Wicked Moth Ousting Technology - An Analytical Approach for Precision Farming

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Abstract

India, as a profuse agricultural country, needs advancement in the process of farming through technology. For that, we propose a technology called Wicked Moth Ousting Technology (WMOT). WMOT in Precision Farming using supervised Machine Learning (ML) can be an infallible solution for modern and sustainable agriculture. This paper proposed a well-trained, tested, and predicted model that will decrease the use of pesticides using a supervised ML algorithm and photographic phenomena. WMOT uses the photogrammetric method to create orthophotos. By checking the photographs using a supervised ML algorithm Support Vector Machine (SVM), the proposed model will identify the infected plants and the automated nozzles will open only for that plant to spray from the unmanned air vehicle. This proposed way of farming will be economically beneficial and the use of fewer chemicals is also advantageous for human health and the ecosystem. It is a proposed work based on the prevention, of the attack of yellow stem borer (Scirpophaga incertulas) on the eastern part of Bardhaman district of West Bengal state, using pesticides precisely through the mentioned ML algorithm.

Keywords
Wicked Moth Ousting Technology, Precision Farming, Support Vector Machine, Supervised Machine Learning, Yellow Stem Borer.

1. Introduction
India ranks second in the world in terms of producing rice. In India, around 44.6 million hectors of field are used to produce 87.8 million tons of rice. It is around 2.85 tons per hector.(Chatterjeeet al. 2014) The ratio between actual potential of the fields and the final production of paddy is low. Insects, which acts as the main cause of the potential decrees of paddy. Around 100 of insects can attack a paddy field and among those 20 pests are considered as major one to demolish a paddy field.(Cramer et al. 1967) In India only yellow stem borer (*Scirpopagha incertulas*) causes 80% of damage.(Darro et al. 2023) Yellow stem borer is from Pyralidae (Lepidoptera) family. When a paddy field is attacked by yellow stem borer in vegetative stage, the symptom called dead heart and if the paddy field is attacked in reproductive stage produces white ear heads.(M. D. Pathak and Z. R. Khan 1994) For the sake of generating high ratio of yielding advancement in technology used in paddy farming is very much needed. Precision farming can be the solution of this. Using automation one can precisely use pesticides and herbicides according to the need. The reduced usage of pesticide and herbicides will help to maintain the cultivation more sustainable.

1.1 Objectives
Countries like India are totally dependent on the rice as their main resource for carbohydrates as a result India has to grow a humongous amount of paddy each year. India is the second largest rice producer in the world yet the pests and

insects alone cause almost 25 percent losses. yellow stem borer (Scirpophaga incertulas) is a species of moth that destroys paddy plants at any stage from seeding to maturity. up to 80% of the paddy field can get destroyed if it gets infected by Yellow Stem Borer.(Darro et al. 2023) Right now, these moths are controlled simply by applying fertilizers in the whole field of paddy several times from seeding to maturing which is neither cost efficient because of the amount of fertilizer is needed for the whole field not just once but several times nor is this amount of chemical mixed rice is healthy for consuming. Agricultural advancements are necessary for the growth of the plants and here comes the role of precision farming. Precision farming is a way of farming which uses high technologies and analytical tools to make decision for improvement of the crop. Here we propose a technology using machine learning that will help us identify the yellow stem borer infected paddy plant and then only on that plant we will spray the fertilizer. In this way we can reduce the amount of fertilizer needed so it will be cost efficient as well as the plants will be less chemical mixed thus healthy for consuming.

2. Literature Review

Spraying technologies using automation has gone to another level within some year. Spraying through automation opens a new horizon towards precision farming. It shows how reducing the usage of herbicides can make an impact in cost reduction.(A.S. et al. 2022) Spraying using automation must need some checking. The model must identify the infected crops. Identification can be done using the shape and using the colour of the crops. Data augmentation method using Support Vector Machine (SVM) and Convolutional Neural Network (CNN) are able to identify the rice grain by examining its shape and colour.(Rao et al. 2020) For Classification problem there are many supervised machine learning algorithm, among all the algorithm Support Vector Machine is the most popular. It creates best fit line or boundary that can segregate n- dimensional space into classes, that can help to predict data into correct position.(Dharan, n.d.) Multi-class Support Vector Machine is used to segment more than two types of rice grains. The overall mean percentage of accuracy a very good percentage which implies that the SVM can classify rice grains according to colour and shape.(Ibrahim et al. 2019) Basically a paddy field is attacked by 20 types of major pests, among those yellow stem borer is the most harmful.

The poor ratio of paddy cultivation is mostly for the attack of yellow stem borer.(Wagh et al. 2023) SVM already applied in detection of one disease of seedlings, it gives around 88% positive predictive score and 92% differentiating power among infected and non infected crops seeds in 2016. In 2017 SVM used to detect disease in leaves. It gained 93.33% accuracy in training set and 73.33% accuracy in testing set. Again in 2017 AdaBoost classifier and SVM both used simultaneously to identify white backed planthoppers in paddy fields. It gained 85.6% successful identification rate. In 2018 deep CNN and SVM used to identify seven leaves diseases and it gained the success rate of 87.50%. With 86.35% accuracy, SVM and estimating tool for severity of leaf disease can identify four leave diseases. In 2019 SVM and CNN achieved 91.37% accuracy in classifying rice diseases. In another work in 2019 includes SVM, CNN, LBPH, Haar-WT to detect leaf disease. The accuracy for CNN and SVM is 95%, the accuracy of SVM and LBPH is 82% and the accuracy for SVM and Haar-WT is 83%. Again in 2019 SVM, KNN, BPNN, naïve bayes uses to detect five leaf diseases and SVM achieved 98.63% which is better than any other classifier.(Aggarwal et al. 2022)

3. Methods

Yellow stem borer attacks during the cultivation period. The proposed way out is to use unmanned air vehicle that can capture orthophotos using photogrammetric method. These orthophotos will be in RGB form.(Jamil et al.) After capturing photos it will undergoes through various stages. At first the checking occurs between soil and greenery. If the outcome of the checking is greenery then the next checking occurs between grass or paddy.

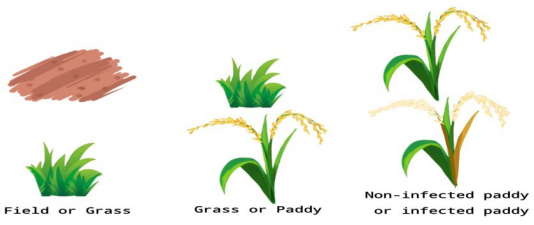

Figure 1. Three stage checking process

If the outcome is paddy then it will check for the captured photo is an infected one or not using Support Vector Machine (SVM).(Dharan et al.) The total checking process is totally dependent upon Grayscale conversion, Binary conversion, Roberts segmentation. After completion of all the image segmentation process, the Support Vector Machine (SVM) starts classifying the paddy crops. This is a binary classification between infected or non infected paddy.

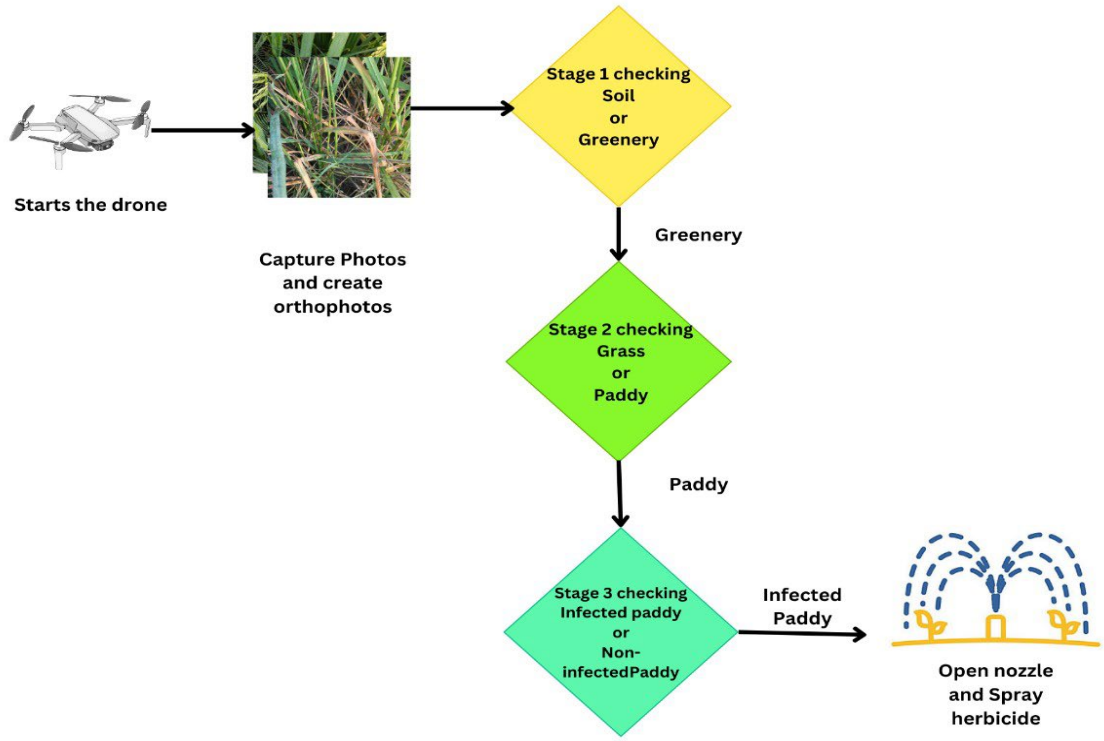

Figure 2. Process flow of WMOT

4. Data Collection

The yellow stem borer infected plants can be identified with longitudinal white patches on leaf sheaths and the central leaf will dry out thus turning brownish. These are the symptoms which we will use as a data in image format. Also grown insects lay egg on the leaves and larvae feed on leaf sheaths before it enters the stem of the paddy plant these stage images can also be data for identification. .

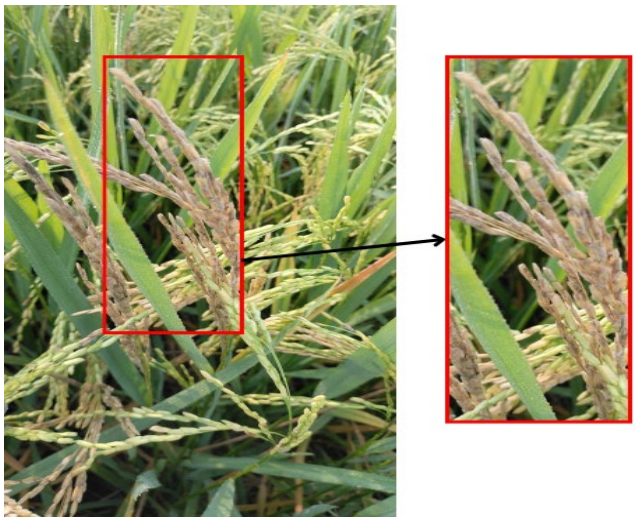

Figure 3. Whitehead caused by yellow stem borer

Figure 4. Dry central leaf caused by yellow stem borer

In figure 1 we can see the whitehead caused by the yellow stem borer and also in the figure 2 we can see the main stem of the paddy plant have become brownish cause the larva has attacked the stem of the plant. These identifications in a field are very time consuming if done manually but we will use these images as dataset and train a machine to identify the infected plants.

Figure 5. Yellow stem borer and larva of yellow stem borer

Yellow stem borer causes various problems to a paddy plant in which the common two identification are deadheart and whitehead. Deadheart is a condition in which the larva of the yellow stem borer feed on the inner surface of the stem walls and cause of this the central leaf does not unfold and turns brownish and dries off.(Pathak et al. 1994) On the other hand, due to the feeding of main stem the panicle development often causes potential or complete sterility and result in whitehead. The white empty panicles are light weighted and white in color.(Head et al.)

Table 1. Data collection for the proposed model

Sample	Number of images	Number of training data	Number of testing data
Yellow stem borer attacked paddy plant.	985	788	197

5. Results and Discussion

5.1 Numerical Results

Classification metrics are one of the finest ways to make comparison classification results. Here only precision and accuracy will be checked. The confusion matrices consist four condition named true positive (TP), true negative (TN) , false positive (FP) and false negative (FN).(Jayaswal et al.) The mathematical expressions for precision and accuracy is:

$$Precision = \frac{TP}{TP+FP}$$

$$Accuracy = \frac{TP+TN}{TP+FP+FN+TN}$$

With 985 collected data we found 712 numbers of true positive (TP), 198 numbers of true negative (TN), 56 numbers of false negative (FN), 19 numbers of false positive (FP). So, with this data we gained 97.4% precision and the accuracy is 92.38%.

5.2 Graphical Results

Graphically we found a bar that can represent the accuracy of the detection through SVM. The result using confusion matrix is shown in the graph below:

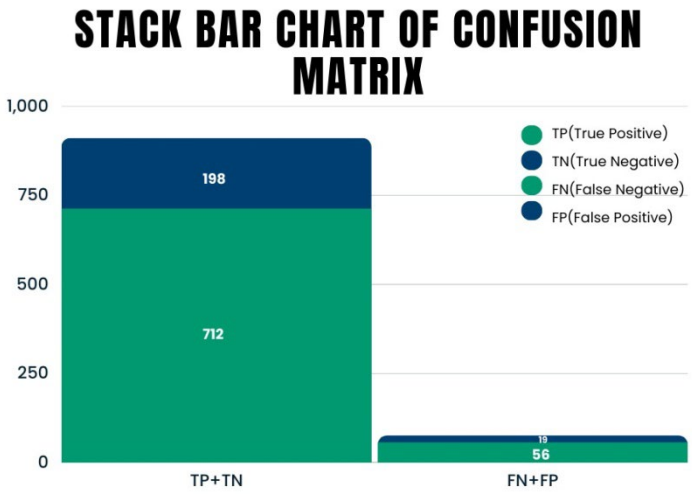

Figure 6. Accuracy graph using confusion matrix

5.3 Proposed Improvements

This work only identifies the attack, symptoms of yellow stem borer , there are many pest and insects that can harm paddy, rice and many other crops. Insects like stalked-eyed flies, African rice gall midge, caseworm, rice hispa, spittlebugs, rice leaf folders, rice mealy bug , stink bug, rice bug, termite can cause Rice Yellow Mottle Virus (RYMV), rice blast, brown spot , sheath rot, leaf scald, false smut, grain rot and many more diseases.(Tatsushi et al., 2009) Using binary classification we can't classify all these at a time. Using multiclass classification SVM will be able to detect the infection and symptoms of different insects and pests. In multiclass classification the machine separates into three or more class to classify data.(Javaid et al.)

6. Conclusion

Production of paddy has always been a challenge due to the insects and pests specially the yellow stem borer which destroys most of the paddy production and this moth attacks in various stages of growth of paddy plant. The use of machine learning algorithms like SVM (Support Vector Machine) can help us differentiate between a yellow stem borer infected plant and a non-infected plant by doing binary classification. It helps us identifying which plant is in need of fertilizer so that a nozzle will open on that spot and only spray fertilizer on that area this way the amount of fertilizer needed for the field will reduce and the end product rice will be very little chemical mixes thus good for consuming.

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