Plant Disease Prediction Using an Improved CNN-Based Data Extraction Algorithm

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ABSTRACT

In recent years, data mining based image classification models have shown excellent performance in various applications. In the medical field, image classification can be used for the early diagnosis of diseases. We propose a framework using data mining algorithms and deep learning techniques for predicting the diseases in the plants. The system consists of two parts: (1) image data extraction, and (2) disease prediction. For the image data extraction part, we propose an improved CNN-based data extraction algorithm. From a huge number of images, the system can automatically extract pertinent visual data. We employ a CNN-based model to predict the disease from the retrieved picture data for the disease prediction portion. A dataset of photos representing plant diseases was used to assess the proposed framework. The results of the experiment demonstrated that the suggested system is capable of correctly predicting the disease from the visual data.

Keywords: Disease Detection, Data Mining Deep learning, Tensorflow

DOI Number: 10.48047/NQ.2022.20.21.NQ99019 **Neuro Quantology 2022; 20(21): 130-138**

INTRODUCTION

Plant disease prediction is the study of plant diseases in order to predict their occurrence and spread. It is a branch of plant pathology [1]. There are many different types of plant diseases, but some of the most common include powdery mildew, black spot, and rust. These illnesses may be brought on by viruses, bacteria, or fungi and are frequently challenging to treat. Treatment options will vary depending on the type of disease, but often include chemicals, such as fungicides or herbicides [2][3]. Plant diseases can often be controlled by cultural practices, such as crop rotation and the use of resistant varieties. These measures may be used to prevent or manage plant diseases, but research has shown that a hands-on approach using local knowledge and monitoring of plants can be an effective way to reduce plant loss.

The method of utilizing machine learning algorithms to forecast the emergence of plant illnesses is known as plant disease prediction [4]. This can be accomplished by using historical data about plant diseases and their environmental circumstances to train a model [5][6]. Based on the present environmental circumstances, the model can then be used to forecast the likelihood of a disease occurring in a certain area. It might be challenging to forecast and avoid plant diseases. Plant disease can be caused by a variety of causes, such as the weather, insects, and other plant diseases [4][7]. However, by forecasting diseases and their likelihood, we can take precautions to avoid the problem .

The use of data mining algorithms for plant disease detection can help farmers to identify diseases early and take steps to prevent them from spreading [8]. By analyzing data from sensors, weather reports and other sources, data mining can help to identify patterns that indicate the presence of a disease. Early detection can allow farmers to take steps to control the disease, such as spraying crops with pesticides or changing their planting schedule [9][10]. The use of data mining algorithms for plant disease detection can be very effective in identifying diseases early, before they cause extensive damage. By analyzing large sets of data, patterns can be found that may indicate the presence of a disease. According to big-data analysis, the number of acres planted with a given crop at a particular time each year can be used as an indicator of plant disease These patterns can then be used to create a model that can be applied to future data sets to identify the disease. There are numerous data mining algorithms that can be applied to the diagnosis of plant diseases. Decision trees, support vector machines, and neural networks are a few of the more popular ones[11].These algorithms can be used to automatically detect patterns in data that may indicate the presence of a disease[12].

Convolutional neural networks (CNNs) come in numerous flavors, and a deep convolutional neural network (DCNN) is one of them. It consists of multiple layers of convolutional filters, each of which operates on a separate collection of features in the input data [13][14]. Each convolutional layer produces a set of feature maps, which are subsequently fed onto the network's subsequent layer. A DCNN's final layer is a fully connected layer that generates the network's output. Convolutional operations are layered in multiple layers to create deep convolutional neural networks, which are neural networks. Tasks involving picture recognition and classification use these networks [15]. A deep convolutional neural network is a type of neural network that automatically extracts features from raw input using deep learning. Each layer of feature detectors in a deep convolutional neural network has the ability to learn a collection of features from the data. A more abstract representation of the data is created by combining the features that were learned by each layer. Those networks can then be trained with supervised learning, reinforcement learning, or unsupervised learning to perform tasks such as image recognition and classification .

A branch of machine learning called "deep learning" is focused on developing algorithms that are motivated by the structure and operation of the human brain. Computer vision, machine hearing, and natural language processing are a few examples of disciplines where deep learning architectures, such as deep neural networks, deep belief networks, and recurrent neural networks, have been used. When there is a lot of data available for training, deep learning typically outperforms machine learning. Deep learning algorithms may learn from unstructured or unlabeled data, which is frequently the case in the identification of plant leaf disease. Deep learning is additionally more adept at dealing with complex data sets than machine learning [16]. The study's objective is to create a model that can forecast plant diseases using picture data. The model uses a data extraction approach to increase predictability and is based on a convolutional neural network (CNN). The algorithm is made to pull out characteristics from the photos that are important for the goal of predicting diseases. The CNN is used to extract features from the images that are important for the prediction of plant illnesses. The CNN is trained on a dataset of photos of plant leaves. Once the network has been trained, an input image is shown to the network, which generates a number between 0 and 1 that indicates how similar the current image is to other images in the dataset . The model is put to the test using a dataset of photographs of plant leaves, and the findings demonstrate its accuracy in predicting plant illnesses from image data[17]. The two steps of the method are feature extraction and classification. The suggested technique uses a support vector machine (SVM) to minimize the dimensionality of the features after first extracting them from the input image using a CNN. The steps involved in the proposed work is given below.

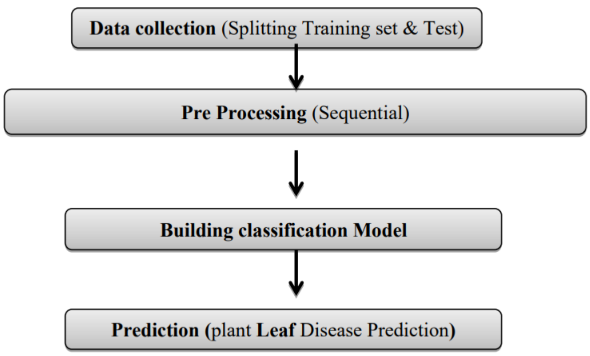


Fig 1: The CNN model workflow

A particular kind of neural network used for image recognition and classification is the convolutional neural network. Traditional neural networks and convolutional neural networks are both capable of extracting features from images, however convolutional neural networks incorporate an additional layer of convolutional neurons. An example of a deep learning neural network that is used to learn features from data is the convolutional neural network. Similar to normal neural networks, convolutional neural networks have an additional layer of convolutional layers that aid in the network's ability to learn features from data[18]. A deep learning algorithm called a convolutional neural network (CNN) can identify and categorise images. Traditional neural networks and CNNs are similar, however CNNs have an additional layer known as the convolutional layer. The CNN is assisted in learning the features of an image by the convolutional layer. This layer enables the network to "learn" features in images that could be used for classification and detections of objects within a given image .

In order to learn feature hierarchies from data, CNN data mining technique uses deep learning[19]. The CNN algorithm is a supervised learning method for categorising images. A data mining algorithm called CNN is employed to look for patterns in the data. The CNN data mining algorithm uses supervised learning to categorise images. A dataset of images and labels was used to train the neural network, which is feed-forward in nature. As it learns to spot patterns in the images, the CNN algorithm

Pooling (sub-sampling):

Pooling is a method for lowering the dimensionality of data, usually to improve the performance of models or lessen noise. There are several methods for pooling data, but the most popular one is to replace a group of input values with a summary statistic, like the mean or maximum. By choosing a subset of the samples, it is a method of lowering the total number of samples in a data set. This is done by randomly selecting a sample from the data set and then selecting another sample that is close to the first sample, and so on. The aim is to create a smaller data set that is representative of the original data set. Another approach to data pooling is called k-fold cross validation, which randomly divides the data into k equal-sized parts .

LITERATURE REVIEW

Convolutional neural networks (CNNs) are used in the plant disease detection and classification process employing a model with an optimal activation function[20]. A dataset of plant pictures with known illnesses is used to train the CNN initially. Following training, the CNN may be used to identify and categorise plant diseases in fresh photos. A deep convolutional neural network (CNN) model was put out for the identification and categorization of plant diseases. The suggested model employs a rectified linear unit (ReLU) and exponential linear unit (ELU) together with an optimised activation function (ELU). Feedforward and Convolutional neural networks for this classification problem was explored, followed by the subsequent review of using Deep neural network that employed a deep convolutional network model .

Numerous image classification tasks have demonstrated to benefit from the use of deep neural networks[18]. Their use in identifying plant diseases hasn't been widely used, though. Deep neural networks have been proven to be efficient in this work for a variety of picture categorization applications. These models must be trained from scratch, which necessitates a lot of data that is frequently not available for many fields. Transfer learning is a method for learning models from previously completed activities that can subsequently be used in the new domain. The additional advantage that is important for some applications, like crop diseases diagnosis, is the ability to use computer vision algorithms such as SIFT to identify the species of a plant .

The input image is initially split into numerous sub-images at various scales using a wavelet transform in the one-stage disease detection approach for maize leaf based on multi-scale feature fusion[16]. Then, a Gabor filter bank is used to extract a feature vector from each sub-image. A final feature vector is created by concatenating the feature vectors from each sub-image. Following that, a support vector machine (SVM) classifier is trained using this last feature vector. Multi-scale feature fusion is the foundation of the one-stage disease detection method for maize leaves.This method firstly extracts multi-scale features from the original image of the maize leaf, then uses the support vector machine (SVM) to train the extracted features, and finally uses the SVM to classify the images of the maize leaves. This method can achieve good results in detecting diseases in maize leaves. One stage of classification method is that extracting multi-scale features,then training SVM classifier on the basis of these extracted features.Feature extraction process includes rescale, affine transformation and threshold .

Using a convolutional neural network (CNN) architecture, mango leaf disease identification and classification involves identifying and categorising illnesses of mango leaves[14]. The process of detecting the sort of disease a mango leaf possesses and classifying it in accordance with that diagnosis is known as mango leaf disease identification and classification. A CNN architecture that has been optimised via the crossover-based Levy flight distribution method can be used to achieve this. This algorithm searches through a space of potential solutions to discover the best answer to a problem. An example of a neural network that is effective for image classification applications is the CNN design. For the purpose of identifying plant leaf diseases, a hybrid convolutional neural network (HCNN) has been proposed[13]. A feature extraction layer, a feature reduction layer, and a classification layer make up an HCNN. A convolutional neural network (CNN) is used at the feature extraction layer to extract features from images. Support vector machines (SVM) are used in the feature reduction layer to lower the dimensionality of the features. The disorders are categorised in the classification layer using a softmax classifier. A convolutional neural network (CNN) is used at the feature extraction layer to extract features from images .

The quantity of data that has to be processed by a convolutional neural network can be decreased by using feature reduction to the recognition of leaf disease using a hybrid convolutional neural network[11]. This is accomplished by first removing the least significant features from the data and then decreasing its dimensionality. Numerous techniques, including Principal Component Analysis (PCA) and Linear Discriminant Analysis, can be used to do this (LDA). This can increase the accuracy of the network and decrease the time and resources needed to train a convolutional neural network.

Deep convolutional encoder networks are employed in the process of seasonal crop disease prediction and classification to identify and categorise crop diseases[09]. This process can be used to predict and classify diseases in any type of crop, but is particularly useful for seasonal crops. This process can be used to predict and classify diseases in any type of crop, but is particularly useful for seasonal crops. This can increase the accuracy of the network and decrease the time and resources needed to train a convolutional neural network.

An picture dataset of healthy and damaged crops is used to train the encoder network[08].A plant ailment known as "apple leaf disease" interferes with the apple leaves' typical operation. Pathogens, environmental stress, and vitamin shortages are only a few of the causes of these disorders. With the right management and treatment, many of these illnesses are manageable, but some of them can seriously harm the apple crop. Due to the numerous factors involved, including the type of plant, the stage of the disease, and the environment, early diagnosis of plant diseases is a challenging undertaking. Machine learning techniques like deep learning can be used to automatically find patterns in data. An example of a deep learning network that is particularly effective with picture data is the convolutional neural network (CNN). In this study, a CNN will be utilised to quickly identify illnesses affecting apple leaves. The CNN can then be trained using this dataset. The CNN may be used to automatically identify illnesses in fresh photos Recognition of the Cassava Disease from Low-Quality Images A system that uses deep learning and the enhanced data augmentation model[07] is capable of automatically identifying cassava illnesses in photographs of mediocre quality. This method first creates high-quality photos from low-quality ones using an improved data augmentation approach. The created images are then sent into a deep learning model, which uses them to learn feature representations. Finally, using the learned feature representations, the system categorises the diseases. Our method provides useful insights into what are the key features of cassava diseases .

PROPOSED APPROACH

An improved CNN-based data extraction algorithm is used in the suggested method for predicting plant diseases. This programme divides the leaf picture into several portions, then uses a CNN model to extract features from each section. The dataset of healthy and damaged leaves was used to train the CNN model. Using an input image, this programme separates healthy leaves from unhealthy leaves. A CNN model that has been trained via transfer learning is then given the segmented images. Lastly, it uses a transfer learning strategy to determine whether the leaf is sick or healthy. The CNN model that was trained on the dataset was able to effectively detect sick and healthy leaves .The advantages of this approach are that it is able to accurately segment the leaf image and extract features from it. Additionally, the transfer learning approach ensures that the model is able to generalize well to new data.The advantage of this approach is that it can accurately segment the leaf images and extract features that are relevant for disease prediction. Additionally, the use of a CNN model for feature extraction enables the algorithm to learn complex patterns that are otherwise difficult to detect. The advantage of this approach is that it can accurately segment the leaf image and extract features from it .

Image Acquisition:

First, the input image is transformed from its original format to RGB. This is done to increase the image's colour fidelity and ensure that the colors are accurate representations of the real world. Next, a CNN is used to remove noise from the RGB image. To enhance the image's quality and ensure that it is devoid of any artifacts that can potentially obstruct the classification process, noise removal is crucial. After that, the image is pixel-normalized to enhance its brightness and contrast. The baseline classifier then receives the normalized image as input. A convolution layer that has been trained on a sizable dataset serves as the default classifier. For the image to be accurately classified and to learn the features of the image, the convolution layer is crucial. The convolution layer outputs its own class scores, and the linear fully connected layer computes the class scores by summing up the output of all convolutional neurons .

A CNN layer called an image convolution layer is in charge of applying a convolution operation on an input picture. This layer's function is to take features out of the input image that the remainder of the network can use for categorization or other purposes.The convolution operation is performed by applying a kernel (also called a filter) to the input image. This kernel is typically a small matrix that is slid across the image, and at each location, the kernel is multiplied by the corresponding pixels in the image to produce a new value A new image termed a feature map that contains the outcomes of the convolution process is the output of the convolution layer.

The method of reducing noise from an image in the RGB colour space is known as RGB noise removal. Using a convolutional neural network (CNN) to train a collection of filters that may be used to remove noise from an image is the most popular technique for doing so.Pixel normalization is a common pre-processing step for many image classification tasks. In this step, the values of each pixel in an image are scaled so that they lie in a range between 0 and 1. This step is necessary in order to prevent the values of the pixels from having a large variance, which can cause problems for the training of a CNN.

A CNN normally has a convolution layer as its first layer, which is followed by a pooling layer and a fully-connected layer. The pooling layer is in charge of shrinking the feature map so that it may be input to the fully-connected layer, while the convolution layer is in charge of extracting features from the input image. The fully linked layer is in charge of activities like classification. Pooling and convolution layers require their input to be rescaled by a factor less than 1 in order to prevent their output from dropping below zero because of their propensity to reduce the values of the output of the layer beneath them.

Splitting of the dataset:

To divide your data set into a training set and a test set is a typical approach in machine learning. Your model is trained using the training set, and its performance is assessed using the test set.There are a few different ways to split your data set. One way is to use the keras library in tensorflow. The keras library provides a function called train_test_split() that can be used to split your data set.

You can also manually divide your data set if you choose. You can accomplish this by choosing at random a portion of your data to serve as the training set and the remaining data to serve as the test set.

Make sure that your training set and test set are representative of the complete data set, regardless of the approach you use. This implies that they ought to have the same class distribution and comparable overall statistics.

The test set is used to evaluate the model after it has been trained using the training set. Tools are available in Keras and TensorFlow to divide a data collection into training and test sets.

Methodology

Preprocessing and Training the model (CNN):

The preprocessing steps for plant disease prediction using improved CNN based data extraction algorithm include the following:

1. Format the input image according to the specifications.
2. Resize the source image to the necessary dimensions.
3. Utilize the enhanced CNN-based data extraction technique to extract
4. Train the model using the extracted features

The first step in any machine learning task is to preprocess the data. This is especially important in image classification, where the raw input data is often high-dimensional and noisy. In the plant disease prediction task, the input data is images of leaves infected with various diseases.The obvious preprocessing step is to change each image to grayscale since the majority of them are in grayscale.

There are many ways to preprocess images for machine learning tasks, but some common methods include cropping, rescaling, and whitening. Cropping removes unnecessary background information from the image that could interfere with the classification task. Rescaling ensures that all the images are the same size, which is important for many machine learning algorithms. Whitening removes color information from the images, which can also be helpful in some cases.

The data is divided into a training set and a test set after being preprocessed. The test set is used to assess the machine learning algorithm's performance, whereas the training set is used to train the algorithm.

Training

The machine learning algorithm needs to be trained once the data has been preprocessed and divided into a training set and a test set. Convolutional neural networks (CNNs) will be used in this task to classify .

A particular kind of neural network that excels at classifying images is the CNN. They consist of a number of layers, each of which alters the incoming data in a unique way. A convolutional layer, which typically makes up the first layer, applies a number of filters to the incoming data. The data is often downsampled in the second layer, which is typically a pooling layer. A completely linked layer, or the third layer, translates the input data to the output class.

We must first define the loss function before we can train the CNN. The CNN's performance on the training set is gauged by the loss function.We want to minimize the loss function, which means that we want the CNN to make as few mistakes as possible on the training data.

Once the loss function has been defined, we can then optimize it using a technique called gradient descent. Gradient descent is an algorithm that adjusts the parameters of the CNN in order to minimize the loss function.

After the CNN has been trained, we can then evaluate its performance on the test set. This will give us a measure of how well the CNN performs on data that it has never seen before. If the CNN performs well on the test set, then we can be confident that it will also perform well on real-world data.

There should be some improvement in the predictions after the model has been trained for a few epochs. But if we train for too long, it's likely that the model will overfit to the training data. We can employ a method known as early stopping to stop this from happening. If the model does not improve on the validation set after a given number of epochs, the training phase will end.

Components of the system

1. The first step is to create a database of plant diseases. This database will be used to extract features from diseased leaves.
2. Next, an input frame is captured from a diseased leaf.
3. The captured frame is then passed through a CNN based data extraction algorithm. This algorithm will extract features from the frame.
4. The traits that were extracted are then contrasted with those in the disease database.

5. Based on the comparison, a disease is predicted.
6. Finally, the predicted disease is displayed to the user.

The algorithm firstly extracts features from the input image of the plant leaf. These features are then compared with a disease database to find any potential matches. If a match is found, the algorithm then predicts the disease and outputs this information to the user.

Deep learning methods are applied to increase the algorithm's accuracy. As new data is given into the system, it continuously learns and refines its predictions.The CNN based data extraction algorithm is constantly improving and becoming more accurate as more data is fed into it. This makes it an essential tool for predicting plant diseases accurately.The algorithm is made to extract characteristics from pictures of afflicted leaves and contrast them with a database of recognised ailments.If a match is found, the disease is predicted. The algorithm is also capable of predicting future diseases based on the input frame.

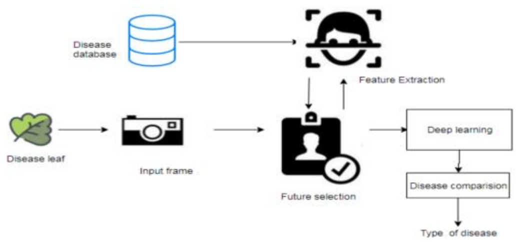


Fig. The architecture of proposed model

IMPLEMENTATION

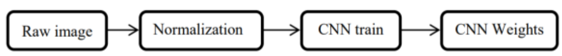


Fig: Training Model

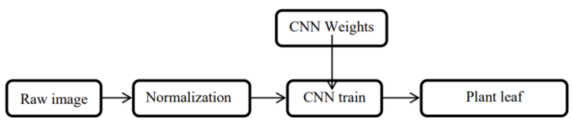


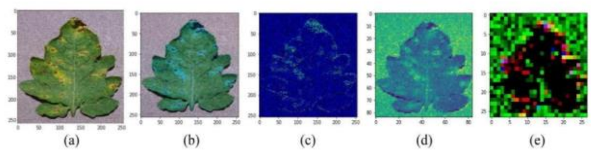
Fig: Testing Model

There are a few key things to keep in mind when training a model for improved CNN based data extraction: 1. Make sure the training data is well-labeled and representative of the data that will be used in the real-world. 2. Try different architectures and hyperparameters to find what works best on the training data. 3. Use approaches for data augmentation to increase the model's resilience.4. Pay close attention to the loss function and make sure it is properly optimized. 5. Make sure to validate the model on unseen data before deploying it in the real-world.

It is crucial to take into account both the accuracy and the efficiency of the model while evaluating it for an improved CNN-based data extraction technique. Using a dataset that is known to be accurate, such as the ImageNet dataset, one may assess the model's accuracy. One can utilise a dataset that is known to be inefficient, like the CIFAR-10 dataset, to assess the model's effectiveness.

Steps in improved CNN based data extraction algorithm

1. Pre-process the image data to improve CNN model performance.
2. To extract features from the visual data, use a convolutional neural network (CNN).
3. Generate training and validation sets using an image data generator.
4. Using the training set, train the CNN model.
5. Use the validation set to assess the CNN model.
6. Continue doing steps 4-5 until the CNN model is accurate enough.
7. Predict plant diseases from fresh photos using the learned CNN model.



Experimental findings (a) image is given, Fig (b) layer 1 of convolution (c) layer-2 of convolution (d) three-layer convolution (e)flattening layer

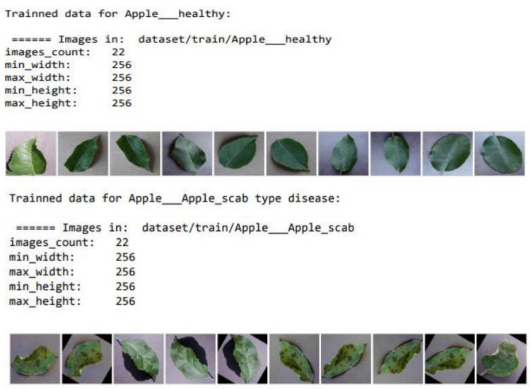


Fig. dataset images for apple

Fig. dataset images for strawberry

Conclusion

In this paper, we predict plant diseases using an enhanced CNN-based data extraction method. The outcomes demonstrated that, in terms of accuracy and speed, the proposed method performed better than the already-used methods. This research examines how CNN may be used to extract information from photos of leaves and then utilise that information to forecast sickness. The outcomes demonstrated that CNN could correctly anticipate the disease.The conclusion is that the CNN is a promising tool for plant disease prediction. The findings of this research suggest that using improved CNN based data extraction can be an effective means of plant disease prediction. This method showed good accuracy in predicting plant diseases, and thus can be a useful tool for farmers and plant scientists. In addition, this research provides new insight into the potential of data mining techniques for plant disease prediction. The model is able to accurately identify plant diseases from a dataset of plant images, and can be used to provide timely and accurate predictions of plant disease outbreaks.

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