ROLE OF ARTIFICIAL INTELLIGENCE IN INSECT PEST MANAGEMENT

Anam Khan
Ph.D Research Scholar, Department of Entomology,
College of Agriculture, SVPUA&T, Meerut

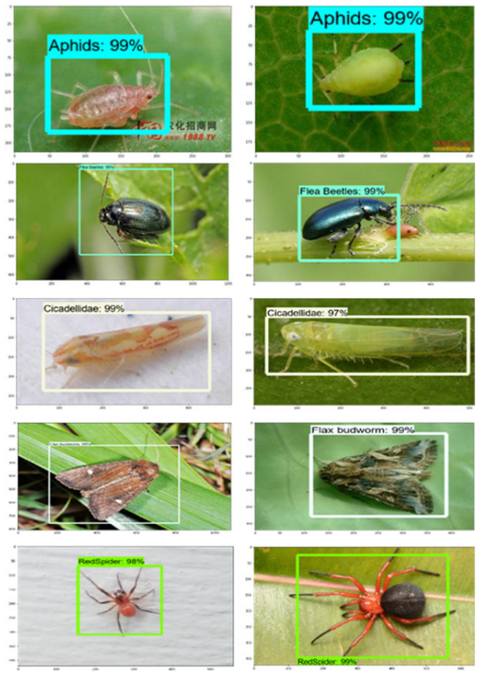
INTRODUCTION

Artificial intelligence is used to describe machines that mimics cognitive functions that humans associate with the human mind such as learning and problem solving. It has played an important role in various sectors of agriculture. Insect pests are one of the major problems in the agricultural field. The Food and Agriculture Organization (FAO) reported that these pests cause between 20 and 40 percent loss of global crop production every year. The pest infestation costs the global economy around $220 billion and invasive insects around US $70 billion annually. Different pesticides have been used by farmers widely to increase the quality as well as storage life of crops. But the continuous and indiscriminate use of these pesticides resulted in the environmental contamination and potential high-risk diseases such as cancer, extreme respiratory and genetic diseases, and foetal death eventually. To detect plant pests at an early stage and save undesirable consumption of pesticides, advanced technical solutions are needed in agriculture. Invasive pests like fall army worm (*Spodoptera frugiperda*) in corn and Rugose spiraling whitefly in coconut (*Aleurodicus rugioperculatus* Martin) have recently threatened cultivated crops in the country and cause extensive damage. The Indian Agricultural Research Institute–Natural Bureau of Agricultural Insect Resources estimated the intensity of infestation of fall army worm to the tune of 9–62% with an economic yield loss of 34%.

The plant protection measures are to be taken on a community basis so as to ensure effective management of pests. Smart agriculture has been recently introduced to apply Artificial Intelligence (AI) techniques for precision control of plant insect pests.

Drones are unmanned aerial vehicles exploited in a wide array of disciplines such as defence, monitoring systems, and disaster management but are only beginning to be utilized in agricultural sciences. Drones work on principles of artificial intelligence. These are used for spraying of pesticides to control insect pest efficiently over a larger area by ensuring complete coverage of crop.

Computer vision is good at spotting disorders in agriculture, but it can also help with preventing them. Unmanned aerial vehicles (UAVS) equipped with computer vision AI make it possible to automate spraying of pesticides uniformly across a field. With real-time recognition of target spraying areas, UAV sprayers are able to operate with high precision both in terms of the area and amount to be sprayed. This significantly reduces the risk of contaminating crops, humans, animals, and water resources and help in insect pest management efficiently.



IMPORTANCE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

- Increasing efficiency of time, labour, and resources.
- Improving environmental sustainability.
- Making resource allocation smarter.
- Providing real-time monitoring to promote greater health and quality of produce.

Uses and Role of Artificial Intelligence in Insect pest management

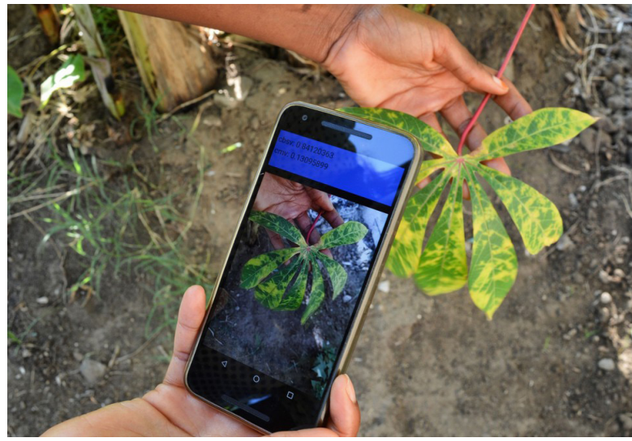
Detection of pests of plants can be automated by using image recognition technology based on deep learning. Researchers first set up a sticky trap to capture six different species of flying insect and collect real-time images. They then based the detection and coarse counting method on YOLO object detection, and the classification and fine counting on Support Vector Machines (SVM) using global features. When all was said and done, their computer vision model was able to identify bees, flies, mosquitoes, moths, chafers, and fruit flies with an accuracy of 90.18%, and count them with 92.5% accuracy. V7 is an AI Data Platform for automated annotation combining dataset management, image and video annotation.

Fig. Potato beetles labelled using V7's auto-annotation tool

Computer vision systems and image processing using artificial intelligence techniques i.e. machine learning and artificial neural networks (ANNs) have been widely used to solve agricultural problems. Image based recognition of insect-pests have been proposed in entomology. Faster region based convolutional neural networks (Faster R-CNN) is a unified deep CNN for target detection and identification in images including feature detection, candidate regional generation, regional image classification, and location refinement.

In order to classify insect pests using the public IP102 dataset, Kasinathan et al. compared four machine learning techniques, namely artificial neural network (ANN), support vector machines (SVM), k-nearest neighbours (KNN), naïve bayes (NB) with a proposed CNN model which had achieved highest classification rates of 91.5% and 90.0% for 9 & 24 crop pest classes, respectively. For Soybean fields, Residual Neural Network and Visual Geometry Group Network have been proposed to support farmers to control soybean pests using acquired images using drone with a high resolution camera. The resulted accuracy of highest classification rate was 93.82%.

Deep learning module is responsible for image processing to detect and classify crop pests using Faster R-CNN approach as shown in diagram. Convolutional layers of Inception V2 model has been used in the study as a feature extractor for the Faster R-CNN. It can balance between the processing speed and accuracy in modern deep-learning based detection systems. Region of Interest (RoI) pooling layer corresponding region of proposal from backbone feature map and divide it into sub-windows. Inception V2 model generates the feature maps of input image and RPN takes this feature maps image as input to provide a set of rectangular region proposals as output.



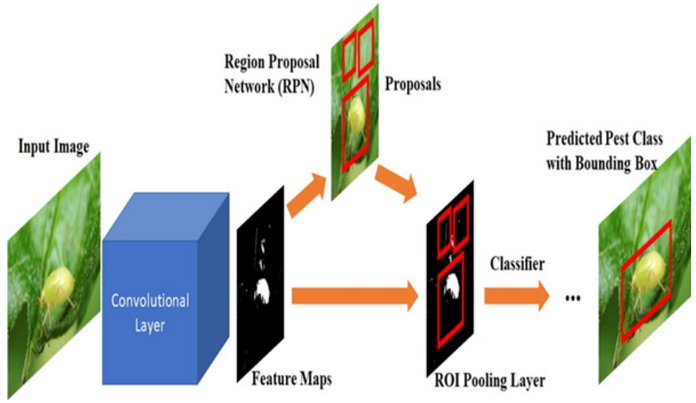


Fig. Depicting basic workflow of Faster R-CNN for detection and classification of target crop pests

The database module as shown in figure provides all pest images of five classes for training Faster R-CNN in the cloud computing system. It retrieve all data of resulted pest prediction containing name and bounding box of detected pests in tested images and use of recommended pesticides.

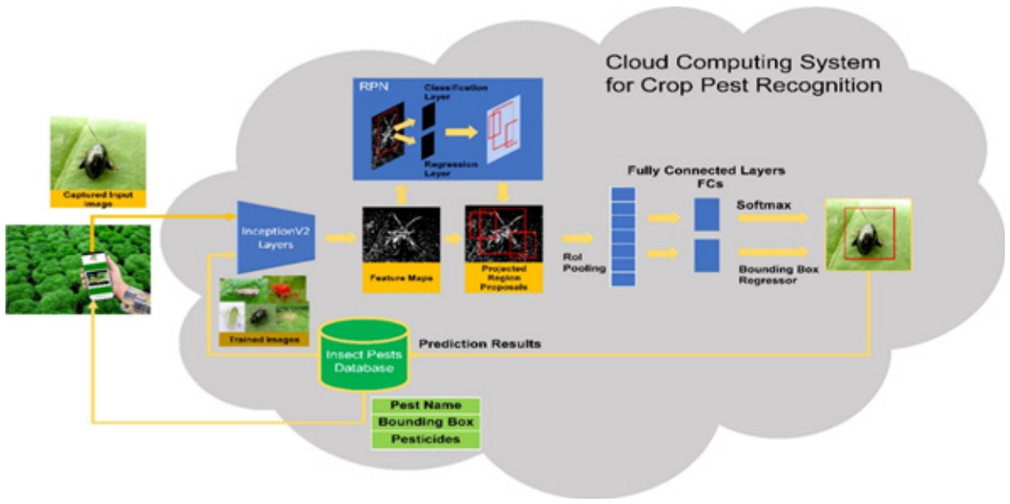


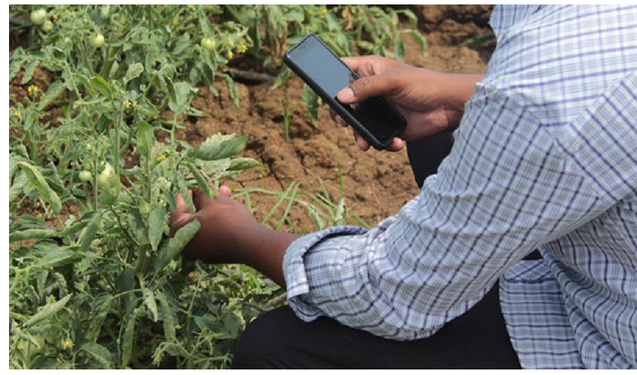
Fig. Schematic diagram of developed mobile based system for recognizing crop pests.

Different apps have been launched for identification of insect pests on different crops like Artificial Intelligence based mobile app for identification and advisory of maize disease and pests. This project was funded by National Agricultural Science Fund (NASF). This app works on artificial intelligence principle and captures images of different insect pests of Maize like *Sesamia inferens, Chilo partellus, Spodoptera frugiperda* from farmer farm and provide advisory to farmers using trained deep learning algorithm. Another app is Plantix, a mobile crop advisory app for farmers, extension workers and gardeners. Plantix was developed by PEAT, a Berlin-based AI startup. The app claims to diagnose pest damages, plant diseases and nutrient deficiencies affecting crops

and offers corresponding treatment measures. Users can participate in the online community where they find scientists, farmers and plant experts to discuss plant health issues. This app helps in live tracking and monitoring of fall armyworm in those states and districts which are heavily infected with it. Another app is Pest Detector app which utilizes a custom machine learning model to recognize Aphids, Army worms, Larger grain borer, Stem borer and Stem weevils. It can detect pest by pointing the camera on location of crop pest and once the pest is identified to a confidence level of over 97% one can swipe to next step which gives a background on the pest and eventually to the last step which gives you information on how to control the detected pest.

A majority of the research on UAV for pesticide spray in crops was carried out in rice, wheat, corn, cotton, pepper, and sugarcane as these crops consume more pesticides than any others. In order to improve insecticidal use efficiencies in crops, drone operational parameters such as flight speed, flight height, nozzle type, payload, and drone type are be optimized for the given situation. Overall, flight height of 2–3 m, flight speed of 3–5 ms−1, two fan nozzle, four rotor UAV, and 15 L payload are found to be optimal to undertake pesticide sprays using drones in agricultural crops.

In cotton, aphids and mites are serious sucking pests of great concern that cause extensive damage to crop. In order to address these pests, aerial sprays using drones were attempted studied the efficacy of unmanned aerial vehicles (UAVs) on cotton aphids and spider mites. Drone technology works on principle of artificial intelligence and is used for aerial spraying for Brown plant hopper in Rice, Aphids and Spiders in Cotton, and Fall Armyworm in Sugarcane and thus resulting in effective insecticidal spray as compared to the conventional spray and thus help in insect-pest management in different agricultural and horticultural crops.



CONCLUSION

AI training require technical and educational investments in the agricultural sector. Knowledge of farmer regarding field needs to be translated to AI training. Crop pests can be detected and classified based on Faster R-CNN and cloud computing system. Five classes of well-known crop pests are successfully classified using the developed image-based recognition system. The evaluation results of insect pest classification using the proposed Faster R-CNN showed superior performance compared to BP neural networks and SSD Mobile Net. The main prospect of using artificial intelligence is adding new agricultural pest classes with recommended pesticides for specific crops. Computer vision is the latest way farmers can adopt new technology to meet the global food demands by managing insect pests through artificial intelligence techniques and hence contribute to the increase in food security. Many mobile apps based on artificial intelligence have been developed by different research institutes scientists for different crops to identify and manage the insect pest of crop efficiently.