INSECT CLASSIFICATION AND ALERT SYSTEM USING CNN

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ABSTRACT

Humans, Animals, Plants and Insects are the close integral part of our ecosystem. As insects certainly affects the human lifestyle as insect borne diseases are taking more than 0.7 million lives every year. Traditional counter measures to tackle the insect borne diseases are performed after the cases of particular diseases starts reporting in the area. Presented paper provides an automated system for classification of harmful insects and alerting though sms. Proposed model uses Convolutional Neural Network(CNN) for classification, CNN model trained in the proposed system achieves accuracy of 82 % on 15 different classes. Image database for the following experiment was taken from Kaggle and IP102 datasets. TensorFlow, Keras and OpenCV trained model will detect the insect present in the image and will send the alert message to the saved phone number.

***Keywords* – CNN, Insects, Pest, Image Classification, vector borne**

INTRODUCTION

From existence of human kind to today, humans are battling with the insect borne diseases and effects of pest on agriculture. While there are multiple ways to tackle this problem, those are the counter measures taken to stop the spread of the diseases. And the spread of the diseases is taken into account after number of cases starts to show up. In some agricultural cases it spreads so fast that chances are major part of the crops in the field will be degraded until some action taken onto them. This delays to take some counter measures sometimes leads to pressure on medical system and low market in crops cases. Proposed system aims to alert the respective person/committee to take counter measures even before the diseases starts to spread. Proposed system focuses on insects which are harmful to humans and pests which leads to destruction of crops. Major part of insects species are some which are attracted towards the UV based photocatalytic trap as it proven to be effective than others [1]. Study [1] shows effectiveness of photocatalytic trap where pollutants are present compared to complex systems requiring heavy load work. When insect detected system is trained to send alert to the respective person informing about the insect details. Another advantage of proposed system is if the harmful insects are less in population, they will be eliminated by trap itself. System deals with the multiple types of insects and pest, for this problem system uses CNN to classify the insects over the other image classification techniques. [5] Proposed systems outcomes an alert message to the respected person, when any harmful insect is trapped inside the trap and has been detected by the model. CNN uses audio form of input and visual form of inputs, as the proposed system is to be deployed in outdoor areas, there exists a noise which will affect the quality of noise generated by insects, due to this problem using visual data approach is more reliable. Data used in training the model is gathered from various sources such as Kaggle, Google and dataset IP102.

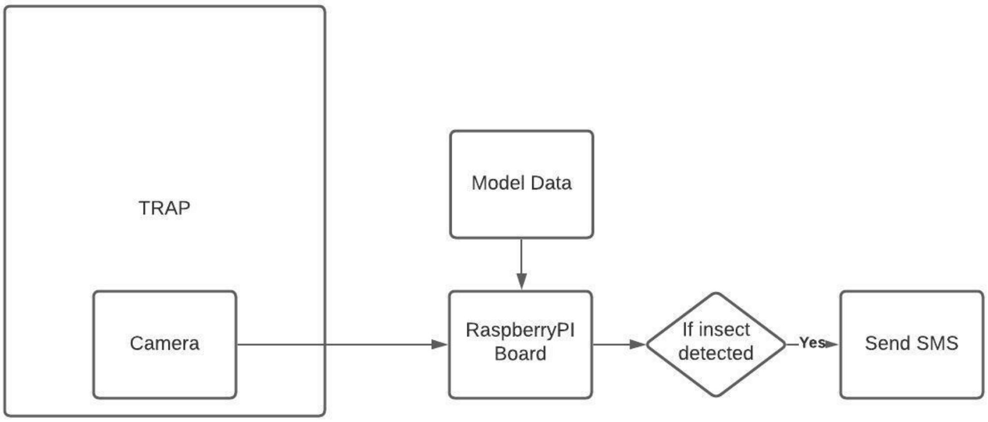

Fig. 2 System Model

MATERIALS AND METHODS

Insects Classification

1. **Insect Database Collection for Classification**
   As CNN algorithm we used uses visual data to perform classification operations, large image dataset had to be collected. Dataset used in this paper is collected from IP102, Kaggle datasets and Google datasets. Dataset contains 1,448 images belonging to 15 classes. Further this dataset was split into 80% for training and 20% for testing purpose. Table 2.1 contains the details about dataset.

Sr. No.	Insect (Classes)	No. of Images for class
1	Culicidae	100
2	Reduviidae	104
3	Anthophila	110
4	Pegomya hyoscyami	114
5	Coleoptera	100
6	Nilaparvata lugens	124
7	Paraponera clavata	112
8	Anisoptera	96
9	Sciaridae	89
10	Tabanidae	114
11	Lepidoptera	104
12	Tetranychus urticae	112
13	Glossina	95
14	Vespula	88

Table 2.1 Dataset Details

2. Data Preprocessing And Data Augmentation

As the dataset used in building the model has nearly similar number of images for each class but this data is very low for building a high accuracy model. Without sufficient number of data the model leads to overfitting. To tackle this issue Data Augmentation is used which increases the number of images present in the dataset using various methods such as Horizontal Flip, Vertical Flip, Rotation Range, Shear Zoom and width/height shift.

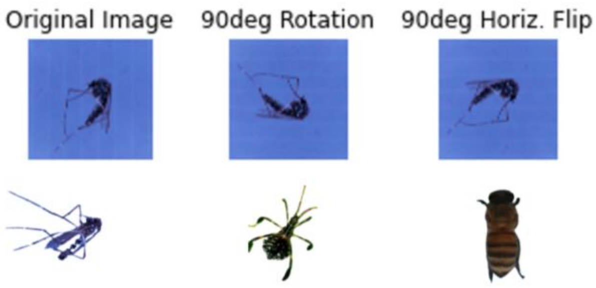

Fig. 2 Data Augmentation and Segmentation

Data augmentation helps to increase the number of images used in dataset, which leads to reducing overfitting.

3. Insect Classification Methodology

Insect classification process consist of multiple sub-processes performed in the hierarchical order to be performed. Data augmented dataset will be treated as training dataset and some of training dataset will be reserved for validation data. Reserved validation data is part of the dataset which is unseen to the model. Steps involved in the training a CNN model are presented in Fig. 3

i. Feature Extraction

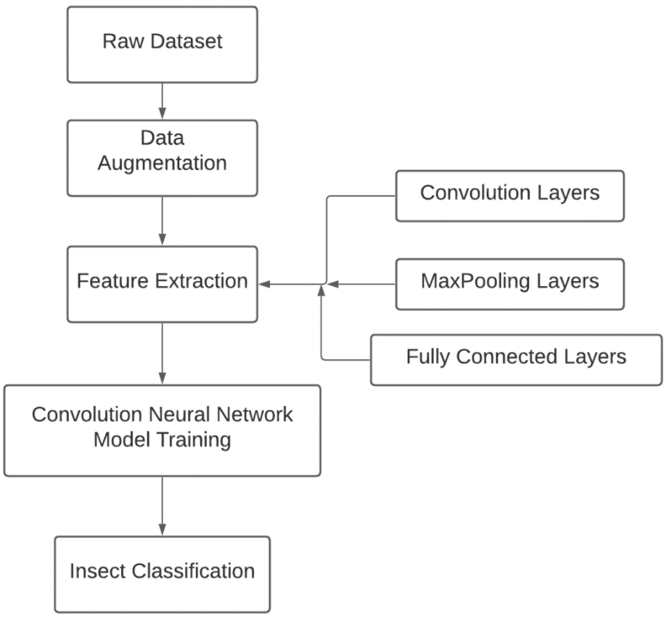

Fig. 3 Model Training Flow

Data augmentation has been already done to the dataset and that dataset has been fed to the model training stage. Feature extraction stage consist of 3 main layers namely Convolution Layers, MaxPooling Layers and Fully Connected Layers.

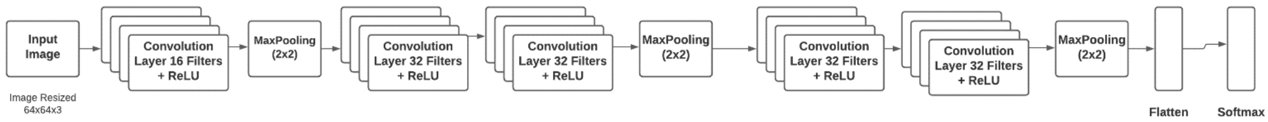

Fig. 4 Model Layers

A. Convolution Layers

A convolution is basically how input is modified by the filters. CNN model used in this paper consist of 4 convolution layers consisting of 16, 32, 32, 64, 64 filters respectively[7]. First layer which input layer resizes the image to size of 64x64 and convolving with kernel size of (3x3). Filters in the layers each one of them have different feature such that if first layer has 16 filters and second layer has 64 filters then second layer will have 32x16 features map. Layers in the presented model has activation as ReLU(Rectified Linear Unit). ReLU activation basically takes anchor into account only if it is non negative.

B. MaxPooling Layers

MaxPooling layer helps the model to be overfit, Extract representative features from the input tensor and Reduces computation and thus aids efficiency. MaxPooling used in the model have kernel size of (2x2). Means it will have 4 anchors to extract the max value from four of them. When the kernel will iterate over the whole image, resultant formed image will be given to the next image as input.

C. Fully Connected Layers

Fully Connected Layers are part of second stage in model building, which classification. Convolutional layers provides the feature extracted data in form of nD arrays. All the features from the convolution layer are flattened and 1-D array is given to the fully connected layer as input. Layers used in presented model are following

C.1 Dense Layer with activation function as ReLU

Dense is layer which deeply connected with the previous layer. Previous layer in the model for the first dense layer is flatten layer, all the neurons in the flatten layer will be connected to the all the neurons in the Dense layer as shown in Fig. 5. Dense has been added with activation as ReLU, meaning all the non positive values in the input will be treated as zero.

C.2. **Dense Layer with activation function as softmax**

Softmax activation gives the output in the form of probability for the input data telling how much does the given input data is from one of the classes feed into the model. Softmax layer is always kept in the end of any CNN model.

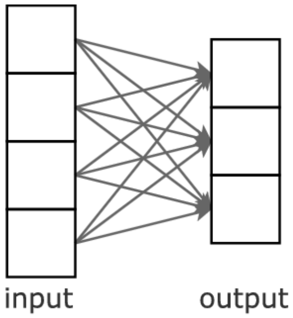

Fig 5 Fully Connected Layers

ii. Convolutional Neural Network Model Training

All preprocessed data was fed to the model fit algorithm with optimizer as adam, loss function as 'categorical crossentropy' and metric was 'accuracy'.
RMSProp, SGDNesterov, AdaGrad, AdaDelta and Adam are the optimizers are developed so far, while Adam is proven to be effective in large dataset and models.[8]
Categorical CrossEntropy is used in CNN to deal with multiple class problems.

Accuracy is the quintessential classification metric. It is pretty easy to understand. And easily suited for binary as well as a multiclass classification problem.

Accuracy = (TP+TN)/(TP+FP+FN+TN)

		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

Fig 6 Accuracy Matrix

Accuracy is the proportion of true results among the total number of cases examined. CNN model was trained with the batch size of 10, the number of epochs as 100 and optimizer as 'adam'. Accuracy of 82% was achieved and loss reduced to 0.56. Fig.

A shows plot for accuracy against epochs and Fig. 7 shows loss against epochs.

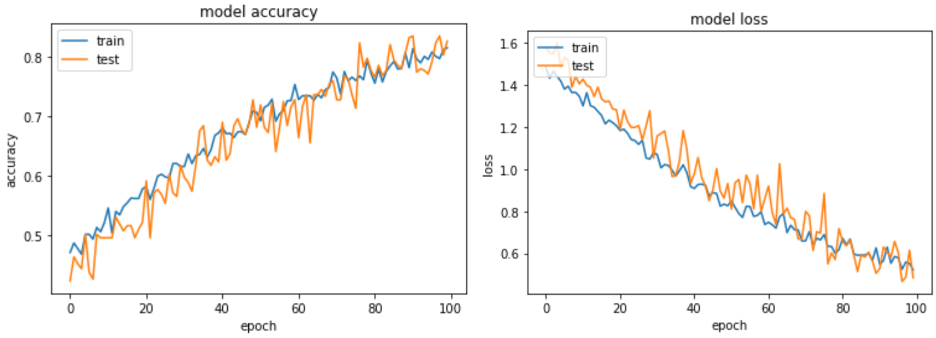

Fig 7 Model Accuracy and Model Loss plot

b. Insect trap setup

For experimental purposes any insect trap was can be used to attract the insects and trap them. Photocatalytic mosquito trap suggested in Study of mosquito attractants for photo catalytic mosquito trap[1] can be used. Trap specifically targeted onto mosquitoes. For agricultural application different bet trap may be used to lure insects and pests harmful to crops and animals.

c. Alerting System

When the system will get the input from the camera system, CNN model will run the image from preprocessing steps and will extract the features to classify the image into one of the categories of insects. After the classification system will send SMS to the number embedded into the code. For testing purpose Culicidae(Mosquito) image was given and following results was achieved.

Fig 8 Alert Message

CONCLUSION

Aim of this was to build a system which can send an early alert to take counter measures for tackling diseases spread through insects. Insect borne diseases contribute more than 0.7 million casualties every year. Elimination of such insects has to be done at early stage only, but current method takes situation in the consideration after number of cases starts to show up. It is important to know the advance knowledge of the upcoming threat.

Proposed system can be implemented along with insect trap to attract the insect and for clear classification between them. Proposed system works on CNN classification technique to identify between the different 14 harmful classes of the insect. Model trained with data augmented 1448 images for 15 classes. Model achieved the accuracy of 82% on training dataset. Fig. 7. Images used in this model are taken from Google, Kaggle and IP102 dataset. Model uses the TensorFlow framework written in python language. When tested with the insect images results shown in Fig. 8 was achieved. The achieved classification accuracy helps to reduce computation time for better insect recognition.

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