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A Review of Literature on Application of Image Processing for Identification of Agricultural Pests on Various Crops

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Abstract*— Plant pest identification and detection is vital for food security, quality of life and a stable agricultural economy. Various different pests including whiteflies, thrips, aphids, etc affect agricultural crops leading to decrease in production of yield. If proper identification of these pests is done then farmers can take preventive as well as control measure such as by spraying pesticides leading increase in production. To achieve this lot of research was done for pest identification and detection in greenhouse environment and in real field. However each approach has its own limitation like one of the methodology was to identify only whitefly insect in greenhouse environments while other methodology was able to identify aphids, thrips, and whitefly insects. This paper presents the survey about various approach used by scientist for identification and detection of agricultural pests which occur on crops.

***Index Terms*— pest, identification, whitefly, sticky traps.**

I. INTRODUCTION

India is an agricultural country wherein most of the population depends on agriculture and agriculture is one of the major domains which decides economy of the nation. The quality & quantity of the agricultural production is affected by environmental parameters like rain, temperature & other weather parameters which are beyond control of human beings. Another major biological parameter which affects productivity of the crop is the pests, disease where human beings can have control to improve the productivity of crop[10] Agriculture is one of most important sources for human sustenance on earth. Not only does it provides the much necessary food for human existence and consumption but also plays a major vital role in the economy of the country. [1]

Enormous agricultural yield is lost every year, due to rapid infestation by pests and insects. Approximately 18% of crop yield is lost due to pest attacks every year which is valued around 90,000 million rupees. Several millions of dollars are spent worldwide for the safety of crops, agricultural produce and good, healthy yield. In the recent past, several approaches based on automation and image processing has come to light to address this issue. Conventionally Manual pest monitoring techniques, sticky traps, black light traps are being utilized for pest monitoring. Manual pest monitoring techniques are time consuming and subjective to the availability of a human expert to detect the same. [1]

Fig. 1. Whitefly lying eggs

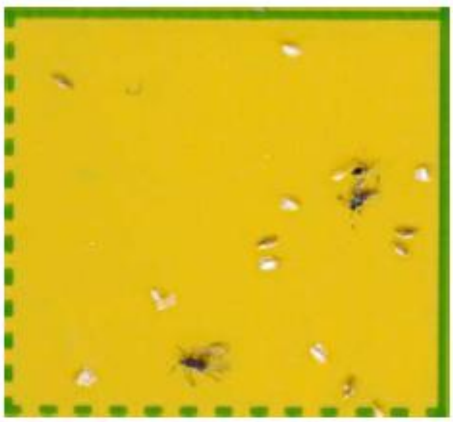

Fig 2. Whitefly pests on sticky trap.

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A lot of research is being carried out worldwide to identify scientific methodologies for early detection/identification of these bioagressors.

II. RELATED WORK

A. Paul Boissard, Vincent Martin, Sabin Moisan

Their goal was early detection of bioagressors. They presented a strategy based on advances in automatic interpretation of images applied to leaves of roses scanned in situ. They proposed an cognitive vision system that combines image processing, learning and knowledge-based techniques. Their system was illustrated with automatic detection and counting of a white fly (Trialeurode Vaporariorum West-wood) at mature stage.[6] They had compared their approach with manual methods and their results showed that automatic processing was reliable. They only detect mature stage of white fly and count the number of flies on single leaflet.

Fig 3. White flies on rose leaf

Their system has to analyze raw images and to label interesting regions that correspond to objects of interest (e.g., insects) a software system must take into account both kinds of knowledge. To separate the different types of knowledge and the different reasoning strategies, they proposed architecture based on specialized modules. It consists of two knowledge-based systems (KBS), a set of image processing (IP) algorithms, and an initial learning module, a training image sub-set. This preliminary stage was used to complement the knowledge necessary to run the two following KBSs. The classification KBS aims at selecting interesting regions in images. It retains only the regions corresponding to target insects and returns their number to the user. The supervision KBS was used to monitor the execution of image processing requests. It selects and plans the best programs with the best parameter values for each image. From raw images provided by the end-user, the goal was to extract numerical values needed by the classification KBS. The role of the classification system was to recognize and to count white flies on an image. They used 180 images as test dataset .among this images they tested 162 images and each image having 0 to 5 whitefly pest. They calculate false negative rate (FNR) and false positive rate (FPR) for test images with no whiteflies (class 1), at least one white fly (class 2) and for whole test set. Their future scope was to detect other white fly stages (eggs, larvae) and other bio-aggressors or plant disease. [6]

B. Jongman Cho ,Junghyeon choi

They extend implementation of the image processing algorithms and techniques to detect pests in controlled environment like greenhouse. Automatic identification of the selected pest in greenhouse such as whiteflies, aphids, and thrips, was carried out on the specimens collected on yellow sticky traps. In figure number 2 ,it is seen that on sticky traps white fly pest as well as other pest is exist. Three kinds of typical features including size, morphological feature (shape of boundary), and color components were considered and investigated to identify the three kinds of adult insects, whiteflies, aphids and thrips. In their proposed method they firsts identify Aphids after they go for other two insects. Aphids were easy to discriminate because they have small variation in color information and the body size was substantially different from other species. [9] So, aphids were identified and extracted first and the other two insects were identified later to decrease classification error.

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Aphids were easy to discriminate because they have small variation in color information and the body size was substantially different from other species. They used YUV color image model for extracting more accurate boundary of the object which was placed in similar background color. The intermediate image which has red (*R*), green (*G*), and blue (*B*) color components was converted into YUV format. The next processing procedures were segmentation and labeling which was the same as those for aphid identification. If the size, i.e. the number of pixels of an object was in the predetermined range, the object was selected as a candidate of a whitefly or thrips respectively. Finally, the selected aphids, whiteflies, and thrips were counted and the number of each species was reported. However color components of sticky trap used in their study were similar to those of thrips, which caused identification error. In addition, the green colored grid marks printed on the sticky trap also caused identification error.[9]

C. Vincent Martin, Sabine Moisan

They promote early pest detection in green houses based on video analysis. They captured video of sticky traps and after that they process video to detect the pests which are appearing on the sticky traps. The research was done in controlled environment like greenhouse their goal was to define a decision support system which handles an video camera data. They implemented algorithms for detection of only two bioagressors name as white flies and aphids. The system was able to detect low infestation stages by detecting eggs of white flies thus analyzing behavior of white flies. In figure number 1 it is clear seen that white fly pest lying its egg which is used as input to a DIViNe1 system. [2]

They set up a first experiment with a network of five wireless cameras in a rose greenhouse. The position, number, and nature of video cameras are critical to obtain an optimized video sampling in terms of cost/accuracy. In their experiment, choose to position the video cameras uniformly in the horizontal plane in order to optimize the horizontal sampling in terms of canopy area covering. The video cameras currently observed sticky traps in order to detect flying insects. In a second time, they planned to focus other video cameras directly on plant organs as recommended by agronomic expertise, e.g. on growing stems for early detection of mature white flies. their system, named DIViNe1, was composed of several modules. First, to allow a tractable data rate, an intelligent acquisition process records images only when insect motion has been detected. Then, adaptive programs analyze visual data extracted from images (color, texture, shape, and size) to detect regions that may correspond to insects in different contexts. Classification algorithms select interesting regions, retaining only the ones corresponding to target insects and count them. Finally, they intended to use scenario recognition techniques to analyze insect behaviors such as egg laying or intra-guild predation. [2]

D. Sushma R. Huddar, Swama Gowni , Keerthana K, Vasanthi S and Sudhir Rao Rupanagudi

They described a unique methodology to automatically detect pests on plants. They used whitefly pest for their research. They proposed pest detection system including four steps name as color conversion, segmentation, reduction in noise and counting whiteflies. In color conversion, RGB image was converted into YCBCR. Segmentation was performed with the help of RDI algorithm which give better results than Gaussian mixture models and watershed segmentation. Noise such as dusts, water droplets was removed with the help of erosion algorithm and image enhancement was performed using dilation operation. Moore neighbor tracing and Jacob's stopping criterion was used for counting whiteflies on each affected leaf. A distinct algorithm name as relative difference in pixel intensities (RDI) was proposed for detecting pest named as white fly affecting various leaves. The algorithm not only works for greenhouse based crops but also agricultural based crops as well. But the problem with algorithm is that it is not applicable for detecting other major pests. The algorithm was tested over 100 images of white fly pest with an accuracy of 96%. [1]

E. Yan Li Chunlei Xia Jangmyung Lee

They proposed a new method of pest detection and positioning based on binocular stereo to get the location information of pest, which was used for guiding the robot to spray the pesticides automatically. The production of agricultural cultivation in greenhouse requires of big quantities of pesticides for pest control. Pesticides application was a major component of plant production costs in greenhouse, and the excess in their applications have a great negative impact on the environment. A pesticide application was ideal if the spraying coverage was presented as evenly distributed over the whole plant canopy and, if the product application was correctly adjusted for minimizing the losses towards the soil or the environment. Color conversion from RGB to HSV was taken place .further image segmentation and area based matching was perform. The difference of color features between pest

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and plant leaves was extracted by the image segmentation to identify pest. According to the results of image segmentation and binocular stereo vision technique, the 3D position of the pest has been obtained. In the process of position locating, centroid matching technique was adopted to displace the common object-matching. The formula based on binocular stereo vision to measure distance is revised, additionally.[7]

F. Vincent Martin, Sabine Moisan, Bruno Paris, and Olivier Nicolas

They set up a first experiment with a network of five wireless cameras (protected against water projection and direct sun) in the greenhouse. The AXIS 207MW video cameras they provided a high image resolution (1280×1024 pixels) at 10 frames per second. Video acquisition allows a continuous survey and detection during daylight which favors rapid protection decisions. The positions, number, and nature of video cameras were critical to obtain an optimized video sampling in terms of cost/accuracy. In their experiment, they choose position the video cameras uniformly in the horizontal plane in order to optimize the horizontal sampling in terms of canopy area covering. [15]
To allow a tractable data flow on the network, they proposed an intelligent acquisition process that records images only when an insect motion was detected. At first, the video cameras were observed sticky traps in order to detect flying insects. In a second time, they intended to locate other video cameras directly on plant organs as recommended by agronomic expertise, e.g. on growing stems for early detection of mature white flies. The acquired data were then processed: they used video analysis algorithms combined with a priori knowledge about the visual appearance (e.g., shape, size, color) of insects to detect. The first objective was to detect and track bioagressors. They were developing adaptive vision methods at different levels (acquisition, detection, and tracking) to provide robust results: segmentation and classification should be able to cope with illumination changes during daytime and tracking algorithms should accommodate plant movements. For instance, they introduced contextual parameter tuning for adaptive image segmentation, that allows to efficiently tune algorithm parameters with respect to variations in leaf color and contrast. They intended to enforced adaptability by incremental learning techniques, e.g. to learn the visual appearance of pests.[15]

G.Thiago L. G. Souza , Eduardo S. Mapa, Kayran dos Santos and David Menotti

They presents an automatic method for classification of the main agents that cause damages to soybean leaflets, i.e., beetles and caterpillars. Acquired images were preprocessed and the contours of the damages were taken. Each contour was modeled as a complex network. Features were extracted for each damage based on the connectivity and the joint degree of the network. These features were then used to trained a SVM algorithm. they analyzed thresholds which model the network and the proposed method reports accuracy greater than 90% for damaging agent classification. Their future scope include to analyze the impact of damage classification on leaflet.[4]

H. Brendon J. Woodford , Nikola K. Kasabov and C.

Howard Wearing in paper titled "Fruit Image Analysis using Wavelets" proposed wavelet based image processing technique and neural network to develop a method of on line identification of pest damage in pip fruit in orchards. Three pests that are prevalent in orchards were selected as the candidates for this research: the leaf-roller, codling moth, and apple leaf curling midge. Fast wavelet transform with special set of Doubenchies wavelet was used to extract the important features. To retrieve the related images, the search is done in two steps. The first step matches the images by comparing the standard deviations for the three color components. In the second step, a weighted version of the Euclidean distance between the feature coefficients of an image selected in the first step and those of the querying image is calculated and the images with the smallest distances are selected and sorted as matching images to the query [13]

I. Prasad Babu & Srinivasa Rao

They proposed Back propagation neural network for recognition of leaves in . It was proved that just a back propagation network and shape of leaf image is enough to specify the species of a leaf. Prewitt edge detection and thinning algorithm is used to find leaf tokens as input to back propagation algorithm. It was reported that there is a scope for enhancement of this work which involves more experimentation's with large training sets to recognize various leaves with pest or damaged leaves due to insects or diseases and develop an expert system. [14]

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III. CONCLUSION & FUTURE SCOPE

In this paper, we give brief summary about various methods and technique which were provided by various authors for detection of agricultural pests. Various methodologies were proposed earlier for identification and detection of agriculture pests with the help of image processing. Each methodology is having its own methods as well as environments in which it applied. There are some methods which are applied to only greenhouse environments where as some of methods is able to identify only one pests name as white fly. However some authors used video based technique for identification of white fly pests which are exits on sticky traps. From survey it is conclude that there is necessity for proposing one unique method which will identify not only white fly pests as well as larvae stage of various pests. also this methods not only applied in greenhouse environments as well as real field environments. our future scope is to proposed one methodology for identification of different pests of various crops which not only detects and tells which pest has affect the crop as well as it provide the solution to prevent it or to control it. This proposed system is helpful to farmers as well as robotic vehicle system which is used for spraying pesticides automatically when any pests occur on plants.

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