ANDROID APPLICATION FOR FALL ARMYWORM IDENTIFICATION ON MAIZE USING DEEP LEARNING

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Introduction:

Fall Armyworm is a species in the order Lepidoptera. It is called 'armyworm' because in its larval stage, individuals gather in huge masses ('armies'), which can destroy large tracts of crops. The FAW arrived in India in 2018. The pest infestation has already spread to most parts of the subcontinent and has been reported from maize farms in 20 states. It can feed on over 80 different plant species, including Bermudagrass, corn, fescue, Johnsongrass, rice, ryegrass, small grain crops, sorghum, Sudangrass and timothy. It possesses unique characteristics that make it a dangerous devastating pest than any other crop pests. Its characteristics enable it to cause massive damage to other crops such as rice, sugarcane, wheat etc. This pest is native to South and North America, but alien invasive in Africa and also commonly found in the Northern part of India like Rajasthan, districts of Karnataka such as Shivamogga, Belgaum, Ballari, Chikballapur and Kolar. They can also spread rapidly over a large area in no time. In 2018, an article by The Hindu stated that this species had been detected and spread rapidly across 14 hectares of maize crops per locality.

So, we have proposed to develop a Deep Learning model using Transfer Learning, as a solution to detect these pests from useful and non-harmful pests and worms. Deep Learning is a new branch of Machine Learning that constitutes accurate techniques for image processing. Studies show that it has been applied in agriculture and has achieved correct results. Research has been successfully carried out for FAW classification in its Moth stage.We have taken this idea from a base paper that focused on moth stage. Therefore, this project proposes developing a CNN network for detection and classification of FAW from other worms during larval stages. This image classification model will be deployed on an Android Application, since it can be easily accessed by everyone. For Image Classification, accuracy of the classification as well as the quality retrieved features from the images are vital for the process.

Objectives:

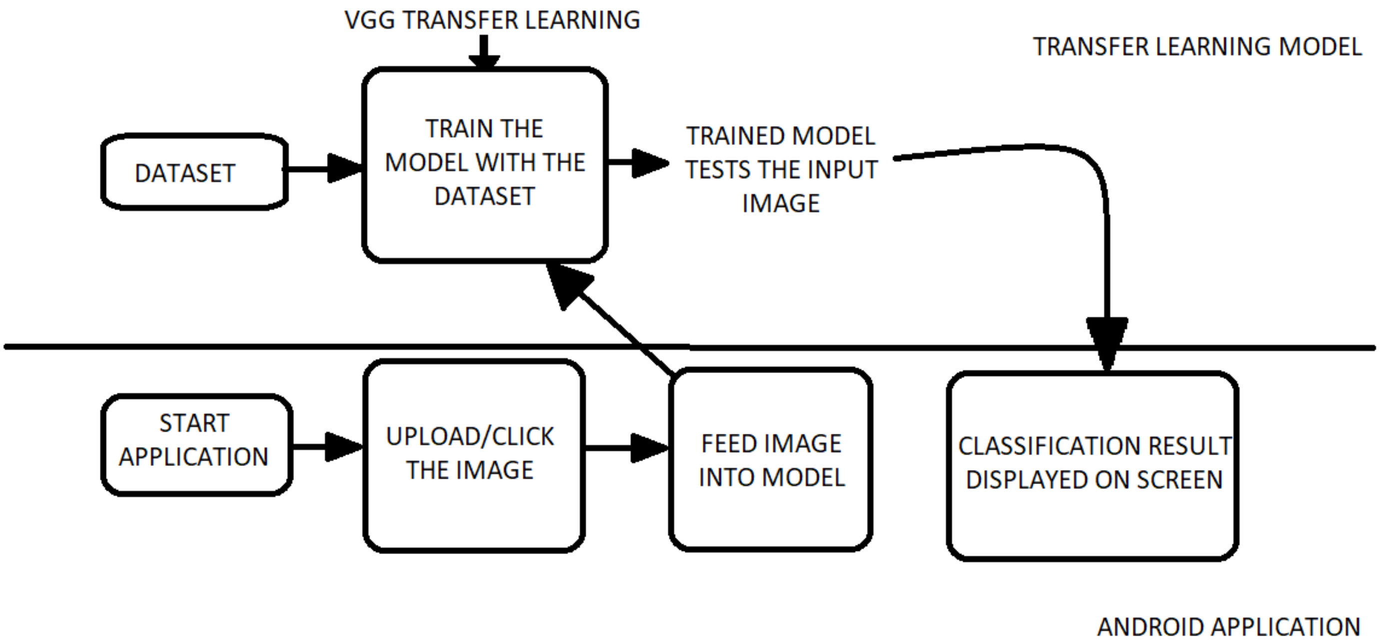
The objective of the project is to design and develop an automatic identification of pest namely Fall Armyworm (FAW), scientifically known as *Spodoptera frugiperda* in the maize agricultural field at larval stage using its image.

It is very difficult to identify the FAW in its larval stage since it is similar to other pests. The proposed system will help the farmer to distinguish between the FAW with other pests in its early stage (larva stage). The images of the worm captured using camera will be taken as input and will be identified whether its is a Fall Armyworm or not, which is challenging in bare eye.

Thus the overall objective of this project is to

1. Develop an **android application** for automatic identification of Fall Armyworm on Maize field using Deep Learning technique.
2. To design a **Deep Learning technique** using Convolutional Neural Network that will classify a given image of a Fall Armyworm or not. This model will be used in the android application.

Methodology:



Architectural Diagram

Here, we first focused on increasing our dataset to make the training of the model more accurate, to better fit a variety of images. To do this we first performed augmentation on our dataset using inbuilt python functions. The original dataset of 600 images were increased to 6025 training and 1903 validation images. The images in the resultant dataset were then rescaled to a standard size in order to reduce the complexity in processing the images during training. We then decided to use the concept of Transfer learning to build our image classification neural network. Transfer learning is a process where we use a pre-trained model that has successfully classified a known dataset and fine tune its parameters for our custom problem statement. First, our team researched and found out the four highly used and comparatively accurate transfer learning models: InceptionV3, VGG16, ResNet and EfficientNet. We used a sample dataset which was 100 images out of the original dataset of two classes to be used to train these four models. We observed that the accuracy of all four models (TABLE 1) were great with VGG16 having the highest accuracy of 99.50% on our dataset. Hence after studying our research, we proposed to use VGG16 as our pre-trained model for our problem statement.

Transfer Learning Model	**Obtained Accuracy**
InceptionV3	98.56%
VGG16	99.50%
ResNet	100% (But overfitting)
EfficientNet	93.40%

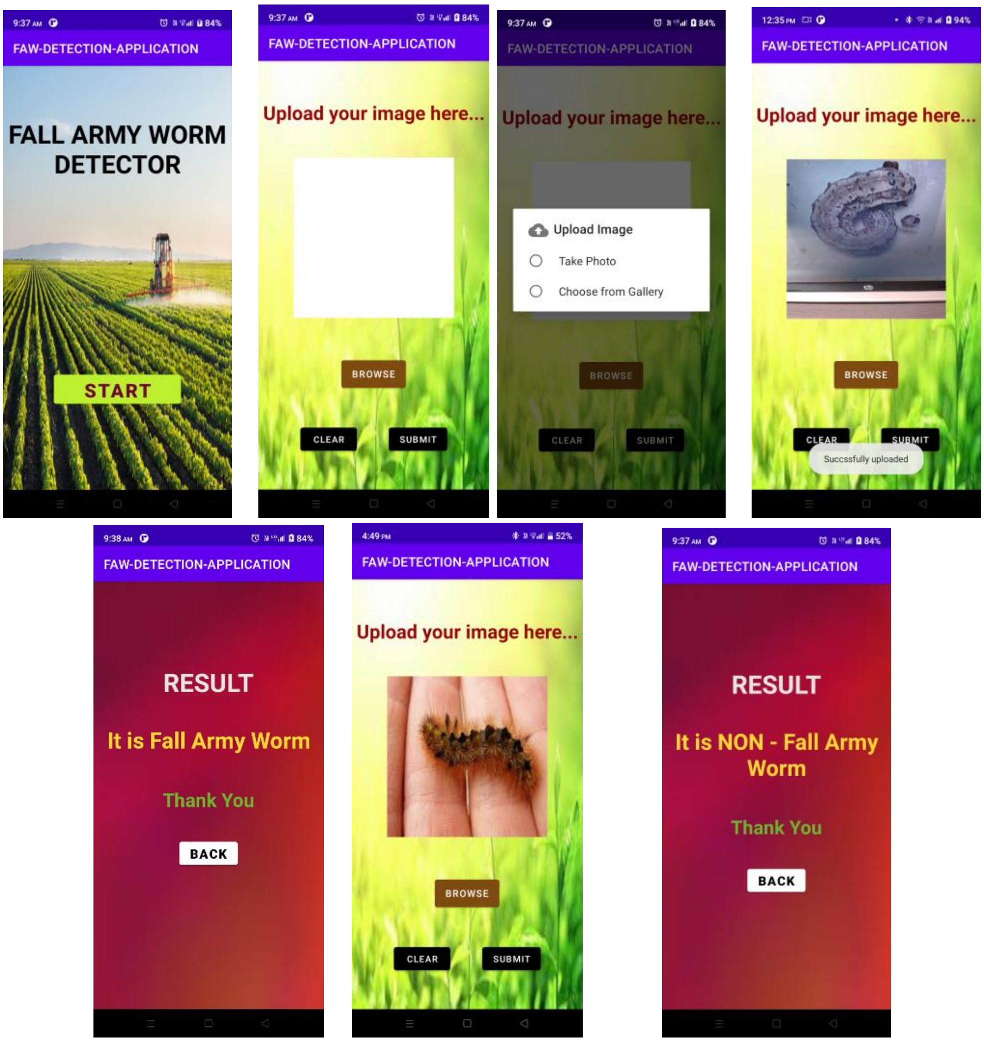
Table showing accuracies for transfer learning models on sample dataset

In order to fine-tune our model we first modified the input and output layers. The input layers were modified in order to process our images from our custom dataset. The last layer was modified from 1000 to 2 neurons since our problem is to classify FAW and Non-FAW images. We then trained our augmented dataset by modifying the model parameters to various cases. We observed that by setting the learning rate as 0.0001, dropout as 0.3 and batch size as 32 we obtained a higher accuracy of 99.21% compared to other cases . This accuracy was observed to be constant after training the model for about 100 epochs. This trained model was tested with sample images and then saved using python inbuilt functions. The Android application was developed using the tool Android Studio. We first developed the front end. The saved model was then converted into an .h5 file. Through inbuilt tensorflow modules we were then able to convert the .h5 file into a tensorflow-lite (tflite) file. This was then deployed in our application using tools in Android Studio. The Architecture consists of the Transfer Learning model and the Android Application (FIG 1)

Results and Conclusions:

Researches have already been conducted on identification and classification of Fall Armyworm in its Moth stage. This is explained in the paper 'Chulu, F., Phiri, J., Nkunika, P. O., Nyirenda, M., Kabemba, M. M., & Sohati, P. H. (2019). A convolutional neural network for automatic identification and classification of fall armyworm moth. *International Journal of Advanced Computer Science and Applications*, *10*(7)'. Since android application is easily accessible by everyone, we have developed an android application for detecting the fall armyworm in its larvae stage. The reason we are focussing on detection of fall armyworm in its larvae stage is because the rate of spread and destruction is less in larvae stage compared to that of Moth stage. A deep learning model is retrained with our dataset and modified according to our problem statement. Then this model is deployed into an Android Application. This android application is developed in Android Studio, where we used XML for frontend design and Java in the backend for connecting the model to android. This application has three pages i.e. home page, upload page and the result page. When an application starts, there will be a START button in the home page, on clicking this button it will redirect us to the next page. There will be a BROWSE button on the second page. On clicking it, the application allows users to upload the image(input) either by capturing a live-image or by uploading from the gallery. The selected image will be displayed on the screen and is fed into the deployed model in the application. This page also has a CLEAR and SUBMIT button. On clicking the clear button, the image will be deselected and the user can upload a new image. On clicking the SUBMIT button it will redirect us to the last page where results are displayed. The image is tested using the trained model and messages are displayed accordingly , i.e if the image is of fall armyworm, it will display as 'It is Fall Armyworm ', if not it will display as 'It is Non- Fall Armyworm'.

Snapshots:



Future Scope:

Future improvements include expanding the detection to more locally found harmful species. Description about these species including life cycle. Also information regarding the rate at which the pest spreads can also be included. Additionally, contact details of local pest control businesses would be provided based on the location of use by the farmer. The application could also have a centralised database to analyze regularly the spread of pests and their types based on locality and season. We can also include the control measures information for preventing the crops from being destroyed which will help the farmer. Since we have developed an Android application, further we can develop a Web Application. Currently, our app takes the image as input, additionally we can include video as input for the model. These are the future scopes of our Project.