Review of Pest Attack Prediction and Detection Methodologies

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Abstract - *The pests and diseases in the fields are the major contributors to the crop loss. In countries like India with a large population, it is necessary to get maximum outcome out of farming and that can be possible if we can control the pest attack in the fields. In this digital world, many advanced technologies are available to fight the pest attack. By using these technologies, we can predict the pest attack, determine which pest has attacked and can take the required measures in advance to reduce the loss. These technologies include machine learning, artificial intelligence, computer vision, deep learning and many more. In this paper, we will be looking at some promising methods to be implemented by the researchers to counter the pest attack in the fields.*

***Key Words*: Pest attack, Machine learning, Artificial network, Neural network, Computer vision, Expert system.**

INTRODUCTION

Since ages agriculture is an essential part of our lifestyle. But in the current scenario because of rapid increase in population the agricultural land area has been reducing as that land is converted into residential areas, but on the other hand the population is increasing at a similar pace. In addition to this climate change is also affecting the yield in the fields. Hence smart agricultural methods are required in the countries like India where there is shortage of agricultural land area.

When compared with population so "more with less" concept is followed. In any farm the biggest problem for farmers are the pests which damage the yields completely and which leads to the loss of crops and economic loss. To overcome this problem farmers, use heavy pesticides to kill the pests in the fields, these pesticides are strong chemicals and are harmful for crops as well as the people consuming it in the form of the agricultural product.

Most of the farmers use pesticides just to be safe and not on the basis of any strong evidence of the attack or just because someone in the neighboring land has used the pesticide. This leads to unnecessary use of pesticides hence affecting the crops as well as the lives of farmers. Therefore, only required amount of pesticides should be used by farmers to reduce the harmful causes of pesticides on humans and crops, but at the same time they cannot risk the damage to the plants by these pests. Agricultural pest is defined as the insects/animals feed on the plant tissues.

These pests are of different types and different plants are affected by different types of pest attacks. These pests mainly depend on the weather conditions and crops. Due to this, farmers cannot use one kind of pesticide for all the crops, and if they use the wrong pesticide for some crops it won't give effective results and will lead to economical loss and crop yield. Early detection of pest attacks or proper detection of the pest attack is necessary. In this paper, we will be having a look at some of the pest detection methods.

These methods use computer vision, machine learning or deep learning. Many methods use these technologies individually for giving the results but in recent times integrations of two or more such technologies are under study which will give more accurate results.

1.1 Automatic counting the Insects/pests in the field using the computer vision

In this approach, the number of pests on any plant are automatically counted without any human interference in the process. The insect population growth control is based on the infestation level and plant's development stage. Most of the times, this is done manually which is time consuming and hence there is growing motivation for using digital images collected directly from the field, making it possible to develop a computer vision system to identify and count different species of pest and insects from the field. For implementing the system, it is necessary to collect a large sample of dataset in the form of digital images automatically, hence unmanned aerial vehicles can be used which will have the cameras mounted on them to capture the images continuously.

In stage 1, image segmentation is done by simple linear iterative clustering superpixels method to segment the images collected as per the pest's categories. For example, the set of 10000 collected images can be divided into groups of 7 clusters to increase the accuracy and training for the deep learning model in the classification. It is trained with the three different types of approaches to increase the accuracy, they are fine tuning, Image net, transfer tuning.

In deep learning, designing the automatic counter to count the eggs (soyabean cyst) on the plants using the microscopic images. These images are trained by the convolutional neural network with data labelled to learn how to reconstruct an egg pattern converting the image size to patches of 16×16 pixels to determine if the patch contains an egg or not.

The identified eggs are then counted using the matrix labelling function. Similar method is applied in the pakchoi leaves. In this method, different stages of aphids are obtained, In this way, using binary mask over each image identifying each pixel as aphid (white) or background (black). After segmentation, they just count the number of pixels having the white components as of aphid nymph for each image.

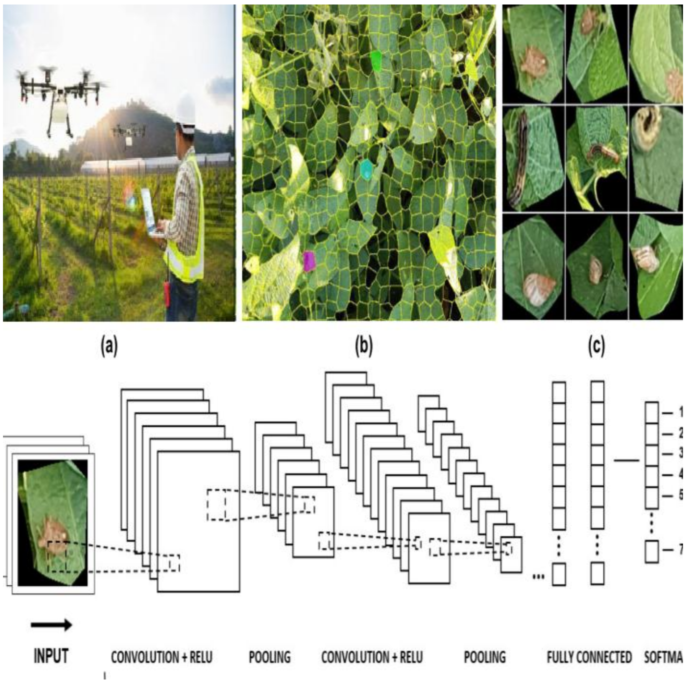

Fig1. Proposed computer vision system for calculation of pesticides in the field

1.2 Limitations

This method has improved the detection of pests way faster and accurate than the manual observation but at the same time, it has its own limitations. It fails in certain cases lesions on leaves, old aphid exoskeletons, and areas of complex lighting conditions which do not give proper results. Another limitation is labelling pixel by pixel before training. As it can have huge number of variations

2.1 Detection of pest attack using raspberry pi and weather parameters.

The main objective of this method is to use the raspberry pi and weather parameters such as temperature, humidity, leaf wetness duration. These are the parameters which lead to the growth of the pests in the field. The previous proposed work only consists of temperature and humidity but in this system, images of the plants are also used. The humidity, temperature are measured by the humidity and temperature sensor respectively installed in the field.

The motivation behind this system implementation is to give farmer the correct pest attack information and as early as possible in addition to that also suggesting them which kind of pesticides can be used and the quantity to be used so that it won't have any side effects on the plants and the farmer who is applying the pesticides. It will also protect the plant from large amount of pesticides and save farmers' expenditure on unwanted pesticides.

This system is divided into stages where in stage one, the humidity and the temperature are measured by the sensors installed. Before processing that data, the ideal temperature and humidity values are considered, then the collected values are compared with the ideal values and then it is determined if values are going beyond the threshold or not. In the stage two, if the values exceed the threshold value then leaf images are captured, which can be taken by any means i.e manually or from some automated system. Once the image is captured then it is compared with the existing image of the healthy leaf or image of the same plant taken in the previous record which can be a day before or few hours before the latest image is taken.

The difference of the image is compared with different image processing algorithms. The difference is identified between two images. In stage three, the difference between two images is identified and compared with the existing dataset available. The comparison with the existing dataset is to identify the pest attack or the disease. Then the results are displayed to user in the form of any notification from text message or any other form of platform. In all this process, the raspberry pi 3 is used for computation and the sensor used for the temperature and humidity is DHT11.

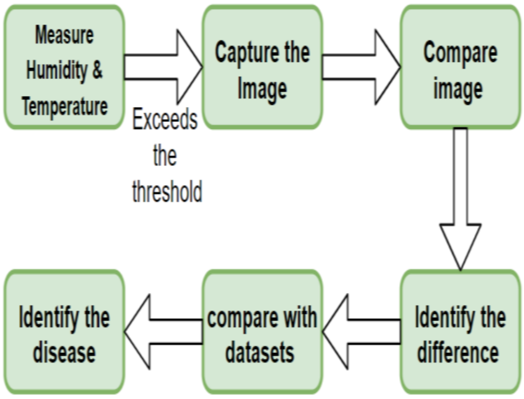

Fig 2. System block diagram for detection of pest attack using raspberry pi and other parameters

2.2 Limitations

The limitations of this approach are - the consistent image capturing is not possible, fitting number of cameras and capturing image of every leaf is very complex task.

3.1 Expert system for detection of pest attack.

This system is a rule-based system where the user will diagnose the pest attack using If-Then rules based on the knowledge representation. At first, the characteristics of the infected crop is collected. Then classification of the kind of pest or disease based on the leaf color change, deformity of the leaf, the stem color change, abnormalities in the grains. After collecting the characteristics, the knowledge representation stage is performed.

The knowledge representation model used in this method is based on the production rule using IF - THEN pattern. Each symptom has determined the weight value that was determined in the range of 0...1. This value represents the confidence value of each symptom that causes particular pests or diseases.

The pest and the disease diagnosis use a forward chaining inference. This allows the user to select the symptoms of the infected plants. The user can select the image and the textual statement of symptoms in the expert system. The system will process the user's choice and give the diagnosis result of the infected plants. The expert system can be of any type, it can be a web-based application or a mobile phone app. The validation of the expert system is constantly done by the experts from time to time to determine the accuracy of the system.

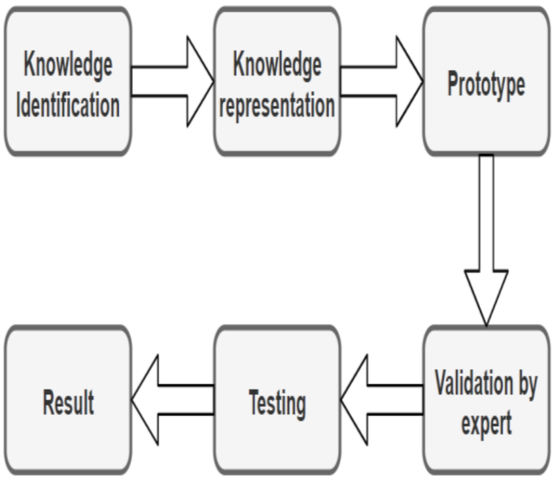

Fig 3. System block diagram for the expert system

3.2 Limitations

This system works with help of human observation, hence human interference is needed for system to proceed.

4.1 Early warning pest attack detection system.

This approach is based on using machine learning methods to determine the vulnerability of pest attack. The idea basically deals with the early warning about the pest attack in the farms so that the farmers can take effective measures and save the crops before they are completely destroyed by the pests. This method uses multiple weather parameters to determine the vulnerability of a certain pest attacks.

The weather parameters used in this approach are maximum temperature, minimum temperature, relative humidity, sunshine hours, rainfall and windspeed. All these parameters in some way affect the growth of the pest on the crops. In the stage one, the historical pest attack data is collected of the region for which we are planning to predict the pest attack. The historical data should be accurate to get the maximum accuracy. Once the historical data is collected, then the current weather conditions are collected and past week's weather data is used to predict the current situation's vulnerability to a pest attack.

For predicting the attack, various machine learning algorithms can be used to get the maximum accuracy. All the historical data should be trained using machine learning algorithms. Once, the algorithm is trained it can predict the possible pest attack.

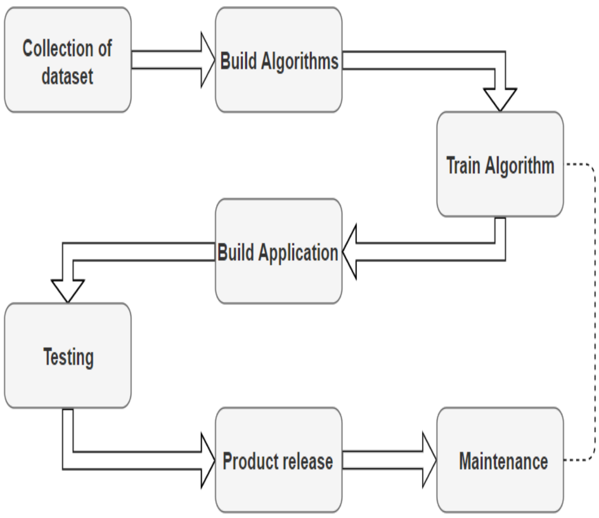

Fig 4. System block diagram for Early warning pest attack detection system

4.2 Limitations

The historical data of pest attack of any region is very difficult to find out and validate. Pest surveillance data of every pest attack have not been recorded for every location and every crop.

Hence, primary requirement of this method i.e historical pest surveillance data collection is a complex process.

CONCLUSION

In this way, we have seen some methods for pest attack management, these methods use different kind of implementations, different datasets, different approaches but at the end, they share the similar goal to reduce the pest attack in the farms. Implementation of any of these methods will help to reduce the pest attack and will help the farmers to reduce the mass usage of harmful chemical pesticides in their farms, hence preventing soil and water pollution as well. Use of such latest technologies in the field will definitely lead to the smart agricultural evolution in India.

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