

AGRICULTURAL PEST DETECTION USING DEEP LEARNING

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This Report Presented in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science in Computer Science and Engineering

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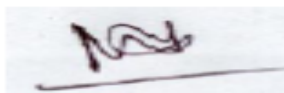
DHAKA, BANGLADESH

JANUARY 2022

APPROVAL

This Project titled “**Agricultural Pest Detection using Deep Learning**”, submitted by Khandoker Shamimul Haque, ID No: 181-15-1992 and Md. Imran Hossan, ID No: 181-15-1984 and Shahariar Hasan Shadin, ID No: 181-15-1960 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 17.01.2022

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We hereby declare that, this project has been done by us under the supervision of **Mr. Md. Reduanul Haque, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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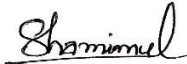
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ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project/internship successfully.

We really grateful and wish our profound our indebtedness to **Mr. Md. Reduanul Haque, Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of “**Deep Learning**” to carry out this project. His endless patience ,scholarly guidance ,continual encouragement , constant and energetic supervision, constructive criticism , valuable advice ,reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Professor Dr. Touhid Bhuiyan, Professor, and Head**, Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

Classification of insect species in agricultural sector is still very challenging even though a lot of work have been done in this area. The tininess of pest or insect and the difference of their structure make this job even more difficult. Nowadays almost every classification is based on manually engineered features like scale-invariant feature transform (SIFT) and the histogram of oriented gradients (HOG). But here, we will use Convolutional Neural Network (CNN) which is a feature learning algorithm. Here the task is to train a pretrained model to detect and drag out necessary feature needed for the particular task. It detect various pest in the crops like paddy, wheat, corn, pulses, potato, sugarcane etc. We want to develop a pest detection architecture which is based on image processing and for this approach we are using huge amount of pest image and all of the pest images are learned from a huge amount unlabeled image patches using of supervised learning methods and Convolutional Neural Network (CNN) algorithm. Throughout the study we will be using some captured previously captured pest image with different background then try to identify the presence of pest in the crop by processing the data using deep learning algorithm. A sample dataset of pests will be using for this work by deep learning algorithm. We will use some preprocessed model of tensorflow. We think we will be able to develop a system that will give us more accurate results in pest detection, because this system is able to detect different types of pests easily. We will try to reduce crop damage using our system.

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CHAPTER 1

Introduction

1.1 Introduction

Small things can make a huge impact and we understand this from pest attacks in grain fields. Now a days over a million categories of pest all over the world. Some pests are known and some are unknown but most of them are highly threatening for grain fields and most of these pests are able to annihilate a crop badly. Among some of those factors which effects on the agricultural productivity pest are one of them and arguably the most important one. Besides for being unknown about pest category farmers apply some pesticides which are not supposed to applied on the particular pest, which results unwanted loss and unhealthy crops which results a huge damage in national GDP and growth. On the other hand, there are some pests which are rather harmful then useful for crops. If unknowingly pesticides are applied it could effect on those pest and environment as well.

It's not a small issue for farmers and also for the economic side of a country because it's stand with a huge amount of economic yield loss. From the report published by The Food and Agricultural Organization (FAO) shows that losing of 20 to 40 percent crops production every year all over the world is distracted by pests and economically it's costs around \$220 billion and invasive insects around US\$70 billion annually [2]. So, this study of detecting pest keeps a huge demand for the present circumstances.

We are talking about millions of pests, so there have different sizes, different colors and also different shapes and this is making a challenging task for identification and recognition. previously many methods have been applied in the grain fields to reduce invasion the of pests but most of the case it doesn't work properly. Though there are some effectiveness of those method which is not as much useful on the fields. So, now agriculture fields are highly need some advance technology to find out those pests easily and save unwanted use of pesticides cause pesticides are equally dangerous for the crops and the environment.

For this reason, we want to introduce some advance agricultural technology which is applied in Artificial intelligence, information and wireless communication technology in all perspective of agriculture for realizing precision control of pests in the farm fields. Using machine learning and artificial neural networks have been extensively able to solve these kinds of problems by image processing system. Convolutional neural network (CNN) is one of the best systems for detecting pests and identification from the image that which pest it is. We want to develop an application system that uses image processing based on CNN to identify agricultural pests. Our main goal is reducing crop damage as many as possible by using our system.

1.2 Motivation

A massive portion of crops gets destroyed only because of some harmful insects. That not only effect on the farmer also effect on the national growth as well. In a country like ours where agriculture is the most important sector of national economy, this kind of loss is totally unacceptable and highly expensive as well. This is one of the reasons why we got interested working on this project. Besides, to increase the growth of the desired crop so that we can gain better revenue from our agricultural sector is another motivation for us to select this topic for research. Farmers are one of the most neglected people, who arguably provide the most for the country, but achieve the less attention or support in our country. In this circumstance if they get depreciated for the bad crops it is nearly unbearable for them. So, it is really important to work on this topic.

1.3 Rational of the Study

Some of the works that have been done on this area of agricultural, most of them used hand-crafted features like scale-invariant feature transform (SIFT) and the histogram of oriented gradients (HOG). The problem of this approach are the features are decided manually by the person. The problem with the approach is that we cannot be sure that the number of inclinations is a good descriptor for classifying pest images.

On the other hand, here we will train a deep learning model to detect and extract the necessary features for the classification purpose. This is the main usage of Convolutional

Neural Network (CNN) to search for the best feature to classify the images. As in this approach learned features are dragged out automatically to perform a certain task, that's why they are very effective at it. In fact, this approach outperforms the manual approach.

1.4 Research Questions

There is an aggregate question in our overall research followed by some other question having partition of some more focused queries [1].

- What work have been done yet on pest detection publicly in Bangladesh?
 - a) What approach been taken to classify the pest?
 - I. What methodology were adopted?
 - II. What species were targeted?
 - b) How accuracy much accuracy was gained?
 - I. What model have been used for to train the dataset?
 - II. Which model gave the best accuracy?
 - c) How they applied in field level?
 - I. Which data have been used - topical, provincial, international?
 - II. Which institution were involved?

1.5 Expected Output

Detecting agricultural pest is the main goal of this work. A model has been proposed that will be trained by huge amount of pest images and will be able to detect pest from input images with high accuracy.

1.6 Project Management and Finance

No financial aid was received for this research work.

1.7 Report Layout

Remnant of the discussion of the paper is described in following manner. Related work is discussed in section 2. Methodology shown in section 3. Architecture of the used model is given in section 4. Description of our dataset is given in chapter 5. Experimental Result

is shown in chapter 6. Chapter 7 contains error analysis. In chapter 8 we discussed about the Impact on Society, Environment and Sustainability of our work. Finally, chapter 9 includes with Summary and conclusion.

CHAPTER 2

Background

2.1 Preliminaries/Terminologies

Pest Detection, Deep Learning, Image Processing, CNN, Classification.

2.2 Related Works

As it is considered that, agricultural pest puts a huge impact on large portion of agricultural development, researchers, agricultural scientist and agricultural development institute around the globe applied some approaches to detect agricultural pest with a view to agricultural development. Deep learning-centered studies have issued leading point of interest for researchers in recent years.

Liu Liu et al. [3] coined a multi-class pest detection and classification for discerning presence of pest in an input image. They collected around 80k images which consist of over 580k pests. They accrued 75.46% of mean Average Precision. Hulya Yalcin [4] introduced an algorithm to detect and perceive insects in a pheromone trap. The approach was in two stages, first individualize insects from back view then innovate machine learning and feature extraction for recognize various kinds of pests. They used four types of feature extraction methods depend on the outlook and form of the pest then the features were classified by K-nearest neighbor. Dr. Abraham Chandy [5] applied deep learning algorithm to detect insect in coconut tree. They took their data through drone which flies across the field and captures the data and then process it, to warn the farmer about the pest. Peter Gehler et al. [6] worked on denomination arrangement by combining several different feature genres. Their classifier has to decide in which class the image associate with. Here they faced the interior inconsistency, to overcome this problem they favorably assembled a set of different and expletive feature.

Natalia Larios et al. [7] in their paper they tried to build up an automated architecture to identify stonefly larvae with a view to monitoring the freshwater stream health. Their whole operation was based on two steps training and classification. They used two portion of image and they to increase the accuracy the of their classifier they made three

partitions in their data set. They manage to achieve 95% accuracy from their classifier. Shahrul Nizam Yaakob et al. [8] tried to apply various type of moment invariant technique with a view to classifying the feature vectors for pest classification. Their whole work was based on Quality threshold ARTMAP which usually based on FAM-NN and QT clustering. With Krawtchouk Moment Invariant (KMI) technique they achieved around 99% classification accuracy. Chengjun Xie et al. [9] introduced a process where they tried to recognize pest or insect. To combine different features of insect they used multiple task sparse representation. They also used MKL to fuse multiple features. They used two different public dataset and used some several methods alongside their own. They manage to achieve 97.2% categorization accuracy for dataset 1 and 90.3% for dataset 2 with their developed method. Chengjun Xie et al. [10] they tried to classify pests of field crops by using multilevel unsupervised feature learning methods. They tasted 40 common pest manners to test their classifier model, which outperform state of the art model. They successfully achieved 89.3% classification which gives nearly 8% accuracy more than ACFCI.

Luis O. Solis-Sánchez et al. [11] implemented machine vision system to identify pest in crop and take proper decision to stop damage in greenhouse. They used LOSS V2 algorithm as the extended version of LOSS algorithm which they previously worked in. After identification they used a processing technique that produce more accurate detection, the technique is scale invariant feature transform.

2.3 Comparative Analysis and Summary

In paper [6] & [9] they both combined feature for multiclass object classification. In both paper Multiple Kernel Learning is used to combine multiple features, which can linearly combine similar functions among the images. Though they used the same technique for feature combination, but their approach was different. In [6] Peter Gehler et al. included several methods into a single model. They used baseline, MKL and boosting approach. They also showed their training procedures. However, they improved their performance using LP- β which consistently outperforms the other methods. On the other hand, in [9] Chengjun Xie et al. their approach was formed in three sections sparse representation,

sparse coding, applying MKL for pest classification. Their proposed model outperforms the other models they compared which includes SC, NSC, SVM so forth.

In [8] & [10] they also worked on pest classification though their approach is quite different. In [8] Shahrul Nizam Yaakob et al. they used different invariant technique to drag out the features of pest. They achieve the most accuracy using Krawtchouk Moment Invariant technique among all the other techniques. To getting higher accuracy they adopted several normalization techniques. On the other hand, in [10] Chengjun Xie et al. adopted learned feature where different features of pest are learned from a huge number of images.

In [3] Liu Liu et al. they tried to detect pest of multiclass. Using CNN, they tried to extract the different features of pests. To identify the region of the pest in the image they used Region Proposal Network (RPN). They manage to achieve 75.46% mAP.

2.4 Scope of the Problem

As being an agricultural country pest detection has a numerous number of scopes to be implemented. In paddy field every year a lot of grain gets lost due to some paddy pest. Besides, some other field like cornfield, coconut tree, wheat field and other fruit field like mango, jackfruit and so forth.

2.5 Challenges

One of the most challenging problems of that research concerns with the collection of images of different kind of pest images and in a large number of amounts. Another section of concern is the quality of images. Because of bad quality of the efficiency will be decrease in a noticeable margin. Besides we have to collect several species of pest that are very rare in this region. Also, the variation of the pest in same species is also a matter of challenge.

CHAPTER 3

Research Methodology

In this project, for detection the pest, we take our dataset into two categories to facilitate our work. One of which is the train dataset and the other is the test dataset. First, we augmented both of our datasets. Because in order to fit our dataset into a model and train all our images, it is very important to take all the images with same features. Then the most important thing, which is to train the CNN model. We did this using our augmented data. Finally, we counted our accuracy by fitting our test dataset to our trained model.

3.1 Research Subject and Instrumentation

The main purpose of our research is to classify paste. Paste classification is a daunting task. Because there are so many species of pests all over the world. To classify paste from such a large group, it is necessary to collect a lot of image data. Because we worked on image processing in this paper. We have basically divided the paste into 9 categories. They are aphids, armyworm, beetle, bollworm, grasshopper, mites, mosquito, sawfly, stem_borer. For this we have to shoot many pictures manually. We went to various recharge institutes and shoot images from their fields. We used the Canon EOS 800 The DSLR camera to shoot all these pictures.

3.2 Data Collection Procedure/Dataset Utilized

The most important task for our project is to collect data. Most of our dataset's data has been collected from Kaggle.com. Some data has been collected from various websites. And the rest of the data collection we have collected by taking pictures manually so that the dataset is much bigger. Because the larger the dataset, the greater the accuracy.

At the very outset we collected some pest data from of different species. Here we tried to collect all kind of pest data which are responsible for agricultural damage and we skipped

some species which are not responsible for damage. We took these data in a different folder so that we can easily call them for training. We have collected our dataset from Kaggle [12] Data set of pests for training is displayed in Figure. 5.

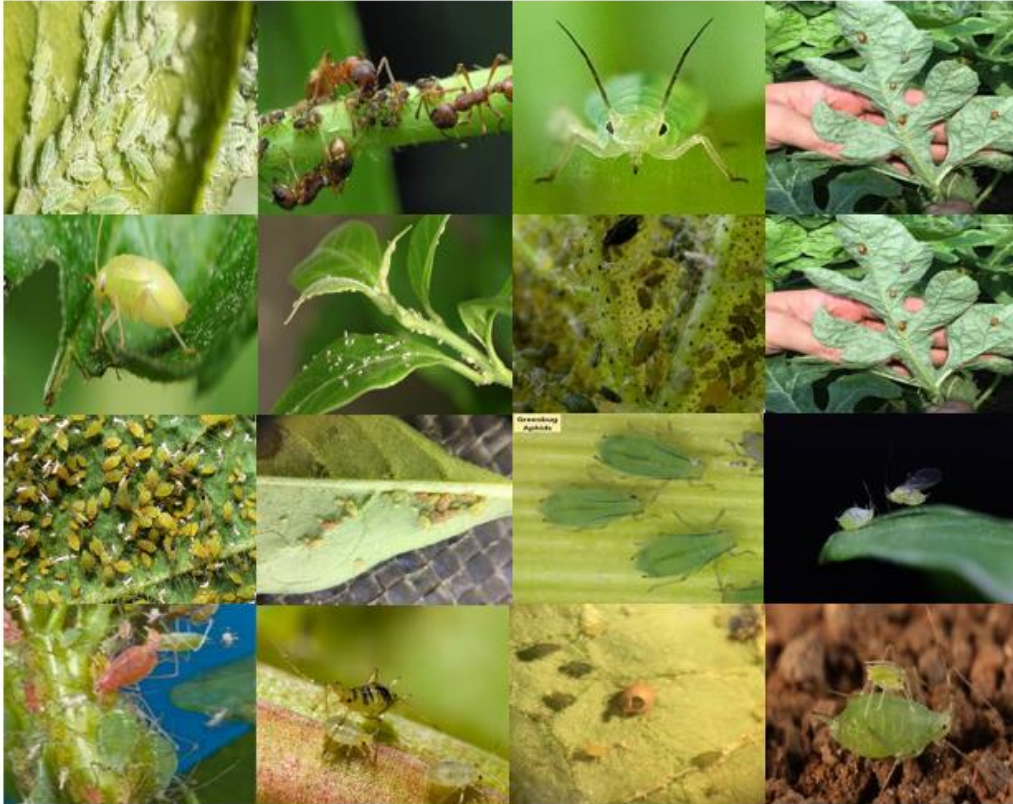


Figure 3: Data sample of pest for training.

We took some data to identify the accuracy of our model in the test folder. In this context we collected the same species as we took for training. We collected this dataset from the

same open-source platform Kaggle [12]. The data set only consist of those data which are doing damage in crops field.

Data set of pests for training is displayed in Figure. 6.



Figure 4: Data sample of pest for testing.

3.3 Statistical Analysis

We have used 9 types of pest image in our project. They are aphids, armyworm, beetle, bollworm, grasshopper, mites, mosquito, sawfly, stem_borer. For evaluate or model we

split out dataset into two categories as train and test. In test dataset we used 50 images in each category, while the train dataset we used 300 images in each category. As a result, the number of our dataset images stands at 2960, which is enough for give better accuracy. However, the dataset has been enlarged by augmenting the dataset to increase the accuracy.

3.4 Proposed Methodology/Applied Mechanism

Deep Learning, a highly powerful tool. It can control the big size of data. ‘Convulsive Neural Network’, This is what we commonly call 'CNN'. It's mostly applied in image processing. Research on the ‘Convulsive Neural Network’ was done in the 1980s. evolutionary network is made up of ideas about how neurons work in our visual cortex. This is why the architecture of this network is different from normal neural networks. The word convolution comes from arithmetic which means a mathematical combination of two functions whose outcome is a third function. Convulsion is the process of bringing two sets from input together.

Augmentation means to increase. Data augmentation is a process by which we can transform images. The most important task of deep learning is to train the model. Which is done through the dataset. The more data we can train a model, the more accuracy we will get from that model. And that's why we've augmented our data to further enhance and enrich our dataset. And so, we used zca_epsilon, rotation, width_shift, height_shift, shear, zoom, fill, horizontal_flip and verticle_flip in our images.

After completing the above processes, the important task for us is to re-train our pretrain model with our augmented data. For which we have fitted the augmented data to the model. After completing the pretraining of the model, we brought out our accuracy by evaluating the test dataset to that model.

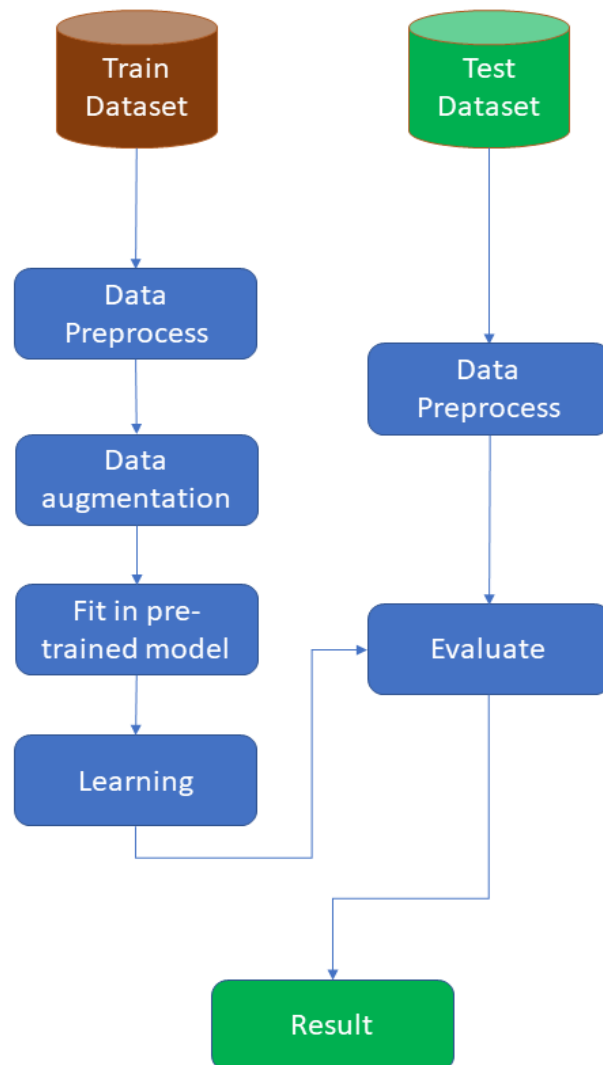


Figure 1: Augmentation and training as a flow diagram.

CHAPTER 4

Experimental Results and Discussion

4.1 Experimental Setup

In this section we are looking forward to explaining the whole process of our model. Which was designed with a view to solving a very common real-world problem. We proposed a CNN based architecture for this context. We have used a pretrained model MobileNet-v2 from ImageNet which consist of 53 layers. Our model usually depends on inverted residual structure. In this model we have two blocks first one is residual block. This model is consisting of 8 layers of those two blocks. Capability of a linear classifier on the non-zero volume part of the output domain. Here capacity of our linear classifier on the non-zero volume is the part of the output. Here we have an expansion factor t , and t is similar for all the main experiments. If the input gets n channels the internal output gets $n \cdot t$ channels [13].

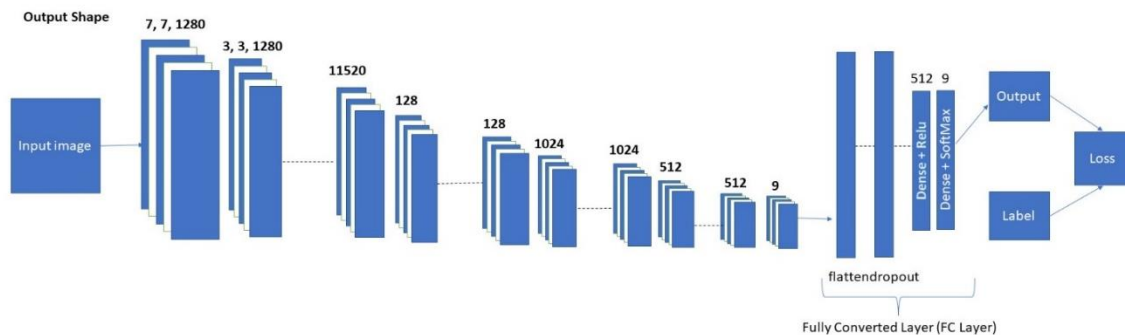


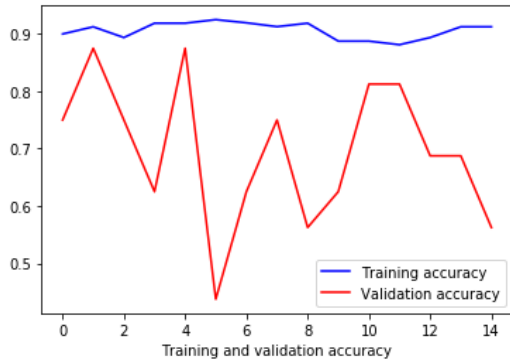
Figure 2: Architecture of our model.

4.2 Experimental Results & Analysis

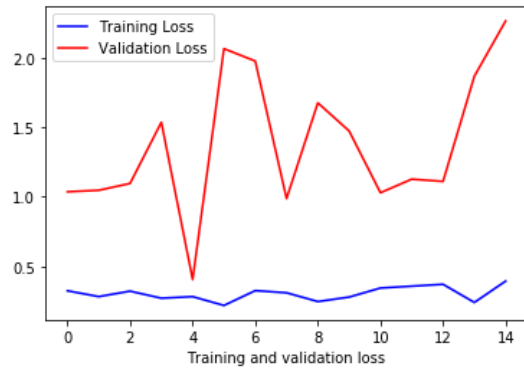
Table-1 which is signifying our accuracy and loss value for the training and validating from our model. Where 1, 3, 5, 6, 9, 11, 13, 15th epochs are shown with accuracy and loss value for validating and training. We can see from the values of epochs that whenever the accuracy increases, the amount of loss decreases because in this case the efficiency of our model increases. As a result, we've been able to pull out 90% of the accuracy from our models.

Table 1: Model accuracy and losses on training and validation data

Epoch	Training Accuracy	Training Loss	Validation Accuracy	Validation Loss
1	0.9000	0.3242	0.7500	1.0362
3	0.8938	0.3218	0.7500	1.0964
5	0.9187	0.2823	0.8750	0.4054
7	0.9195	0.3254	0.6250	1.9756
9	0.9187	0.2468	0.5625	1.6752
11	0.8875	0.3441	0.8125	1.0292
13	0.8938	0.3709	0.6875	1.1107
15	0.9125	0.3937	0.5625	2.2644



(a)



(b)

Figure 5: Training vs validation accuracy(a) and Training vs validation loss(b)

4.3 Discussion

We have used MobilenetV2 model in our evaluation. This is a pretreated model. Alone we re-trained this model with our dataset. Then the values we got from its history are what we see in Table 1. From the results we can see that the validation accuracy has increased with the increase of epochs. We've rolled out our model in up to 15 epochs and got 90% accuracy. If we increase the number of epochs more then we will get better results from our model. We used some more models but we were able to get the most accuracy from MobilenetV2. For our dataset MobilenetV2 is the best model.

A very little amount of picture of our dataset of which our model couldn't detect pest because of noise. Often, sun shine make picture over exposed and unclear and sometime lack of sunshine make picture very unclear to read. Often, we have observed that our model couldn't detect the pest successfully because of the background which is very similar to the pest itself. Even often for camera angle our model couldn't detect the pest.

Fig 10. Some photo where our model was struggling to detect pest.

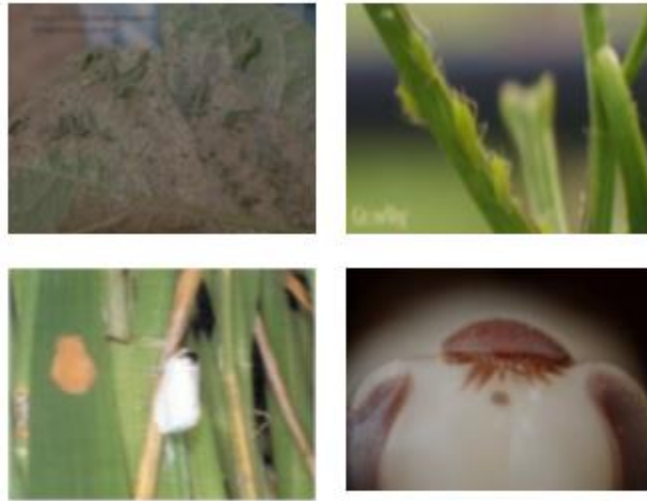


Figure 6: Some photo responsible for error.

CHAPTER 5

Impact on society, Environment and Sustainability

5.1 Impact on Society

Every Year a lot of crops are ruined just because of pests on the crops and it has a huge impact on the economical side. It also has an impact on society and we can try to reduce its awareness. We hope our work will keep some impact to build this awareness. This work can benefit the rural farmers in their agricultural field and the sufferings will be reduced at least in a little margin. Besides it will be helpful for the national growth and benefit as well. This work can open up the door to the next level digitalized farming as well. If we could properly implement the work in field level it could be the starting of new revolution of modern days agriculture.

5.2 Impact on Environment

By using this research work we can easily detect the pests and it will give us all the information of those pests which it detects and we can easily find which pests are harmful to crops and which are not because, if we find any kind of pests which are not harmful to crops and necessary for the environment, those pests we need to keep alive for environment balance because pests have a huge impact on ecological balance. we detect pests and roughly destroy all of them then it will be very harmful to the environment so by using this application can detect pests and also there will be an identification of destructive and non-destructive pests and it will have a good impact on the environment.

5.3 Ethical Aspects

Detecting pests is the first goal of our research work after that it will show that is it harmful or not if it is harmful then it shows some solution which is the post plan of this application. We will give the solution of chemical use because different people have different ideas to use different types of chemical and some of the chemicals are not good

for crops and the environment also. There will be a section where we will discuss about ethical side of the pest's detection and also the ethical use of chemical.

5.4 Sustainability Plan

We have some aspects of this research work and the first part of the aspects is pest detection after that we have some more plans to do more in this project like it will show which pests are harmful for

crops and which are not then it will give the solution of chemical use like which chemical is to be used in which aspects and we have a plan to improve our model day by day so that we are able to provide something good.

CHAPTER 6

Summary, Conclusion, Recommendation and Implication for Future Research

6.1 Summary of the Study

For this research work, initially we collect the data for this research then we pre-train a model using those collecting data then we re-train it. After re-training this data, we validated our test data that how much accuracy it will give.

6.2 Conclusion

Million metric ton of crops gets wasted only because of some pest and insect which cost huge amount of loss in agricultural section, though there has been huge amount of research done in this context. The main victim of the loss is none other than the rural farmers. From this point of view, here in our research we are proposing a CNN based deep learning approach to detect agricultural pest. Our model can successfully identify the pest from captured photo. Our proposed model accrued 90 percent of accuracy. We are hoping that our proposed model will make some impact on the situation and decrease crops destruction due to pest or insect.

6.3 Implication for Further Study

In this research we working on agricultural pest detection for this work we collected data from Kaggle in this time but we have a plan to use real data in future and in this time, we work only on agricultural field but

we have a plan to work or more field like coconut tree pest detection using drone, flower pest detection etc. In this work we don't get enough accuracy for this reason we want to improve our model and also want to apply more algorithms to improve accuracy.

For the instant solution farmer need mobile application for this reason we have a plan to design a mobile based application with an easier user interface so that farmer can easily find out anything. Further we also have a plan to include an automated crop health detection system it will be very easier for the farmer to identify the crops health then they will get an idea that what to do next.

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