A DIGITAL IMAGING BASED AUTOMATED COUNTING SYSTEM FOR COCONUT MITES *(ACERIA GUERRERONIS KIEFER)*

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Introduction and Background

In Sri Lanka Coconut is considered to be one of the key plantation crops in Sri Lanka However, in the recent past, various quantifications have been reported by cultivators about the economic loss due to coconut mite infestation. As a result of the mites attack, the nut can be seriously scarred and reduced in size. The mites are small in size, with the largest stage around 250μm in length, but they often build up extremely large and dense populations. It spreads in many tropical countries where coconuts grow in abundance.

Studies towards controlling the mite infestation required estimation of mite population in nut samples. Direct counting of the total number of mites is difficult due to the large number of mites present on a single nut and also they are microscopic in size. The methods developed by CRI to estimate the total population on a nut is, by washing the population in a nut using a detergent solution and counting the number of mites in a small sample of the wash by viewing through a microscope. But this process requires the services of an experienced observer to make a fair judgment in cases where unclear mites appear in the field of view. However the whole operation is undoubtedly a tedious and time consuming task and it is often an arduous task to get a precise and accurate result for the mite count for all types of samples.

This paper discuss an alternative solution, with the possibility of supporting the task of the human observer by automating at least the more clearly identifiable cases where direct human intervention is not required.

As an attempt a system had developed (Gamage, 2001) and there acquired colour image was converted to a grayscale image first was enhanced by histogram equalization in order to improve the visual appearance of the image. Then the peaks in the image histogram are widened, while the valleys are compressed. Even though the resulting image was of better contrast than the original, the image had non uniform illumination. The objects were separated from the background in this situation by utilizing an adaptive threshold. Next, the features of the image were extracted by conditional morphological operators. It enhanced the gray scale image further. Finally the number of objects in the image was found by a region labeling algorithm which assigns a unique name or number to all pixels that belong to the same connected component of the image. As a result individual components can be extracted from the image programmatically and therefore are available for further processing and analysis.

Methodology

The digital images of the mites were acquired through a microscope using a commercially available digital camera. Several digital image processing techniques were carried out to pre-process the microscopic images and to identify each mite separately for counting. The acquired RGB image (Figure1:(a)) was converted to a grayscale image (Figure1:(b)). In this project the intensity range of grayscale images was rescaled in an abstract way as a range from 0 and 1, with any fractional values in between. The accuracy provided by this format was barely sufficient to avoid visible banding artifacts, but very convenient for programming.

The peak intensity points of the grayscale image were identified by a contrast enhancement. A clear identification of the peak intensity points helped to obtain better results of segmentation since the peaks acted as the starting points for the watershed segmentation which was later applied to segment the mites. A combination of A combination of top-hat transformation and bottom-hat transformation was used here to enhance the contrast of the image in the task of segmentation. It can be seen in that the top-hat image contains the 'peaks' (Figure1:(c)) of objects that fit the structuring element and the bottom-hat image shows the gaps between the objects of interest (Figure1: (d)). To maximize the contrast between the objects and the gaps that separate them from each other, the top-hat transformed image was added to the original image and the bottom-hat transformed image was subtracted from the resulting image. Thus, the enhanced image (Figure1:(e)) is obtained by '(original image+top-hat transformation) - bottom-hat transformation'.

It can be seen, some of the mites are obscured by a bright region on their body. By complementing the enhanced image our objects of interest were converted from intensity peaks to intensity valleys. The output image was of the same type (Figure1: (f)). In the resulting grayscale image, the intensity levels below a user defined value were thresholded to a lower level. The new image was superimposed with the complemented image. The location rather than the size of the regions in image is important. The resulting image was modified to contain only the valleys thus detected (Figure1: (g)).

Experimental Results

The system was tested with few sample pictures received form the CRI and the following results were obtained. Table 1 shows the performance of the developed system in providing an automated count close to what is obtained by manual counting. It is planned to carry out field trials in collaboration with the CRI in future.

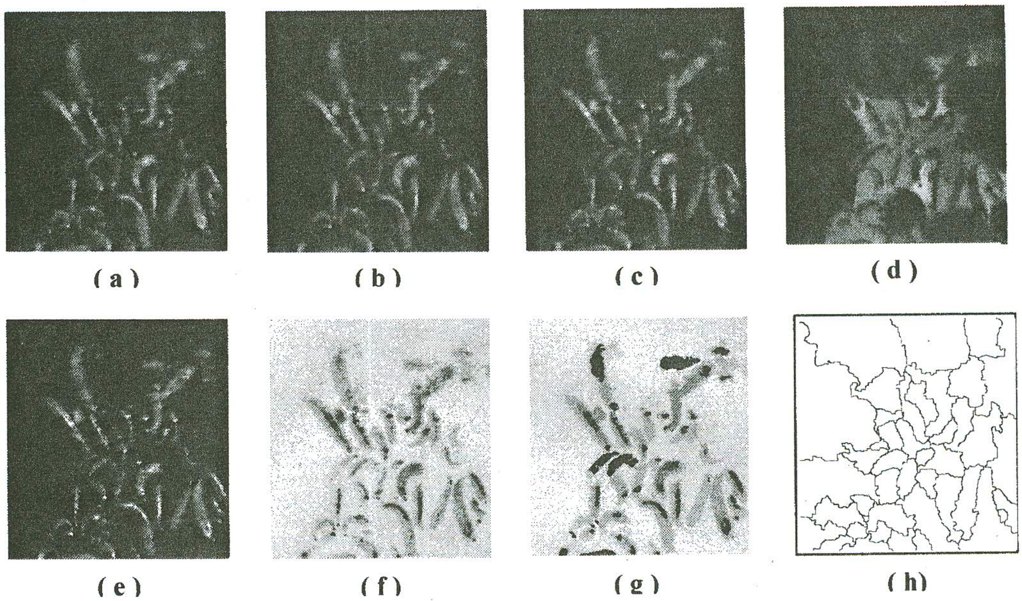

Figure 1: (a) Original RGB image (b) Grayscale image obtained by the acquired color image (c) Top-hat transformation (d) Bottom-hat transformation (e) Enhanced image using Top-hat and bottom-hat transformation functions (f) Complement of the enhanced image (g) Imposed image after the thresholded image imposed to the complemented image (h) Regions detected by the watershed transformation.

In order to handle a wider range of images with above attributes, the system was designed and developed to function with the operator's feedback also, instead of being fully autonomous in processing images. In places where the system finds it difficult to segment the mites clearly due to the quality of the image or the obscure orientation of the mites, the operator was given an opportunity through the user interface, to improve the accuracy of classification by adjusting the processing parameters based on operator's judgment.

Table1. Comparison of mite counts

System Count	**29**	**27**	**47**	**32**	**11**
Manual Count	**31**	**28**	**46**	**35**	**11**

Conclusion

The developed image processing system showed its ability to perform automatic counting of mites in the images presented to it. It could be seen that the new software provides a count which closely matches that of the manual count.

References

Gamage, C.K. Counting Coconut Mites in Digital images, 2004, M.Sc. Thesis, PGIS, University of Peradeniya, Sri Lanka.