both horizontally and vertically to determine the coordinates of each insect in the image. The width and height of the extracted image was determined by using its starting and ending coordinates. Once the start and end coordinates of the objects are, the width and height of the matrix as defined by those coordinates will take note and the matrix will be saved.

RESULTS

The tea pest detection and extraction system was tested in the experimental plots of nearby tea gardens of Darjeeling foothills and adjoining plains. Each area has 100x100 meters wide. The specimens were collected on the sticky traps that were captured by the 4 wireless cameras installed in the field. The cameras were used to observe the sticky traps which capture a still image every 2 minute. These images were used both in the development and system testing. The proposed pest detection system based on image processing techniques was tested in seven consecutive days in the tea field and was found efficient. The result is shown on Table I.

TABLE I: THE DETECTED IMAGES OF DIFFERENT INSECT PESTS IN SEVEN CONSECUTIVE DAYS

	Camera 1	Camera 2	Camera 3	Camera 4	Total
Day 1	**20**	**23**	**24**	**18**	**85**
Day 2	**26**	**21**	**12**	**15**	**74**
Day 3	**23**	**16**	**21**	**12**	**72**
Day 4	**21**	**29**	**14**	**17**	**81**
Day 5	**18**	**27**	**21**	**13**	**79**
Day 6	**11**	**24**	**22**	**20**	**77**
Day 7	**15**	**29**	**27**	**12**	**83**

CONCLUSION

An automatic detection and extraction system for the tea pests of Darjeeling foothills areas was presented and different image processing techniques were used to detect and extract the pests in the captured image. Several attempts have also been made to build automatic insect identification systems based on image analysis as showed by the Samanta and Ghosh (2012) for eight major insect pests from tea gardens of North Bengal. The presented system is simple and yet efficient. The uses of background modeling to detect the presence of insect pests in the captured image, and a median filter were used to remove the noise produced by different lighting conditions. The mechanism used to extract the detected objects from the image is simple, the image was scanned both horizontally and vertically to determine each coordinates and save the object image. A similar type of neural network based identification system for pecan weevil was also observed by Al-Saqer (2012). To make the monitoring data available developing an online pest monitoring-reporting system would be helpful to end users. Using this system databases, different tea plantation authorities of Darjeeling foothills and adjoining plains could share and exchange the pest data from different locations. This system would also ensure uniform data collection, availability and associated warning from different plantations. The data will be stored at a centralized location and immediate remedial measures could be suggested by the expert through satellite conferences, counseling and online discussion. The data base could be shared with other agencies such as different tea research organizations, central government agencies and over a period of time the same data could be used for preparation of pest calendar and forecasting system which may usher a non-conventional pest management practices using information technology as a component of IPM.

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