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An Architecture for Classification of Plant Health Disease Using Deep Learning Methods

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Abstract: *We suggest in this work that with the assistance of imaging processing, plant disease detection systems can automatically detect the symptoms that occur on the leaves and stem of a plant, which in turn assists in the cultivation of healthy plants on a farm. These systems monitor the plant, including its leaves and stem, and if there is any variation noticed from the plant's characteristic attributes, that variation will be automatically identified and the user will also be informed of it. An analysis and evaluation of the disease detection technologies currently used in plant species has been presented here. The most recent advancement in the field of deep learning, known as the convolutional neural network (CNN), has significantly improved the accuracy of picture classification. This thesis is based on the pre-trained deep learning-based method for identifying plant illnesses. It was motivated by CNN's success in the picture classification field. The contribution of this work can be broken down into two categories: the first is the utilization of the most cutting-edge large-scale architecture available, such as AlexNet GoogleNet, for the recognition of plant diseases; the second is the application of baseline and transfer learning methods for making predictions for a dataset. The proposed model from CNN underwent training and testing using data sets obtained from the website. The proposed architecture was put through its paces in terms of training, testing, and experimentation and the results showed that it is capable of realizing a higher GoogleNet model getting of 99.10%. Precision in contrast to that of other models.*

Keywords: Plant Leaf, Disease Detection, Image Acquisition, CNN, Deep Learning, AlexNet, GoogleNet.

Introduction

Agriculture has been growing important food crops since the dawn of time. Agriculture has evolved into not only a means of meeting ever-increasing food demands, but also a cornerstone of the country's economy. Agriculture has been linked to a number of professions as economic growth has accelerated. Agriculture, in general, is a pillar or development of the domestic economy, offering private- sector investment opportunities as well as being one of the primary sources of production or economy linked to agriculture. Manufacturing, distribution, and marketing are all part of modern agriculture's advanced technology. As a result, agriculture encompasses and involves marketing, processing, and production. In addition to meeting human feed requirements, agriculture empowers them. Agricultural practices, such as irrigation, pesticide use, crop rotation, and others, have been underpinning improvements for a long time. Agriculture has changed dramatically since the 19th century, resulting in several times higher food yields than in the early Middle Ages. Agriculture employs roughly 70% of Indians, and the country has the world's seventh-largest GDP-progressive economy. The Indian economy is primarily based on agricultural production. Diverse crops, such as food grains, berries, and vegetables, have a significant impact on Indians. Agriculture and associated industries such as horticulture, sericulture, forestry, poultry, fishing, and logging account for about 17% of the country's GDP and provide the majority of employment. The focus of farm research and development has mainly been on rising returns. Crop yield and quality increased greatly as a result of the use of modern machines and instruments. In each crop cycle, the use of recurring fruit crops is also critical for farm yields. Pests and diseases will wreak havoc on crops, resulting in a significant drop in production. This condition is primarily caused by pests and diseases, which occur when farmers sell their goods on local markets or export them due to poor quality and grade, and therefore pathological issues that decide the quality and quantity of the produce must be closely monitored. New methods and technologies that make better use of IT, such as digital imaging and machine learning, are required to develop newer and more reliable automated devices to diagnose the many diseases that affect agricultural crops. Farmers would profit greatly because, in today's world, every farmer has a Smartphone, and the new proposed system can be introduced using those Smartphone's.

The internet and the World Wide Web are profoundly interconnected in today's digital world (www). It's a never- ending well of wisdom. Ordinary users had access to this data consumption in the early days. Just a few experts and industries developed and disseminated such knowledge [1]. Web browsing, multimedia, picture capturing, and storage devices have all advanced in recent years, bringing a huge revolution to the digital system. It made it easier to build and share new online papers. This has prompted millions of people to create their own web pages and to update them with new text, images, and videos from virtually every area. The size of the image collections, database, text content, and videos has expanded. Obtaining information from such a large collection is a challenging challenge. It necessitates recovery frameworks. It could be set up to recover data, text, documents, and images, among other things. Retrieval systems are a form of retrieval system. Image recovery is a computer-based process for retrieving images in large image databases thoroughly or similarly. For traditional methods of recovery, metadata such as keywords or image text descriptions are used. The foundation of this method is a clear meaning or keywords. We often find it difficult to articulate exactly what we believe we have for us [2]. Instead, picking a lovely rose to install the set will be easy. This means that the things we see in the vision may match our imagination, but the things we see in the textual description may not. It's also possible that images identified by other names in the description are lacking. It is conceivable. This manual annotation takes time, and in many situations, the preferred keyword for expressing the image cannot be captured. All of this points to the importance of locating and locating the perfect picture of the visual analysis of image data. Image recovery based on content is the name given to this form of recovery (CBIR). CBIR refers to any technology that allows users to scan for digital images using visual content rather than metadata. From a basic picture-similarity function to an annotation engine, this CBIR specification allows a wide range of techniques to be classified as CBIR [2]. The term "content" may refer to image information such as color, shape, texture, or other types of image data. Plant diseases are described as any disruption of a plant's normal physiological function that results in noticeable symptoms. A symptom is an event that occurs in relation to something and is used to prove its existence. Pathogens that cause plant disease may be present in plant leaves, stems, bulbs, fruit, and roots. Changes in the size, shape, and appearance of leaves, branches, flowers, and fruits are all symptoms of disease. Depicts the leaf diseases of soybean, potato, and maize It depicts how the disease has altered the green sheet, including color, form, and rough texture transitions.

Plant diseases are classified into various groups based on their frequency, severity, and cause [3, 4]. The type of plant disease is classified as either localized or systemic. On the basis of natural propagation and mode of infection, plant disease is often classified as soil-borne disease, airborne disease, or seed-borne disease. A variety of diseases are included in a classification category based on symptoms. Rust, smuts, spotting leaves, mildew, mildew, powdery mildew, and so on are examples. By host plant, plant diseases are also known as cereal, vegetable, fruit, and forest diseases. On the basis of agriculture, plant diseases are referred to as maize diseases, soybean diseases, and so on. Root and fruit diseases, foliage diseases, and shooting diseases are the three types of plant diseases classified by organ. Plant diseases are classified as chronic, epidemic, seasonal, or pandemic depending on the occurrence and spread of the disease. It is widespread in a particular area when a disease is consistently moderately present year after year. Epidemic disease manifests itself in a severe form in large crop areas on a regular basis. Sporadic illness manifests itself in sporadic and unpredictable ways. It's formed in a mild to serious way. Pandemic diseases have spread throughout the continent. Pathogen production distinguishes monocyclic, polycyclic, and polymeric diseases. Monocyclic diseases occur only once in a harvest season (for example, smut in meat), while polycyclic diseases occur several times in a cropping season (e.g. Late Blight in Potato). Polymeric diseases are polycyclic diseases with a disease cycle of more than a year (e.g. Rust Apple). On the basis of cause, vegetable diseases are commonly referred to as fungal diseases, bacterial diseases, and so on. Nutritional deficiencies are also a cause of certain herbal diseases. Khaira in rice disease, for example, is caused by a lack of zinc.

Social Impact of Research-Pesticides will have an effect on the growth of major crops like rice, weed, corn, soybeans, and sugar cane. A wide range of plant diseases can have a major impact on various economies and communities. It can also have a major negative impact on the climate. Farmers face a difficult challenge in correctly classifying and identifying pesticide and disease organisms, which occurs close to the start of crop production. As a result, correctly identifying plants and plant diseases is easier to prevent such losses. When rice disease was not properly managed, it resulted in significant plant losses. It is possible to set up an automated system that can provide disease warnings ahead of time.

Aim and Objectives followed in this paper: Its aim is to develop a deep learning model that can reliably recognize and differentiate plant conditions (with a 91% accuracy rate).

- Comparative analysis of deep leaning models that are commonly used for detection of plant diseases.
- Development of deep leaning based disease detection and classification model based on available and new data points.

II. Related Work

Many methods were used to correctly diagnose the disease in the plants in the photographs. The majority of them are concerned with image processing in general, SVM classification, K-mean, genetics, and so on. We couldn't have asked for a more positive outlook. Some researchers have recently used neural network-based methods in this area. When opposed to traditional image-processing methods, deep neural networks are effective at detecting image disease. Mango disease control is a vital part of environmental protection since it is so closely related to the health and production of the crop. India is particularly important in today's fast-growing world. The prevalence and simplicity of certain major diseases pose major challenges in the management and control of these conditions. As a result, the most recent study is crucial. Disease is a major impediment to fruit development, resulting in both qualitative and quantitative losses. It is important to understand the origin, persistence, and spread of the pathogens that cause disease in order to enforce management measures quickly. The various causes of the epidemic must also be recognized, and these diseases must signal the appearance of preventive or treatment chemicals, as well as their timely implementation. The most suitable diagnostic system will be used to diagnose the disease on fruit seeds efficiently and reliably. In order to reduce the loss of fruits in the region, during traffic and in the field, as well as the development of various diseases that affect fruits, detailed etiological, epidemiological, and control research is needed.

V Srinidhi et.al (2021) Over the years, many incidents of plant diseases have aggravated the suffering of millions of people worldwide, with estimated annual harvest losses of 14% worldwide. Plant pathology is the science of plant diseases that seeks to improve the viability of plants to survive in adverse environmental conditions and the parasitic microorganisms that cause the disease. Temperature, pH, humidity and moisture are environmental factors that contribute to the development of plant diseases. Misdiagnosis can lead to financial loss, misuse of chemicals that induce environmental imbalances and pollution, and the emergence of resistant pathogen strains. Diagnosis of current illnesses is time consuming, costly and based on human reconnaissance. Automatic disease segmentation and diagnosis from images of leaves of plants are much more useful than conventional ones. Automatic plant disease detection includes image acquisition, preprocessing, segmentation, extension using subsequent models, feature extraction, and classification. This project uses Deep Convolutional Neural Networks models i.e. EfficientNet and DenseNet to detect diseases of apple plants from images of apple leaves and classify them accurately into 4 classes. The categories include "Health", "Scab", "Rust", "Various diseases". In this project, a dataset of apple leaf disease is improved using data expansion and image annotation techniques: frugal edge detection, blurring, and inversion. According to the extended dataset, models using EfficientNetB7 and DenseNet are proposed, which provide accuracies of 99.8% and 99.75%, respectively, and overcome the known shortcomings of convolutional neural networks.

Shen Xizhen et.al (2021) Edge detection technology is a key technology in the field of image processing. Aiming at the problem that existing frugal algorithms cannot effectively determine image edges with low adaptive capacity, this paper proposed an improved frugal edge detection algorithm. The algorithm uses advanced filtering methods to denoise the image. Calculate the gradient amplitude using the following four-way gradient template. Finally, the high and low thresholds of the images are obtained by image block processing combined with the maximum inter-class variance (Otsu) algorithm. Experimental results show that the improved frugal algorithm has excellent noise removal performance and can more accurately detect plant leaf edge information.

III. Proposed Methodology & Results

Proposed model is based on deep learning algorithms are designed to analyze and detect plant disease. This Model contains leaf retrieval, image segmentation, and identification with the utilization of targeted deep learning algorithm. This study will help extract various features from plant leaf under three categories: color, shape, and texture that will be more reliable and will provide the more accurate system. Recognition System Plant disease identification includes several steps and are discussed in the proposed approach. Phases in identification of plant disease In general deep learning has always two processes to handle with image data set using Convolutional Neural Network (CNN).They are training and testing model. Accuracy of the plant diseases with various images of leaves may produce different results as mentioned in frontier results may take 30% of testing and 70% of training of same sample of leaves, whereas the precision mean and recall keeps varying according to the time interval of all the time range changes. The system used to identify plant disease operates in two main phases namely training as well as testing phase .The training phase again is sub-divided into further phases such as taking an image from the leaf, segmenting the interested regions, extracting features followed by the classifier training. The major step in testing phase is identification of image as infected leaf or not.

In all the methodologies depicted in the exploration were the picture of the plant leaves is resized to 256 x 256 pixels for the expectation of ailments in the leaves. Over the analyses, there are three unique renditions of the Whole Plant Village datasets

Transfer learning as well as deep feature extraction is implemented using the classifiers on the data set. Hence, we make a brief explanation of the following techniques. Detailed schemes of our architectures are given below in Figure 4.1and Figure 4.2.Transfer learning seeks to enhance target learner's efficiency in targeted areas through passing the information found in related but distinct root areas. It is now a prominent and yet exciting field of machine learning given the large implementation opportunities. One of the mean reasons of its high ranked usage is related to the fact that it is easy to take benefit of its speed during the training time. Transfer learning is also by far more convenient to implement than any CNN architecture with random defined weight.
Module Description:

- Input Image.
- Preprocessing.
- Segmentation.
- Feature extraction
- Classification

Input Image: The basic data structure of MATLAB is a matrix, which is made up of a set of real or complex elements. Naturally, arrays are well-suited to displaying ordered image sets, real-value, color, or intensity data. (Arrays are suitable for complex images.)In the MATLAB workspace, most images are represented as two-dimensional arrays, with each matrix element corresponding to a single pixel in the image. For example, a 256 x 256 column image with dots of various colors can be stored as a matrix. Some images (such as RGB) require a three-dimensional array, with the first plane representing red pixel intensity, the second plane representing green pixel intensity, and the third plane representing blown pixel intensity.

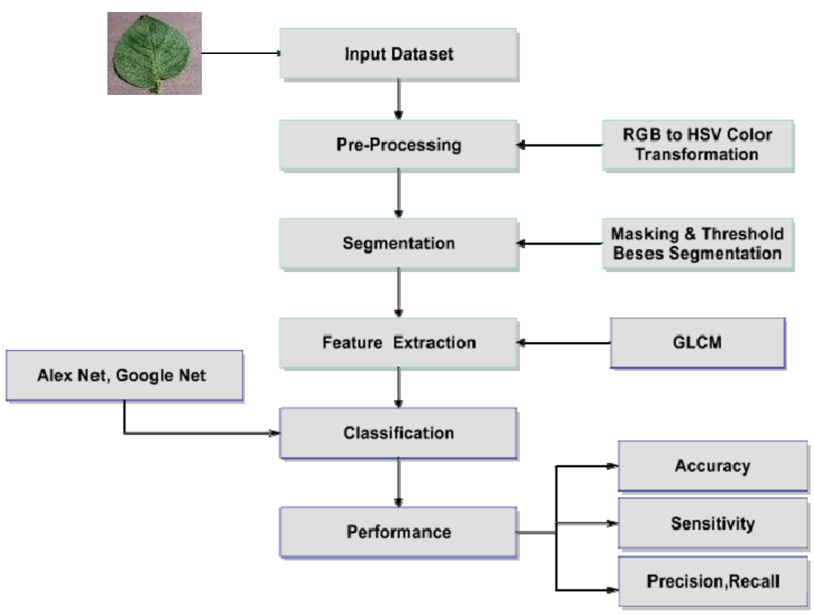

Figure 1: Proposed diagram.

Figure 2: input image.

Preprocessing: RGB images are converted to HSV color space representations. The key spectral components of each color in the RGB model are red, green, and blue, and the model is based on a Cartesian coordinating scheme. While the RGB model is useful for interpreting the individual, it is not well suited for representing colors. To get around these limitations, the RGB image is converted to HSV format. After converting from RGB to HSV, the hue and saturation components are used to further analyze since they are the most educated. The RGB to HSV conversion is done on a per-pixel basis.

RGB to HSV color transformation: The RGB images were converted into HSV color space representation. In the RGB model each color appears in its primary spectral components of red, green and blue and this model is based on a Cartesian co-ordinate system. Though RGB model matches to the human eye in such a way as strongly perceptive to the primary colors, this model is not well suited for describing colors in terms that are practical for human interpretation. To avoid these limitations, the acquired RGB images were converted into HSV format.

Segmentation (Masking & Threshold based segmentation): the segmentation method is divided into two stages: (1) masking and (2) threshold segmentation. I masking of green pixels Pixel masking is when the image's pixel value is set to zero or a different value. Since the green region of plant leaves is the healthiest, a higher rate of diseased component care is best avoided in the green sector. If the intensity of the green pixels is greater than the default value, all of those values are set to zero. After masking, pixels with zero values are discarded. Following the masking In the masking process, the values in the H and S planes are used to identify the diseased portion of the blade, and the value "1" is assigned to that portion. The remaining areas are all set to "0." The result is a binary image containing only them and zeroes. The diseased leaf area can then be removed.

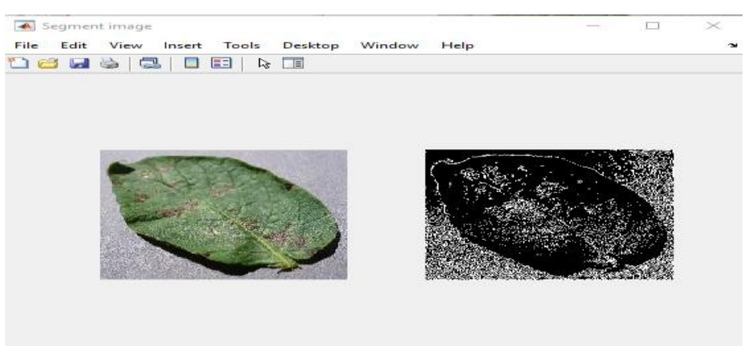

Figure 3: Segmentation Image.

Threshold segmentation- The image is segmented using equivalent segmentation based on the image's intensity or grey scale. This simple yet effective threshold-dependent approach for segregating images based on geographic images. On a dim or dark backdrop with light artifacts, this method is widely used. To segment image pixels into multiple categories and separate the object from the background, the threshold algorithm chooses a suitable threshold T. A binary image clearly indicates that the image contains both zero and one values. The binary image is then multiplied by the RGB image's original value. This removes the leaf's infected portion. The knife mask and the resulting damaged area mask were used for further study. After the processing step, multiply the "damaged" area mask by adjusting the image RGB got. Since the mask only includes 1 and 0, the diseased part of the blade in the mask has the value of 1. When this image is multiplied by an RGB image, only the diseased aspect is shown.

Feature extraction (GLCM): Functions are derived by reducing the amount of resources required to represent large amounts of data. The extracted functions should contain relevant information from the input data so that the necessary tasks can be completed using this simplified representation rather than the entire initial data. Quantifying the site's structural material is a useful method for explaining it. Smoothness, rawness, and regularity metrics are all properties of texture descriptors. This study employs statistical methods for explaining texture. The grey level co- occurrence is used to evaluate the leaf image matrix in this process. The GLCM matrix is a matrix that is generated from an image of a specific picture I. This matrix produces a GLCM by deciding that a pixel of the grey value is displayed in the frequency next to the pixel of the cooler j. In every I j) feature of GLCM, the number of times the pixel level with the I is shown near the pixel with the j number is indicated. GLCM reduces the image to 8 grey levels, while I am a powerful image. GLCM value can be used to erase textures.

Classification Techniques: considered under the supervised learning mechanism. The feed forward back Propagation Neural Network is generally consisting of three layers such as an input layer, a hidden layer, and an output layer. The neural network is to be trained with the available data. The structure of convolutional neural network mainly includes an input layer, convolution layer, pooling layer, fully connected layer, Activation functions, commonly rectified units (ReLUs) layers. The number of layers used their arrangement and introduction of other image processing units vary from one architecture to another determining their specificity.

GoogleNet: The GoogleNet Architecture is 22 layers deep, with 27 pooling layers included. There are 9 inception modules stacked linearly in total. The ends of the inception modules are connected to the global average pooling layer. GoogleNet overall has 4 million parameters.

AlexNet: Along with the advances in hardware, the CNN architecture becomes larger. AlexNet consists of 5 convolutional layers, 3 max-pooling layers, 2 normalization layers, 2 fully connected layers, and 1 softmax layer. Each convolutional layer consists of convolutional filters and a nonlinear activation function ReLU. The pooling layers are used to perform max pooling. Input size is fixed due to the presence of fully connected layers. AlexNet overall has 60 million parameters.

Recognition of leaf images using classifiers: Initially Images that are segmented help in identifying the infected places in an easier manner with many available techniques as well as methods. Threshold based systems were used by few existing systems. Few other systems based on threshold such as entropy based methods are also prevalent along with methods where the threshold is set manually that helps to segment affected part easily. Extracting Features CNN is one of the important techniques which an image of affected leaves from plant is taken into account and passes as input layer via a multiple layers of identified neurons. All the individual layers depicted in the fig. The input for supervised methods is labeled images whereas unlabelled images serve as inputs for unsupervised learning. With these inputs the model is able to learn and predict the output as whether the image fed into the model is affected by disease or not.

Performance Estimation: Process performance is measured based on performance indicators such as precision, sensitivity, specificity, or time consumption.
TP- is total number of properly categorized prospects (true positives).
TN- is total number of poorly classified prospects (true negative numbers).
FN- is total number of false rejections, which represents the number of false pixels of foreground pixels classified as background (false negatives).
FP- is total number of false positives, which means that pixels are mistakenly classified as foreground (false positives).
TN- is total number of poorly classified prospects (true negative numbers). FN- is total number of false rejections, which represents the number of false pixels of foreground pixels classified as background (false negatives).
FP- is total number of false positives, which means that pixels are mistakenly classified as foreground (false positives).
Accuracy: Precision is an indicator for evaluating classification models. Informally, precision is part of the correct prediction of our model. Formally, precision has the following definition:
Accuracy =correct number of predictions, total number of predictions, for binary classification, precision can also be calculated according to positive and negative, as follows:
Accuracy = TP + TNTP + TN + FP + FN
Where TP = true positive, TN = true negative, FP = false positive, FN = false negative
The classification process is done by adopting Deep learning model. Back propagation method is considered under the supervised learning mechanism. The feed forward back Propagation Neural Network is generally consisting of three layers such as an input layer, a hidden layer, and an output layer.

Figure 4: Confusion Matrix for dataset.

Table 1: Comparison result of different deep learning architecture with existing technique

	Deep Learning Architecture	Accuracy
Proposed techniques	Alex Net	98.85
	Google Net	99.10
Existing work	CNN	98.56

Table 2: Comparison result of different deep learning architecture

Deep Learning Model	Specificity	Sensitivity	Accuracy	Recall	Precision	Jaccard Coefficient	AUC	Dice	Classification Error
AlexNet	99.16	99.16	98.14	98.88	98.33	99.074	0.22	99.53	1.85
Google Net	99.1	96.66	98.33	96.66	96.66	97.77	0.22	98.87	0.80

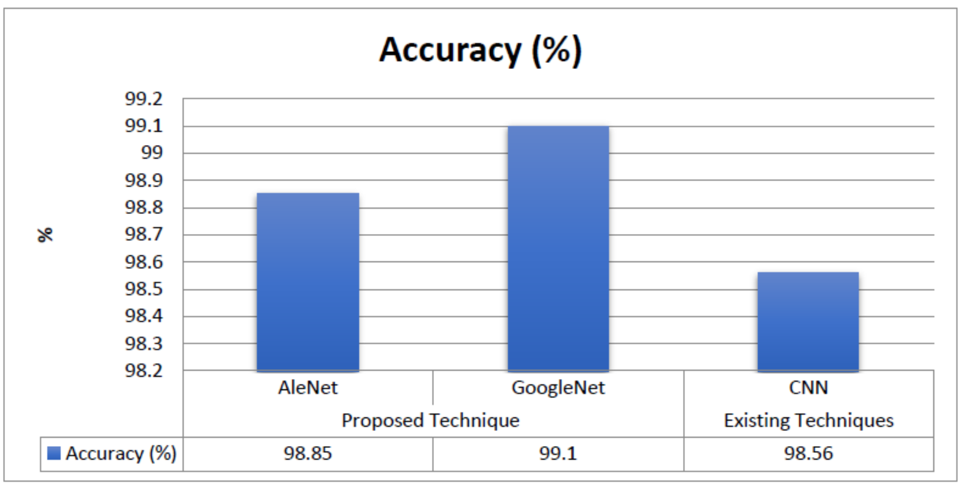

Figure 6: Comparison result of different deep learning architecture with existing technique.

Figure 6 showing the comparison performance of proposed model with existing techniques the proposed model compare with the other deep learning model, after the training and testing process AlexNet and GoogleNet model, the GoogleNet model get 99.10% the higher accuracy as compare to AlexNet model , GoogleNet model showing higher accuracy if we compare with the existing model.

IV. Conclusion

An image processing algorithm to find the disease detection and identification is proposed. The plant leaves are taken as the set of leaves in detecting leaf diseases. The algorithm produces better results and healthy and unhealthy plants can be differentiated with the help of this algorithm. With this image analysis technique good healthy plants can be extracted out from a cultivating farm which increases the productivity and the quality of the pepper plants also can be assured. This algorithm helps in identifying the presence of diseases by observing the visual symptoms seen on the leaves of the plant. A picture processing algorithm is proposed for detecting and recognizing diseases. The leaves of pepper plants are used to identify leaf diseases. With the help of the algorithm, the algorithm can differentiate between healthy and unhealthy plants, resulting in better performance. This image analysis technology can be used to extract healthy pepper plants from farms, thereby increasing pepper fruit production and ensuring pepper plant quality. This algorithm aids in the diagnosis of diseases by observing the visual symptoms of plant leaves. An image processing algorithm to find the disease detection and identification is proposed. The plant leaves are taken as the set of leaves in detecting leaf diseases. The algorithm produces better results and healthy and unhealthy plants can be differentiated with the help of this algorithm. With this image analysis technique good healthy plants can be extracted out from a cultivating farm which increases the productivity and the quality of the pepper plants also can be assured. This algorithm helps in identifying the presence of diseases by observing the visual symptoms seen on the leaves of the plant.

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