Counting Insects Using Image Proccessing Approach

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Abstract— **Insects cause devastating damages to humans and environment. They are vectors for infectious diseases, they feed on almost all agricultural crops, and they attack various sorts of food in storage facilities. Insect monitoring and early detection plays a very important role for efficient insect-pest-management program. Classical methods such as sticky traps and pesticide negatively affect the environment and beneficial insects and lead to ecological damage. We have designed a computerized system to monitor insects and record their activity in different environments and through a defined time frame. We implemented the connected component algorithm to record insects' count then generate line graphs and scatter plots. The output of graphical representation shows insects activity within a defined time interval.**

Keywords- Insect monitoring; connected components algorithm

I. INTRODUCTION

Insects are the most diverse species of animals living on earth. They can be found in all habitats like jungles, deserts, and also in highly harsh environments such as pools of crude petroleum (Imms, 1964). Insect pests inflict damage to humans, farm animals and crops. Insect pests have been defined by Williams (1947) as any insect in the wrong place. Depending on the structure of the ecosystem in a given area and man's view point, a certain insect might or might not be considered a pest. Some insects can constitute a major threat to entire countries or a group of nations. One prominent example is the tsetse fly that puts about 100 million people and 60 million head of cattle at risk in sub-Saharan Africa due to the transmission of Trypanosomiasis (ICIPE,1997).

Pest monitoring and detection is a cornerstone in most pest management programs. Early detection and intervention in any insect outbreak would save resources and reduce the potential damage for crops and environment. There are several methods for insect monitoring, part is also used as control method as well; listed two main methods that are used for both monitoring and control of pests; Physically based methods: such as visual (yellow or blue colored) sticky traps. They are commonly used for both monitoring and control of many insect pests especially those which are attracted to a specific color. Night active insects are controlled by light traps. Chemically based traps like sticky traps with pheromonal additives and attractants. Phermonal traps are usually targeting males' insects and lead to the decrease in the insect population by limiting breeding. Despite the fact that physical and chemical traps are useful to be used in many circumstances, they still have some unavoidable disadvantages including;

- Could affect or kill beneficial insects like bees and natural predators
- They are affected at the long term by weather so they lose part or all of their efficiency by losing color or the ability to be sticky.
- Monitoring and detection by human resulted in high degree of error.
- Classical monitoring is time consuming and labor intensive.

Based on the previous background, a more accurate and reliable system for monitoring insects' activity and behavior is justified. The objective of this study is to establish a fully computerized system that overcome traditional and classical methods of monitoring and to be environmentally and user friendly.

II. MATERIALS AND METHODS:

The hardware setting of the system includes a simple webcam, a computer with operating system like Windows® xp or above, a connection cable between the camera and the computer.

The software was programmed by VB.Net, Microsoft Access 2007 and used EMGU library.

The algorithm

connected-components algorithm Was used mainly in the construction of this system The connected-components algorithm is able to identify regions in an image.

This might be useful when finding significant edges or blobs of similar appearance in an image.

Connected component labeling works by scanning an image, pixel-by-pixel (from top to bottom and left to right) in order to identify connected pixel regions, i.e. regions of adjacent pixels which share the same set of intensity values V (For a binary image V = 1; however, in a graylevel image V will take on a range of values, for example: V = 51; 52; 53; ….; 77; 78; 79; 80)

Connected component labeling works on binary or graylevel images and different measures of connectivity are possible. However, for the following we assume binary input images and 8-connectivity. The connected components labeling operator scans the image by moving along a row until it comes to a point p (where p denotes the pixel to be labeled at any stage in the scanning process) for which V = 1. When this is true, it examines the four neighbors of p which have already been encountered in the scan (i.e. the neighbors (i) to the left of p, (ii) above it, and (iii and iv) the two upper diagonal terms). Based on this information, the labeling of p occurs as follows:

- If all four neighbors are 0, assign a new label to p, else
- if only one neighbor has V = 1, assign its label to p, else
- if one or more of the neighbors have V = 1, assign one of the labels to p

and make a note of the equivalences.

After completing the scan, the equivalent label pairs are sorted into equivalence classes and a unique label is assigned to each class. As a final step, a second scan is made through the image, during which each label is replaced by the label assigned to its equivalence classes. For display, the labels might be different graylevels or colors.

The system was tested in indoor environment by using a blank reference frame as a background and dark-colored insects (ants). The webcam was placed 40 cm away from the reference frame. Monitoring activity starts with taking a reference (blank) shot before insects are introduced. The camera then takes a shot (frame) every time period that is determined previously. The next step involves photo discoloring into a black-white image and the number of black objects is counted using connected component algorithm Finally, each image is compared with the reference frame to estimate insect number. Counts are transferred into a database for further processing where a graphical representation is generated. The user can visualize results as a line graph or scatter plots. Accumulative graph and pie chart can be also visualized as an output from the system.

The interface of the system was designed to be as friendly as possible and easy to understand and follow. After the program is launches, the user can either choose to start a new test or retrieve old test and data (Figure 1). The next screen gives the user a possibility to choose the webcam in function (Figure 2). The last screen is then showing progress in time (Figure 3).

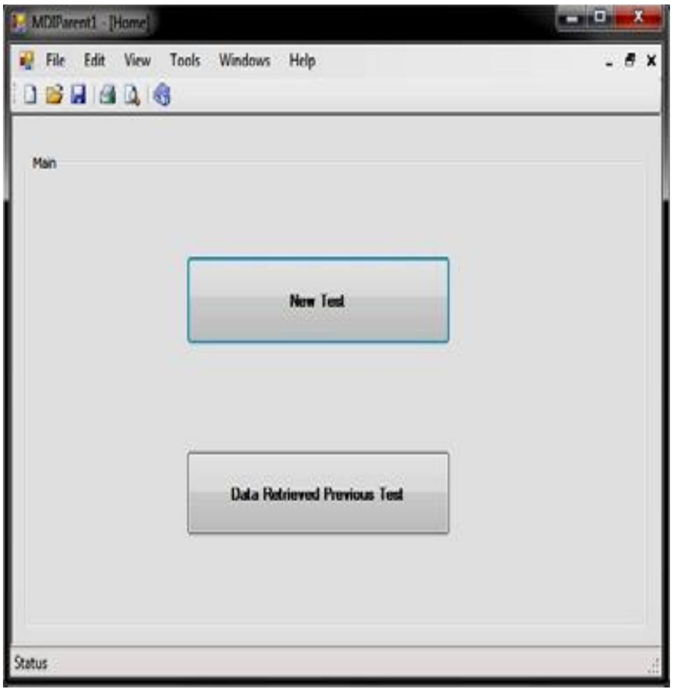

Figure 1. The interface of the software. It is designed to be user friendly and easy to follow. The user can choose either to start a new test or retrieve old data.

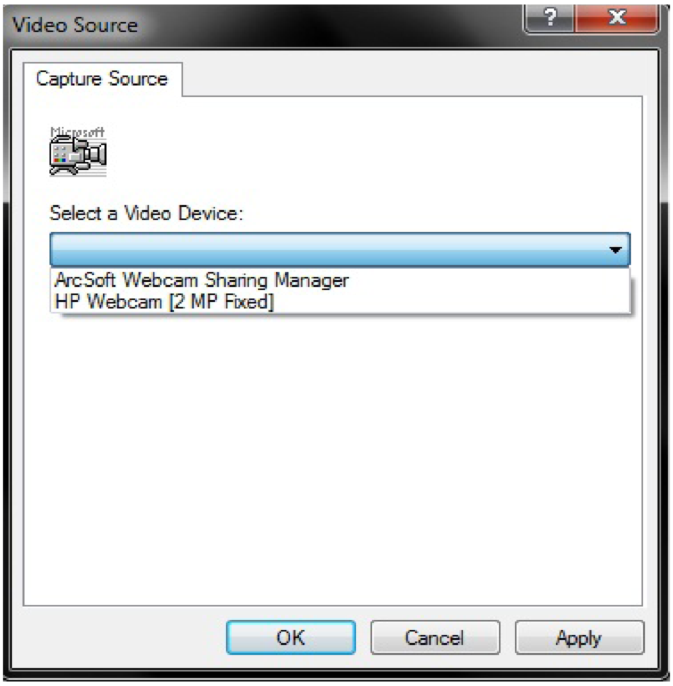

Figure 2. Video source choice. Here the user would decide which camera is functioning for the test.

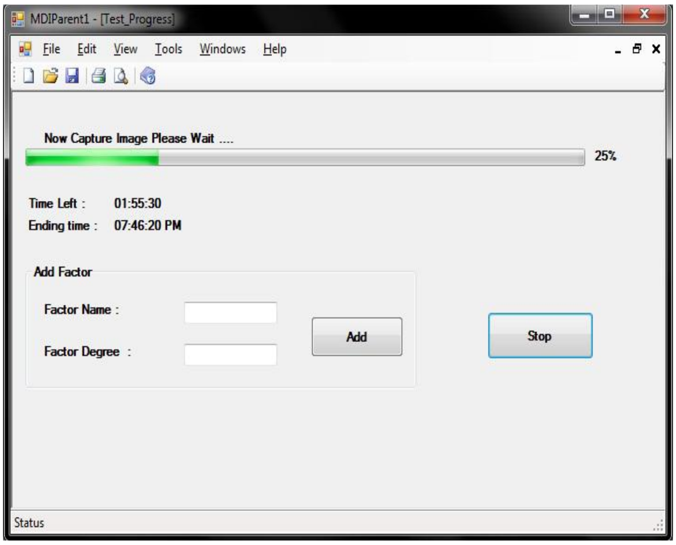

Figure 3. The above green bar indicates time in progress and the fields below are used mainly if the user would like to test the result after manipulating certain factor,

III. RESULTS:

The system worked successfully with the defined settings. The primary shot, discolored shot and counts are shown in

The counts were successfully transferred into the database and the output curves are shown in figure 5.

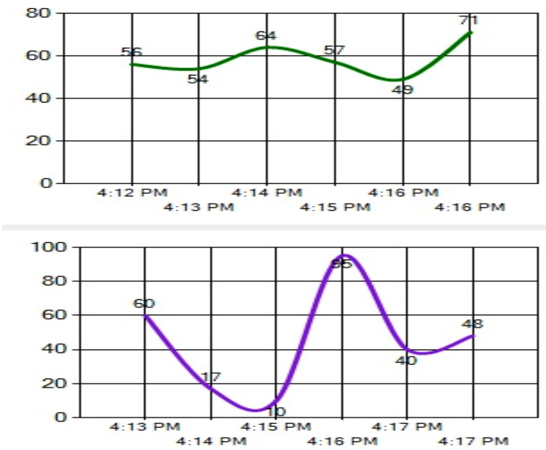

Figure 5. Two line graphs showing the activity (movement) of insects in two areas in a specified time interval. The above graph reflects less activity than the graph below.

A cumulative graph (figure 6) and pie chart (figure 7) were generated showing accumulative insect activity in four different webcams.

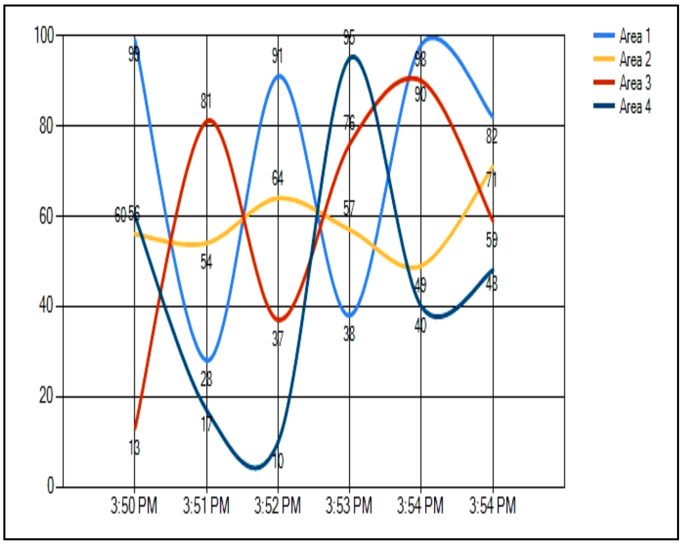

Figure 6. A cumulative line graph of four cameras reflecting insects' activity within four minutes time interval.

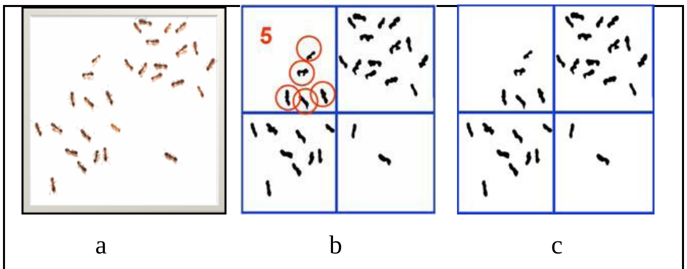

Figure 4. a) The primary image which was taken by the webcam, b) the image after the discoloring process, c) the number of insects that were counted.

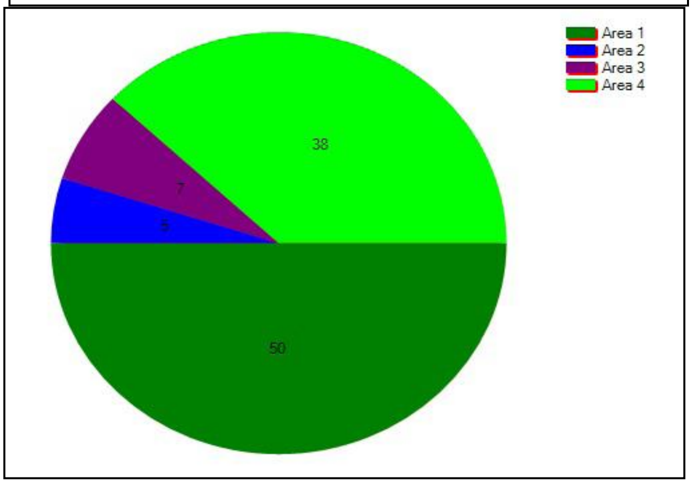

Figure 7. A pie chart showing percentage distribution of insects' motility within four minutes time interval..

IV. DISCUSSION AND CONCLUSIONS:

Our system is considered affordable as it costs only the price for the webcam and the software. The user interface and the software are friendly and easy to follow, they are understandable by normal users. The main advantages of our system are (a) it is environmentally friendly since it is not based on application of chemicals or pesticides. (b) it is durable and less affected by weathering. (c) harmless to beneficial insects since it does not affect natural enemies or bees. (d) high degree of accuracy at least when tried under controlled environments.

For future enhancements, the system can recognize insects according to their size, color and sex. For monitoring of large areas, wireless cameras can be used to overcome the problem of cable connectivity.

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