



Real Time Pest Detection and Identification Using Image Processing

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Abstract: *Timely pest detection and identification in agricultural crops is essential to ensure good production. This action helps fight the pests and also reduce the use of pesticides. There exist different techniques which are used for detection and identification of bio-aggressors, the major one being image processing. Image processing involves capturing a static or dynamic image and applying various preprocessing techniques to the image to highlight and detect the object in the image or motion in case of video analysis.*

Keywords- *Image Processing, Static Image, Dynamic Image, Preprocessing, Video Analysis*

I. INTRODUCTION

Various papers have been published which explain different techniques used including image processing for detection of objects, extraction of features and identification of pests based on various parameters such as color, boundary, background color, foreground color, intensity of pixels etc. This paper includes the literature review of most of the papers that have been researched upon by the authors with the intention of getting a fair idea about the methods which are efficient and useful. The paper has been divided into 8 sections each comprising of a set of papers which have a common goal.

Section A contains all the papers which are based upon video and static image analysis that grab images and detect motions of pests to detect them.

Section B concentrates on different image processing techniques for identifying leaves which are diseased and leaves which are attacked by pests.

Section C has papers which identify different types of pests based on features such as color, boundary, size etc.

Section D consists of classification of different kinds of plants on which the experiments have been carried out including greenhouse plants, ornamental plants, cash crops etc. and the outcomes of the experiment.

The papers in section E identify pests on sticky traps and on the plant itself using techniques such as segmentation, denoising, feature extraction etc.

Section F comprises of papers that focus on object extraction and feature recognition and use MATLAB and other techniques like fuzzy rule to detect objects.

Section G illustrates construction and working of automated spraying system.

Papers in section H give results of the harmful effects of pesticides on humans as well as animals and plants based on research carried out over a long period of time.

II. LITERATURE REVIEW

A thorough research was done on several papers describing various methods adopted for pest detection and identification to familiarize with the existing methods. These papers were classified as follows:

A. Video analysis and static image analysis

For detection and identification of pests, the input can be a dynamic image i.e., a video or a static image. Ying yang et.al.[1] use video analysis to count the number of pests as well as determine if they are alive or not. Methods such as motion estimation, multiple-frame verification etc, are used.

Muraliet.al. [2] use cameras and scanners to capture still images of mono crops infested with coffee berry or aphids and the pest image is highlighted after multiple clustering of the original image taken from the mono crop plantation using various algorithms like k-means, fuzzy c-means and EM.

Ganesh et.al.[3] captured the images of the infested leaf by digital cameras and computer vision techniques have been used for automatic detection of the bio-aggressors. Image processing is done on the acquired image that undergoes object extraction, filtering (Laplace or Gaussian), segmentation and feature extraction.

Sabine et. al. [4] describe how images are captured only when there is insect movement and contextual parameter tuning has been used to provide effective segmentation of image.

B. Diseased leaves and pest ridden leaves

Health of crops is severely affected either due to a leaf disease or due to infestation by pests.

Artiet et. al. [5] describe the detection of areas on cotton plant leaves having bacterial, fungal or viral diseases. The different techniques used are fuzzy c-means clustering, Otsu segmentation, homogenization, k-means clustering techniques in hue-saturation, threshold and image clipping filtering.

Powdery mildew disease is detected on betel leaf by J.Vjaykumaret. al.[6]. Image processing is done using image processing toolbox in MATLAB. Gray scale images are obtained from RGB images. The plotted histograms help identify powdery mildew disease by calculating the frequency value of grayscale for back and front view of the leaves. The lesser the frequency values, the more chances of it being infected (generally a frequency of 0-150).

The major diseases in plants are due to infestation of the crops by pests. The inappropriate usage of insecticides not only affects the plants and soil but also damages the food chain. JayamalaKet. al. [7], give us the study of different types of plant diseases based on visually observable patterns. Image processing is used to get the shape, color, size and area of the infected portion of the leaf. The techniques used for plant diseases in the various papers are back propagation, neural network, image analysis using CLASE (Central Lab of Agricultural Expert System), Image Segmentation and Self Organization Mapping (SOM) for classifying the diseases, k-means clustering, Otsu segmentation and image clipping and thresholding.

Utkarshaet. al.[9] acquired digital images using a camera. Hue Intensity Saturation (HIS) images are obtained from RGB images. Masking of green pixels is done because they represent healthy areas on leaves and it reduces processing time. Removing masked pixels that are red, green, blue is done by giving a zero value and remaining pixels are stored in binary image. A matrix is generated with 0 and 1 values of the binary image. Back propagation algorithm of Neural networks are used for automatic detection of disease.

C. Types of pests

There are many existing methods that detect and identify different types of pests like whiteflies, aphids, thrips and borers. Whiteflies and aphids are detected on yellow sticky traps by Rupeshet. al.[10] using pan tilt camera with zoom features. The features like eccentricity, color, mean, standard deviation etc, are extracted and stored in the support vector machine (SVM) and these features are used for detecting and classifying whether the bio-aggressors are aphids or whiteflies.

Pratibhaet. al. [11] use image processing techniques to detect borers on tomato plants. The system gives the image to a borer detection algorithm. RGB to grayscale image conversion takes place here. Image undergoes segmentation to extract the target area. Morphology is done by distinguishing the border and the tomato pixels so as to remove noise. The target object is extracted which is the borer. It also gives a count of the borers in the tomato.

Chang-woo et. al. [12] used three kinds of features including size, boundary shape and color components were considered and investigated to identify the three kinds of adult insects, whiteflies, aphids, thrips and their average values for these features.

D. Plant Classification

Vincent Martinet. al.[14] detect and give an approximate count of mature whiteflies and aphids in the greenhouse crops. Yellow sticky traps were used to attract the insects. Once the insect used to get stuck on these traps, an average count of the insects were given based on which the quantity of pesticide to be sprayed on the plants was given. Early detection of the pest was not possible since the insects were detected on yellow traps and not on the plant directly. The insect behavior patterns were recognized for example, the circular egg laying pattern of the whiteflies which were helpful in the classification of the pest. Continuous surveillance of the greenhouse crops was not possible because manual work is time consuming and not efficient. Adaptive segmentation techniques were used like background modeling which gives the details on how to detect the insects in different intensities of light.

Eric et.al.[15] detect the coffee rust disease. The algorithm consists of contrast enhancement using LUT gamma correction algorithm. Secondly, the image that is enhanced is further worked on to remove the unwanted background and lastly, the image is segmented using fuzzy C mean clustering to detect the infested part of the leaf. The severity of infected leaf area is estimated by calculating the ratio of the infected pixel distributions to the normal leaf pixel distributions.

Jayme et. al. [16] give the count of whiteflies on soya bean leaves. Two main strategies for automatically counting whiteflies are used, one using sticky traps, where the count of the whiteflies is given using color transformations, but it doesn't give a count of nymphs. The other strategy where the count is given directly on the leaves by segmentation and color conversion depending on the difference intensity, counting and noise reduction based on Moore neighbor tracing and Jacob's stopping criterion and both nymphs and eggs are taken into consideration.

E. Detection of pests on the crops and sticky traps

The counts of the bio-aggressors are given from the leaves directly.

Rupeshet. al. [10] uses primitive methods like yellow sticky traps for detecting the pest. It has few drawbacks like it gives a wrong estimate on the quantity of pests because it doesn't detect the pest on the green house crop directly. Thus this paper aims for early detection and classification of pest. The methodology been suggested is image acquisition by using a pan tilt camera with zooming feature, followed by image pre-processing to enhance the image by converting it to gray scale image, resizing it and then filtering so that the image is more appealing to the human eye. The features like color, standard deviation, eccentricity, mean etc, are extracted and stored in the support vector machine (SVM) and these features are used for detecting and classifying whether the bio-aggressors are aphids or whiteflies. The input image is given to the SVM and based on the training data in the SVM, the required output is generated.

Johnyet. al.[17]make use ofWireless cameras for capturing image. Image Processing is done by converting RGB into an image which is gray scale. An input image is compared with a reference image. If the pixels in both are different, then the input pixel becomes the output image else if same then background is white. After determining the difference the input image becomes the reference and the output image becomes the extract and will be used as an input in the next phase.

C.Thulasiet. al.[18]use ZIGBEE networking and IEEE 802.15.4 MAC layer protocols. Images are processed by the computer which gives the insect count. Image Processing is done using MATLAB-image conversion i.e. converting RGB into grayscale, de-noising, edge detection and 2-d convolution. In 2-d convolution, the resultant matrix is the sum of 2 matrices minus 1.

Gauravet. al.[19]carried out image segmentation using saliency map which gives the conspicuity at every location by a scalar quantity and to help select locations. The segmented image is given to feature extraction stage which quantifies some characteristics of the target object. Discrete wavelet transform is used for this purpose whereby the main energy of the image is accumulated in sub-bands which records informationabout featuresof the image.

F. Object Extraction and Feature Recognition

Reza Oji[20] uses affine scale invariant feature transform (ASIFT) and a region merging algorithm for object recognition and detection of the boundary. ASIFT generates all the views of the images obtained by the longitude and the latitude angle and then applies the other parameters by using the SIFT algorithm.

Dr.C Naga Rajuet. al. [21] obtainedthe structural information of the imageusing the techniques like Ant-colony optimization, fuzzy logic and segmentation. When we apply ant colonyoptimization to the image, the independent agents collects the intensity value of each pixel. The pixels are highlighted to extract the structure by assigning them to particular groups according to fuzzy rule.

HuiHui Wang et.al.[22] usethresholding, color feature extraction, smoothing preprocessing,Color Clustering Distribution(CCD) layer mapping,CCD smoothing and object identification and recognition to extract the object from an image.

Bhavya R et.al.[23]compared various techniques like Prewitt's algorithm,Sobel's algorithm and Robert's algorithm. The authors have concluded that the proposed method of adding unequal weights to the background and foreground and adding the gradient to obtain final edge detection was more efficient.

Amit Thakuret. al. [24] discussed on identification of the object in the picture by using technique like grid based color moments (gbcM) by supplying the features like texture, color and shape. Feature extraction is done by techniques like i^{th} color channel at the j^{th} image pixel as P_{ij} . Data sets are fed into the SVM and the object is finally extracted.

Y.Ramadeviet. al.[25] use different edge detection techniques like Sobel, Prewitt, Roberts, Canny, Laplacian of Guassian(LoG) for image segmentation. Genetic algorithms, Expectation-Maximization (EM) algorithm and OTSU are used to demonstrate the synergy between the segmented images and object recognition. The author focus on segmentation using edge detection and the experiments are studied using MATLAB.

G. Automatic Pesticide Application

The person applying pesticides in a greenhouse are usually required to wear protective clothing and face mask to breathe filtered air. The clothing is usually uncomfortable and may be a risk to health. D. E. Roweet. al. [26] discuss on a spray system that is automated.Pesticides are applied at a specific time through mist nozzles suspended in greenhouse. The spray system minimizes pesticide exposure to the applicator and others and thus reduces potential liability.

GeYufenet. al.[27]have developed an indoor-simulation pesticide spraying system based on machine-vision. A series of experiments and studies on some problems likedata transmitting, image segmentation, decision making, signal capturing were implemented to check the feasibility and reliability of the system. Algorithm based on relative color indices was brought to light.The new one has an equally good segmentation result and greatly shortens time of segmentation. It can be extended for outdoor application.

Philip J. et.al.[28]present an engineering solution to the current human health hazards involved in spraying potentially toxic chemicals. This is gained by the construction and design of an autonomous mobilerobot for use in pest control and disease prevention applications in greenhouse. The efficiency is shown by theability to successfully navigate itself down rows of a greenhouse, while the pesticide spraying system covers the plants evenly with spray in the set dosages.

H. Effects of pesticides

Stuart H. Hurlbert et.al. [29] present the direct and toxicological effects of pesticides on the growth. Survival or reproduction of organisms may be called primary, irrespective of the ecological or physiological mechanisms of exposure. The ecosystem changes that follow and result from these primary effects are conveniently termed secondary effects. The purpose of this review is to summarize existing knowledge of these secondary effects of pesticides on aquatic ecosystems.

Tim Braunet. et. al.[30] use a novel color-based recording and evaluation technique which allows determining the spatial distribution of foliage along planar vine rows with high accuracy. The approach uses optical row tracking to construct a composite, and user trainable Bayesian color classification to segment foliage from a distinctively colored canvas carried along behind the row. The information gives insight into the seasonal growth patterns of commercial plantations. It also validates the performance of the pesticide sprayers.

J.L. Flexneret. Al.[31] gives the effects of microbial pesticides on non-target, beneficial arthropod. In general, it was found that: (1) effects from indirect mortality of natural enemies are probably more significant across all microbial types

than are direct mortalities from microbial pesticides; (2) significant levels of direct mortality of beneficial insects can be caused by bacterial and protozoan microbial pesticides; (3) no direct mortality from viruses of pests has been documented for arthropod natural enemies; (4) the direct effect of fungi on arthropod natural enemies has not been well studied and probably has been underestimated; (5) unique standard methods need to be developed for microbial assays and for expressing more exactly the dosage administered to the host or natural enemy.

III. CONCLUSION

The methods adopted by most of the papers include capturing static images or multiple video frames of the objects. It is then followed by a series of preprocessing steps like obtaining a gray scale image of the original RGB image, segmentation of the image to enhance the desired object and to mask the background. Noise removal and extraction of important features like color, size and boundary are also done. A multitude of algorithms have been used by different papers for object extraction and recognition apart from the standard steps.

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