PLANT DISEASE DETECTION

A Course Project report submitted

in partial fulfillment of requirement for the award of degree

BACHELOR OF TECHNOLOGY

in

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

by

B.HARINI SRI	**(2103A52006)**
B.ANVITHA	**(2103A52007)**
M.VYSHNAVI	**(2103A52023)**

Under the guidance of

Mr. Ramesh Dadi

Assistant Professor, Department of CSE.

Department of Computer Science and Artificial Intelligence

Department of Computer Science and Artificial Intelligence

CERTIFICATE

This is to certify that project entitled **"PLANT DISEASE DETECTION"** is the bonafied work carried out by **B.Harinisri,B.Anvitha,M.Vyshnavi** as a Course Project for the partial fulfillment to award the degree **BACHELOR OF TECHNOLOGY** in **ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING** during the academic year 2022-2023 under our guidance and Supervision.

Mr. D.Ramesh
Asst. Professor,
(CSE), S R University,
Ananthasagar, Warangal.

Dr. M.Sheshikala
Assoc. Prof. & HOD
S R University,
Ananthasagar, Warangal.

ACKNOWLEDGEMENT

We express our thanks to Course co-coordinator **Mr. D.Ramesh, Asst. Prof.** for guiding us from the beginning through the end of the Course Project. We express our gratitude to Head of the department CS&AI, **Dr. M.Sheshikala, Associate Professor** for encouragement, support and insightful suggestions. We truly value their consistent feedback on our progress, which was always constructive and encouraging and ultimately drove us to the right direction.

We wish to take this opportunity to express our sincere gratitude and deep sense of respect to our beloved Dean, School of Computer Science and Artificial Intelligence, **Dr C. V. Guru Rao**, for his continuous support and guidance to complete this project in the institute.

Finally, we express our thanks to all the teaching and non-teaching staff of the department for their suggestions and timely support.

ABSTRACT

The Indian economy relies heavily on agriculture productivity. A lot is at stake when a plant is struck with a disease that causes a significant loss in production, economic losses, and a reduction in the quality and quantity of agricultural products. It is crucial to identify plant diseases in order to prevent the loss of agricultural yield and quantity. Currently, more and more attention has been paid to plant diseases detection in monitoring the large acres of crops. Monitoring the health of the plants and detecting diseases is crucial for sustainable agriculture. Plant diseases are challenging to monitor manually as it requires a great deal of work, expertise on plant diseases, and excessive processing time. Hence, this can be achieved by utilizing image processing techniques for plant disease detection. These techniques include image acquisition, image filtering, segmentation, feature extraction, and classification. Convolutional Neural Network's(CNN) are the state of the art in image recognition and have the ability to give prompt and definitive diagnoses. We trained a deep convolutional neural network using 20639 images on 15 folders of diseased and healthy plant leaves. This project aims to develop an optimal and more accurate method for detecting diseases of plants by analysing leaf images.

Table of Contents

List of figures

INTRODUCTION

1.1 OVERVIEW

Plant disease identification by visual way is more laborious task and at the same time, less accurate and can be done only in limited areas. Whereas if automatic detection technique is used it will take less efforts, less time and become more accurate. In plants, some general diseases seen are brown and yellow spots, early and late scorch, and others are fungal, viral and bacterial diseases. Image processing is used for measuring affected area of disease and to determine the difference in the colour of the affected area. Developed Technologies have provided the ability to produce sufficient food to meet the demand of society. But still, the safety and security of the food or crops remained unattained. Factors like change in climate, the decline in pollinators, Plant disease, and others are challenging to the farmers. An important foundation for these factors needs to be attained on a priority basis . Making use of analysis and detection processes using present technology helps the farmers to get rid of such problems. During pandemic situations like COVID 19 the nation is dependent on the recent technologies to prevent address the issues to reduce the transmission of the diseases. As plant diseases are a significant threat to human life as they may lead to droughts and famines. In turn it results causing substantial losses, where farming is accompanying in commercial purpose. The use of technologies like Computer vision and Machine Learning (ML) helps to fight against disease.

1.2 PROBLEM STATEMENT

Automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring large fields of crops, and thus automatically detect the symptoms of diseases as soon as they appear on plant leaves. The goal of this project is to classify the leaves as healthy and unhealthy where the leaves in healthy represents those without any disease and the leaves in unhealthy represents the presence of disease.

One of the important sectors of Indian Economy is Agriculture. Employment to almost 50% of the countries workforce is provided by Indian agriculture sector. India is known to be the world's largest producer of pulses, rice, wheat, spices and spice products. Farmer's economic growth depends on the quality of the products that they produce, which relies on the plant's growth and the yield they get. Therefore, in field of agriculture, detection of disease in plants plays an instrumental role. Plants are highly prone to diseases that affect the growth of the plant which in turn affects the ecology of the farmer. In order to detect a plant disease at very initial

stage, use of automatic disease detection technique is advantageous. The symptoms of plant diseases are conspicuous in different parts of a plant such as leaves, etc. Manual detection of plant disease using leaf images is a tedious job.

1.3 EXISTING SYSTEM

The existing method for plant disease detection is simply naked eye observation by experts through which identification and detection of plant diseases is done. For doing so, a large team of experts as well as continuous monitoring of plant is required, which costs very high when we do with large farms. At the same time, in some countries, farmers do not have proper facilities or even idea that they can contact to experts. Due to which consulting experts even cost high as well as time consuming too. In such conditions, the suggested technique proves to be beneficial in monitoring large fields of crops. Automatic detection of the diseases by just seeing the symptoms on the plant leaves makes it easier as well as cheaper. This also supports machine vision to provide image based automatic process control, inspection,and robot guidance. The current approach for detecting plant disease is simple naked eye observation by plant experts, which can be used to detect and identify plant diseases. In these circumstances, the suggested technique is useful for tracking vast fields of crops. Furthermore, in some nations, farmers lack adequate facilities or are unaware that they can contact experts. As a result, consulting experts is not only more expensive but also more time consuming. In those circumstances, the suggested technique for tracking a large number of plants would be useful.

1.4 PROPOSED SYSTEM

This study is focused on the identification of plant diseases. The segmentation, feature extraction, and classification techniques are used to detect plant diseases. Photos leaves from various plants are taken with a digital camera or similar unit, and the images are used to classify the affected region in the leaves. To detect plant disease, we use convolution neural network and a Deep neural network in the proposed framework. This paper proposes a framework that employs low-cost, open-source software to achieve the task of reliably detecting plant disease.

Image acquisition -> Image pre-processing -> Image segmentation -> feature Extraction -> Disease classification.

1.5 OBJECTIVES

The objectives of plant disease detection are to:

We can reduce the attack of pests by using proper pesticides and remedies .We can reduce the size of the images by proper size reduction techniques and see to it that the quality is not compromised to a great extent. We can expand the projects of the earlier mentioned authors such that the remedy to the disease is also shown by the system . The main objective is to identify the plant diseases using image processing. It also, after identification of the disease, suggest the name of pesticide to be used. It also identifies the insects and pests responsible for epidemic. Apart from these parallel objectives, this drone is very time saving. The budget of the model is quite high for low scale farming purposes but will be value for money in large scale farming. It completes each of the process sequentially and hence achieving each of the output.

Thus, the main objectives are:

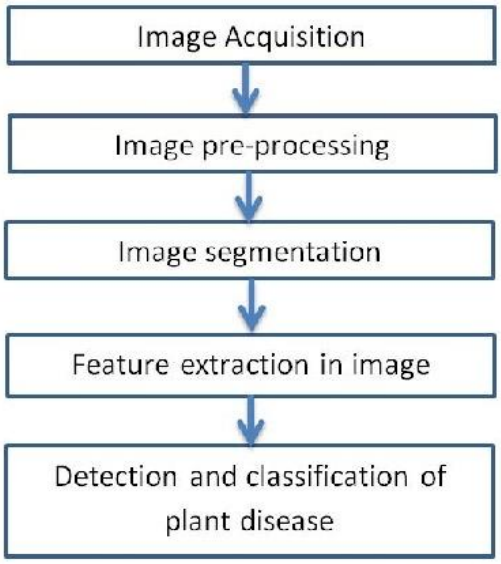
1) To design such system that can detect crop disease and pest accurately.

2) Create database of insecticides for respective pest and disease.

3) To provide remedy for the disease that is detected.

1.6 ARCHITECTURE

The architecture of the proposed system is as displayed below:



LITERATURE SURVEY

1. Malvika Ranjan et al. in the paper ―Detection and Classification of leaf disease using Artificial Neural Network" proposed an approach to detect diseases in plant utilizing the captured image of the diseased leaf. Artificial Neural Network (ANN) is trained by properly choosing feature values to distinguish diseased plants and healthy samples. The ANN model achieves an accuracy of 80%.

2. According to paper ―Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features by S. Arivazhagan, disease identification process includes four main steps as follows: first, a colour transformation structure is taken for the input RGB image, and the by means of a specific threshold value, the green pixels are detected and uninvolved, which is followed by segmentation process, and for obtaining beneficial segments the texture statistics are computed. At last, classifier is used for the features that are extracted to classify the disease.

3. Kulkarni et al. in the paper ―Applying image processing technique to detect plant diseases, a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it gives better results with a recognition rate of up to 91%.

4. In paper -Plant disease detection using CNN and GAN, by Emaneul Cortes, an approach to detect plant disease using Generative Adversarial networks has been proposed. Background segmentation is used for ensuring proper feature extraction and output mapping. It is seen that using Gans may hold promise to classify diseases in plants, however segmenting based on background did not improve accuracy.

5. In the paper -Convolutional Neural Network based Inception v3 Model for Animal Classification‖, Jyotsna Bankar et al. have proposed use of inception v3 model in classifying animals in different species. Inception v3 can be used to classify objects as well as to categorize them, this capability of inception v3 makes it instrumental in various image classifiers.

DATA PRE-PROCESSING

3.1 DATASET DESCRIPTION

About the dataset:

- The dataset consists healthy and unhealthy images .
- The dataset contains 1531 images.
- Dataset has 1148 training images and 383 testing images.

My Drive › Plant disease › Healthy

Name	Owner	Last mo...	File size
871bbbd18a4560e7.jpg	me	7 Mar 2023	982 KB
869c8acd737cc133.jpg	me	7 Mar 2023	969 KB
864e65893673aba5.jpg	me	7 Mar 2023	1 MB
859d3ac6e0bc4fa1.jpg	me	7 Mar 2023	734 KB
855d9ab1c98b6d0d.jpg	me	7 Mar 2023	781 KB
854d79c3a9a9c5ac.jpg	me	7 Mar 2023	841 KB
854b9969503d1f1f.jpg	me	7 Mar 2023	884 KB
853fb699a1810dbb.jpg	me	7 Mar 2023	1 MB
852bc06b76d837f0.jpg	me	7 Mar 2023	705 KB
852b4e943d69cb55.jpg	me	7 Mar 2023	892 KB

HEALTHY IMAGES:

UNHEALTHY IMAGES:

3.2 DATA CLEANING

Data cleaning is an important step in any machine learning task, including plant disease detection. It involves identifying and correcting errors and inconsistencies in the dataset to ensure that the data is accurate, complete, and ready for analysis.

Here are some common data cleaning steps that can be applied to plant disease detection datasets:

1. Remove duplicates.
2. Remove outliers
3. Check for missing data
4. Normalize the data:
5. Check for class imbalance.

Overall, data cleaning is an important step in preparing the dataset for plant disease detection. By removing errors and inconsistencies, and ensuring that the data is accurate and complete, the model can be trained on high-quality data that will lead to more accurate and reliable predictions.

3.4 DATA VISUALISATION

The plant disease detection data set contains healthy and unhealthy images in them in array form i.e x the output contains symptoms of as features and whether the leave is healthy or unhealthy in the image or not i.e is y.

Data conversion and open CV:

- Data conversion from image data to an array is an important preprocessing step in many machine learning and computer vision applications. When working with images, we typically represent them as matrices of pixel values. However, machine learning algorithms require numerical data in form of arrays or tensors to be able to process the data effectively.
- One common method of converting image data to an array is by using opencv, an open-source computer vision library. Opencv provides a range of functions to load,

process and manipulate image data in a variety of formats. To convert an image to an array using opencv, we first load the image using the imread() function. This function reads the image and returns a numpy array representation of the image in bgr format. We display the image by using pyplot() module we use imshow function from it.

- OpenCV for Python provides a simple and efficient API for performing various image processing operations, such as image filtering, thresholding, and edge detection.
- OpenCV for Python is a powerful tool for image and video processing that can be used for various applications in computer vision and machine learning. Its easy-to-use API and compatibility with popular Python libraries make it a popular choice among developers and researchers.

METHODOLOGY

4.1 PROCEDURE TO SOLVE THE GIVEN PROBLEM

Here in this project we can use these machine learning algorithms:

Logistic Regression.

KNN (K-Nearest neighbours).

Decision Tree.

SVM (Support Vector Machine).

SUPERVISED MACHINE LEARNING:

Supervised learning (**SL**) is a machine learning paradigm for problems where the available data consists of labeled examples, meaning that each data point contains features (covariates) and an associated label. The goal of supervised learning algorithms is learning a function that maps feature vectors (inputs) to labels (output), based on example input-output pairs.[1] It infers a function from training data set consisting of a set of training.[2] In supervised learning, each example is a pair consisting of an input object (typically a vector) and a desired output value (also called the supervisory signal). A supervised learning algorithm analyzes the training data and produces an inferred function, which can be used for mapping new examples. An optimal scenario will allow for the algorithm to correctly determine the class labels for unseen instances. This requires the learning algorithm to generalize from the training data to unseen situations in a "reasonable" way (see inductive bias). This statistical quality of an algorithm is measured through the so-called generalization error.

Steps to follow:

To solve a given problem of supervised learning, one has to perform the following steps:

1. Determine the type of training examples. Before doing anything else, the user should decide what kind of data is to be used as a training set. In the case of handwriting analysis, for example, this might be a single handwritten character, an entire handwritten word, an entire sentence of handwriting or perhaps a full paragraph of handwriting.
2. Gather a training set. The training set needs to be representative of the real-world use of the function. Thus, a set of input objects is gathered and

corresponding outputs are also gathered, either from human experts or from measurements.

3. Determine the input feature representation of the learned function. The accuracy of the learned function depends strongly on how the input object is represented. Typically, the input object is transformed into a feature vector, which contains a number of features that are descriptive of the object. The number of features should not be too large, because of the curse of dimensionality; but should contain enough information to accurately predict the output.
4. Determine the structure of the learned function and corresponding learning algorithm. For example, the engineer may choose to use support-vector machines or decision trees.
5. Complete the design. Run the learning algorithm on the gathered training set. Some supervised learning algorithms require the user to determine certain control parameters. These parameters may be adjusted by optimizing performance on a subset (called a *validation* set) of the training set, or via cross-validation.
6. Evaluate the accuracy of the learned function. After parameter adjustment and learning, the performance of the resulting function should be measured on a test set that is separate from the training set.

LOGISTIC REGRESSION:

- Logistic regression is used to obtain odds ratio in the presence of more than one explanatory variable.
- The procedure is quite similar to multiple linear regression, with the exception that the response variable is binomial.
- The result is the impact of each variable on the odds ratio of the observed event of interest.
- Logistic regression is a statistical analysis method to predict a binary outcome, such as yes or no, based on prior observations of a data set.
- A logistic regression model predicts a dependent data variable by analysing the relationship between one or more existing independent variables.
- There are three main types of logistic regression: binary, multinomial, and ordinal.

- Its features are sepal length, sepal width, petal length, petal width.
- Besides, its target classes are setose, versicolor and virginica.
- However, it has 3 classes in the target, and this causes to build 3 different binary classification models with logistic regression.
- Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables.
- Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas Logistic regression is used for solving the classification problems.

KNN (K-Nearest neighbours):

- K-Nearest Neighbor (KNN) Algorithm for Machine Learning.K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique.
- K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories.
- K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.
- K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems.
- A non-parametric, supervised learning classifier, which uses proximity to make classifications or predictions about the grouping of an individual data point.
- K-NN is a non-parametric algorithm, which means it does not make any assumption on underlying data.
- KNN is a lazy learning algorithm because it does not have a specialized training phase and uses all the data for training while classification.
- KNN is also a non-parametric learning algorithm because it doesn’t assume anything about the underlying data.

- KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data.
- It is also called a lazy learner algorithm because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset.
- **The K-NN working can be explained on the basis of the below algorithm:**

  Step-1: Select the number K of the neighbours.

  Step-2: Calculate the Euclidean distance of K number of neighbours.

  Step-3: Take the K nearest neighbours as per the calculated Euclidean distance.

  Step-4: Among these k neighbours, count the number of the data points in each category.

  Step-5: Assign the new data points to that category for which the number of the neighbour is maximum.**Step-6:** Our model is ready.

DECISION TREE:

- A decision tree is a type of supervised machine learning used to categorize or make predictions based on how a previous set of questions were answered.
- The model is a form of supervised learning, meaning that the model is trained and tested on a set of data that contains the desired categorization.
- Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.
- In a Decision tree, there are two nodes, which are the Decision Node and Leaf Node. Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches.
- The decisions or the test are performed on the basis of features of the given dataset.
- It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions.
- It is called a decision tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure.
- In order to build a tree, we use the CART algorithm, which stands for Classification and Regression Tree algorithm.

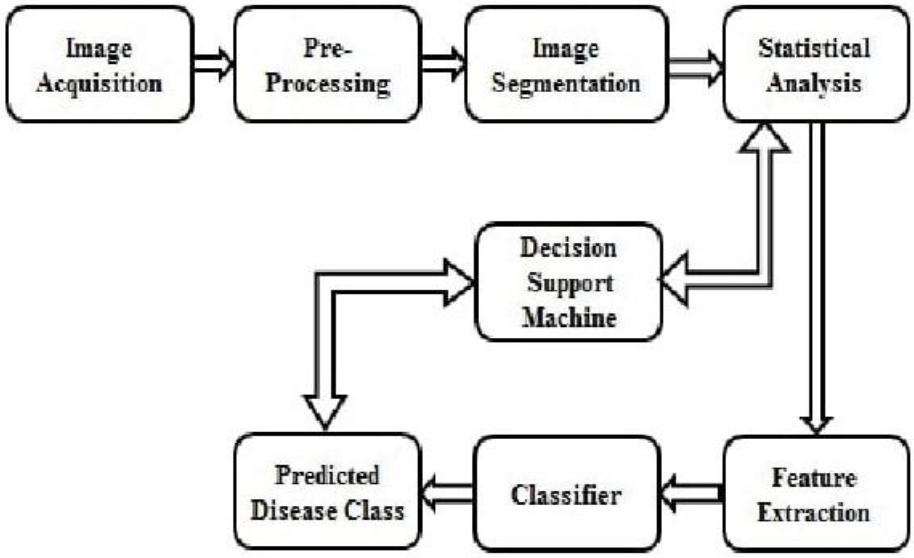
- A decision tree typically starts with a single node, which branches into possible outcomes.
- Each of those outcomes leads to additional nodes, which branch off into other possibilities.
- This gives it a treelike shape. There are three different types of nodes: chance nodes, decision nodes, and end nodes.
- The main components of a decision tree include a root node, decision nodes, chance nodes, alternative branches, and an endpoint node.
- Optional features include rejected alternatives.

SVM (Support Vector Machine):

- Support Vector Machine Algorithm
- Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.
- A support vector machine (SVM) is a supervised ML algorithm that performs classification or regression tasks by constructing a divider that separates data in two categories.
- The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.
- SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine.
- SVM are of two types: Linear SVM and Non-linear SVM.
- Linear SVM: Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.

- Non-linear SVM: Non-Linear SVM is used for non-linearly separated data, which means if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.
- SVM works by mapping data to a high-dimensional feature space so that data points can be categorized, even when the data are not otherwise linearly separable.
- Support Vector Regression is a supervised learning algorithm that is used to predict discrete values. Support Vector Regression uses the same principle as the SVMs. The basic idea behind SVR is to find the best fit line. In SVR, the best fit line is the hyperplane that has the maximum number of points.
- SVMs are used in applications like handwriting recognition, intrusion detection, face detection, email classification, gene classification, and in web pages. This is one of the reasons we use SVMs in machine learning. It can handle both classification and regression on linear and non-linear data.

4.2 MODEL ARCHITECTURE:



4.3 SOFTWARE DESCRIPTION :

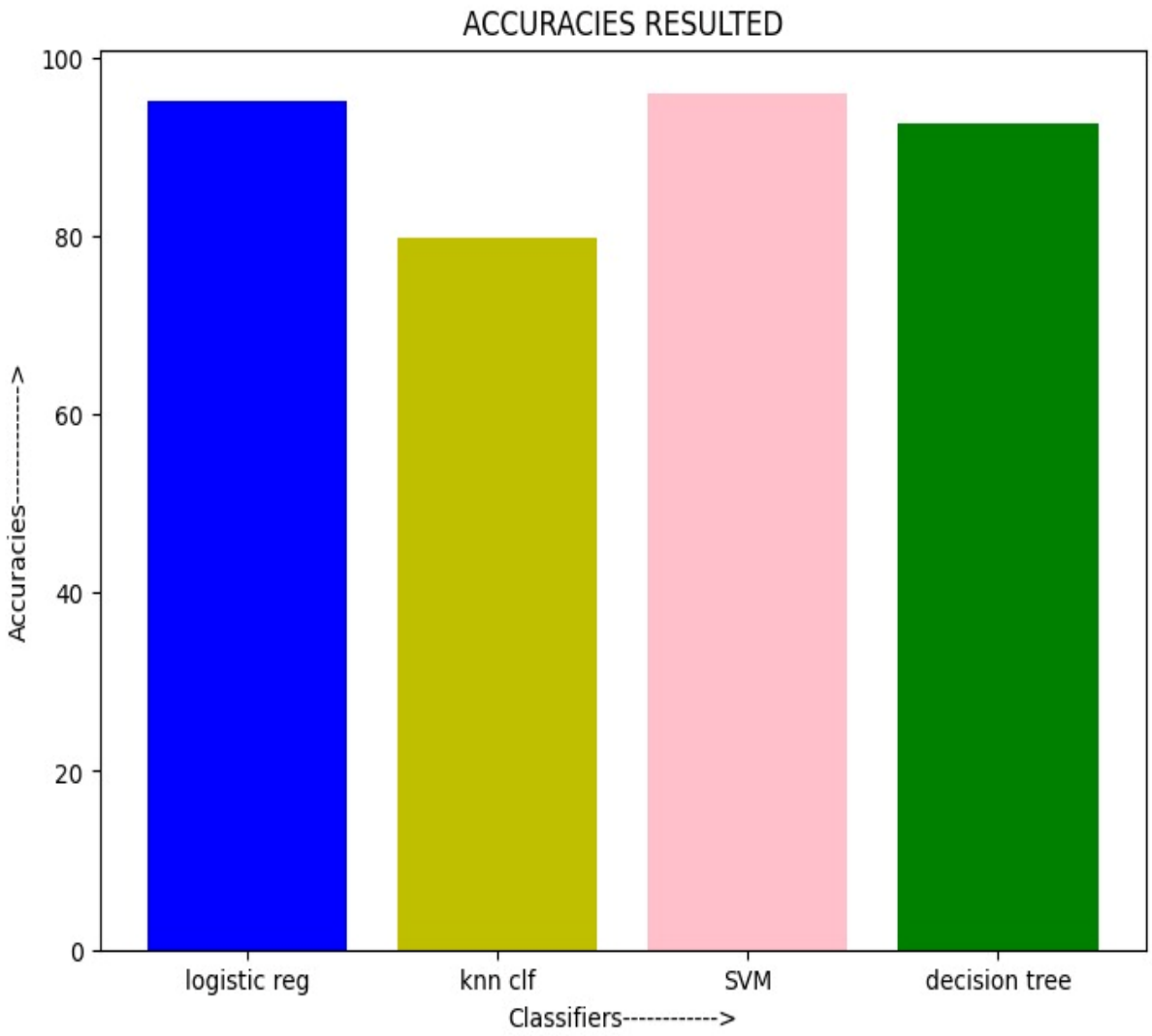
Software requirements:

Operating system: Windows 11

Platform: google colab.

Programming language: python

RESULTS


ACCURACIES RESULTED
100
80
60
40
20
0
Accuracies---------->
logistic reg
knn clf
SVM
decision tree
Classifiers---------->
0
20
40
60
80
100

CONCLUSION AND FUTURE SCOPE

Even though there are various methods for detecting and classifying plant diseases using automatic or computer vision, research into this field has been lacking. In addition, there are few commercial options, with the exception of those focusing on the identification of plant species via photographs. Over the last few years, there has been tremendous progress in the performance of convolutional neural networks. The new generation of convolutional neural networks (CNNs) has shown promising results in the field of image recognition. A novel approach to automatically classifying and detecting plant diseases from leaf images was examined through this project utilizing deep learning techniques. With an accuracy of 90%, the developed model could distinguish healthy leaves from eight diseases that could be observed visually. On the basis of this high level of performance, it becomes apparent that convolutional neural networks are highly suitable for automatic diagnosis and detection of plants.

The main goal for the future project is to develop a complete system comprising a trained model on the server, as well as an application for mobile phones that display recognized diseases in fruits, vegetables, and other plants based on photographs taken from the phone camera. This application will aid farmers by facilitating the recognition and treatment of plant diseases in a timely manner and help them make informed decisions when utilizing chemical pesticides. Also, future work will involve spreading the use of the model across a wider land area by training it to detect plant diseases on aerial photos from orchards and vineyards captured with drones, in addition to convolution neural networks for object detection. Drones and other autonomous vehicles, such as smartphones, to be used for real-time monitoring and dynamic disease detection in large-scale open-field cultivations. A future possibility for agronomists working at remote locations could be the development of an automated pesticide

prescription system that would require the approval of an automated disease diagnosis system to allow the farmers to purchase appropriate pesticides.

REFERENCES

1.Chohan, Murk & Khan, Adil & Chohan, Rozina & Hassan, Muhammad. (2020). Plant Disease Detection using Deep Learning. International Journal of Recent Technology and Engineering.

2. Mohanty SP, Hughes DP. Using Deep Learning for Image-Based Plant Disease Detection.

3.Vijeta Shrivastava, Pushpanjali, Samreen Fatima, Indrajit Das, " Plant leaf diseases detection and classification using machine learning", International Journal of Latest Trends in Engineering and Technology , Vol.10, Issue.2, April 2018.

4. Ferentinos, Konstantinos. (2018). "Deep learning models for plant disease detection and diagnosis. Computers and Electronics in Agriculture.

5.Guo, Yan, et al. "Plant Disease Identification Based on Deep Learning Algorithm in Smart Farming." Discrete Dynamics in Nature and Society, Hindawi,

6. Arsenovic Marko, Karanovic Mirjana, Sladojevic S. "Solving Current Limitations of Deep Learning Based Approaches for Plant Disease Detection".

7. B. Sandika, S. Avil, S. Sanat and P. Srinivasu. "Random forest-based classification of diseases in grapes from images captured in uncontrolled environments," 2016 IEEE 13th International Conference on Signal Processing.

8. Alagumariappan P, Dewan NJ, Muthukrishnan GN, Raju BKB, Bilal RAA, Sankaran V. Intelligent Plant Disease Identification System Using Machine Learning. Engineering Proceedings.

9.Adrian Rosebrock. "Keras ImageDataGenerator and Data Augmentation PyImageSearch." PyImageSearch, 8 July 2019.

10. MK Gurucharan. "Basic CNN Architecture: Explaining 5 Layers of Convolutional Neural Network | UpGrad Blog." UpGrad Blog, 7 Dec. 2020.

11. Michael A. Nielsen. “Neural Networks and Deep Learning.” Neural Networks and Deep Learning.
12. DeepAI. “Adam Definition | DeepAI.” DeepAI, DeepAI, 5AD.
13. Christian Versloot. “Sparse Categorical Crossentropy Loss with TF 2 and Keras – Machine Curve.” Machine Curve, 6 Oct. 2019.
14. Abhinavsagar. “GitHub – Abhinavsagar/Plant-Disease : Code for the Paper On Using Transfer Learning for Plant Disease Detection.” GitHub.
15. vipool. “Plant Diseases Classification Using AlexNet | Kaggle.” Kaggle: Your Machine Learning and Data Science Community, Kaggle, 29 Nov. 2018.
16. Lincy, Babitha & Rubia, Jency. (2021). Detection of Plant Leaf Diseases using Recent Progress in Deep Learning-Based Identification Techniques.
17.Aravind Krishnaswamy Rangarajan, Raja Purushothaman, Aniirudh Ramesh. “Tomato Crop Disease Classification Using Pre-Trained Deep Learning.