CLASSIFICATION OF IMMUNITY BOOSTER MEDICINAL PLANTS USING CNN: A DEEP LEARNING APPROACH

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Approval

This thesis titled on "**Classification of Immunity Booster Medicinal Plants Using CNN: A Deep Learning Approach**", submitted by Student Name: **Md. Musa** (ID: 171-35-1870) to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Software Engineering and approval as to its style and contents.

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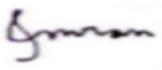

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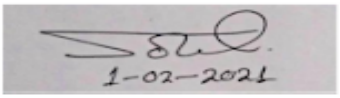

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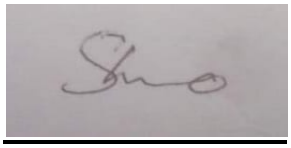

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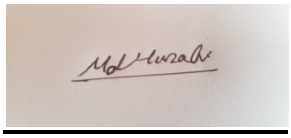

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ABSTRACT

Environment has blessed us with various kinds of plants. Some of them uses as resources of medicines as it is called medicinal plant. In Bangladesh medicinal plants are also known as Ayurvwda, Homeopathy and Unani. Expert says medicinal plants can be very useful in the fight with recent pandemic which is Covid-19. As we know health of a man depends on his immune system, so it is important to keep immunity stronger. Strong immune system can be influential to any infectious virus, bacteria and pathogens. On the other hand inactive one can get easily infected with virus and other illness. There are certain medicinal plants which reinforce our immunity. Therefore classification of these medical plants is very important. In this article we proposed a renowned algorithm called CNN for the classification. We used CNN for recognizing the plant from leaf images and got an accuracy of 95.58%. We believe that people who don't know or can't recognize these medicinal plants, they will able to recognize it in future with our methodology. In future infectious virus can appear which can be more threatening than others, our research will help people to know about immune system and medicinal plants which reinforce our immunity, so that they can fight with diseases and viruses.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Covid-19 has shown us the importance of our immune system .Immune is our most centric benefactor and its prime duty is to keep us healthy and strong. A strong immune system depends on which foods we are taking and if we take foods which are fresh and contain vitamins and minerals, our immune system will be capable of to do its battle against virus, harmful bacteria, toxins and other pathogens. The immune is not a single entity, it's a system. Balance and harmony is main requirements for function it well. Nature has blessed mankind with enormous medicinal herbs which provide timely and suitable remedies to various health disorders. In the time of health crisis like novel Corona virus, the medicinal herbs are enable the people to boost their immunity.[9] Understanding the correlation among immune system, medicinal herbs and Covid-19 in the present time is very necessary. Adequate nutrition is the backbone for the development, maintenance and optional functioning of immune cells in this outbreak of Covid-19.

Based on the principle of plant classification, plants are categorized through plant parts like roots, leaves, flowers and fruits. But in many cases attributes like roots, flowers and fruits don't show much differences in computationally and mathematically. However for species identification leaves are reach resources and some of them boost our immunity and also used in medicinal treatment. World Health Organization (WHO) stated that on the purpose of remedies medical plants are used by 65% to 80% of the world population and there are around 17810 of different medicinal species in the world.[1]

We have collected 920 images from different nursery and botanical garden. The images has six different classes. The local names of this plants are Tulsi, Neem, Tejpatta, Darchini, sojne andpathorkuchi. We crop certain amount of images at very beginning. Then data augmentation has been applied to make the dataset more large to minimize overfitting problem. Because of different shapes of our dataset, we need to make all images into fixed pixels. After that for training purpose we used our own developed CNN architecture. Later we evaluate our training model for unseen data. Data information has given below

Cinnamomumverum (Darchini): We have been using cinnamon in food for so long. The essential ingredient in hot spices is cinnamon. The pair also play a role in enhancing the aroma of food. But we are not aware of its medicinal benefits. None of the people who worked in the cinnamon factory during the Spanish flu pandemic in 1917 were infected with the virus. In other words, eating is far away, being in contact with cinnamon is also good for health. A report from Stanford University claims that cinnamon powder was one of the best medicines to eradicate the Spanish flu at that time. Some were cured by using a small amount of cinnamon oil in their milk. In recent pandemic few doctors also recommend patient to try cinnamon. But it is not proven that cinnamon can cure Covid-19.[14]

Ocimumtenuiflorum(Tulsi): Basil is a plant rich in medicinal properties. Basil is said to be a nerve tonic and it is quite beneficial for enhancing memory. It eliminates mucus problems from the airways. Basil leaves are extremely beneficial for the health of the stomach and kidneys.

Respiratory problems: Basil leaves work like magic when it gets cold. Basil leaves are used for all kinds of throat problems.

Heart disease: Basil leaves contain vitamin C and antioxidants. These ingredients help to keep the heart free from various problems. Basil leaves increase the performance of the heart and keep it in good health.[15]

Cinnamomumtamala(Tej patta): From pies to fish, meat or vegetarian curry ... bay leaves are must. Not only this, with the help of turmeric you can do many things. Increases digestion, which in turn increases the body's metabolism rate. As a result, the weight is reduced a lot. Also, bay leaf expert to reduce flatulence, indigestion, chest irritation. Bay leaves contain antimicrobial ingredients that reduce heart infections. Its antioxidants reduce the risk of heart disease.[17]

Azadirachtaindica(Neem): Neem has many incredible benefits. Neem is very effective in killing viruses and bacteria. And to increase the immunity of the pair match the weight. Neem pata does everything from strengthening the immune system to removing skin blemishes. Apply neem leaf juice on the wound after cutting or burning; Neem leaf juice is very effective in removing body odor and sweat odor.Eliminates gas-indigestion- Neem works very well for long-term problems of gas or indigestion. Protects teeth and gums - Keeps teeth and gums away from any kind of infection. That is why neem are used for cleaning teeth.[13]

Moringaoleifera(Sojne): Scientists think that horseradish leaves are dark in terms of nutrition. Vegetarians can benefit the most from horseradish leaves. In terms of quantity, sagina leaves of the same weight contain 8 times the vitamin-C of orange lemon, 4 times calcium of milk and 2 times vitamin A of carrot, 3 times potassium of carrot and 3 times potassium of banana. Scientists also say that horseradish leaves contain 42% of meat, 125% of calcium, 61% of magnesium, 41% of potassium, 61% of iron, 262% of vitamin A and 22% of vitamin-C, along with many essential nutrients.

One tablespoon of dried horseradish leaf powder provides essential nutrients to children aged 1-2 years with 14% meat, 40% calcium and 23% iron and vitamins. 6 teaspoons of sajna leaf powder daily is able to supply all the calcium and iron required by a pregnant or lactating mother.[12]

Bryophyllum pinnatum(Pathorkuchi): Pathorkuchi leaves help in removing kidney and goiter stones. It controls high blood pressure and relieves bladder problems. Fresh crushed leaves and its juice are very useful to protect against any liver problems. Mixing red chilli with the juice of Patharkuchi leaves gives relief from piles and hemorrhoids.[16]

Around the world high percentage of people use medicinal plants leaves for their primary healthcare. Leaves has no side effects and if we can increase the use of these plants it can decrease the side effects of medicines. Plants are not only used in medical science but it also use as resources of cosmetics and other products also. Large number of industries are heavily dependent on medicinal plants as plants are there main resources of manufacturing. In this time these plants are in the threat of extinction because of deforestation, urbanization and lack of awareness in medicinal plants. According to the Food and Agriculture organization in 2002 the number of medicinal plants were 50,000 and in 2016 according to the Royal Botanic gardens the number is decreasing in high rate and the estimate number is now 17,810 [19]. So it is high time to save these plants for our beneficial concern.

1.2 MOTIVATION OF THE RESEARCH

Medicinal plants not only used in medical science but it also help us to boost our immunity. As immune system is the centric benefactor unit in our body and Its main duty to keep us healthy and strong, therefore Its mandatory for us to look after it. Because with a weak immune system one can easily affected or have a higher risk of experiencing severe symptoms and frequent

infections. A person with a compromise immune system can affected with Bacteria, Viruses, including the viruses that causes the infection of Covid-19. But it is sad that high percentage of people around the world don't about immune system and the role of immune system in our body. There are many research has been done on medicinal plants recognition but there are no such research of medicinal plants which boost our immunity. Our study will help people to know about immune system and its role in our life and it will also help people to recognize those plants.

1.3 PROBLEM STATEMENT

We found that numerous researchers have researched already in this field. They apply various method and there is no common dataset on plant leafs like other plant recognition datasets. We collected data from different nurseries using smartphone camera. We apply CNN method for classify leaf images into six categories Darchini,Tilsi,Neem,Tej patta, sojne and pathorkuchi.

1.4 RESEARCH QUESTIONS

The research questions was

- RQ1: How CNN perform to detect medicinal plants from leaf images.
- RQ2: Classify leaf images in six categories.

1.5 RESEARCH OBJECTIVE

The prime object of this thesis is to build an automated system for recognizing the medicinal plants using our own dataset. Others objectives are:

- To train the CNN model with our training dataset.

- To predict medicinal plant type from unknown test dataset.

1.6 RESEARCH SCOPE

Research gap was found in different papers we have gone through. The accuracy was quite low in some research. Almost all the research was based on only medicinal plants recognition which are used as medicine or the resources of medicine. There are no such research of medicinal plants which increase our immunity. Therefore we have selected those selective medicinal plants and collected their leaves from nurseries to make an automation system of recognition medicinal plants by algorithm called CNN (convolutional neural network).

CHAPTER 2

LITERATURE REVIEW

2.1 PREVIOUS STUDY

A lot of work is being done with medicinal plant images.In medical science plants has huge impact and it is considered as great asset. In 2016 D venkataraman and mangayarkarasi N proposed an automated system based on vision approach which helps a common man on identifying the medicinal plants.Usually plants are classified on leaves features like – shape,colour and texture. Their classification was based on leaves texture. They used GLCM method for classifying the leaves and to find the dissimilarity between the leaves.[2]

Proper identification of the medicinal plants are necessary because it plays an important role on a huge number of stakeholders ranging from physician, botanist, government and common people as well.In year 2017 Adams Begue and VemitheKowlessur collected leaves of 24 medicinal plants species and exterted each leaf on their width, shape, colour, length, perimeter, area and vertices number.They used Random Forest algorithm for their classification and gets 90.1% accuracy. Their anticipation fros this automated recognition was encourage researchers to develop more techniques on species identification and help common pepole to know more about medicinal plants.[3]

Plants are not not only used in medical science it also used in several types of cosmetics and other products as well.Many Industries highly depends on medicinal plants as plants are their main resources. In 2016, PrabhakarPoudel and Shyamdew Kumar proposed an automation sytem for leaf detection. They used optical method for classifying the images.Leaf extraction was based on diverse feature, categorization and pattern identification. They used algorithm called Support Vector Machine (SVM) for classification and Scale Invariant Feature Transformation (SIFT) to extract features.[7]

In 2019 C. Amuthalingeswaran had build a Deep Neural Networks model for the identification of medicinal plants. They used 8000 images for four classes and got accuracy of 85%. They collected their images from the open field land areas.[24]

Plants study known as botany and a botanist daily routine work is examine plants in research lab. In 2019 Nazish Tunio, Abdul Latif Memon proposed an image based algorithm model for extracting the region of interest (ROI) and identify the plants species and recognize the plants particular disease as well. They used Support Vector Machine (SVM) classifier to execute better results and they got accuracy of 93.5% with the leaves dataset which had four different classes. [25]

A.Aakif proposed an algorithm for identification of plants in three stages i) Pre-processing ii) Feature extraction iii) Classification in 2015. Different leaf feature were extracted and these feature became input vector for their build model Artificial Neural Network (ANN). They trained their model with 817 leaf images from 14 different classes and got accuracy of 96% and for checking the effectiveness of the model they trained it with another dataset and also got accuracy of 96%.[26]

In 2017 MM Ghazi used Deep Convolutional Network for identification the plants species. They used popular deep learning architectures like GoogLeNet, AlexNet, and VGGNet and trained it with LifeCLEF 2015 dataset. Their combined system had overall accuracy of 80% on validation set.[27]

Govardhan Jain, Deepti Mittal designed a computer-aided classification system for leaf images of medicinal plants in 2017. The goal of their research was design computer-aided classification system (CAC) to discriminate among various medicinal leaves. They used six leaf classes for shape extraction so that they can obtain high accuracy. They designed two Neural Network(NN) classifiers. First one is radial bases function neural network (RBFNN) and second one is feedforward backpropagation neural network (FFBPNN) and comparative study for the dataset revealed that RBFNN got 92% accuracy and which is 2.7% higher than FFBPNN.[28]

On the other hand in 2013, R. Janani and A Gopal Artificial Neural Network (ANU) classifier to identifie the medicinal plants from leaf images Artificial Neural Network (ANN) was used for less computational complexity and to gain high efficiency. The models gives 94.4% of accuracy after testing on 63 leaf images and which was impressive.[4]

Nowadays medicinal plants are becoming extinct and rare to find because of deforestation, urbanization and less awareness on medical plants.With keep that in mind C. Ananth and Azha. Proposed an automation system of plants identification because manual classification has huge chance of human error.In this research they use MATLAB.They extract leaf images and used models like segmentation, thresholding and applied to neural network[5].

In recent times (2019) digital image Processing for identification of medicinal plants was proposed by P. Chitra and S. JanesPushparani. Speeded Up Robust Feature Transform (SURF) and Scale Invariant Feature Transform (SIFT) both was used for leaf extraction and for distinguishing the structure. They used Support Vector Machine (SVM) classifier to get correct plant identification. [8]

RAJANI S and VEENA M.N proposed an automatic identification and classification of medicinal plants. Create awareness and encourage pepole to know more about medicinal plant is their main goal of this automatic identification. Like many others they only used plant leaves images for the classification but they also used plant flowers, fruits and seeds images for their classification.[6]

2.2 RESEARCH DETAILS AND GAP

We provided details of the other researches of this field so that we can find the gap and can continued the study on the basis of this gap.

TABLE 1: RESEARCH DETAILS

Paper	Year	Author	Objective	Data	Methodology	Conclusion
MediNET: A Deep Learning Approach to Recognize Bangladeshi Ordinary Medical Plants using CNN	2020	Md. Rafiuzzaman Bhuiyan, Md. Abdullahhil-Oaphy[21]	The individual who don't distinguish medicinal plants they will recognize using this methodology	They collected data from different nurseries in Dhaka. They have collected 750 leaf images for five different classes	They have used renowned algorithm called CNN (Convolutional Neural Network	They get accuracy of 84.58%
Medicinal Plant leaf image classification analysis using SVM classifier kernel functions	2019	KAYATHIRI M, KRISHNAVENI K, PONMALAR K [11]	Recognition of medicinal plants	760 leaf images Of 30 classes	SVM(Support Vector Machine)	It gets accuracy of 96% with SVM classifier
Study on identification and classification of medicinal plants	2018	RAJANI S, VEENA M.N	Shown the importance of medicinal plants in recent years and technique description	It is a paper of analyzing image processing techniques	It is a review paper of medicinal plants identification using different technologies	From this literature survey majority researchers get to know about perfect extraction of plants and efficiency of automatic identification

Automatic recognition of medical plants using machine learning techniques	2017	Adams Begue, Venitha Kowlessur, Upasana Singh	To help taxonomists to develop more efficient species identification techniques and also contribute in the protection of endangered species	They collected leaves from 24 different species and photographed using smartphone	Random Forest Classifier, K- nearest neighbors, SVM	They get an accuracy of 90.1% with Random Forest classifier
Recognition of ayurvedic medicinal plants from leaves: A computer vision approach	2017	Amala Sabu, K sreekumar,Rahul R Nair [10]	Many people don't know about medicinal plants and researcher main concern is to preserve this knowledge in digital form with the help of machine learning	Collected different herbal plants from rural areas	SURF and HOG for leaf extraction and k-NN classifier	Get sufficient result for building apps in real life
vision based feature extraction of leaves for identification of medical values of plants	2016	D Venkatarman and Mangayarkarasi N	Create an automated system which identifies the plants and provides its medical thus helping a common man to be aware of the medicinal plants	They collect Indian herbal plants leaves which called Ayurveda	SVM, Probabilistic Neural Network	The feature of leaves can be stored as train data and in feature user gives a dataset and it matches with trained one and give result

			around them			

CHAPTER 3

RESEARCH METHODOLOGY

For this study we use convolutional neural network (CNN) for plant detection. Our working procedure is in figure 1.

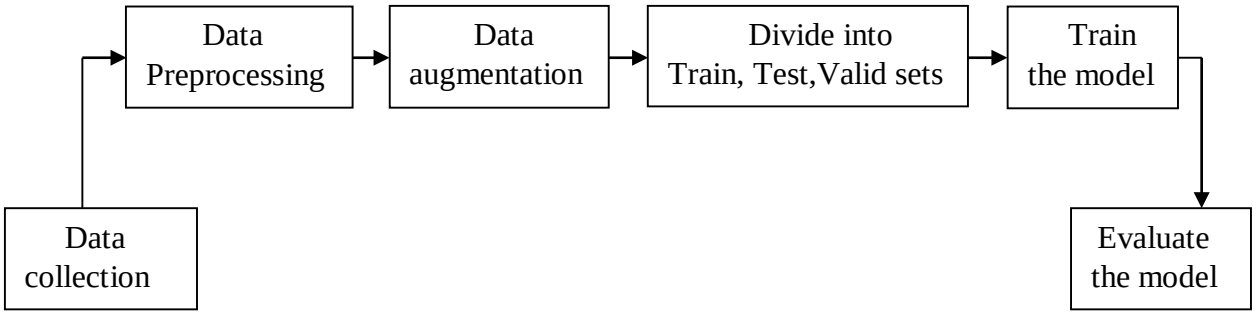

FIGURE 1: WORK FLOW

3.1 DATASET COLLECTION

Different types of medicinal plants leaves are collected from different nurseries and botanical garden in Dhaka. This dataset contains 900 images from 6 different classes. We use 200 images for testing and rest 700 images for training and validation. Now each of them contains 150 images. We have using local names of medicinal plants for our work. The classes of our dataset are:

i. Darchini

ii. Tulsi

iii. Tej patta

iv.Neem.

v. Pathorkuchi

vi. Sojne

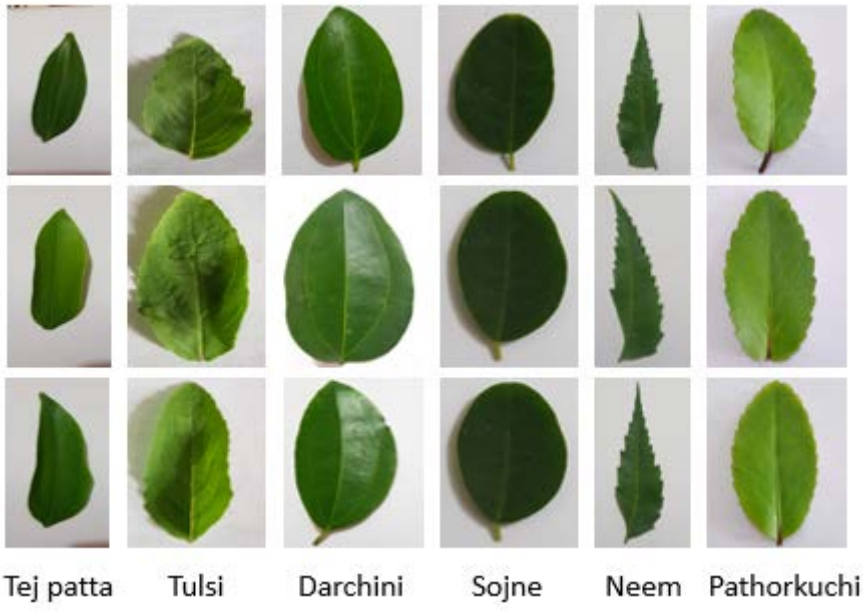

FIGURE 2: SAMPLE OF DATASET

3.2 DATA AUGMENTATION

In limited dataset overfitting is a common problem.We may face overfitting problem as well as our dataset is also limited.we implement data augmentation to eliminate overfitting. Augmentation is actually a artificial process which extend the dataset.In our dataset Augmentation Technique modified version of images is absence. Augmentation was done four way.

i. Rotate 90 degree left.
ii. Height shift range.
iii. Shear by certain amount.
iv. Flip horizontally

3.3 DATA PREPARATION

After finishing augmentation process these data have different shapes. For training and test purpose our proposed model need fixed shapes. Data was resized into 128 x 128 pixels and we used RGB for getting decent accuracy. We separated 20% images for testing and 80% images for training and per class respectively.

3.4 DEEP LEARNING BASED CLASSIFICATION

Artificial Neural Network classification is an unimaginably mainstream approach to solve the problem of pattern recognition. Convolutional Neural Network (CNN) is called fully connected neural network and it was one of the vital components adding to these tests. Out of many advantages of CNN there is a principal advantage which is without human guidance important features are automatically detected. CNN model has two section initial segment is for feature extraction and the subsequent part works for classification. The principal layer will endeavor

to recognize edges and shape a model to identify the edge. At that point rather layers may attempt to consolidate them in simpler ways. Add filter to the image and try to extract the image edges are first layers work. Second layers is called pooling layer and like first layer it also add filter to the image. This layer discovers features more profoundly from the image and layer has RelU functionality which helps to connect following neuron. At that point flatten layer convert 3D image data to 2D data for classification.[20]

Input Layer: In input layer we are passing the raw images, it is dimension of 128x128x3.

Convolution Layer: It is also called as heart structure of CNN. Convolution layer calculates the dot product between height,width of the input layer and the filters. It also contains filters. If the dimension of image is 128x128x3 and number of filter is 24 then dimension of output is 128x128x24.

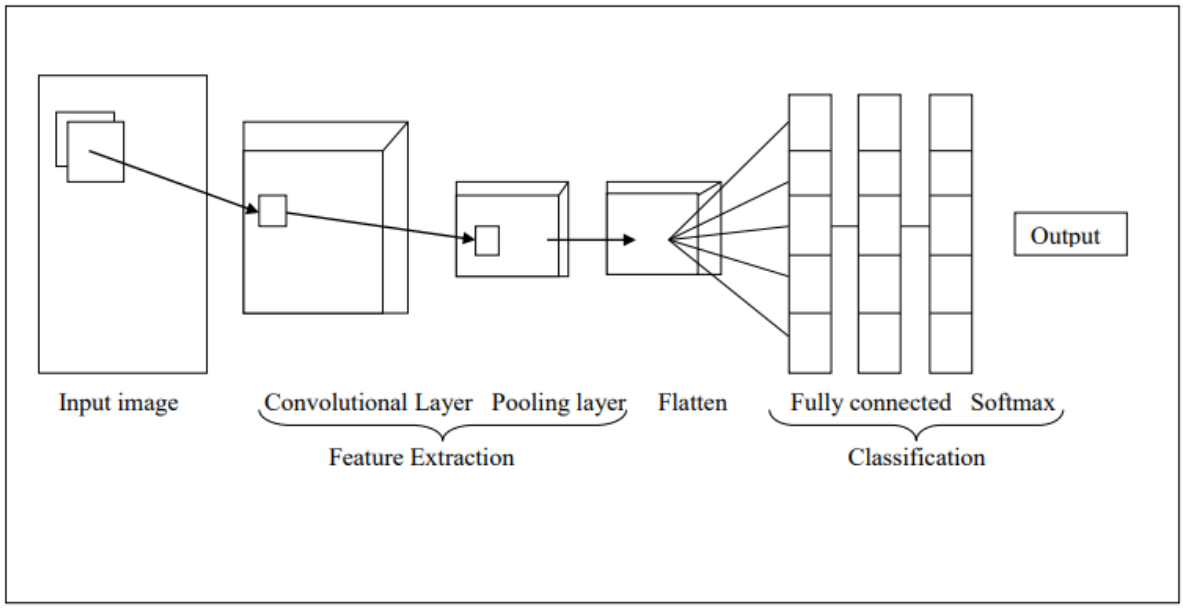

FIGURE 3: THE STRUCTURE OF CNN

Activation Function Layer: Activation are a type of functions and it gives a corresponding output which are fed from an input. Linear and nonlinear activation functions are out there. In our research we utilized a Nonlinear Activation Function called ReLU. ReLU usually convert negative numbers by setting them to zero.

$$F(x) = \max(0, x)$$

Pool Layer: Pool layer comes after activation layer. There are many types of pool layer. Max pooling is mostly used pooling layer and also used it for our task. The primary work of max pooling is reducing the dimension of the images. If pool size 2 x 2 and stride 2 using the max pooling layer, then the output dimension is 64x64x24. Fig. visualization of a max pooling operation

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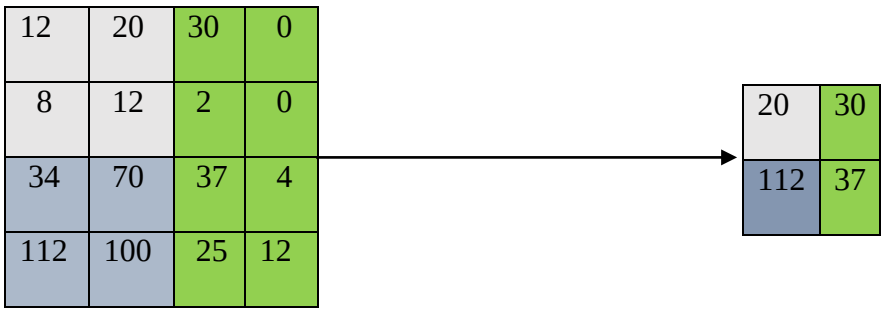

FIGURE 4: 2 X 2 MAX POOLING

Fully Connected Layer: It is the last layer of CNN. It is compositions of the full combination of all the previous layers and it takes input from the previous layers then makes into id vector.

Proposed Model

We developed an architecture for recognizing medical plants. It is 12-layered network. The layers are –

Convolution layer: In our model we use four convolution layer and they are:

i. Convolution 32 – 3 × 3 filter.
ii. Convolution 64 – 3 × 3 filter.
iii. Convolution 128 – 3 × 3 filter.
iv. Convolution 256 – 3 × 3 filter.

Pooling layer: Pooling layer come after covolutional layer. We use four max pooling layer with a pool size of 2 x 2.

Dropout layer: In neural network there are dropping out some units and it is called dropout. Dropout is use for avoid overfitting. Our proposed model has two dropout layers with layer rate of 0.25 and 0.5.

Flatten layer: There are a pooled feature map of 2D vector and this vector create a continuous 1D vector where the process is called flattening. Our model has one flatten layer.

Dense Layer: Dense layer used as a classifier.

3.5 TRAINING THE MODEL

We utilize renowned optimizer called Adam [18] optimizer to prepare our model with a smaller learning rate. It is perhaps the most used optimizer which is faster and more dependable to utilize. For 15 epochs with a batch size of 35 first we need to compile our model and then using fit ( ) method start training our model. As the problem is multiclass classification categorical cross entropy is used for loss function.

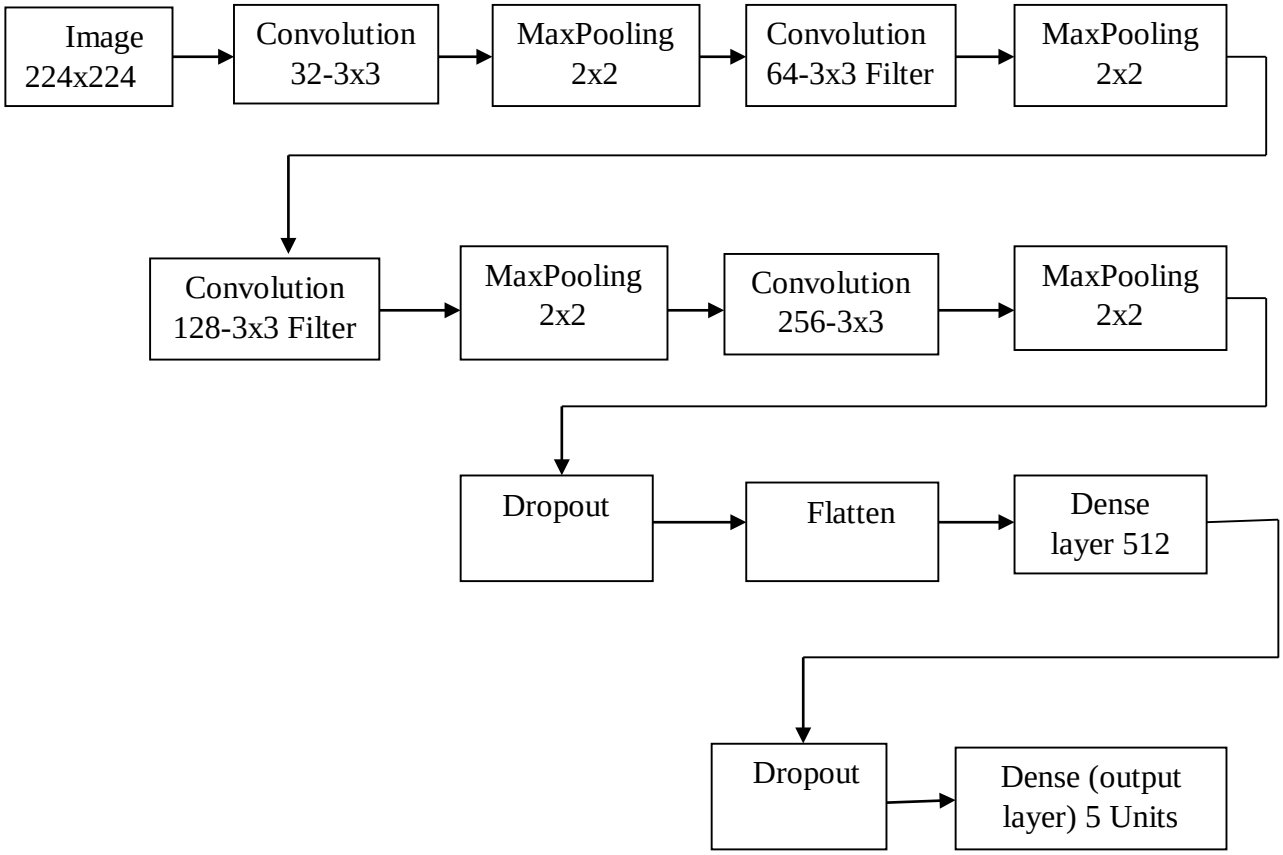

FIGURE 5: PROPOSED MODEL ARCHITECTURE

3.6 EXPERIMENT

Implementation of our model was based on TensorFlow, then the model was trained for 50 epochs 700 of training dataset and validate with 200 dataset and for reducing the cost function we used optimizer [22] ,with three covolutional and pooling layer our model also has one fully connected layer. Activation function ReLU (Rectified Linear Unit) [23] was implied between the convolutional and pooling layers. The ReLU has the simplification structure R[i] = max (I, 0) in its linear functions part. It keeps up just the gainful actuation esteem by diminishing the negative segment to invalid while the implicit max administrator encourages snappier estimation.Filter size 3, pooling size 2,dropout o.25, Phase 1 and zero-padding are hyper parameters. In the last fully connected layer gives the classification of the input. We used optimizer and for the losses calculation we utilized Categorical Crossentropy function, here N is the number of dataset and C is the total number of classes and probability predicted by the value of i, observation to the value of c category.

$$SGC(p,t) = -\frac{1}{N}\sum_{c=1}^{c} 1\, yi \in Cc \log P\, model(Yi \in Cc)$$

.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 ANALYSIS TECHNIQUE

We used python and numerical computation library by google TensorFlow for our analysis. We also used machine learning library scikit learn and as an IDE we used google collabarotery. Convolutional Neural Network was our used method for this study.

Accuracy

The most natural indicator of a performance is mentioned as accuracy. It is just a proportion of accurately anticipated perception to the complete perceptions. We got accuracy of 95.58% that means our model predict leaf image 95% correctly.

$$Accuracy = TP + TN \ \div TP + FP + FN + TN$$

Precision

The word precision means that two or more values of measurement are close to each other. The value of accuracy varies due to observation errors. Used to find the continuity or reproducibility of precision measurements. The characterization of precision is consistent and significant statistical numbers. The result of measuring high-precision means that consistent or repetitive text values are found. Lower precision means the value of the measurement varies. However, this highly precise text does not need to give accurate results. This matrix answers that kind of question “Was the positive classification ratio correct?”

$$Precision = TP \div TP + FP$$

Recall

Recall is the fraction of the total amount of relevant instances of actual recovery. By labeling Recall as real (positive) our model captures how real positive it is. we know that with any high cost associated with False Negative we will be the Recall model metric to select our best model. This matrix answers that kind of question "Was the ratio of actual positives correctly identified?

$$Recall = TP \div TP + FN$$

F1 Score

The exact and remember weighted ranking is known as F1. The score takes all the false positives and false negatives into the account. It is little hard to understand than accuracy; but if ones have an inconsistent class distribution than it is more useful than accuracy.

$$F1\ Score = 2 * (Recall * Precision) \div (Recall * Precision)$$

4.2 PERFORMANCE EVALUATION

In machine learning evaluating the model is very important. It shows how efficient the scoring of dataset has been by a trained model. After finishing training and validation we achieve our result. When we apply the model into training data it is called training accuracy and while we apply model to the test data with different classes it is called validation accuracy.

Figure shows that training accuracy of our model is 95.58% and we maintain our validation accuracy 92% to 95% .

TABLE 2: ACCURACY AND LOSS METRIX

Algorithm	**Accuracy**	**Validation Accuracy**	**Loss**	**Validation loss**
CNN	95.58%	94.5%	0.07	0.08

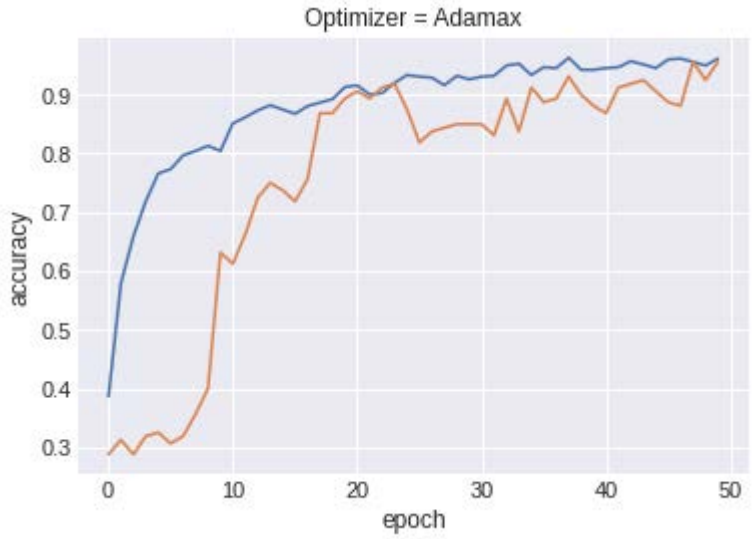

FIGURE 6: TRAINING VS VALIDATION ACCURACY

In Figure we can see the training and validation loss of our model. Our validation loss is 0.08.

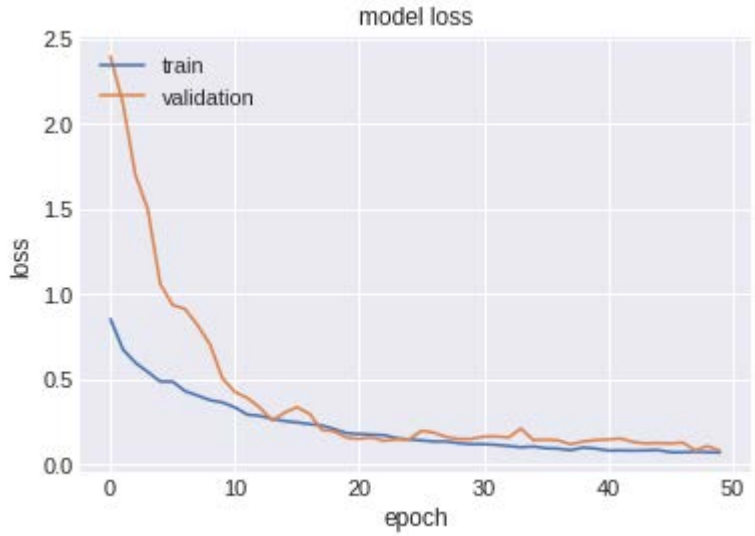

FIGURE 7: TRAINING VS VALIDATION LOSS

4.3 SIMULATION PARAMETER

Throughout our simulation we used optimistic and realistic parameters considering the image combination. We used python as our primary language for simulation process and we also utilized Adam optimizer including an optional learning rate for training optimization.

TABLE 3: SIMULATION PARAMETER

Method	Parameter
Language	Python
Optimizer	SGD optimizer
Learning Rate	0.01
Loss Function	Categorical Cross-Entropy
Performance Matric	Accuracy
Total Class	06
Augmentation	Scale,Rotate,Flip,Shift
Batch size	32

4.4 RESULT DISCUSSEN

The classification report visualizer shows the accuracy, precision, F1, and support scores for the model. To help simpler translation and issue discovery, the report coordinates mathematical scores with a shading coded heatmap. All heatmaps are in the reach (0.0, 1.0) to encourage simple comparison of classification models across various order reports.After all our training process we test our model with 200 data. Table 3 shows the classification report which are calculated from our model. We evaluated precision, recall and f1-score.

TABLE 4: CLASSIFICATION REPORT OF OUR MODEL

Class	**Precision**	**Recall**	**F1-score**
Darchini	0.87	1.00	0.93
Tulsi	1.00	0.93	0.96
Tej patta	1.00	1.00	1.00
Neem	0.94	0.97	0.95
Pathorkuchi	1.00	0.87	0.93
Sojne	0.90	0.93	0.92
Average	0.95	0.95	0.95

CONFUSION MATRIX

Confusion matrix is the summary of predicted result on a classification problem. The quantity of right and inaccurate predictions are summed up with count values and separated by each class. This is the way in to the confusion matrix. It displays the path in which our classification model is confused when it originate predictions.

TABLE 5: EVALUATION MATRIX

	Predicted Class		
Actual Class		Yes	No
	Yes	True Positive	False Negative
	No	False Positive	True Negative

Here,

- TP = True positive
- TN = True Negative
- FP = False Positive
- FN = False Negative

Table 6 shows the confusion matrix of our table

TABLE 6: CONFUSION MATRIX

	Darchini	Tulsi	Tej patta	Neem	Pathorkuchi	Sojne
Darchini	27	0	0	0	0	0
Tulsi	0	27	0	2	0	0
Tej patta	0	0	31	0	0	0
Neem	0	0	0	30	0	1
Pathorkuchi	2	0	0	0	27	2
Sojne	2	0	0	0	0	28

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 FINDINGS AND CONTRIBUTIONS

The goal of this study was to classify the leaf images with Convolutional Neural Network and find best possible accuracy. We collected data from different nurseries in Dhaka city. We collect total 900 leaf images and label image data into their classes darchini, tulsi, tej patta, neem, sojne and pathorkuchi. We tried to fit the data with CNN model. We used 700 images for training and 200 images for test the model and then we evaluated our model with evaluation metrics. For evaluation we used Precision, Recall and F1 score. We got a satisfied result. Hope this study will help people to know about importance of medicinal plants and its uses. Further this research can be helpful to other researcher on future work on this field.

5.2 LIMITATION

In the mean time of Covid-19 it was hard get outside and collects data from different nurseries. Deep learning requires huge number of data for its classification. There was dataset of medicinal plants but plants which boost our immunity were immunity was missing.

5.3 FUTURE WORKS

There are numerous sorts of rmedicinal plants discovered everywhere on the world. Every one of them has its own kind of characteristics which could be cure of numerous sorts of illnesses. Along these lines, we need to future make the dataset bigger with different medicinal plant leaf images and proposed a CNN with more enhancements. Using new advances and progression

in computer vision, we make better solution for treatment. In future individuals are utilize more medicinal plants leafs for their treatment as opposed to medication.

5.4 CONCLUSION

In this paper, our proposed model shows good exactness for restorative plant leaf order. We proposed a model by our own. This strategy performed well on field pictures that we are tried. This work helps non botanist for perceive their longing therapeutic plants. Further it very well may be utilized to group such a restorative leaf and pertinent for regions where leaf order is required.

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system, so it is important to keep immunity stronger. Strong immune system can be influential to any infectious virus, bacteria and pathogens. On the other hand inactive one can get easily infected with virus and other illness. There are certain medicinal plants which reinforce our immunity. Therefore classification of these medical plants is very important. In this article we proposed a renowned algorithm called CNN for the classification. We used CNN for recognizing the plant from leaf images and got an accuracy of 95.58%. We believe that people who don't know or can't recognize these medicinal plants, they will able to recognize it in future with our methodology. In future infectious virus can appear which can be more threatening than others, our research will help people to know about immune system and medicinal plants which reinforce our immunity, so that they can fight with diseases and viruses. . 0. v CHAPTER 1 INTRODUCTION 1.1 BACKGROUND Covid-19 has shown us the importance of our immune system .Immune is our most centric benefactor and its prime duty is to keep us healthy and strong. A strong immune system depends on which foods we are taking and if we take foods which are fresh and contain vitamins and minerals, our immune system will be capable of to do its battle against virus, harmful bacteria, toxins and other pathogens. The immune is not a single entity, it's a system. Balance and harmony is main requirements for function it well. Nature has blessed mankind with enormous medicinal herbs which provide timely and suitable remedies to various health disorders. In the time of health crisis like novel Corona virus, the medicinal herbs are enable the people to boost their immunity.[9] Understanding the correlation among immune system, medicinal herbs and Covid-19 in the present time is very necessary. Adequate nutrition is the backbone for the development, maintenance and optional functioning of immune cells in this outbreak of Covid- 19. Based on the principle of plant classification, plants are categorized through plant parts like roots, leaves, flowers and fruits. But in many cases attributes like roots, flowers and fruits don't show much differences in computationally and mathematically. However for species identification leaves are reach resources and some of them boost our immunity and also used in medicinal treatment. World Health Organization (WHO) stated that on the purpose of remedies medical plants are used by 65% to 80% of the world population and there are around 17810 of different medicinal species in the world.[1] We have collected 920 images from different nursery and botanical garden. The images has six different classes. The local names of this plants are Tulsi, Neem, Tejpatta, Darchini, sojne andpathorkuchi. We crop certain amount of images at very beginning. Then data augmentation has been applied to make the dataset more large to minimize overfitting problem. Because of different shapes of our dataset, we need to make all images into fixed pixels. After that for training purpose we used our own developed CNN architecture. Later we evaluate our training model for unseen data. Data information has given below Cinnamomumverum (Darchini): We have been using cinnamon in food for so long. The essential ingredient in hot spices is cinnamon. The pair also play a role in enhancing the aroma of food. But we are not aware of its medicinal benefits. None of the people who worked in the cinnamon factory during the Spanish flu pandemic in 1917 were infected with the virus. In other words, eating is far away, being in contact with cinnamon is also good for health. A report from Stanford University claims that cinnamon powder was one of the best medicines to eradicate the Spanish flu at that time. Some were cured by using a small amount of cinnamon oil in their milk. In recent pandemic few doctors also recommend patient to try cinnamon. But it is not proven that cinnamon can cure Covid-19.[14] Ocimumtenuiflorum(Tulsi): Basil is a plant rich in medicinal properties. Basil is said to be a nerve tonic and it is quite beneficial for enhancing memory. It eliminates mucus problems from the airways. Basil leaves are extremely beneficial for the health of the stomach and kidneys. Respiratory problems: Basil leaves work like magic when it gets cold. Basil leaves are used for all kinds of throat problems. Heart disease: Basil leaves contain vitamin C and antioxidants. These ingredients help to keep the heart free from various problems. Basil leaves increase the performance of the heart and keep it in good health.[15] Cinnamomumtamala(Tej patta): From pies to fish, meat or vegetarian curry ... bay leaves are must. Not only this, with the help of turmeric you can do many things. Increases digestion, which in turn increases the body's metabolism rate. As a result, the weight is reduced a lot. Also, bay leaf expert to reduce flatulence, indigestion, chest irritation. Bay leaves contain antimicrobial ingredients that reduce heart infections. Its antioxidants reduce the risk of heart disease.[17] Azadirachtaindica(Neem): Neem has many incredible benefits. Neem is very effective in killing viruses and bacteria. And to increase the immunity of the pair match the weight. Neem pata does everything from strengthening the immune system to removing skin blemishes. Apply neem leaf juice on the wound after cutting or burning; Neem leaf juice is very effective in removing body odor and sweat odor.Eliminates gas-indigestion- Neem works very well for long-term problems of gas or indigestion. Protects teeth and gums - Keeps teeth and gums away from any kind of infection. That is why neem are used for cleaning teeth.[13] Moringaoleifera(Sojne): Scientists think that horseradish leaves are dark in terms of nutrition. Vegetarians can benefit the most from horseradish leaves. In terms of quantity, sagina leaves of the same weight contain 8 times the vitamin-C of orange lemon, 4 times calcium of milk and 2 times vitamin A of carrot, 3 times potassium of carrot and 3 times potassium of banana. Scientists also say that horseradish leaves contain 42% of meat, 125% of calcium, 61% of magnesium, 41% of potassium, 61% of iron, 262% of vitamin A

and 22% of vitamin-C, along with many essential nutrients. One tablespoon of dried horseradish leaf powder provides essential nutrients to children aged 1-2 years with 14% meat, 40% calcium and 23% iron and vitamins. 6 teaspoons of sajna leaf powder daily is able to supply all the calcium and iron required by a pregnant or lactating mother.[12] Bryophyllum pinnatum(Pathorkuchi): Pathorkuchi leaves help in removing kidney and goiter stones. It controls high blood pressure and relieves bladder problems. Fresh crushed leaves and its juice are very useful to protect against any liver problems. Mixing red chilli with the juice of Patharkuchi leaves gives relief from piles and hemorrhoids.[16] Around the world high percentage of people use medicinal plants leaves for their primary healthcare. Leaves has no side effects and if we can increase the use of these plants it can decrease the side effects of medicines. Plants are not only used in medical science but it also use as resources of cosmetics and other products also. Large number of industries are heavily dependent on medicinal plants as plants are there main resources of manufacturing. In this time these plants are in the threat of extinction because of deforestation, urbanization and lack of awareness in medicinal plants. According to the Food and Agriculture organization in 2002 the number of medicinal plants were 50,000 and in 2016 according to the Royal Botanic gardens the number is decreasing in high rate and the estimate number is now 17,810 [19]. So it is high time to save these plants for our beneficial concern. 1.2 MOTIVATION OF THE RESEARCH Medicinal plants not only used in medical science but it also help us to boost our immunity. As immune system is the centric benefactor unit in our body and Its main duty to keep us healthy and strong, therefore Its mandatory for us to look after it. Because with a weak immune system one can easily affected or have a higher risk of experiencing severe symptoms and frequent infections. A person with a compromise immune system can affected with Bacteria, Viruses, including the viruses that causes the infection of Covid-19. But it is sad that high percentage of people around the world don't about immune system and the role of immune system in our body. There are many research has been done on medicinal plants recognition but there are no such research of medicinal plants which boost our immunity. Our study will help people to know about immune system and its role in our life and it will also help people to recognize those plants. 1.3 PROBLEM STATEMENT We found that numerous researchers have researched already in this field. They apply various method and there is no common dataset on plant leafs like other plant recognition datasets. We collected data from different nurseries using smartphone camera. We apply CNN method for classify leaf images into six categories Darchini,Tilsi,Neem,Tej patta, sojne and pathorkuchi. 1.4 RESEARCH QUESTIONS The research questions was • RQ1: How CNN perform to detect medicinal plants from leaf images. • RQ2: Classify leaf images in six categories. 1.5 RESEARCH OBJECTIVE The prime object of this thesis is to build an automated system for recognizing the medicinal plants using our own dataset. Others objectives are: • To train the CNN model with our training dataset. • To predict medicinal plant type from unknown test dataset. 1.6 RESEARCH SCOPE Research gap was found in different papers we have gone through. The accuracy was quite low in some research. Almost all the research was based on only medicinal plants recognition which are used as medicine or the resources of medicine. There are no such research of medicinal plants which increase our immunity. Therefore we have selected those selective medicinal plants and collected their leaves from nurseries to make an automation system of recognition medicinal plants by algorithm called CNN (convolutional neural network). CHAPTER 2 LITERATURE REVIEW 2.1 PREVIOUS STUDY A lot of work is being done with medicinal plant images.In medical science plants has huge impact and it is considered as great asset. In 2016 D venkataraman and mangayarkarasi N proposed an automated system based on vision approach which helps a common man on identifying the medicinal plants.Usually plants are classified on leaves features like – shape,colour and texture. Their classification was based on leaves texture. They used GLCM method for classifying the leaves and to find the dissimilarity between the leaves.[2] Proper identification of the medicinal plants are necessary because it plays an important role on a huge number of stakeholders ranging from physician, botanist, government and common people as well.In year 2017 Adams Begue and VemitheKowlessur collected leaves of 24 medicinal plants species and exterted each leaf on their width, shape, colour, length, perimeter, area and vertices number.They used Random Forest algorithm for their classification and gets 90.1% accuracy. Their anticipation fros this automated recognition was encourage researchers to develop more techniques on species identification and help common pepole to know more about medicinal plants.[3] Plants are not not only used in medical science it also used in several types of cosmetics and other products as well.Many Industries highly depends on medicinal plants as plants are their main resources. In 2016, PrabhakarPoudel and Shyamdew Kumar proposed an automation sytem for leaf detection. They used optical method for classifying the images.Leaf extraction was based on diverse feature, categorization and pattern identification. They used algorithm called Support Vector Machine (SVM) for classification and Scale Invariant Feature Transformation (SIFT) to extract features.[7] In 2019 C. Amuthalingeswaran had build a Deep Neural Networks model for the identification of medicinal plants. They used 8000 images for four classes and got accuracy of 85%. They collected their images from the open field land areas.[24] Plants study known as botany and a botanist daily routine work is examine plants in research lab. In 2019 Nazish

Tunio, Abdul Latif Memon proposed an image based algorithm model for extracting the region of interest (ROI) and identify the plants species and recognize the plants particular disease as well. They used Support Vector Machine (SVM) classifier to execute better results and they got accuracy of 93.5% with the leaves dataset which had four different classes. [25] A.Aakif proposed an algorithm for identification of plants in three stages i) Pre-processing ii) Feature extraction iii) Classification in 2015. Different leaf feature were extracted and these feature became input vector for their build model Artificial Neural Network (ANN). They trained their model with 817 leaf images from 14 different classes and got accuracy of 96% and for checking the effectiveness of the model they trained it with another dataset and also got accuracy of 96%.[26] In 2017 MM Ghazi used Deep Convolutional Network for identification the plants species. They used popular deep learning architectures like GoogLeNet, AlexNet, and VGGNet and trained it with LifeCLEF 2015 dataset. Their combined system had overall accuracy of 80% on validation set.[27] Govardhan Jain, Deepti Mittal designed a computer-aided classification system for leaf images of medicinal plants in 2017. The goal of their research was design computer-aided classification system (CAC) to discriminate among various medicinal leaves. They used six leaf classes for shape extraction so that they can obtain high accuracy. They designed two Neural Network(NN) classifiers. First one is radial bases function neural network (RBFNN) and second one is feedforward backpropagation neural network (FFBPNN) and comparative study for the dataset revealed that RBFNN got 92% accuracy and which is 2.7% higher than FFBPNN.[28] On the other hand in 2013, R. Janani and A Gopal Artificial Neural Network (ANU) classifier to identifie the medicinal plants from leaf images Artificial Neural Network (ANN) was used for less computational complexity and to gain high efficiency. The models gives 94.4% of accuracy after testing on 63 leaf images and which was impressive.[4] Nowadays medicinal plants are becoming extinct and rare to find because of deforestation, urbanization and less awareness on medical plants.With keep that in mind C. Ananth and Azha. Proposed an automation system of plants identification because manual classification has huge chance of human error.In this research they use MATLAB.They extract leaf images and used models like segmentation, thresholding and applied to neural network[5]. In recent times (2019) digital image Processing for identification of medicinal plants was proposed by P. Chitra and S. JanesPushparani. Speeded Up Robust Feature Transform (SURF) and Scale Invariant Feature Transform (SIFT) both was used for leaf extraction and for distinguishing the structure. They used Support Vector Machine (SVM) classifier to get correct plant identification. [8] RAJANI S and VEENA M.N proposed an automatic identification and classification of medicinal plants. Create awareness and encourage pepole to know more about medicinal plant is their main goal of this automatic identification. Like many others they only used plant leaves images for the classification but they also used plant flowers, fruits and seeds images for their classification.[6] 2.2 RESEARCH DETAILS AND GAP We provided details of the other researches of this field so that we can find the gap and can continued the study on the basis of this gap. TABLE 1: RESEARCH DETAILS Paper Year Author Objective Data Methodolo gy Conclusion MediNET: A Deep Learning Approach to Recognize Bangladeshi Ordinary Medical Plants using CNN 2020 Md. Rafiuzzaman Bhuiyan, Md. Abdullahhil- Oaphy[21] The individual who don't distinguish medicinal plants they will recognize using this methodolog y They collected data from different nurseries in Dhaka. They have collected 750 leaf images for five different classes They have used renowned algorithm called CNN (Convoluti onal Neural Network They get accuracy of 84.58% Medicinal Plant leaf image classificatio n analysis using SVM classifier kernel functions 2019 KAYATHIR I M, KRISHNA VENI K, PONMALA R K [11] Recognition of medicinal plants 760 leaf images Of 30 classes SVM(Sup port Vector Machine) It gets accuracy of 96% with SVM classifier Study on identificatio n and classificatio n of medicinal plants 2018 RAJANI S, VEENA M.N Shown the importance of medicinal plants in recent years and technique description It is a paper of analyzing image processing techniques It is a review paper of medicinal plants identificati on using different technologi es From this literature survey majority researchers get to know about perfect extraction of plants and efficiency of automatic identification Automatic recognition of medical plants using machine learning techniques 2017 Adams Begue, Venitha Kowlessur, Upasana Singh To help taxonomists to develop more efficient species identificatio n techniques and also contribute in the protection of endangered species They collected leaves from 24 different species and photographed using smartphone Random Forest Classifier, K-nearest neighbors, SVM They get an accuracy of 90.1% with Random Forest classifier Recognition of ayurvedic medicinal plants from leaves: A computer vision approach 2017 Amala Sabu, K sreekumar, R ahul R Nair [10] Many people don't know about medicinal plants and researcher main concern is to preserve this knowledge in digital form with the help of machine learning Collected different herbal plants from rural areas SURF and HOG for leaf extraction and k-NN classifier Get sufficient result for building apps in real life vision based feature extraction of leaves for identificatio n of medical values of plants 2016 D Venkatarman and Mangayarkar asi N Create an automated system which identifies the plants and provides its medical thus helping a common man to be aware of the medicinal plants They collect Indian herbal plants leaves which called Ayurveda SVM, Probabilist ic Neural Network The feature of leaves can be stored as train data and in feature user gives a dataset and it matches

with trained one and give result around them CHAPTER 3 RESEARCH METHODOLOGY For this study we use convolutional neural network (CNN) for plant detection. Our working procedure is in figure 1. Data Data Preprocessing augmentation g Divide into Train, Test,Valid sets Train the model Data Evaluate collection the model FIGURE 1: WORK FLOW 3.1 DATASET COLLECTION Different types of medicinal plants leaves are collected from different nurseries and botanical garden in Dhaka. This dataset contains 900 images from 6 different classes. We use 200 images for testing and rest 700 images for training and validation. Now each of them contains 150 images. We have using local names of medicinal plants for our work. The classes of our dataset are: i. Darchini ii. Tulsi iii. Tej patta iv.Neem. v. Pathorkuchi vi. Sojne FIGURE 2: SAMPLE OF DATASET 3.2 DATA AUGMENTATION In limited dataset overfitting is a common problem.We may face overfitting problem as well as our dataset is also limited.we implement data augmentation to eliminate overfitting. Augmentation is actually a artificial process which extend the dataset.In our dataset Augmentation Technique modified version of images is absence. Augmentation was done four way. i. Rotate 90 degree left. ii. Height shift range. iii. Shear by certain amount. iv. Flip horizontally 3.3 DATA PREPARATION After finishing augmentation process these data have different shapes. For training and test purpose our proposed model need fixed shapes. Data was resized into 128 x 128 pixels and we used RGB for getting decent accuracy. We separated 20% images for testing and 80% images for training and per class respectively. 3. 4 DEEP LEARNING BASED CLASSIFICATION Artificial Neural Network classification is an unimaginably mainstream approach to solve the problem of pattern recognition. Convolutional Neural Network (CNN) is called fully connected neural network and it was one of the vital components adding to these tests. Out of many advantages of CNN there is a principal advantage which is without human guidance important features are automatically detected. CNN model has two section initial segment is for feature extraction and the subsequent part works for classification. The principal layer will endeavor 14 © Daffodil international University to recognize edges and shape a model to identify the edge. At that point rather layers may attempt to consolidate them in simpler ways. Add filter to the image and try to extract the image edges are first layers work. Second layers is called pooling layer and like first layer it also add filter to the image. This layer discovers features more profoundly from the image and layer has RelU functionality which helps to connect following neuron. At that point flatten layer convert 3D image data to 2D data for classification.[20] Input Layer: In input layer we are passing the raw images, it is dimension of 128x128x3. Convolution Layer: It is also called as heart structure of CNN. Convolution layer calculates the dot product between height ,width of the input layer and the filters. It also contains filters. If the dimension of image is 128x128x3 and number of filter is 24 then dimension of output is 128x128x24. FIGURE 3: THE STRUCTURE OF CNN Activation Function Layer: Activation are a type of functions and it gives a corresponding output which are fed from an input. Linear and nonlinear activation functions are out there. In our research we utilized a Nonlinear Activation Function called ReLU. ReLU usually convert negative numbers by setting them to zero. F(x) = max (0, x) Pool Layer: Pool layer comes after activation layer. There are many types of pool layer. Max pooling is mostly used pooling layer and also used it for our task. The primary work of max pooling is reducing the dimension of the images. If pool size 2 x 2 and stride 2 using the max pooling layer, then the output dimension is 64x64x24. Fig. visualization of a max pooling operation . 12 20 30 0 8 12 2 0 20 30 34 70 37 4 112 37 112 100 25 12 FIGURE 4: 2 X 2 MAX POOLING Fully Connected Layer: It is the last layer of CNN. It is compositions of the full combination of all the previous layers and it takes input from the previous layers then makes into id vector. Proposed Model We developed an architecture for recognizing medical plants. It is 12 -layered network. The layers are – Convolution layer: In our model we use four convolution layer and they are: i. Convolution 32 – 3 × 3 filter. ii. Convolution 64 – 3 × 3 filter. iii. Convolution 128 – 3 × 3 filter. iv. Convolution 256 – 3 × 3 filter. Pooling layer: Pooling layer come after covolutional layer. We use four max pooling layer with a pool size of 2 x 2. Dropout layer: In neural network there are dropping out some units and it is called dropout. Dropout is use for avoid overfitting. Our proposed model has two dropout layers with layer rate of 0.25 and 0.5. Flatten layer: There are a pooled feature map of 2D vector and this vector create a continuous 1D vector where the process is called flattening. Our model has one flatten layer. Dense Layer: Dense layer used as a classifier. 3.5 TRAINING THE MODEL We utilize renowned optimizer called Adam [18] optimizer to prepare our model with a smaller learning rate. It is perhaps the most used optimizer which is faster and more dependable to utilize. For 15 epochs with a batch size of 35 first we need to compile our model and then using fit ( ) method start training our model. As the problem is multiclass classification categorical cross entropy is used for loss function. Image Convolution MaxPooling Convolution MaxPooling 224x224 32-3x3 2x2 64-3x3 Filter 2x2 Convolution MaxPooling Convolution MaxPooling 128-3x3 Filter 2x2 256-3x3 2x2 Filter Dropout Flatten Dense layer 512 Dropout Dense (output layer) 5 Units FIGURE 5: PROPOSED MODEL ARCHITECTURE 3.6 EXPERIMENT Implementation of our model was based on TensorFlow, then the model was trained for 50 epochs 700 of training dataset and validate with 200 dataset and for reducing the cost function we used optimizer [22] ,with three covolutional and pooling layer our model also has one fully connected layer. Activation function ReLU (Rectified

Linear Unit) [23] was implied between the convolutional and pooling layers. The ReLU has the simplification structure R[i] = max (I, 0) in its linear functions part. It keeps up just the gainful actuation esteem by diminishing the negative segment to invalid while the implicit max administrator encourages snappier estimation .Filter size 3, pooling size 2, dropout o.25, Phase 1 and zero-padding are hyper parameters. In the last fully connected layer gives the classification of the input. We used optimizer and for the losses calculation we utilized Categorical Crossentropy function, here N is the number of dataset and C is the total number of classes and probability predicted by the value of i, observation to the value of c category. $RFC(l, r) = -N1 \sum cc{=}1\ 1\ yi \in Cc \log P\ llccl(Yi \in Cc)$. CHAPTER 4 RESULTS AND DISCUSSION 4.1 ANALYSIS TECHNIQUE We used python and numerical computation library by google TensorFlow for our analysis. We also used machine learning library scikit learn and as an IDE we used google collabarotery. Convolutional Neural Network was our used method for this study. Accuracy The most natural indicator of a performance is mentioned as accuracy. It is just a proportion of accurately anticipated perception to the complete perceptions. We got accuracy of 95.58% that means our model predict leaf image 95% correctly. $Accrracy = RP + RN \div RP + FP + FN + RN$ Precision The word precision means that two or more values of measurement are close to each other. The value of accuracy varies due to observation errors. Used to find the continuity or reproducibility of precision measurements. The characterization of precision is consistent and significant statistical numbers. The result of measuring high-precision means that consistent or repetitive text values are found. Lower precision means the value of the measurement varies. However, this highly precise text does not need to give accurate results. This matrix answers that kind of question "Was the positive classification ratio correct?" $Prccirill = RP \div RP + FP$ Recall Recall is the fraction of the total amount of relevant instances of actual recovery. By labeling Recall as real (positive) our model captures how real positive it is. we know that with any high cost associated with False Negative we will be the Recall model metric to select our best model. This matrix answers that kind of question "Was the ratio of actual positives correctly identified? $Rccall = RP \div RP + FN$ F1 Score The exact and remember weighted ranking is known as F1. The score takes all the false positives and false negatives into the account. It is little hard to understand than accuracy; but if ones have an inconsistent class distribution than it is more useful than accuracy. $F1\ Rclrc = 2 * (Rccall * Prccirill) \div (Rccall * Prccirill)$ 4.2 PERFORMANCE EVALUATION In machine learning evaluating the model is very important. It shows how efficient the scoring of dataset has been by a trained model. After finishing training and validation we achieve our result. When we apply the model into training data it is called training accuracy and while we apply model to the test data with different classes it is called validation accuracy. Figure shows that training accuracy of our model is 95.58% and we maintain our validation accuracy 92% to 95% . TABLE 2: ACCURACY AND LOSS METRIX Algorithm Accuracy Validation Loss Validation loss Accuracy CNN 95.58% 94.5% 0.07 0.08 FIGURE 6: TRAINING VS VALIDATION ACCURACY In Figure we can see the training and validation loss of our model. Our validation loss is 0.08. FIGURE 7: TRAINING VS VALIDATION LOSS 4.3 SIMULATION PARAMETER Throughout our simulation we used optimistic and realistic parameters considering the image combination. We used python as our primary language for simulation process and we also utilized Adam optimizer including an optional learning rate for training optimization. TABLE 3: SIMULATION PARAMETER Method Parameter Language Python Optimizer SGD optimizer Learning Rate 0.01 Loss Function Categorical Cross- Entropy Performance Matric Accuracy Total Class 06 Augmentation Scale,Rotate,Flip,Shift Batch size 32 4.4 RESULT DISCUSSEN The classification report visualizer shows the accuracy, precision, F1, and support scores for the model. To help simpler translation and issue discovery, the report coordinates mathematical scores with a shading coded heatmap. All heatmaps are in the reach (0.0, 1.0) to encourage simple comparison of classification models across various order reports.After all our training process we test our model with 200 data. Table 3 shows the classification report which are calculated from our model. We evaluated precision, recall and f1-score. TABLE 4: CLASSIFICATION REPORT OF OUR MODEL Class Precision Recall F1-score Darchini 0.87 1.00 0.93 Tulsi 1.00 0.93 0.96 Tej patta 1.00 1.00 1.00 Neem 0.94 0.97 0.95 Pathorkuchi 1.00 0.87 0.93 Sojne 0.90 0.93 0.92 Average 0.95 0.95 0.95 CONFUSION MATRIX Confusion matrix is the summary of predicted result on a classification problem. The quantity of right and inaccurate predictions are summed up with count values and separated by each class. This is the way in to the confusion matrix. It displays the path in which our classification model is confused when it originate predictions. 24 © Daffodil international University TABLE 5: EVALUATION MATRIX Predicted Class Actual Class Yes No Yes True Positive False Negative No False Positive True Negative Here, • • • • TP = True positive TN = True Negative FP = False Positive FN = False Negative Table 6 shows the confusion matrix of our table TABLE 6: CONFUSION MATRIX Darchini Tulsi Tej patta Neem Pathorkuchi Sojne Darchini 27 0 0 0 0 0 Tulsi 0 27 0 2 0 0 Tej patta 0 0 31 0 0 0 Neem 0 0 0 30 0 1 Pathorkuchi 2 0 0 0 27 2 Sojne 2 0 0 0 0 28 CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS 5.1 FINDINGS AND CONTRIBUTIONS The goal of this study was to classify the leaf images with Convolutional Neural Network and find best possible accuracy. We collected data from different nurseries in Dhaka city. We collect total 900 leaf images and label image data into their classes darchini, tulsi, tej patta, neem, sojne and pathorkuchi. We tried

to fit the data with CNN model. We used 700 images for training and 200 images for test the model and then we evaluated our model with evaluation metrics. For evaluation we used Precision, Recall and F1 score. We got a satisfied result. Hope this study will help people to know about importance of medicinal plants and its uses. Further this research can be helpful to other researcher on future work on this field. 5.2 LIMITATION In the mean time of Covid-19 it was hard get outside and collects data from different nurseries. Deep learning requires huge number of data for its classification. There was dataset of medicinal plants but plants which boost our immunity were immunity was missing. 5.3 FUTURE WORKS There are numerous sorts of rmedicinal plants discovered everywhere on the world. Every one of them has its own kind of characteristics which could be cure of numerous sorts of illnesses. Along these lines, we need to future make the dataset bigger with different medicinal plant leaf images and proposed a CNN with more enhancements. Using new advances and progression 26 © Daffodil international University in computer vision, we make better solution for treatment. In future individuals are utilize more medicinal plants leafs for their treatment as opposed to medication. 5.4 CONCLUSION In this paper, our proposed model shows good exactness for restorative plant leaf order. We proposed a model by our own. This strategy performed well on field pictures that we are tried. This work helps non botanist for perceive their longing therapeutic plants. Further it very well may be utilized to group such a restorative leaf and pertinent for regions where leaf order is required. REFERENCES 1. C. H. Arun, W. R. Sam Emmanuel, and D. 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