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AUTOMATED AGRICULTURE ROBOT FOR EARLY STAGE PEST TREATMENT

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Abstract: The aftermath of the pest attack brings a huge loss to the farmers. Various pest detection methods were followed for many years and there is a need for proper implementation which leads to reduced loss and thus increased profit to the farmer. The pests are underneath the leaves, so they require various stages of detection. Early-stage identification of the pest decreases the losses and usage of pesticides. Tremendous uses of pesticides impinge soil fertility and eutrophication. Precision farming methods and techniques must be implemented. Thermal imaging gives the infrared radiation intensity of the objects. The movement of the pest can be identified through it. Drones are used to take wide ranges of images. These images are analyzed and identify the pest intensity. A proper spraying mechanism should be implemented on the land such that it sprays a required amount of pesticide to the plant. The pesticide should be sprayed at the pest area of the plant. Healthy plants are not sprayed with pesticides. Accurate measures of the number of pesticides are sprayed with the help of proper control mechanisms provided by drones; thermal imaging and ground robot-controlled spraying.

***Index Terms* - precision farming, thermal imaging, drones, controlled spraying.**

I. INTRODUCTION

AI and Robotics are taking over in the field of agriculture, Drones and Robots are playing a prominent role in transforming the conventional methods used. Increasing the yield of crops and protecting them from pest attacks by using fertilizers and pesticides has led to severe side effects on farmers and consumers. Challenges in the field vary from place to place and crop to crop .One Major Challenge is improper spraying of pesticide in the fields. We have seen two different types of spraying of these pesticides either manually or with a drone. This may lead to excess spraying of pesticides. The plant which is healthy is also sprayed with pesticides.

Our idea is to make a hybrid which sprays manually to every plant and be quick to analyze the field with drone technology. This design overcomes the flaws in spraying pesticide. The other competitors in this field don't have a wide range of functionalities. Completely relying on drones for precise spraying of pesticide can cost lot of money .Our Robot which is combined with drone reduces the cost and resolves the flaws .Making precise agriculture includes precise spraying of pesticide and fertilizers .Precise spraying reduces crop failures and health problems due to over pesticide.

Pest Spraying with Drones doesn't reach the stem and root of the plant, it gets accumulated over the leaves and sometimes won't reach the affected region. In the case of research we considered the Tomato (Lycopersicon esculentum) plant which is a small and bushy plant is our main testing case. We have classified the set into 10 most popular diseases which Tomato is affected and after the pest detection through drone camera, the intensity of pest over the field and the disease it is affected with .The farmer can choose required pesticide to spray over the field using Ground bot.

Farmers with acres of lands might take time to detect part of the field affected with pests ,by the time it is known to farmers the effect is 20-30%.Early stages of pest detection is needed to reduce the effect to less than 5%. Farming has given very good results with AI and robotics .This could pave a easier way to farmers and reduce the burden .There must be minimum difference maintained between columns of field for the Ground Bot to travel without any hassle .This model doesn't require much modifications to the field and doesn't affect the soil of cultivation land.

II. RELATED WORK

In the context of early pest identification few methodologies are introduced. Schmale et at. (2008) introduced an air sampler which is fitted on a UAV (Unmanned Aerial Vehicle) which can collect and store the air samples. The UAV runs above the agriculture farm with a speed less than 200 m.p.h collects the air samples from above the crops. The collecting of air sample methods are introduced by C.D. Kenny et at. (1951). In his paper he brought a quantitative method of collecting the samples. This type of sampling is called aerobiological sampling. It used a Petri Dish which is used to culture the micro-organisms and cells. This dish is used to store micro-organisms. The analysis of these aerobiological samples helps in early identification of pest and pest attack on crops. The UAV is also used with the multi spectral camera where the images are taken in a wide range spectrum. This helps to get the additional information about the images. [1](Lebsework Negash, Ho-Yeon Kim, and Han-Lim Choi, 2019)

Later drones are used for monitoring the agriculture fields. Drones in agriculture started appearing since1988 and the usage of drones in the fields is dramatically increasing. Different types of sensors and cameras are introduced for image acquisition. Analysing the pest disease and classifying them is also a big challenge. Many methods of analysis and classification of pests were introduced. CNN is one such method of classifying and analysing. CNN is a conventional neural network.

Multispectral cameras are introduced in the agricultural fields. These cameras consist of 4-6 bands of 10-50 nm bandwidth in visible and infrared of electromagnetic spectrum. Hyper spectral imager which is 200-2500 nm) which has two components: Snapshot Imager and Line Scanner Imager. These images are taken in the bands of the IR spectrum. The snapshot imager is fast to analyse and store because it is stored in a raster file. The speed of the drone depends on the speed of capturing the images by the camera. Line scanner is slow and complex to analyse (M Fauvel, Y Tarabalka, JA Benediktsson, 2012).

(P Boissard, V Martin, S Moisan, 2008) In this paper they especially considered greenhouses and Integrated Pest Management (IPM). They followed processes like early detection and multidisciplinary strategy. In the process of early detection, the symptoms of fungi or some other pest have to be identified and also have to observe how much time it takes for the egg to develop and to attack the plant. In greenhouses generally human experts examine the plants every week but it's not that easy for them to test every leaf, so there comes "Adapted sampling" which reduces the amount of data and speeds up the process. Computer vision is used to quantify powdery mildew, weed control and spider mite attacks .But this was not sufficient, so complemented by Artificial intelligence which has a knowledge based approach. Sampling strategy based on dimensions (called spatial sampling) and time duration (called temporal sampling). In their experimentation they considered a rose plant. Firstly, they considered adult flies so they concentrated on matured flies which are mostly observed on the stem of the rose plant. If we consider 100 samples among 1200 plants then 200 images (i.e., front and back of the leaf) to be scanned. Each color image of 3000 × 4000 pixels is recorded in PNG format corresponding to about 20megaoctets of data. The 200 scanned leaflets represent a total of 4 Giga octets of data. As to face a variety of conditions computer vision is not sufficient, a European researcher has proposed Cognitive Vision. The methodology they adapted in this is similar to that of which human biologists follow generally (like analysing raw images and to identify region that is different from features of insect gives some numerical values) and then it has to process the image processing requests and selects the best programs based on numerical values. As we know that whiteflies are semi-transparent, just following a fixed set of parameters doesn't give a proper result. So the image setting parameters have to be adapted based on the plant and pest. The person examining it also must be aware of some vocabulary related to ontology because in case of HSV values matching with some colour of part of an insect then he can specify its shape or size to differentiate it. While analysing the image there is a sequence of processes like object extraction, background subtraction etc.., to obtain the proper structure of the insect (pest).Result of their experiment :Among the 200 images, the ranges of values of corresponding numerical descriptors (e.g., size, colour and shape) have been semi-automatically learned on a subset of 20 images. The global computing time for an image of 2495 × 4056 pixels is around 35 s with a 2.33 GHz Dual Core Xeon processor. It's compared with the manual counting by human experts. Manually it takes 2 days to obtain results but by this automated system within 5 hrs result can be obtained. Only 0.17 % of leaf is covered by manual method of analysis but through this automated system 0.36% of leaf area is covered. This automated system gives rapid results .It is more useful in greenhouses .Furthermore it can be developed by using video cameras, some other sensors and also can use mechanisms like weed control and trimming of unnecessary leaves present on the plant. Automated system with cognitive vision is the system that gives rapid results that follows IPM which is suitable for greenhouses.

III. APPROACH

Detection of disease and pests is done by Deep Neural Networks, Deep Learning and Neural Networks have a number of libraries for image processing. A usual neural network has one hidden layer, whereas deep neural networks have multiple hidden layers. Convolutional Neural Networks (CNN) or ConvNets.CNN is a widely used deep learning library for processing images .After convoluting with filters the relevant features are extracted and connected to each other to make a relation. The Activation function used to activate the neural networks is ReLU(Rectified Linear Unit).

Training data includes 10 classes and 18020 training images and 50 test images. These samples of leaves we collected for analysing. The leaves are chosen in 2 types. One type which is healthy and the other type is affected by the pest.

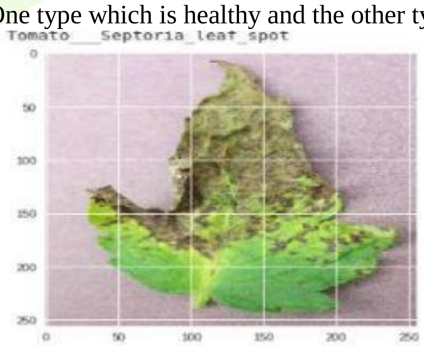

Fig.1 Affected leaf

In the above Fig.1 it shows the sample of image from the data set with graphical plot. Convolution is a process of finding the common area between the two signals, in this case the signals are images. After convoluting the image all the features are learned. This convolution helps in finding the required features and which are not required are removed. For example, the leaves have a common feature of having veins and green in color. This is not necessary, the infected part we need to extract. So by convolution we are eliminating the unwanted information..

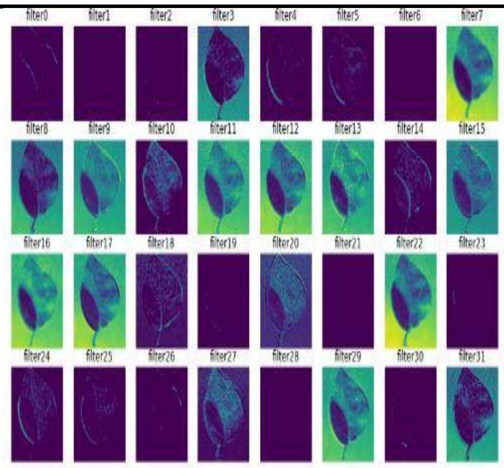

Fig.2 In the figure the filter analysis of leaf are shown

The number. Features are very similar after the first convolution layer and 31 different types of filter are applied to the input leaf and visualized using matplotlib library. After the second layer conv the features extracted visualizes as above giving analysis of learning.

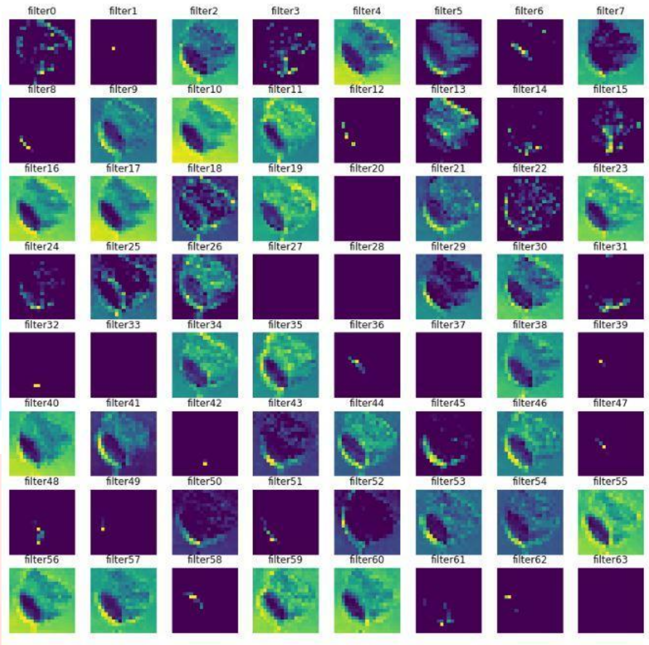

Fig.3 The third convolution

In Fig.3 after the third convolutional layer, it passes through a flatten layer to complete the feature inclusion and extraction, it makes a relation between all the layers. Tf.Keras is used to train the neural networks, while tensor flow runs in the background. The image is Pre-processed and sequential zed. In this manner every tree is scanned and images are stored and there are preprocessed. This method of analysing and classifying is faster and brings good efficiency. The model yielded accuracy of 97%. From this analysis we can bring the conclusion of the amount of pesticide that to be used.

IV. FLOWCHART

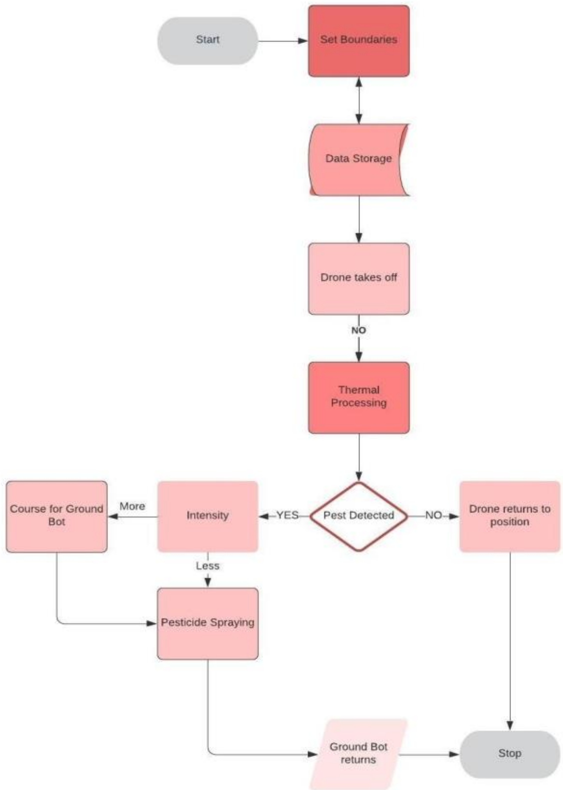

Fig.4 Flowchart for the process

The above Fig.4 illustrates the process of the model.

V. WORKING:

The drone scans the boundaries of the field and sets its boundaries. After the boundaries are set it now scans the entire field with the thermal camera. The images are taken and stored. These images analysed and mapped the hotspot of the pest. Hotspot is a place where the pest is maximum. The drone comes back to the starting position. The whole information about the amount of pest, is given to the ground bot. The thermal analysis is done, where it can know the amount of pesticide has to be sprayed. The ground bot goes to the specified location and sprays the required amount of pesticide. The ground bot also scans the pest underneath the leaves and sprays the pesticides.

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