SUGARCANE PLANT DISEASE DETECTION USING DEEP LEARNING

BY

SADIA SULTANA MAZUMDER
ID: 181-15-10721
AND

ABDULLAH MONOWAR
ID: 181-15-11051

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

Supervised By
Mr. Ahmed Al Marouf
Sr. Lecturer
Department of CSE
Daffodil International University

Co-Supervised By
Shah Md. Tanvir Siddiquee
Assistant Professor
Department of CSE
Daffodil International University

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APPROVAL

This Project/internship titled **"Sugarcane Plant Disease Detection Using Deep Learning"**, submitted by Sadia Sultana Mazumder, ID No: 181-15-10721 and Abdullah Monowar, ID No: 181-15-11051 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 4th January 2022.

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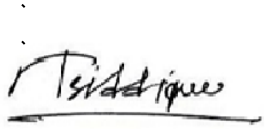
We hereby declare that, this project has been done by us under the supervision of **Mr. Ahmed Al Marouf, Sr. Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

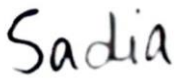
Mr. Ahmed Al Marouf
Sr. Lecturer
Department of CSE
Daffodil International University

Co-Supervised by:



Shah Md. Tanvir Siddiquee
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:



Sadia Sultana Mazumder
ID: 181-15-10721
Department of CSE
Daffodil International University

Abdullah Monowar
ID: 181-15-11051
Department of CSE
Daffodil International University

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ABSTRACT

Bangladesh is an agricultural country and the economy of Bangladesh is dependent on agriculture. Plant diseases are responsible for major economic losses in the agricultural industry worldwide. Sugarcane plant disease is one of them. Sugarcane is the main source of sugar and ethanol. Sugarcane plant disease is mostly known problems in our farmers. In this research, we work on various diseases of this plant to find out the solution and to have some better ways to reduce it. This research helps the farmers to know the diseases of sugarcane. In the first part of the research we collect some related papers, articles and we study about those. Then we collect images of sugarcane for datasets. Collecting images are both disease and healthy plants of sugarcane. We collected almost 2212 sugarcane images. Then we applied Convolutional Neural Network (CNN) as the basic deep learning method in our processed dataset. This helps to classify and detect the disease images. In this work Convolutional Neural Networks (CNN) achieve a best accuracy of 99.46 %.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Sugarcane is one of the most valuable crops cultivated in tropical and subtropical regions in the world. It is the main source of sugar which is an adaptable and irreplaceable functional ingredient in food and also provides the sweetness of foods. The most significant among these are that added sugar in foods acts as a sweetener, preservative, texture modifier, fermentation substrate, coloring and flavoring agent, bulking agent [1]. Sugarcane juice is also the most popular drink in all over the world. Sugarcane is also the source of bioethanol and power. Almost hundreds of countries cultivated sugarcane and it's also their vital crop. Sugarcane is the major cash-cum industrial plant in Bangladesh. It is the only source of white sugar. In Bangladesh sugarcane is filled in around 0.38 million sections of land. The yearly creation of sticks is around 5.5 million m tons [2]. Despite the fact that sugarcane is filled in practically every one of the regions of the country, the chief developing regions are Chittagong, Comilla, Sylhet, Dhaka, Faridpur, Jamalpur, Kishoreganj, Tangail, Jessore, Kushtia, Bogra, Dinajpur, Pabna, Rajshahi, and Rangpur. Diseases found in a sugarcane plant are a main pressing issue and danger to ranchers that Triggers a financial effect. If the cultivation of these plants reduces, there is a bad impact on the economy. Its growth time it suffers from several diseases. The main diseases are red rot, borer, wilt, rust, smut, pineapple disease and chlorosis. In this research, we mainly work on (1) Red rot, (2) Borer, (3) rust, (4) Wilt and also (5) Healthy sugarcane. We use some methods to detect the diseases. Detecting and classifying sugarcane diseases has played a vital role in making such diseases unavoidable. We apply here Convolutional Neural Network (CNN) to classifying and detecting diseases. In deep learning, Convolutional Neural Network (CNN) is used for image classification and detection because of its high accuracy. The CNN method includes a deep learning method that utilizes artificial neural networks. The dataset is made out of 5 classes of sugarcane images in which 4 have the kind of diseases and one to the healthy class.

1.2 Motivation

In Bangladesh's perspective sugarcane plant disease is the most known problem for our farmers. The current creation of sugar in Bangladesh is just around 5% of absolute interest. Around 20% interest is satisfied by jiggery creation basically from sugarcane and staying 75% of all out necessity is satisfied by importation [3]. Every year the farmers of our country face losses due to sugarcane diseases. Accordingly, the production of sugarcane is declining and the government has to bring sugar outside of the country. Though before that many steps have been taken, they are not enough. Till now many factors need improvement. These have inspired us and we decided to work on deep learning and detect diseases which can help our farmers to cultivate more sugarcane. We have not seen much work in this field. . That's why we have a plan to apply a deep learning method to detect disease of sugarcane.

1.3 Rationale of the Study

We have some great ideas about this research, yet we may not be prepared to do our considerations overall and objectives in the given time span. At present time modern technology is everywhere. That's why the main focus of our research is to find out the diseases of sugarcane and classify them.

Machine learning is a part of artificial intelligence which is a trendy technology to detect and classify diseases in some techniques. Deep learning is a branch of machine learning. It is the high level methods of machine learning that utilizes neural networks that work like the human brain. Deep learning is used for image detection, image classification, acoustic etc. It contains many layers and huge data to process. Convolutional Neural Networks (CNN) is a method of deep learning which can take an input image, to different objects in the image and have the option to separate one from another. CNN methods detect the plant diseases and also classify them. Because of all these, we thought that we should apply the Convolutional Neural Networks (CNN) method of deep learning.

1.4 Research Questions

- RQ-1: Will this research be able to detect the diseases of sugarcane plants?
- RQ-2: How will this research detect diseases?
- RQ-3: Should we use the deep learning technique properly?
- RQ-4: Is there any way to detect the sugarcane plant diseases?
- RQ-5: Where do we collect data?
- RQ-6: What types of data will be collected?
- RQ-7: Will this research give accurate results?

1.5 Expected Outcome

In this research, we expect it will help the farmers to detect the diseases of sugarcane. By Using this technique, farmers easily know the diseases. The production of sugarcane increases. The agricultural sector will also benefit. It will reduce diseases of sugarcane. More people know about deep learning and it's techniques to detect diseases. Effective deployment of existing or new deep learning algorithms for detecting sugarcane plant diseases. Maybe develop an application which is very easy for farmers.

1.6 Project Management and Finance

In our research project, we collected the sugarcane images from the previous student of our university. In this COVID-19 situation it was so tough for us to manage our dataset. In this project, there was no financial cost because we didn't need to purchase anything in our project. We read a lot of related papers and articles to implement our project. Then we implemented our research project. In this section, we will show the time it took to manage the project. In the following table we will show the measurement of time spent on our research project.

TABLE 1.6.1: PROJECT MANAGEMENT TABLE

Work	Time
Data Collection	3 Months
Papers and Articles Review	3 Months
Experimental Setup	1 Month
Implementation and Validation	3 Months
Report Writing and Documentation	2 Months
Total	10 Months

1.7 Report Layout

- Chapter 1 contains the introduction part of the thesis with its motivation, rationale of the study, research questions, expected outcome and project management and finance.
- Chapter 2 covers preliminaries, related works, research summary analysis, the scope of the problem, and challenges.
- Chapter 3 discusses the workflow of this research, data collection procedure, and statistical analysis, applied mechanism and feature implementation.
- Chapter 4 explains experimental evaluation and some relevant discussions, the outcome of research via numerically and graphically.
- Chapter 5 discusses this research impact on society, environment and plan.
- Chapter 6 provides a summary of this research work summary and future work.

CHAPTER 2
BACKGROUND

2.1 Preliminaries / Terminologies

Sugarcane diseases are a common problem in the whole world. As a result, the production of sugarcane reduces day by day. In the beginning of those diseases, it was not a major concern. But now it is detrimental to the economy. It's tough for the farmers to identify those diseases. So, many researchers work on those diseases and they apply so many methods. They also successfully applied those methods and published many papers. Some of the methods are machine learning approaches, deep learning methods, image processing, Artificial Neural Networks (ANN), Recurrent Neural Networks (RNN), Support Vector Machine (SVM) etc. Those studies are helpful for the farmers. With this condition, we will plan toward resolving the matter. And we decided to apply Convolutional Neural Networks (CNN) which is the basic method of deep learning. For better results, we will be studying other related research and work about these problems.

2.2 Related Works

This literature review part of this research paper will introduce the close past related works done by some researchers on plant diseases detection and classification. To identify the sort of sugarcane diseases, the condition is to recognize the crop species. We studied their research work to acknowledge the processes and methods expressed by them.

Sammy V. Militante et al. [4] used Convolutional Neural Networks (CNN) the methods of deep learning by detecting Sugarcane Disease. They studied 13,842 images of sugarcane to recognize the disease of sugarcane. Their methods detect the disease and recognize them. They used the CNN algorithm. They achieved 95% accuracy in their work.

Prince Kumar et al. [5] has proposed a model for Sugarcane Disease Detection which is based on deep learning methods. They used 4500 images of sugarcane. Their methods are

to detect the disease. Convolutional Neural Networks (CNN), YOLO and Faster-RCNN algorithms are used in their research. And their best accuracy is 93.20%.

Arpan Kumar et al. [6] has proposed a model for Sugarcane Disease Detection and classification using image processing. Their model recognizes the disease approaches of image processing. Here, K-means cluster algorithm, Gray level Concurrence matrix (GLCM) algorithm and Support vector machine (SVM) algorithm were used. They achieved 97% accuracy.

PENG JIANG et al. [7] has worked on Real-Time Detection of Apple Leaf Diseases Using Deep Learning Approach Based on Improved Convolutional Neural Networks. In this research, the apple leaf infection dataset (ALDD), which is made out of research facility images and complex images under genuine field conditions. In this research used Convolutional Neural Networks (CNN) which introduced GoogLeNet Inception structure and Rainbow concatenation. They worked on 26,377 images and successfully detected the apple leaf diseases. They found accuracy 78.80%.

Sammy V. Militante et al. [8] has worked to Plant Leaf Detection and Disease Recognition using Deep Learning. They worked on potato, tomato, apple, sugarcane, grapes and corn plants. They designed a system which detected and recognized varieties of different plants and also detected several diseases of plants. They applied Convolutional Neural Networks (CNN) which was used for classification and detection of plant diseases. They collected 35,000 images of potato, apple, tomato, corn, sugarcane and grapes. After applying CNN method they achieved 96.5% accuracy.

Muhammad E.H. Chowdhury et al. [9] has proposed a model for Tomato Leaf Disease Detection Using Deep Learning Technique. They worked on 18,162 images of tomatoes. They applied here Convolutional Neural Networks (CNN) which is the part of deep learning method. They applied Inception V3, Resnet18, MobileNet and Desnet 201 techniques to classify and detect the diseases. Inception V3 model showed accuracy of 99.2%. DenseNet201 found 98.05% accuracy.

Dor Oppenheim et al. [10] has worked on Image-Based Potato Tuber Disease Detection using deep learning. They used faster R-CNN and low cost RGB sensors under

uncontrolled light conditions. They applied those algorithms to about 2,465 images of potatoes. They found the highest accuracy 97.1% and lowest accuracy 92.56%.

UDAY PRATAP SINGH et al. [11] has proposed a model for Multilayer Convolution Neural Network for the Classification of Mango Leaves Infected by Anthracnose Disease. They collected 2,200 images of mango leaves. They applied Support Vector Machine (SVM), Particle swarm optimization (PSO) and Radial basis function neural network (RBFNN) algorithms. The highest accuracy of the proposed models is 97.13%.

Shivani Sood et al. [12] has worked on an implementation and analysis of deep learning models for the detection of wheat rust disease. Their datasets consisted of 876 images. They used ResNet50 and VGG16 which are the Convolutional Neural networks (CNN) based models. They achieved 99.07% accuracy using the VGG16 model.

Seksan Mathulaprangsan et al [13] has proposed a model for Rice Diseases Recognition Using Effective Deep Learning Models. They used DenseNet and ResNet models of deep learning. They used ResNet50, ResNet101, DenseNet161 and DenseNet169 models. They applied those algorithms on 12,223 images of Rice. DenseNet161 found the best accuracy 95.74%.

2.3 Comparative Analysis and Summary

There is some work previously done about different plant disease detection and classification with the deep learning algorithm and image processing. At this time, the use of deep learning and image processing methods has expanded with the use of rice disease detection, tomato disease detection, mango disease detection, potato disease detection and several plant disease detection. Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Artificial Neural Networks (ANN), Support Vector Machine (SVM) , K-means cluster, Decision tree, Particle Swarm Optimization (PSO) and so many algorithms are randomly used to detect any model. Previously the most used model was Convolutional Neural Networks (CNN) that was used to detect and classify any plant disease. In the given Table 2.3.1 , we show the comparison of different research works .

TABLE 2.3.1: SUMMARY OF RELATED RESEARCH WORK.

SL	Author name	Methodology	Description	Outcome
1.	Sammy V. Militante, Bobby D. Gerardo, Ruji P. Medina	Convolutional Neural Networks (CNN)	Sugarcane Disease Recognition using Deep Learning	95%
2.	Prince Kumar, Mayank Sonker and Vikash	Convolutional Neural Networks (CNN), YOLO and Faster-RCNN algorithms	Research Paper On Sugarcane Disease Detection Model	93.20%
3.	Arpan Kumar, Anamika Tiwari	K-means cluster algorithm, Gray level Concurrence matrix(GLCM) algorithm and Support vector machine (SVM) algorithm	Detection of Sugarcane Disease and Classification using Image Processing	97%

4.	PENG JIANG , YUEHAN CHEN, BIN LIU, DONGJIAN HE AND CHUNQUAN LIANG	Convolutional Neural Networks (CNN), GoogLeNet Inception structure and Rainbow concatenation	Real-Time Detection of Apple Leaf Diseases Using Deep Learning Approach Based on Improved Convolutional Neural Networks	78.80%
5.	Sammy V. Militante, Bobby D. Gerardo, Nanette V. Dionisio	Convolutional Neural Networks (CNN)	Plant Leaf Detection and Disease Recognition using Deep Learning	96.5%
6.	Muhammad E.H. Chowdhury, Tawsifur Rahman, Amith Khandakar, Nabil Ibtehaz, Aftab Ullah Khan, Muhammad Salman Khan, Nasser Al-Emadi, Mamun Bin Ibne Reaz, Mohammad Tariqul Islam and Sawal Hamid Md. Ali	Inception V3, Resnet18, MobileNet and Desnet 201 techniques	Tomato Leaf Disease Detection Using Deep Learning Technique	Inception V3 accuracy 99.2%, DenseNet201 found 98.05% accuracy.
7.	Dor Oppenheim, Guy Shani, Orly Erlich and Leah Tsror.	faster R-CNN and low cost RGB sensors	Using Deep Learning for Image-Based Potato Tuber Disease Detection	97.1%

8.	UDAY PRATAP SINGH , SIDDHARTH SINGH CHOUHAN , (Student Member, IEEE), SUKIRTY JAIN , AND SANJEEV JAIN	Support Vector Machine (SVM), Particle swarm optimization (PSO) and Radial basis function neural network (RBFNN) algorithms	Multilayer Convolutional Neural Network for the Classification of Mango Leaves Infected by Anthracnose Disease	97.13%
9.	Shivani Sood, Harjeet Singh	ResNet50 and VGG16	An implementation and analysis of deep learning models for the detection of wheat rust disease	99.07%
10.	Seksan Mathulaprangsan, Kitsana Lanthong, Duangpen Jetpipattanapong, Siwadol Sateanpattanakul and Sujin Patarapuwadol	ResNet50, ResNet101, DenseNet161 and DenseNet169 models	Rice Diseases Recognition Using Effective Deep Learning Models	95.74%

2.4 Scope of the Problem

Our works mainly on this research are to detect and classify using deep learning algorithms. Our proposed method can detect the diseases and classify them. The sugarcane plant is dependent upon numerous diseases. The most common diseases are red rot, wilt, grassy shoot, smut, leaf scald disease, red striped disease, mosaic disease, rust, borer etc. These diseases are the cause of bacteria, virus and fungal infections. The diseases are spread all over the land of famers. We work with four diseases. Those are Red Rot, Borer, Rust and Wilt. In this section, we will discuss the diseases we use in our research work.

Red Rot: It is one of the most serious diseases in sugarcane. Red rot disease is caused by a fungus whose name is Glomerella tucumanensis. It changes the leaf color. Firstly it affects the leaf from green to orange and then orange to yellow. After that, from bottom to top the leaves are dry. It also damages the internal tissues and intermingled transverse white spots. It mainly happens because of high temperature, environment pollution and higher relative humidity.

Borer: Sugarcane borer frequently is a serious problem of sugarcane. Sugarcane borer means the larva of a pyramid moth that borers in sugarcane. It moreover attacks the stick stalks in the long periods of inadequate precipitation.

Rust: It is also another serious problem of sugarcane. It is caused by a fungus. Rust that spreads very quickly in sugarcane crops. It occurs during spring and early summer. It causes spots on sugarcane leaves. Spots can be black, white, orange, brown and yellow.

Wilt: It is the major disease of sugarcane. It is visible in the canes of 4-5 month age. When it is affected on the sugarcane plant, sugarcane plants are stunted with yellowing and withering of top leaves. It is also a fungal disease.

2.5 Challenges

The main challenges of our research are collecting images of sugarcane for our dataset. We face many problems collecting our dataset. In this pandemic situation, it was more tough for us. When we collected the images from a previous student of our university. But during Covid-19 period, it was so difficult to talk with him. Managing the dataset was also hard for us and it was also difficult for us to separate the dataset images. All things considered, preparing with many layers with various sizes of epoch consumed a long time in our machine. Sometimes we were faced with an error while epochs were running and not running properly in Google colab. We were not familiar with google colab and its setup. So we had to read a lot to solve this problem. We worked hard to solve our problems and motivated ourselves. Our supervisor also helped us so much. Finally we continued our work and got better results.

CHAPTER- 3

RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

The purpose of this study is to diagnose sugarcane disease to benefit the farmers. To do this, we collect many pictures of the effect of sugarcane from the farmer's sugarcane field and try to get a clear idea about the diseases. We used deep learning to do this. CNN is a mighty deep learning algorithm for image analysis for which we used CNN. Here we have worked on four types of sugarcane disease. We divided our images data into four categories before implementation based on the disease. Here we calculated the accuracy, plot accuracy, plot loss, loss value for the CNN algorithm. We have got excellent accuracy in our model.

3.2 Data Collection Process

We use image data as our dataset. Data collection was very challenging for us. In this COVID-19 situation it was so difficult. A previous student of our university also worked in sugarcane. Then we talked to him about the dataset. He helped us to collect the dataset. He gave us his collected picture to help our research. He gave us almost 2212 images of sugarcane. We collect a lot more information from various agricultural researchers who have worked on sugarcane and sugarcane-related crops. This information has made our data related work a little easier. From them, we can know what kind of diseases are caused by sugarcane. Not all pictures are of diseased crops. There are also some healthy pictures. Here we have worked on four diseases: Rust, Wilt, Red rot and sugarcane borer. Below we have added some demo.

Rust

Figure 3.2.1 we see the sugarcane crops Rust diseases syndrome

Figure 3.2.1 :Rust

Red Rot

Figure 3.2.2 we see the sugarcane crops Red Rot diseases syndrome

Figure 3.2.2 : Red Rot

Borer

Figure 3.2.3 we see the sugarcane crops Borer diseases syndrome

Figure 3.2.3 : Borer

Wilt

Figure 3.2.4 we see the sugarcane crops Wilt diseases syndrome

Figure 3.2.4 : Wilt

Healthy

Here we also added some Healthy Images of sugarcane in Figure 3.2.5

Figure 3.2.5 : Healthy Image

3.3 Statistical Analysis

All data sets have been used correctly in this research of convolutional neural networks. About finding the relationship between test data and train data which helps in making predictions its Statistical modeling. The statistical overview of deep learning along a store on testing faith highlighting statistical link on invisible implication of deep learning. We collected a total of 2212 pictures. Where 1766 pictures were taken for training and the remaining 446 pictures for testing. The Image data set is divided into two model test models & train models. All healthy & diseases images contain a sub model. To find an accurate & correct result of the problem the class contains Statistical. Figure 3.3.1 we see the ratio of Test & Train data.

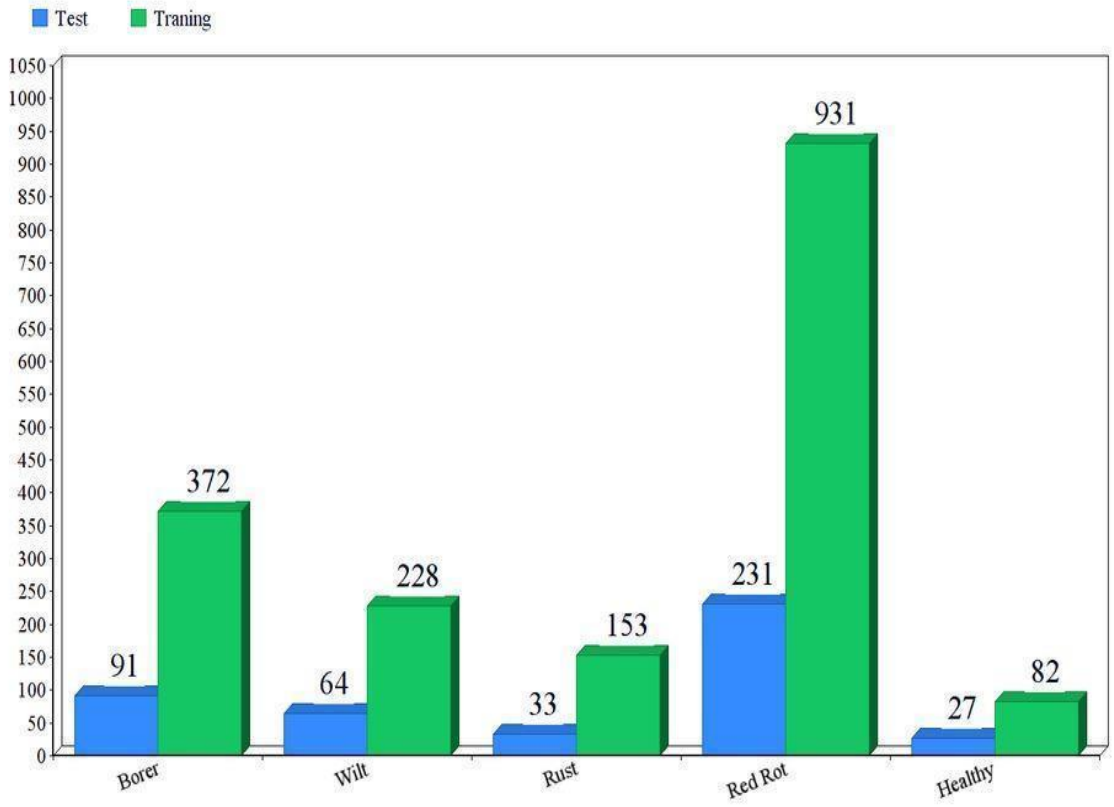

Figure 3.3.1 : Test And Train Data Ratio

3.4 Proposed Methodology

The total working Procedure of making the copy for sugarcane disease by use of deep learning algorithm CNN. It is described in detail here. The whole system is divided into several essential steps, starting with the use of deep neural networks to assign images to the classification system. The process of our work is shown through a flow diagram in Figure 3.4.1. By which it can be understood whether sugarcane is infected or not

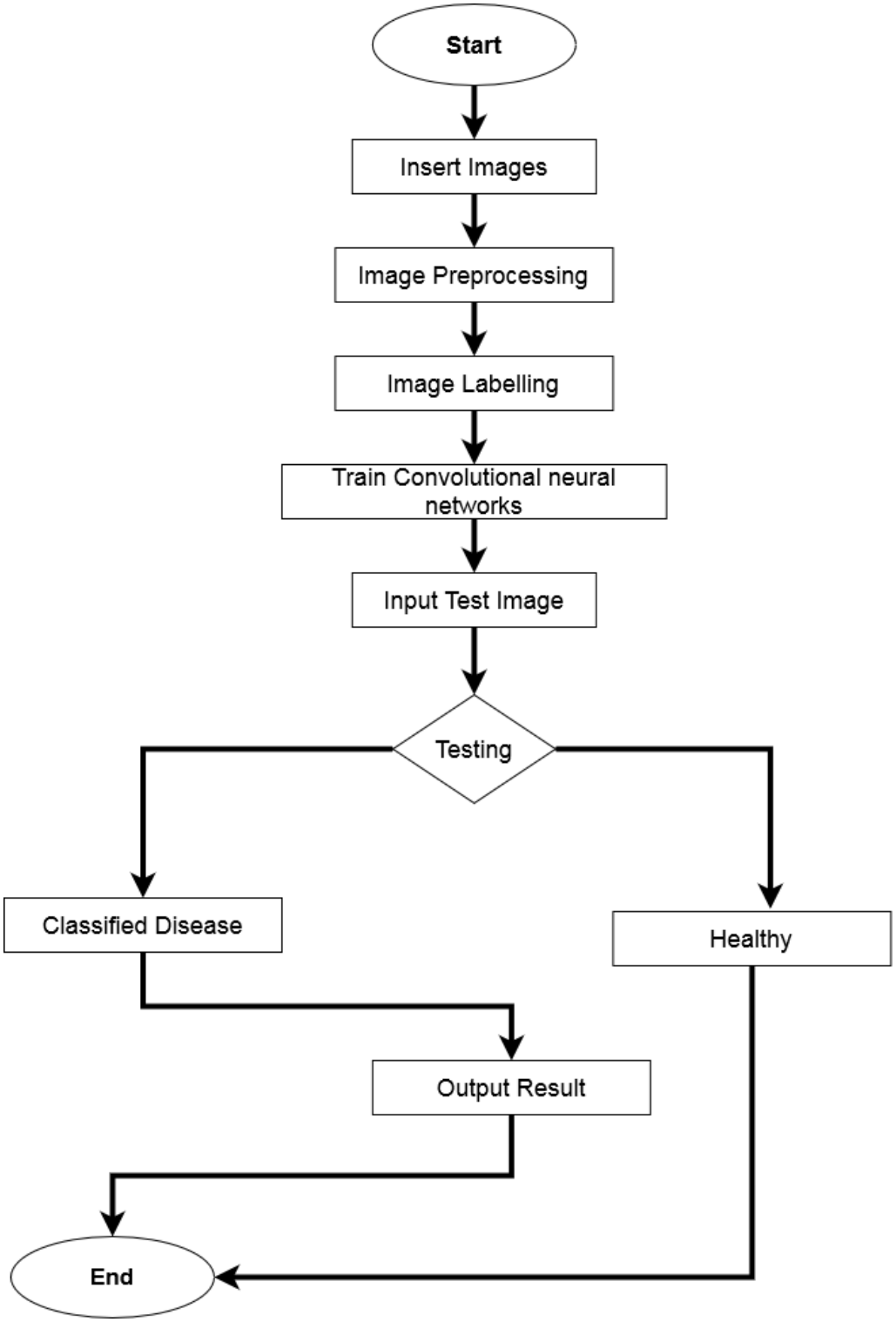

Figure 3.4.1 : Prediction model Workflow diagram

Image Preprocessing and labeling: Image pre-processing is the term for procedure on pictures at the most reduced degree of reflection. These activities don't expand picture data content yet they decline it in the event that entropy is a data measure. The point of pre-processing is an improvement of the picture information that stifles undesired mutilations or upgrades some picture highlights important for additional handling and investigation tasks. Splendor changes adjust pixel brilliance and the change relies upon the properties of a pixel itself. Contrast upgrade is a significant region in picture handling. We confirmed that the pictures' content material all wished for characteristic learning. We have used Brightness corrections, Gray scale transformation for Brightness transformations for images. We have also used image segmentation technique for image preprocessing. We resize the image to 224*224 to restrict the training time. We enlisted the help of sugarcane and sugarcane crop researchers to separate the data by disease name. We also wiped out the copied and unwanted pictures from the dataset. The image data has been classified separately for healthy images.

Train Convolutional neural networks: To find the issue leaves from the Healthy leaves we have utilized Convolutional Neural Network (CNN) technique. For CNN training, first we have to prepare the data. All images on the dataset for CNN training will be the same size. For our dataset we have made all images 224 * 224. In our dataset we have taken 1766 images for training. We have 5 classes in our dataset. The classes are fundamentally unrelated and there is no cross-over between them. We normalize the dataset. In Convolutional Neural Network preparation, pictures are expected to prepare for arrangement. In this segment pictures are being prepared where we utilized pictures in various sickness classes. The CNN process is completed very quickly via ReLU. This strategy is utilized for the result of each convolutional and completely connected layer. Pooling layer is a significant layer of CNN.Pooling layers are utilized to decrease the dimensions of the feature maps. In this way, it lessens the quantity of parameters to learn and the measure of calculation acted in the organization. It makes the model more powerful due to variations in the position of the features in the input image. It controls the overfitting. Mutually ReLUs and dropouts are more helpful. After the convolution process it needs max pooling. Pooling layers give a way to deal with down examining highlights of this

picture and pooling is needed for identifying the image features. The images are then sent to a fully connected layer. This is an essential layer for CNN. which has been effective in acknowledging and classifying pictures. Layers where every one of the contributions of a level are associated with every initiation unit of a higher level. It is separating the image into features and breaking them down freely. This cycle gives the last arrangement decision.

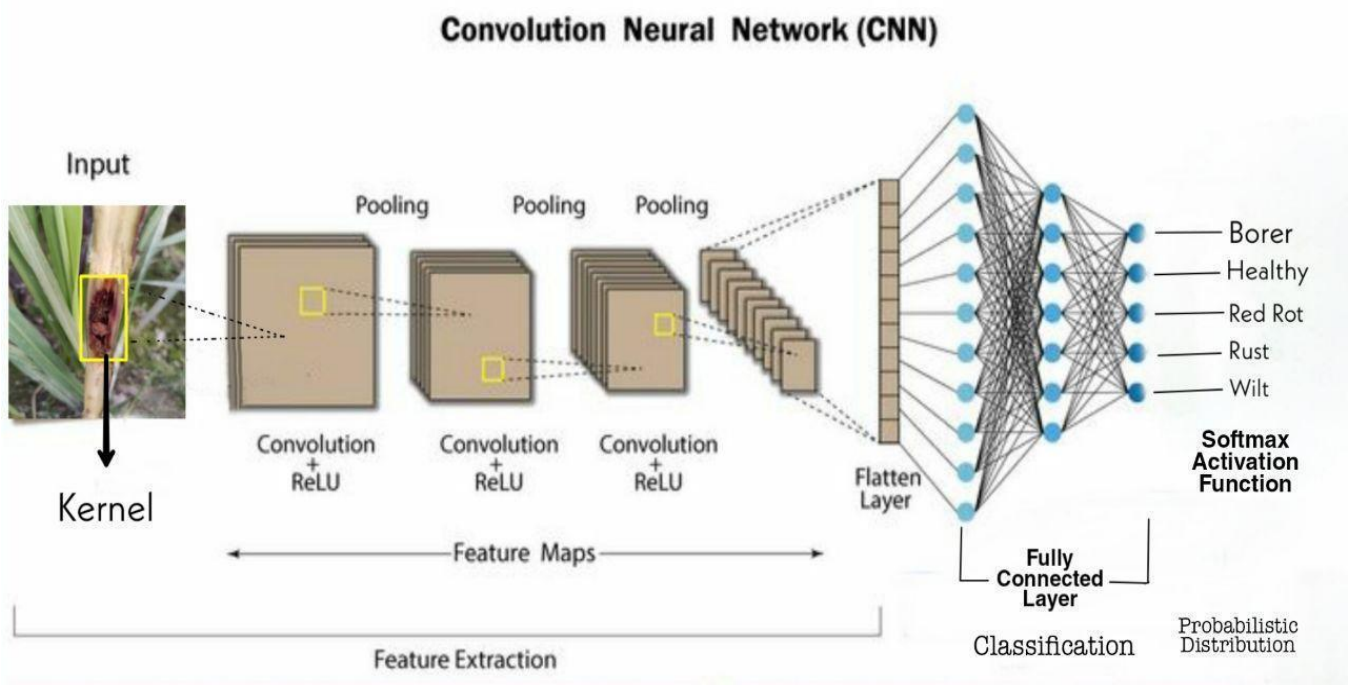

Figure 3.4.2: Convolution process

Testing

Testing is very important because in testing we can understand the performance of our model. We previously trained the informational index by convolutional network process for this reason the data of the training is known. This result picture is checked by the softmax classifier. This classifier is a loss function, in the specific circumstance Machine learning and Deep learning advises us to evaluate how positive or negative a given order term is to precisely arrange main informative items in our informational collection.

3.5 Implementation Requirements

For implementation we have followed some steps. Firstly we need a dataset , to make it we used a mobile camera. We needed an IDE to run the codes. We used google colaboratory as IDE. Google Colaboratory is a very good IDE because all the packages are pre-installed here.Work can be started by only importing the needed package. We also set the runtime as GPU on google colab. We divided our dataset into two sections which were testing and training sections. For the data preprocessing and implementation of algorithms, we mainly used “Google Colab”. Then we completed our implementation and got our result. We got accuracy 99.46%.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

The experiment was performed on Google Colab for preparing the model on the given dataset. It naturally downloads all the libraries from the web, remotely it isn't needed to install any library. Recently it is exceptionally famous for performing deep learning, machine learning and computer vision experiments. GPUand TPU facilities are provided on google colab. In our research, we used a high configuration pc with GPU. Our dataset consists of 2212 images and is divided into five categories. Four categories are affected images and one category is a healthy image. All images were resized to 224×224 pixels. The batch size was set to 16, with epoch equal to 10. It takes much time to complete the epochs. Windows 10 working framework utilized there. At Least 4 GB RAM size pc is fundamental for preparing a profound learning model any other way it won't work as expected. Our pc has 4 GB of RAM and 500 GB of hard disk space. All this analysis we did on our pc.

4.2 Experimental Results & Analysis

This segment talks about the discoveries that have been obtained. The performance of classifier models in classifying the sugarcane images dataset was estimated utilizing a variety of evaluation matrices. We calculated Sensitivity, Specificity, Precision, Recall, Accuracy, F-score and Confusion matrix. Specific classifications need to be measured for this model evaluation.

Sensitivity: Sensitivity detects the true positive value accurately.

Sensitivity = True Positive / (True Positive + False Negative) × 100%

Specificity: Specificity detects the true negative value accurately.

Specificity =True Negative / (False Positive + True Negative) × 100%

Precision: Precision is the ratio of total true positives value which is including true positives and false positives value.

Precision = True Positive / (True Positive + False Positive) × 100%

Recall: The efficiency of a classifier in identifying positive labels is measured by Recall. It measures the number of appropriate positive predictions made out of all positive predictions.

Recall = True Positive / (True Positive + False Negative) × 100 %

Accuracy: Accuracy means the all true value of number in predictions divided by the total number of samples.

Accuracy = (True Positive + True Negative) / Total Number of Samples

F1-score = The weighted average of Precision and Recall is the F1-score.

F1 score = (2 x Precision x Recall) / (Precision +Recall) ×100 %

Below Table 4.2.1 represents the Confusion Matrix.

Table 4.2.1 : Confusion Matrix Of Convolutional Neural Network

Convolutional Neural Network			
Sugarcane Diseases		Predicted Class	
		Healthy	Infected
Actual Class	Healthy	196 (True Negative)	8 (False Positive)
	Infected	4 (False Negative)	2004 (True Positive)

Accuracy: (True Negative + True Positive) / Total number of Samples

In our case Accuracy is (196+2004)/2212=0.994575*100=99.4575 %

Error Rate =(100-Accuracy)% = 0.5425 %

We have run 10 epochs of both training and testing dataset of our research. Our 75% images are training sets and 25% images are testing sets. In every epoch training and testing set show different accuracy and loss value. We found our final accuracy is 99.46%. In the below table we show the accuracy and loss value of our training and testing set.

Table 4.2.2 : Epochs Result Of Train & Validation

Step	Train Loss	Train Accuracy	Validation Loss	Validation Accuracy
1st	1.2797	0.8851	0.2153	0.9865
2nd	0.1499	0.9751	0.0585	0.9955
3rd	0.3294	0.9773	0.0351	0.9955
4th	0.1807	0.9847	0.0038	0.9978
5th	0.0646	0.9938	0.0073	0.9978
6th	0.0057	0.9972	0.0000198	1.0000
7th	0.0868	0.9881	0.1287	0.9843
8th	0.1392	0.9858	0.00040345	1.0000
9th	0.1153	0.9904	0.0090	0.9978
10th	0.0627	0.9943	4.9982e-08	1.0000

In Figure 4.2.1 we can see the Train loss & Validation loss of our model

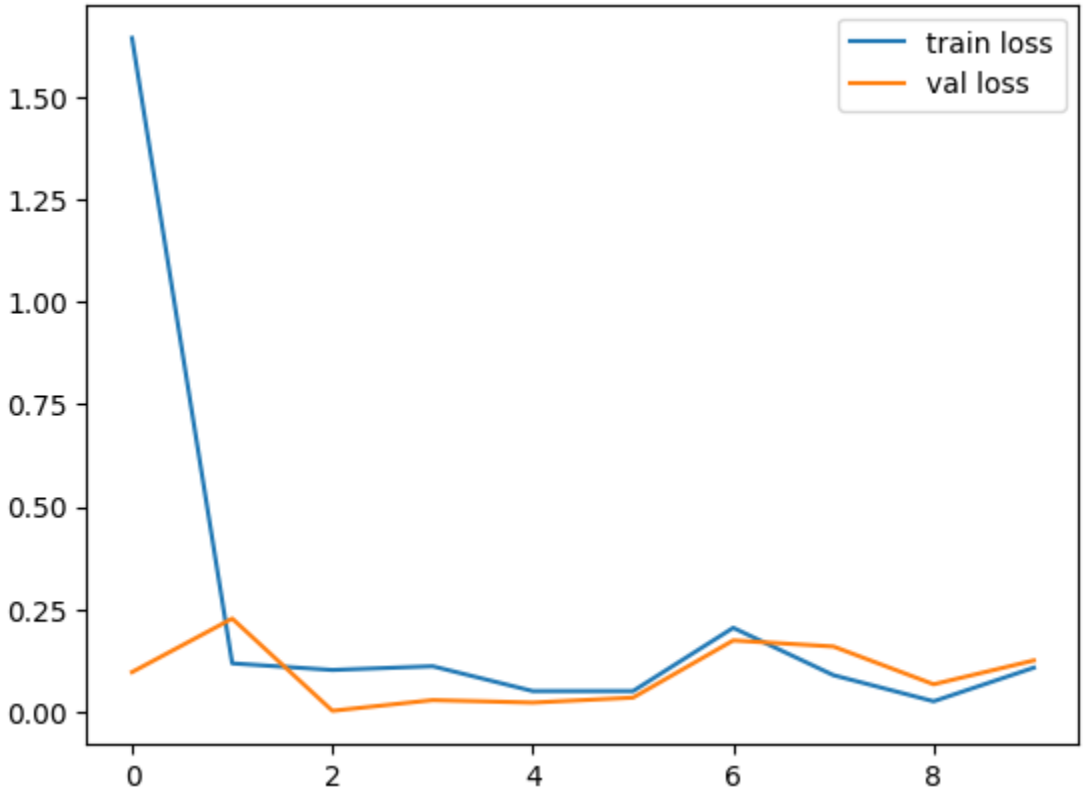

Figure 4.2.1 : Train loss & Validation Loss

In Figure 4.2.2 we can see the Train Accuracy & Validation Accuracy of our model

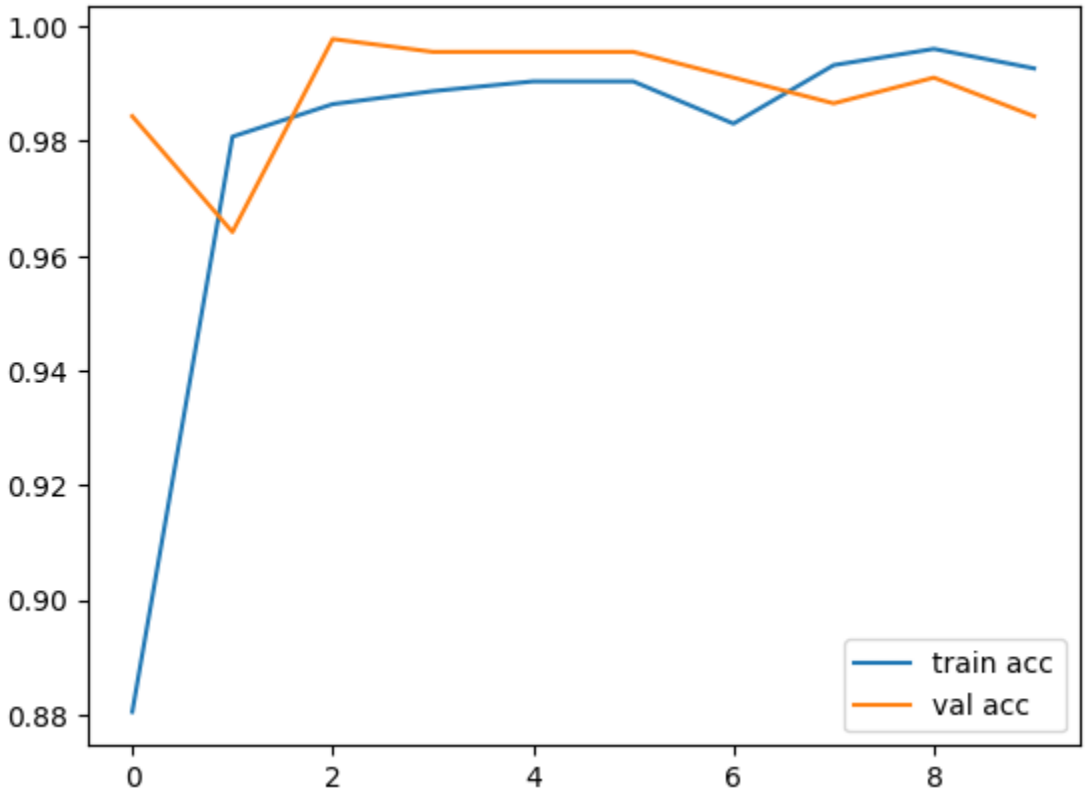

Figure 4.2.2 : Train Accuracy & Validation Accuracy

4.3 Discussion

In this section we discussed the experimental setup of our research and performance of the algorithm, Sensitivity, Specificity, Precision, Recall, Accuracy, F-score and Confusion matrix. We run 10 epochs in our research. In every epoch we showed different accuracy and loss value of training and testing dataset. Our test validation accuracy increased up to 100%. We also discussed the plot of training and validation accuracy and the plot of train loss and validation loss. We did our entire implementation at google colab. We work with Convolutional Neural Networks (CNN) of deep learning methods. It needs a high configuration pc with GPU. We can see here the accuracy of our research is 99.46% . The

validation accuracy and training accuracy graph show the every epochs accuracy result. Training loss is reduced gradually in the train and validation loss graph. And finally, we achieved the accuracy of our research which is 99.46%

CHAPTER 5

Impact on Society, Environment and Sustainability

5.1 Impact on Society

In this research, we execute how to acknowledge sugarcane's infected area. Our research we used a deep learning method that will impact our society positively. It will impact the society by reducing sugarcane crop diseases by detecting sugarcane disease. Farmers can easily find out the disease of the sugarcane plant and can take a step as soon as possible. As sugarcane is a vital crop in our country but it can't fully fill our demand. The demand for sugar, ethanol are high in our country. For this reason, we need to import sugarcane from another country. But if we can protect the crops from various diseases by using this method, farmers can easily know the diseases. When they know about the diseases of sugarcane and control it, the production of sugarcane will increase. Farmers cultivate a lot of sugarcane crops and our industry produces more sugar and ethanol. For this reason, we don't have to import sugarcane from other countries. It will save money and it's also great work for our society.

5.2 Impact on Environment

As we mentioned before in our research we mainly work on our farmers to detect the sugarcane diseases. It will really help our farmers. Our research project will impact the environment both positively and negatively. As far as positive impact is concerned, as a lot of sugarcane crops will survive from diseases the cultivation will increase. Once our country's demand is met, we can also export those to get foreign exchange. As far as negative impact is concerned, after identifying the disease the farmers will surely take action to control those diseases by using a lot of poisonous chemicals and fertilizers that are actually harmful for human beings and the environment will be polluted. That has a negative impact on the environment.

5.3 Ethical Aspects

As sugarcane is a vital crop in our country and it can't fully fill our demand, for this reason, we need to import the sugarcane from another country. But if we can protect the crops from various diseases by using this method, farmers can easily have a control on it and the production of sugarcane will increase. When farmers apply this system, then they cultivate a lot of sugarcane crops. For this reason, we don't have to import sugarcane from other countries because it will save a lot of currency.

5.4 Sustainability Plan

The Sustainability Plan gives us realistic ideas about any research project and future plans. The purpose of our model is to detect the disease of sugarcane. This model has to be targeted to detecting and classifying the sugarcane diseases. So, farmers can easily find the diseases and can take action on the diseases. As a result, the cultivation of sugarcane will increase at a higher rate which will help the farmers.

CHAPTER 6

CONCLUSION, RECOMMENDATION AND FUTURE WORKS

6.1 Summary of the Study

Our research work is divided into some different parts like Data collection, Data preprocessing, implementation and evaluation. Firstly we collected images of sugarcane for our dataset. We collected images from a previous student of our university. He gave us almost 2212 images of sugarcane. We tried to collect more data in our research. But in this pandemic situation it was very difficult to collect so many images. That's why we worked on the previous student dataset. Then we worked on data processing. We divided the data into training and testing. After that, we used google colab for implementation. We used an algorithm to get a good result and good accuracy. We used the CNN algorithm to detect and classify the images. And finally, we successfully did our research and got the best accuracy by using CNN methods. We assure that this research work will be of great use to the farmers. Therefore, our research can be said that CNN algorithm is best for detecting and classifying any plant diseases. And we hope that it will be very helpful for our farmers.

6.2 Conclusion

Agricultural sector is one of the most important sectors in the world where crops are the essential need for food. So, detecting the diseases of crops are helpful to our agricultural sectors. Convolutional Neural networks (CNN) of deep learning algorithms which are used to detect and classify those crops diseases. We worked with CNN and we hope that it will be able to detect and classify the sugarcane diseases. It will really benefit the farmers and also our economical industry. Applying this model, we achieved the best accuracy of 99.46%. Therefore, this study offers an idea of helping farmers using deep learning in detecting and classifying sugarcane diseases.

6.3 Implication for Further study

In the modern age, technology has reached everywhere. It has made life easier than before. In the future, we want to develop an android application. In this way, farmers can easily detect the disease through pictures. In future, we also want to work with more pictures of sugarcane and more diseases of sugarcane. We want to apply new algorithms like Artificial Neural Networks (ANN), Recurrent Neural Networks (RNN), and Support Vector Machine (SVM) etc. And also apply some different models of different algorithms. Applying new algorithms and adding some more models can make our research much more efficient and useful. We also want to work with other plants and detect their disease and classify the diseases.

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APPENDIX

Abbreviation

CNN= Convolutional Neural Networks
DL= Deep Learning

Appendix: Reflections of Research

We had almost no idea about deep learning, artificial intelligence and convolutional neural networks, when we started our research project. We were so worried about our work. Our research became much easier for our supervisor. He was a very nice and kind hearted person. He gave us instructions and he helped us a lot. In our whole research, we learned about new algorithms, new techniques and many new things. We also learned about google colab and python language. Gradually we became more familiar with google colab, python language and so many techniques. After completing this research work, we have gained courage and been inspired to do more in the future.

Sugarcane Disease Plagiarism Report

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