# SOLANUM TUBEROSUM LEAF DISEASES DETECTION USING DEEP LEARNING

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## ABSTRACT

This article provides an overview of several methods for disease identification in leaf pictures. Digital image processing is a quick, dependable, and accurate method for disease diagnosis; other algorithms are also utilised to identify and categorise plant leaf diseases. The methods used to diagnose diseases in this article include machine learning, deep learning, artificial neural networks, and image processing. The primary goal of this research is to investigate several methods for diagnosing illness.Disease during a crop results in low productivity and ultimately causes enormous harm to the agronomists. Therefore, early disease detection will be useful for agronomists so that critical steps may be implemented. The use of machine learning methods to identify plant diseases using a picture of the plant is covered in this research. Accurate plant diagnosis necessitates expertise from specialists but is generally costly and time-consuming. It is now important to design an automated diagnosis method for plant diseases that is precise, simple, and affordable.This study provides an overview of the many classification methods that may be applied to the categorization of plant diseases. A categorization method might involve categorising leaves based on their many morphological characteristics. There are so many different categorization methods, including Support Vector Machine and k-mean clustering.

## I. INTRODUCTION

The majority of people in India depend on agriculture, making it an agronomic nation. Fruit and vegetable crops are grown by farmers in a wide variety. Technical assistance might enhance agriculture. Since infections are often observed on a plant's leaves, fruits, and stems, early disease identification is essential for successful agriculture. Most often, pathogens, microorganisms, fungus, bacteria, viruses, etc. are to blame for plant illnesses. Plant infections can occasionally also be brought on by bad soil and water conditions [1]. Agriculture has been important to human life since ancient times. The primary source of human energy comes from plants. Agriculture-related products are readily harmed by a variety of plant diseases. These illnesses cost farmers in terms of social, ecological, and economic damage. It becomes crucial to do thorough study on plant diseases within a set time frame. Some illnesses are obvious to the naked eye and can be quickly found and treated. Some require strong microscopes or a particular spectrum because they are so smart. Processing all of the clear illness images with extreme precision may be made extremely simple by digital technology. Additionally, it offers the ability to detect ailments remotely without a sector specialist.

Really essential roles for plants in human life Plants are used for a variety of purposes, including providing food, medicine, raw resources, and ecological balance. Plant illnesses are typically brought on by pests, insects, and pathogens, and if they are not promptly handled, they drastically affect yield. Due to several agricultural diseases, farmers suffer losses. Agriculture is one of the key economic sectors in India. The Indian agricultural industry employs approximately half of the workers of the nation. The quality of the items that farmers produce, which is dependent on plant growth and production, determines their economic success. As a result, plant disease detection is an important aspect of agriculture. Diseases that affect plant growth are quite likely to affect plants, which will then have an impact on the farmer's ecosystem. the use of diagnostic tools to identify diseases in their earliest stages .The use of automated illness detection is useful. Plant diseases have obvious signs in many different sections of a plant, such as leaves, etc. It could be difficult to manually find illness using photos of leaves. Therefore, it is necessary to create computer techniques that can automate the process of illness identification and categorization using leaf pictures.

Deep Learning technology has the ability to precisely identify the presence of diseases and pests in farms. With the use of this machine learning algorithm, CART is even able to anticipate with accuracy the likelihood of future illness and insect invasions. In order to spray the proper amount of fertilisers and pesticides to eradicate the host, it is impossible for a conventional human monitoring to precisely forecast the quantity and intensity of pests and diseases attacked in a farm. As a result, a synthetic Perceptron determines the precise value and offers a correction measure for the quantity of pesticides or fertilisers to be sprayed at designated target regions. This aids the farmer in protecting his property against quiet insect and disease attacks and eradicating them without upsetting the balance of the soil or affecting the unaffected areas of other plants. The majority of farmers in India utilise manual monitoring, and a few applications with small databases and limited detection coverage. Since it's better to prevent illness than to treat it, our goal is to foresee pest and disease attacks in the future and teach farmers how to prevent them Agriculture has seen a deep plunge in technology. The instrument that agriculture needs most right now is automation technology. Many businesses have developed cutting-edge solutions in machine learning and artificial intelligence that are turning agricultural into digital agriculture. Numerous studies have shown that using technology in farms would boost agricultural productivity and, therefore, farmer income. This study reviews multiple studies on the identification of various plant leaf diseases using various classification techniques.

## 2. LITERATURE REVIEW

In order to diagnose illnesses in Potato plants using leaf photos, Monzurul Islam, Anh Dinh, Khan Wahid, and Pankaj Bhowmik suggested a technique in 2017 [4]. This method blends image processing and machine learning. They gather the potato leaf database from publically accessibleSVM classifier uses the "Plant Village" plant picture to categorise illnesses. They identify the illnesses known as early and late blight via their studies. As leaves on plants, in particular, show certain apparent symptoms, disease diagnosis may be carried out by image analysis of those visual patterns on leaves, combining imaging technology with machine learning. Mask out the backdrop and the green portion of the leaves while segmenting initial leaf photos. By teaching a multiclass SVM classifier with these characteristics to identify and classify the condition, it is possible to extract regions of interest (ROI) that only include apparent disease symptoms.Select a method using a collection of masks produced by analysing the colour and luminosity components of various sections of the photos in L*a*b* colour spaces. Try to segregate them since the area with illness symptoms differs noticeably from the surrounding area in terms of colour and texture.Then, by masking the backdrop, isolate the leaf-only pictures, and choose a L*, a*, and b* channel threshold that will separate the leaf from the background. In addition, numerical indicators like mean, standard deviation, entropy, skew, and energy were calculated from the histogram. Classification was then carried out by SVM, and finally accuracy, sensitivity, recall, and F1- Score were calculated. The threshold range selection for channel L*, a*, and b* was obtained from histogram analysis. The goal of this research's ongoing effort is to automatically calculate the disease's severity.

Pridarshani Patil presented a method in 2017 [5] for the current effective automated disease management method in potatoes. The photos of potato leaves are taken, examined, and categorised using image processing and machine learning techniques in order to find disease signs.They use a five-module system. Dataset, preprocessing, clustering, feature extraction, and classification are among the steps. All of the photos in the dataset underwent pre-processing, which included rescaling and conversion to the HSV colour space. Then clustering is applied to the training picture set. Extracted texture characteristics are analysed using FCM. For categorization, the extracted texture features are employed. The categorization outcomes identify and categorise whether a leaf picture is healthy or damaged by illness. For classification, SVM, RF, and ANN are utilised. Project is carried outin python and open-cv. It was determined that ANN had the greatest accuracy of any classifier, at 92%.

In 2018 [6], Pieter M. Blok and Manya Afonso devised a technique for identifying the blackleg disease in potato plants. Two deep convolutional neural networks that were trained on RGB photos of both healthy and sick plants were utilised to identify blackleg. A training set and a testing set were randomly selected from the collection of photos. The test set was also employed for the CNN classifier's independent benchmarking.Python was used to programme the CNN classifier using the PyTorch framework. Two residual architectures—one with 18 layers and the other with 50 layers—were trained. The test set was used to conduct the evaluation. A majority vote among the 5 trained models of each network was used to determine whether a picture was healthy or blackleg sick for each test image. The classification system was evaluated using a confusion matrix, which displayed a split of real healthy and real blackleg sick photos. The confusion matrix also calculated recall and accuracy.Their findings served as a reliable detector for potato blackleg disease. Future studies might expand it by using CNN as an object detector. Future studies may potentially look at CNN classification utilising visual channels besides RGB. It is also possible to anticipate that increasing the dataset size and applying data augmentation may enhance detection performance.

Agri-Tech has seen a significant transformation in India. The majority of farmers do not utilise cutting-edge technology on their fields. Several magazines frequently publish articles about IoT-related agriculture, but no one in India has fully embraced any of them. In India, there is a large divide between technology and farmers. To fill this gap between the technology and the farmers, many start-ups have appeared.Even many MNCs are now making investments in India's agri-tech industry. The exponential growth in population is to blame for the rising food demand. The Internet of Things, artificial intelligence, and machine learning have replaced the tractors and other large farm equipment mentioned in earlier times. In American farms, powerful machinery has taken the role of smart sensors. In order to produce food more sustainably, farmers are utilising technologies such as temperature and moisture sensors, drones, smart irrigation, terrain contour mapping, self-driving and GPS equipped tractors/rovers. Farmers are being "teched up," according to "The Economist," when it comes to growing more lucrative and sustainable crops and food. It is a common belief that because of insect and disease assaults on crops, the amount of food available to people eventually decreases. The population of the planet is projected to increase by 9.7 billion by 2050. As a result, a transparent graph showing an increase in food demand is evident.

The Indian start-ups are primarily interested in automation technologies. In farms, automated drones and bots are used to serve and monitor the crop. The technology being employed is likewise changing day by day from routine pesticide and fertiliser spraying in fields to precise target spraying. Artificial intelligence, machine learning, and deep learning algorithms are used to carefully monitor the crops, identify problematic agricultural regions, and then squirt a remedy in that precise target area.

## 3. PROPOSED SYSTEM

Diseases have adverse effects on plant and agricultural lands. The main causes of these diseases are microorganisms, genetic disorders, and infectious agents like bacteria, fungi, and viruses. Fungi and bacteria are mainly responsible for potato leaf diseases. Late blight and early blight are fungal diseases while soft rot and common scab are bacterial diseases[22]. So, spotting and diagnosing these diseases on such important vegetation motivates us to design an automated stratagem that could meliorate crop yield, enhance farmer's profit, and more contribution to the country's economy.

logistic regression is used for classification. Logistic Regression [9] is a supervised algorithm used when the dependent variable(output) takes only discrete values for a given set of features(or inputs).In Logistic Regression Hypothesis Function is calculated and the output of the function is evaluated in terms of probability. After this, the output of the Hypothesis function is passed to Cost Function.

## 3.1 POTATO DISEASE AND SYMPTOMS

### 3.1.1 Bacterial Wilt

Symptoms of the disease: In addition to the potato, the pathogen also harms other weed species and plants including the chile, tomato, tobacco, and eggplant.• All portions of affected plants will exhibit the signs of bacterial wilt infection. • The affected plant starts to wilt, starting at the leaf margins or where the stems branch out, and subsequently it may affect any or all portions of the plant. • The plant wilts and dies as a whole once the leaves turn yellow at their roots. A brown coloured ring will be evident when stems are sliced. • However, black or brown rings will be apparent when a tuber is split in half. These rings release a thick, white fluid when pressed or when left for an extended period of time. • Fluid onset of tuber eyes is another sign. When crops are harvested, dirt adhering to tuber eyes may indicate this. causes of severe infections tubers to rot

Plant showing wilting symptoms Tuber showing wilting symptoms

### 3.1.2 SeptoriaLeafSpot

Symptoms of the disease: Affected plants are often less robust• Slight, circular to irregular spots with a grey Centre and shady margin on leaves. • Spots typically start on lower leaves and slowly advance upwards • At later phase spots merge and leaves are blighted • Whole defoliation of affected leaves may take place. • Stems and flowers are sometimes attacked • Fruits are rarely attacked


Leaves showing disease symptoms

### 3.1.3 Lateblight

Symptoms of the illness include damage to leaves, stems, and tubers. Affected leaves seem burned or blistered, depending on the situation, and eventually decay and dry up. • As leaves wilt, they turn brown or black in hue. Spots on the underside of leaves covered with what seems to be flour appear when diseases are still active. Affected stems begin to blacken from their tips and eventually dry up. Simple infections lead to the death of plants by causing all leaves to decay, dry out, and fall to the ground, as well as stems and foliage to become brown and spotty. This illness changes quite rapidly. Infected plants will perish in two to three days if the infection is not managed.

Leaves showing disease symptoms Tubers showing disease symptoms

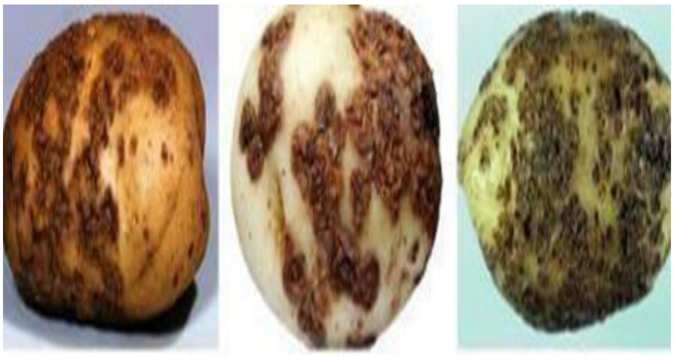
### 3.1.4 EarlyBlight

Symptoms of the illness: This might be a typical potato disease that affects the leaves at any stage of growth and results in recognisable leaf spots and blight. • Typically, illness symptoms start to show up during the tuber bulking stage and progress up to harvest. • On the plants, the initial blight is first noticed as tiny, black lesions that completely cover the older leaves. • As spots grow, concentric rings in the shape of a bull's-eye are frequently observed in the centre of the diseased region by the time they are one-fourth inch in diameter or greater. • The skin around the patches may become yellow. If humidity and warmth are present at this with time, much of the foliage dies. Nearly identical to leaf lesions, stem lesions can occasionally girdle the plant if they develop close to the soil line.

Leaves showing disease symptoms Tuber showing disease symptoms

### Commonscab

Symptoms of the disease: The pathogen infects newly developing tubers across lenticels and sporadically through wounds. • The surface of the potato tuber exhibits a variety of common potato scab symptoms. The condition causes skin lesions that resemble corks in a number of different ways. • The skin of damaged tubers is rough, cracked, and covered with scab-like areas. Potato skins with severe infections have hard, black welts all over them. • Early infections leave tuber surfaces covered in superficial reddish-brown patches. When the tubers mature, lesions spread and get corky and necrotic.



Tubers showing disease symptoms

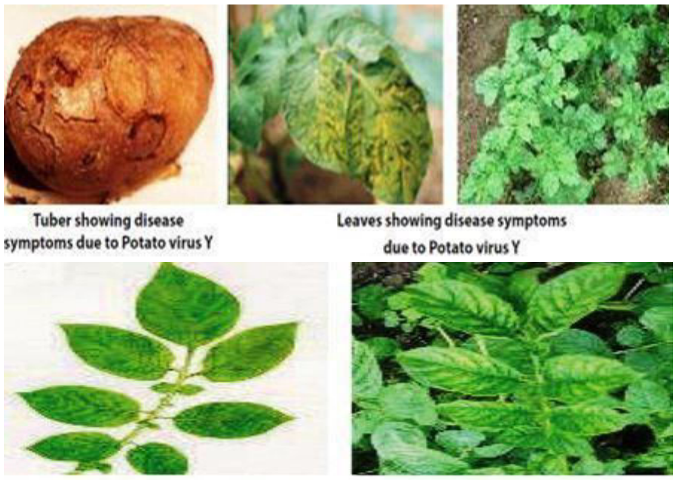
**BlackScurf/Canker**

Rhizoctonia canker is caused when stolons come into touch with soil-borne fungal organisms. • The pathogen damages plant tissue and results in stolon blindness, which lowers tuber yield and productivity. • In addition, it infects tubers, generating black scurf, which only affects tuber look and has no impact on yield.

Tubers showing disease symptoms

**ViralDisease**

Potato virus Y (PVY), which may be a Potyvirus, creates stipple streaks as a sign of the illness. Normal indications of the necrotic strain on foliage include necrosis inside the leaves of sensitive potato cultivars. If a plant is infected early in the season, the symptoms of potato virus S (PVS), which may be a Carla virus, include a slight deepening of the veins, tough leaves, more open growth, moderate mottling, bronzing, or minute necrotic patches on the leaves. Aphids transfer PVS in a transient manner. The type member of the plant virus family Potyvirus is called Potato virus X (PVX). The virus can produce signs of chlorosis, mosaic, reduced leaf size, and necrotic lesions in tubers, yet plants frequently don't show any symptoms. • PVX can combine with PVY and PVS to produce symptoms and yield loss that are worse than each virus would produce on its own. Infected tubers are where this virus is found.




Leaves showing disease symptoms due to Potato virus X

## 4. POTATO SPINDLE TUBER VIROID (PSTVD)

Symptoms of the disease include smaller, downward-curling leaves, which give the plant a more upright growth pattern. Additionally, plants may be stunted, and their leaves may be twisted and grey.

• The stems are frequently highly branched, and the branches' angles with the stem are acute. • Tubers develop pronounced eyebrows and become spindly, oblong, or more rounded than normal for a particular variety. • Tubers may also develop knobs and swellings, as well as cracks.

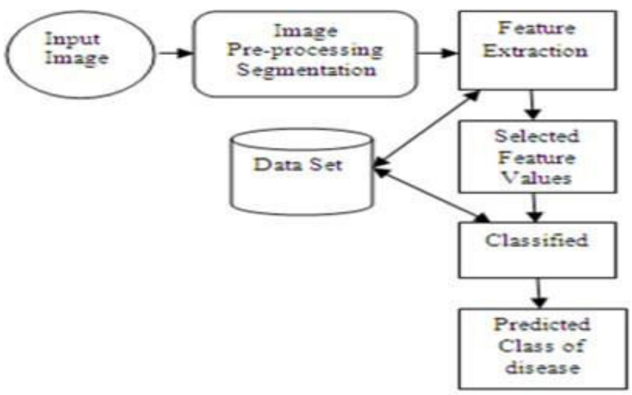
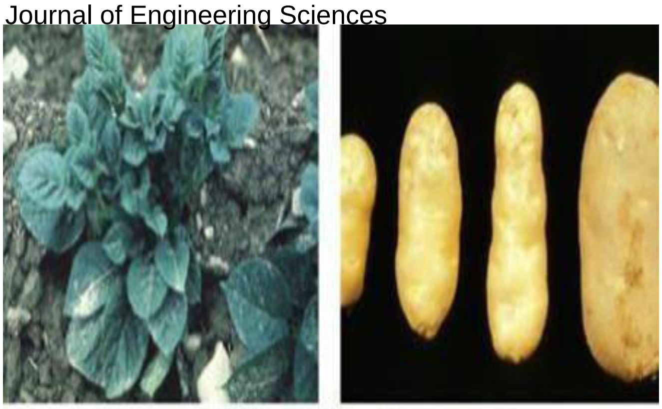



**Fig 1: Basic Steps in Image processing to detect plant diseases**



Leaves and tubers showing disease symptoms

Symptoms of the disease: A rot of the lower stem region may cause black legs. This is frequently aided by chilly, moist environments. When germs enter the tuber through wounds and other entrance sites, soft rot develops. • Symptoms might include everything from fungus lesions to cultivator damage. • The bacteria liquefy the tuber from the inside out and disintegrate the cell walls. True plant diseases do not have any odour.

Seedlings and tubers showing disease symptoms

**5. DIFFERENTTECHNIQUE**

Image processing: There are three fundamental processes in digital image processing: image processing, analysis, and understanding. Preprocessing of plant leaves includes segmentation, colour extraction, disease-specific data extraction, and image filtration. The categorization of illnesses is a typical use of image analysis. Plant leaves are frequently categorised based on their morphological characteristics with the use of several categorization systems. These categories frequently identify different plant leaf characteristics as colour, intensity, and size.

Support vector machines are within the category of supervised learning models in machine learning. SVMs are primarily utilised for multivariate classification and analysis. To produce an output, SVM has to be coupled to a learning algorithm. Compared to other procedures, SVM has demonstrated superior performance for classification and regression. There are coaching groups that are several categories. Machine learning techniques prioritise task performance while concentrating on the data machine learning can be used in one of four areas: 1) identification/detection 2) categorization 3) quantification 4) prediction. On the other hand, machine learning is separated into two groups based on whether results are labelled: 1) supervised learning and 2) unsupervised learning.

The non-probabilistic binary linear classifier that the SVM training algorithm produces assigns new instances to either the same category or the opposite category. The SVM picture depicts points in space that are also mapped to indicate where the instances collide since they must be divided by a region that is as broad as feasible. Support vector machines (SVM) are employed in the classification step of the leaf disease detection procedure. SVM,[13] Gaussian Naive Bayes, logistic regression, linear discriminant analysis, and Random forests are examples of machine learning approaches that provided greater accuracy with a smaller collection of picture data. first create a grayscale picture from an RGB image. Machine learning approaches are used to train the model that aids in requiring an accurate diagnosis of illnesses. Choose the simplest model for testing once the datasets have been trained, supporting the accuracy of various methodologies.

K-means: The k-means method attempts to divide the information set that comprises knowledge about a certain data set into a collection of clusters that can be counted on one hand (k). Centroids are mostly selected in sets of k numbers. A centroid may be a piece of data that is located in the centre of a cluster. The centroids are randomly selected from this collection of input files so that each one is distinct and different from the others. The SVM is trained using these centroids. Then it generates a random set of clusters. . The following steps make up the algorithm: 1) The space, which is represented by the clustered objects, is filled with the K points. They stand for the first groups of centroids. 2) The group with the nearest centroid is given the assignment of each object. 3) Recalculate the K locations once all the items have been assigned centroids

4) Continue to perform steps 2 and 3 until the centroids are stationary. This results in the grouping of the items into different categories. Each centroid is then prepared for the initial instant of the cluster to which it is assigned. The final collection of

centroids will be chosen to achieve the classification or clustering of the data that is provided as the input [15]. Using a collection of characteristics, the K-Means clustering method attempts to divide objects into K different classes [16]. To divide an unknown number of observations into k clusters, the segmentation based on K-means algorithm is utilised. In this method, the segmented picture has k clusters, and the clustering is done using the colours that are present in the image. The segmentation-based K-means clustering technique's key benefit is that it utilises both the local and global aspects of a picture. The K-means clustering technique is quick, reliable, and adaptable

The k-nearest neighbours (KNN) supervised machine learning technique is simple to use and may be used to address both classification and regression issues [18]. The KNN is a classification method used to divide data into more than one class based on how similar and different it is. The n-dimensional numeric properties used to represent the training samples. Every sample corresponds to a certain area in a three-dimensional space. In keeping with this, the majority of the training samples are kept in an n-dimensional pattern space. A k-nearest neighbour classifier searches the pattern space for the k training samples that are most similar to the unknown sample when given an unknown sample. Euclidean distance is used to define "closeness". In contrast to decision making, closest neighbour classifiers assigned hits with weights to each characteristic by using back propagation and tree induction. When the data has a large number of pointless qualities, this might lead to misunderstanding. The use of nearest neighbour classifiers for prediction, or providing a real value forecast for a given unknown sample, is another use. In this instance, the classifier returns the average real value associated with the k closest neighbours of the unknown sample. Among all machine learning algorithms, the k-nearest neighbours algorithm ranks among the best. This is frequently the final stage of the picture processing. During In this stage, the features that were inherited during the feature extraction step are used to classify the picture into a specific category. In this study, we utilise categorization to categorise the ailments the leaves are suffering from. At this stage, our computer learns how to provide a noun to a sick leaf. A variety of algorithms are available for classification. In this study, the KNN (k-Nearest Neighbor) method is utilised.

Back propagation: Back propagation is one of the techniques used in conjunction with the gradient descent optimization approach to train a replacement neural network. This technique examines a loss function's gradient with regard to any or all of the network weights. Back propagation algorithm artificial neural network is used in an extremely recurrent network. The neural network weights are fixed after training, and they are frequently used to determine output values for fresh test pictures that don't appear to be present in the training dataset.

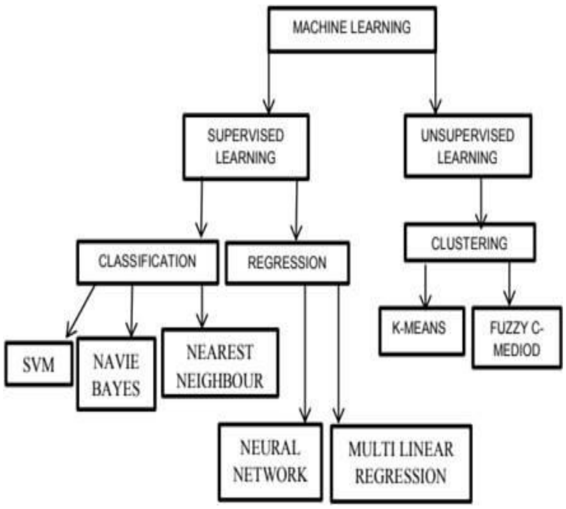



Fig:2Blockdiagramofmachinelearningmethods

Table1.ClassificationtechniquesComparison

| echnique | dvantages | isadvantages |
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## 6. RESULTS

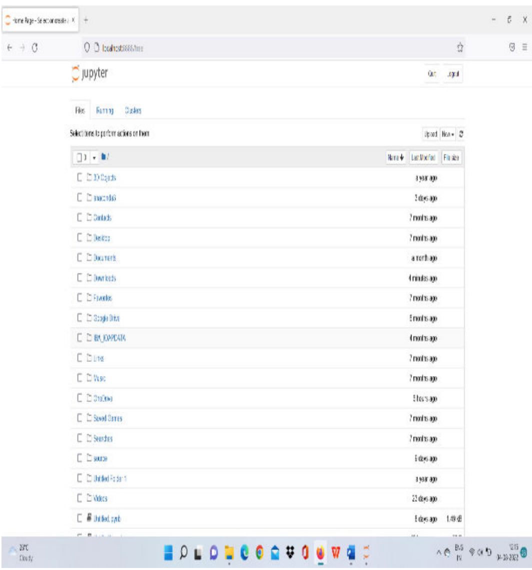


Fig: Open Jupyter

Fig: Select Solanum Tuberosom

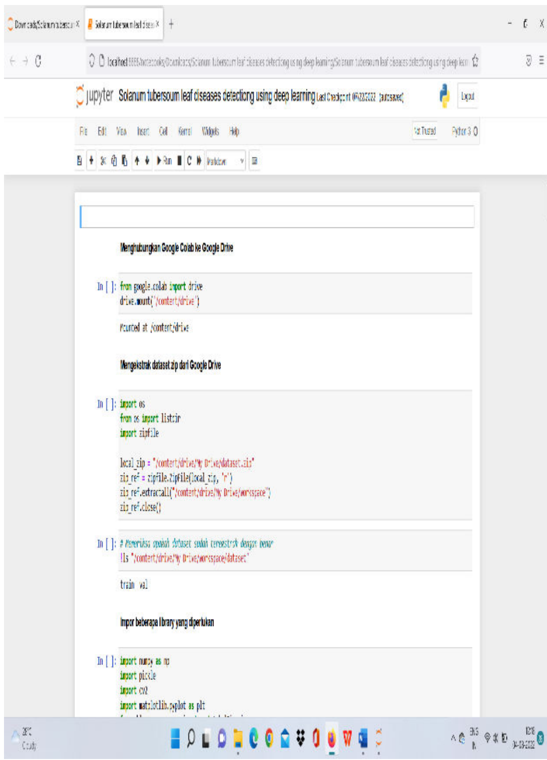
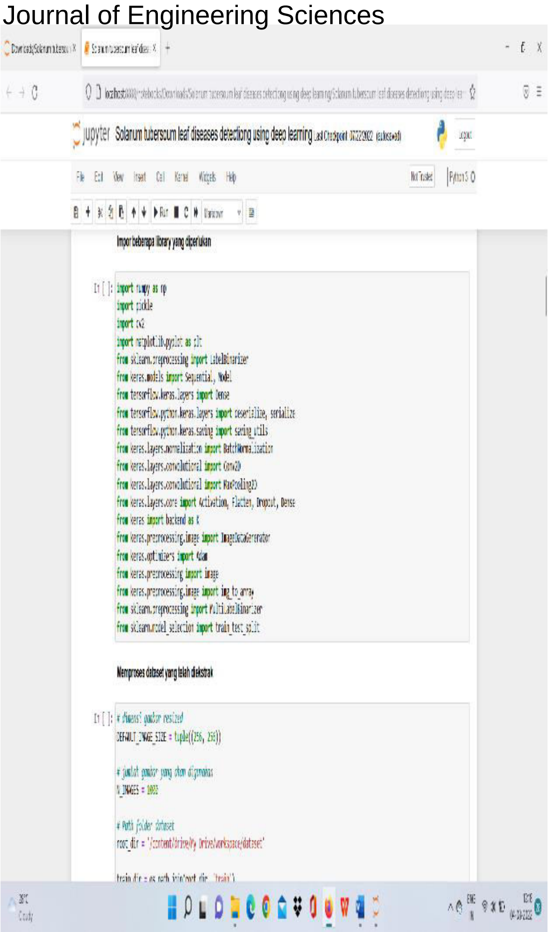
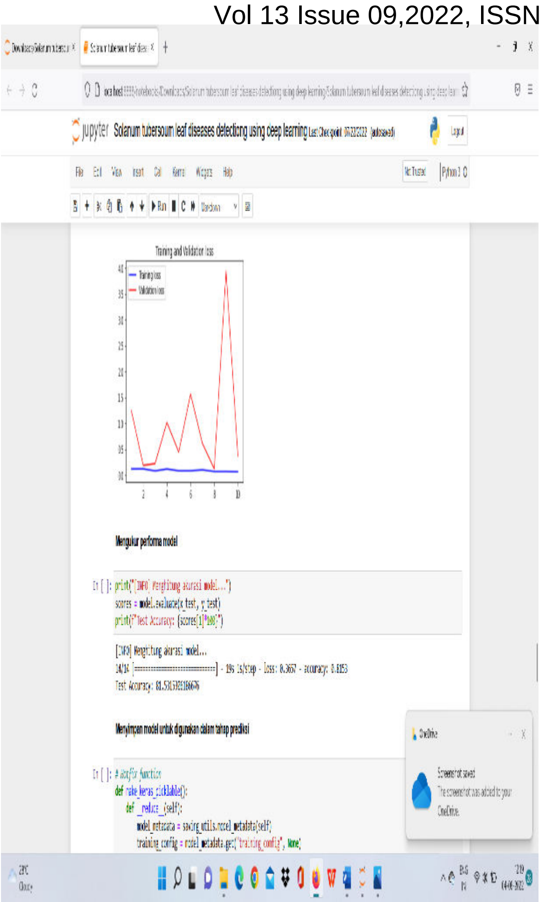
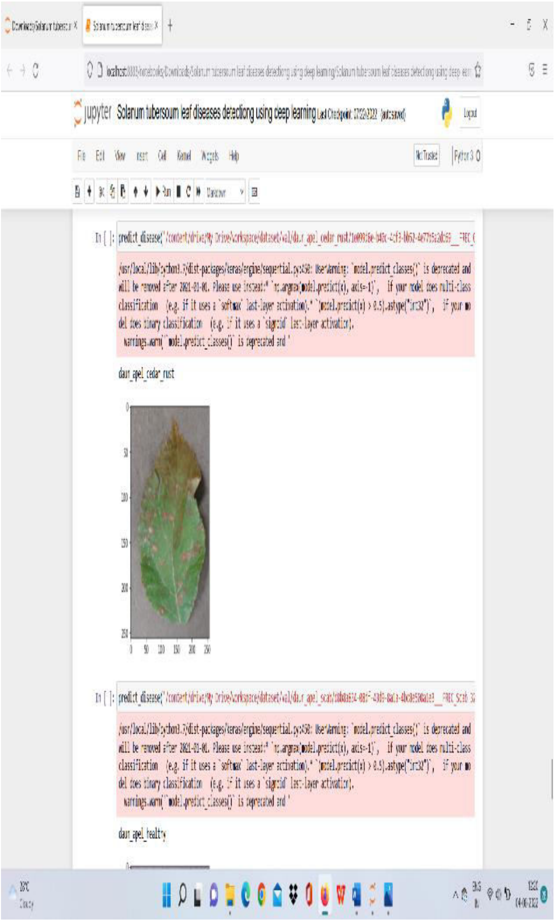
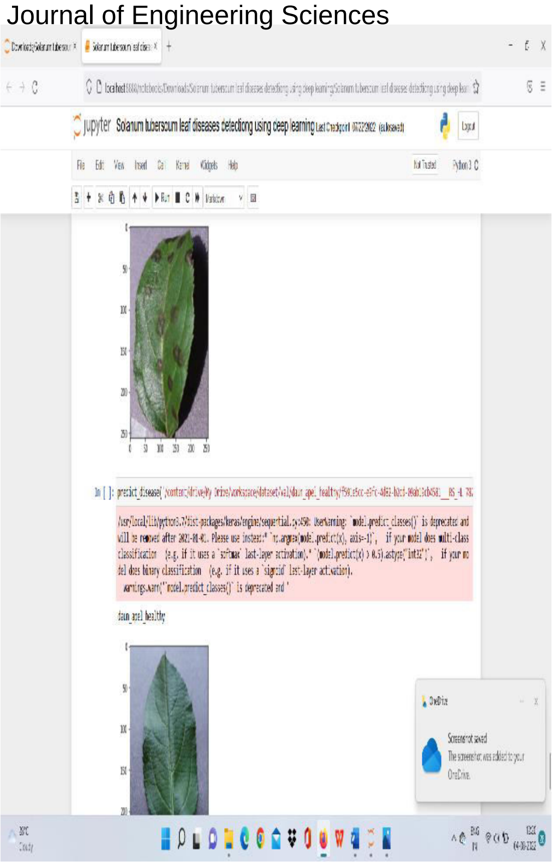


Fig: Run The Code And Outputs









## CONCLUSION

The fundamental potato diseases reviewed in this work are summarised, along with the methods used to identify diseases from leaf photos. During this paper, a comparative analysis of five machine learning classification algorithms for illness identification is carried out. When paired with other classifiers, the SVM classifier is used by numerous writers to categorise illnesses. We can work on early identification of any of those potato illnesses in the future through the use of those techniques.

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