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Banana Crop Disease Detection Using Deep Learning Approach

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***Abstract:** India is primarily an agricultural country where a significant portion of the population depends on agriculture for their livelihood. However, plant diseases are a major issue for farmers, hindering their efforts to cultivate crops. Delayed detection of diseases can result in a significant loss of yield and income for farmers. To mitigate these negative impacts, we have created a project that utilizes machine learning and deep learning techniques such as image processing and Convolutional Neural Networks to detect various diseases in banana plants. Our machine learning model enables early detection of diseases, which can help minimize the loss of yield and enable farmers to take necessary preventive measures to halt the spread of diseases in their crops.*
***Keywords:** Convolutional Neural Network, Deep Neural Networks, Deep Learning, Artificial Intelligence, Machine Learning, Plant Disease Detection, Image Processing.*

I. INTRODUCTION

Banana is a crucial fruit crop globally, with a production of over 94 million tons. In India, it is a significant source of income for a large number of farmers. With an annual production of over 16.40 million tons from 480.40 thousand hectares, and an average yield of 31.5 T/ha, Maharashtra leads in production with 62 T/ha. Banana constitutes 37% of the total fruit production in India, and covers 21% of the total plantation area in the country. Maharashtra, being the largest state after Rajasthan in terms of area and first in production, is a vital contributor. Jalgaon, a district in Maharashtra, holds the most crucial banana farming area, covering 50,000 hectares of banana farms. Unfortunately, every year, farmers face substantial losses due to bacterial, fungal, and viral diseases in banana crops. This paper highlights various techniques used for early detection of diseases in banana crops that can help farmers and reduce their losses.

Bananas are a crucial crop in the fruit industry and are the second most important fruit crop in India after mango. They are available year-round, come in a variety of types, are affordable, and have numerous nutritional benefits and medicinal properties, making them popular globally. Bananas are also a highly sought-after export product. They are rich in carbohydrates, vitamins (especially B vitamins), fiber, and minerals such as potassium, calcium, and magnesium. They are easy to digest and have no cholesterol or fat, making them a healthy choice for patients suffering from various ailments such as hypertension, arthritis, ulcers, gastroenteritis, and kidney disease.

In addition to their use as a food source, banana fiber can be used to make products such as bags, pots, and wall hangings, while banana scraps are useful in making high-quality rope and paper. Banana leaves are also used as a hygienic dinner plate.However, banana crops are susceptible to various types of diseases, including bacterial and fungal diseases, such as black sigatoka, yellow sigatoka, rhizome soft rot, panama and fruit speckle. This study aims to focus on some of the significant diseases associated with bananas.

To address this issue, the research proposes a deep convolutional neural network model to detect banana plant diseases quickly and accurately using images of different banana plant diseases. Detecting plant leaf diseases can be difficult, especially for inexperienced farmers. As a result, an automatic system that identifies crop diseases based on their visual appearance and symptoms could be of significant help to farmers. Various efforts have been made to quickly and accurately detect leaf diseases, and this research proposes using image processing techniques and neural networks to detect plant leaf diseases in banana crops. Deep learning has made significant strides in recent years and is now capable of extracting useful feature representations from large numbers of input images.

This technology provides an opportunity to accurately identify crop diseases in a timely manner, improving the accuracy of plant protection and expanding the scope of computer vision within the field of precision agriculture.

II. LITERATURE SURVEY

Several studies have been conducted in the area of plant leaf disease detection in the past. Researchers have focused on identifying and detecting diseases in various crops including banana, tomato, sorghum, wheat, apple, and others.

Although this paper concentrates on the banana crop, the approaches, techniques, and workflows described in earlier studies exhibit some similarities. While the diseases affecting different crops may vary, the principles utilized for their detection show similarity, and this system can be extended to other crops with appropriate model training.

[1]. Husnul Ajra and colleagues developed a system for detecting and classifying diseases in potato and tomato plants. They used two convolutional neural networks, AlexNet and ResNet-50, to analyze datasets of unhealthy leaves and identify symptoms of disease. The feature extraction and classification were performed by these models. The accuracy achieved by their approach was 97% and 96.1% for ResNet-50 and 96.5% and 95.3% for AlexNet, respectively, for the classification of infected and uninfected leaves and leaf diseases.

[2]. Ms. Deepa and colleagues developed a system for detection of leaf diseases that includes image pre-processing, clustering, training, and classification. The method utilizes K-means clustering to group leaves and then uses support vector machine (SVM) technique for classification. To perform multiclass classification, the system applies one-to-one or one-to-many mapping using multi-SVM.

[3]. Xulang Guan proposed a plant disease detection system that utilized four distinct convolutional neural network models, namely Inception, Resnet, Inception Resnet, and Densenet. The results obtained from the CNN models were processed using the stacking method, resulting in an accuracy rate of 87%. This approach yielded a considerable improvement in accuracy when compared to using a single CNN model.

[4]. Surampalli Ashok and colleagues developed a tomato plant disease detection system that employs a convolutional neural network (CNN) classifier. To prepare the dataset, images are initially pre-processed using a Gaussian filter. The feature extraction is carried out using both Discrete Wavelet Transform (DWT) and GLCM. DWT uses sub-band coefficients, while GLCM computes the correlation to classify the leaf image or segment of a leaf image based on different luminous levels. Subsequently, segmentation is performed, and a CNN classifier is utilized for classification.

[5]. The detection system for plant diseases proposed by Xinda Liu and colleagues utilizes a reweighting approach. The system calculates the weights of patches and allocates them to loss for patch label pair. Then, the patch features are extracted from the network trained with loss reweighting and an LSTM network is employed for further processing.

III. OBJECTIVES

1) Develop an accurate and reliable deep learning model for identifying different types of diseases in banana crops.
2) Improve the speed and efficiency of disease detection in banana crops
3) Increase overall crop yields and reduce crop losses by identifying and treating diseased plants quickly
4) Collect and process large dataset of images of healthy and diseased banana plants
5) Develop a convolutional neural network model for classifying different diseases in banana crops and train it using dataset
6) Test the accuracy and reliability of the model using a separate dataset of images that it has not seen before.
7) Integrate the model into a user-friendly interface that allows farmers or crop management professionals to easily upload images for analysis and receive disease diagnoses.
8) Evaluate the real-world performance of the model by monitoring its ability to accurately detect diseases in banana crops over time, and adjust the model as necessary to improve its performance.

IV. METHODOLOGY

The proposed system is developed using python programming language and its various libraries. The system will be available on desktop or laptop. The farmer will first capture the image through his device. After capturing the image he will provide the image to the developed application. The image will go through a series of steps such as image pre-processing, feature extraction, classification using convolutional neural networks, etc. Finally, a result will be displayed on the screen and the application will detect whether the crop is healthy or infected and if infected, what is the disease that have caused the infection along with the pesticide to be used for treating the crop. The model is made by using convolutional neural network. CNN stands for Convolutional Neural Network, which is a type of deep neural network commonly used for image recognition, computer vision and natural language processing.

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The CNN architecture is designed to automatically and adaptively learn spatial hierarchies of features from input data, using convolutional layers, pooling layers, and activation functions. By processing data in a hierarchical way, CNNs are able to learn high-level features of the input, and can be trained to identify objects, shapes, textures, and patterns within an image. It consists of following components:

1) *Convolutional Layers:* Convolutional layers are the core building blocks of a CNN. These layers apply filters or feature detectors to the input image in order to extract local features, such as edges, corners, and blobs. Each filter is a small matrix of weights that is convolved with the input image, producing a feature map. By using multiple filters, the convolutional layer can extract multiple features from the input image. Convolutional layers are typically followed by activation functions and pooling layers.
2) *Activation Functions:* Activation functions are used to introduce non-linearity into the output of a convolutional layer. The most commonly used activation functions in CNNs are ReLU (Rectified Linear Unit), tanh (hyperbolic tangent), and sigmoid. ReLU is the most popular activation function used in CNNs because it is computationally efficient and provides good performance. ReLU sets all negative values to zero, which allows the model to learn faster and prevents the vanishing gradient problem. In this model, we have used ReLU and softmax functions.
3) *Pooling Layers:* Pooling layers are used to reduce the spatial size of the input feature map by down-sampling. The most commonly used pooling technique is max pooling, which takes the maximum value of a small region of the feature map and discards the rest. Max pooling helps to reduce the dimensionality of the feature map and extract the most important features. Pooling layers are typically inserted after convolutional layers and activation functions.
4) *Fully Connected Layers:* Fully connected layers are used to map the extracted features to the output class labels. These layers connect every neuron in the input layer to every neuron in the output layer, and their weights are learned during training using backpropagation. The output of the last convolutional layer is flattened and fed into one or more fully connected layers, which are typically followed by a softmax activation function to produce the output probabilities for each class.
5) *Dropout:* Dropout is a regularization technique used in CNNs to prevent overfitting. During training, dropout randomly sets a fraction of the neurons in the network to zero. This forces the network to learn redundant representations of the input data, which reduces the risk of overfitting. Dropout is typically applied after the fully connected layers.
6) *Loss Function:* The loss function is a measure of the difference between the predicted and actual class labels of the input images. The most commonly used loss function in CNNs is the categorical cross-entropy loss, which measures the distance between the predicted and actual probability distributions of the classes.
7) *Optimizer:* The optimizer is the algorithm used to update the weights and biases of the network during training to minimize the loss function. The optimizer adjusts the weights and biases based on the gradients of the loss function with respect to the network parameters. Some commonly used optimizers in CNNs include Stochastic Gradient Descent (SGD), Adam, and Adagrad. SGD has been used in the development of this model.

Steps of Working:

Step 1: Image acquisition The first step in the process is to acquire an image of a banana leaf using a device such as a smartphone or camera. The user then uploads the image to the system for processing.

Step 2: Pre-processing Before the image can be used for training the model, it must be pre-processed to ensure that it is in the proper format and size. This involves adjusting the aspect ratio, normalizing, scaling, and reducing the dimensionality of the image. It is important that all the images in the dataset are of the same size to ensure that the convolutional neural network can perform its operations effectively.

Step 3: Feature extraction In this step, important and distinctive features of the image are extracted to be used for further processing. This is a crucial step in the process of building an accurate and efficient model.

Step 4: Preparation of model using CNN The next step involves designing and training a convolutional neural network model using the dataset and libraries such as Keras or TensorFlow. CNN is a popular deep learning algorithm used for image recognition and processing. It is efficient and reliable and is often the preferred choice for computer vision tasks.

Step 5: Displaying results Once the image has been processed and classified by the CNN model, the results are displayed on the screen. In the case of banana leaf disease detection, the user is informed whether the crop is infected or not, and the appropriate pesticide required for treatment is recommended. This step helps farmers take timely and effective action to protect their crops and prevent further damage.

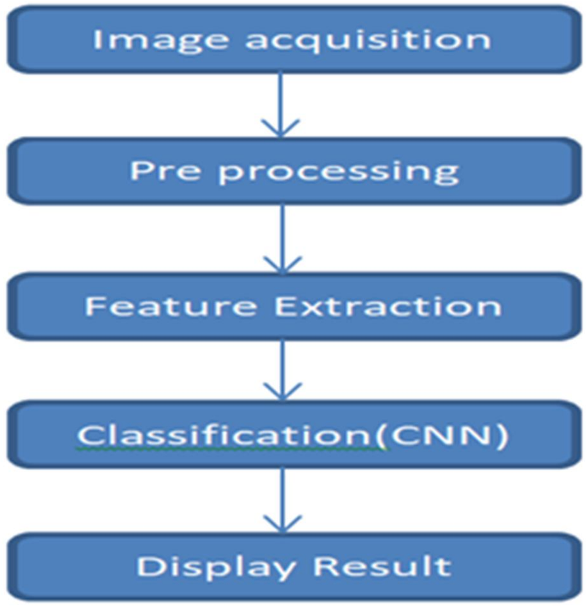

Fig 1. Flow of the system

V. EXPERIMENTAL RESULTS

The convolutional neural network in this model consists of three convolutional layers. The model is trained using images of healthy crops, crops infected with yellow sigatoka, black sigatoka and panama disease. The dataset is prepared using images from the internet, kaggle and also images captured manually. When the application is executed, the user is presented with login screen. After logging in, a screen appears in front of user which shows the options select image, pre-process image, CNN prediction and exit. The output is displayed as shown below in Figure 2. There are four classes, one for healthy crops, one for crops infected with panama disease, one for crops infected with black sigatoka and one for crops infected with yellow sigatoka. The model was able to achieve a testing accuracy of 88.32%. The accuracy and loss graphs are shown in the below figures.

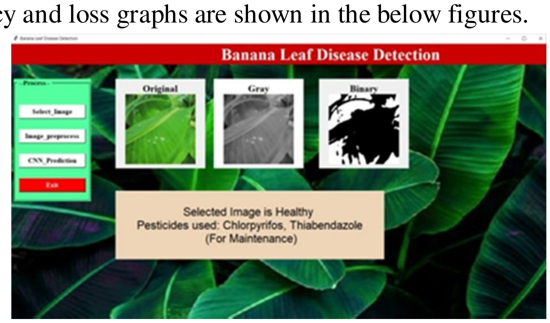

Fig 2. Output for healthy crop image.

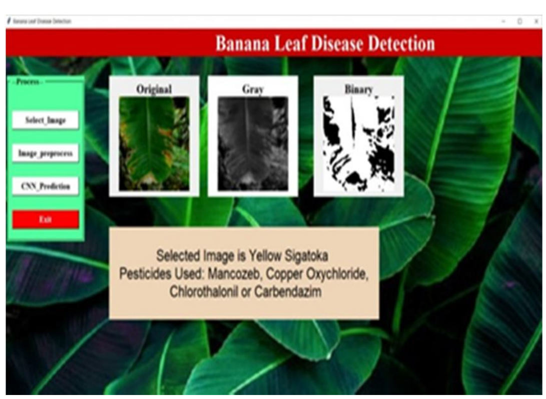

Fig 3. Output for diseased crop image.

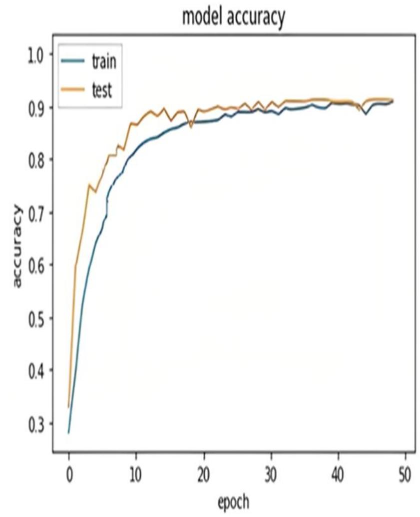

Fig 4. Graph for model accuracy

VI. CONCLUSION

In conclusion, the detection of diseases in banana crops is an important task that can have a significant impact on the agricultural industry. Deep learning models like convolutional neural networks have shown reliability in accurately detecting various diseases in banana crops. By using a combination of image processing techniques and deep learning algorithms, it is possible to create a model that can quickly and accurately identify diseases in banana crops, allowing farmers to take appropriate action to prevent the spread of the disease and improve the health of their crops. The model developed was able to achieve 88.32% of accuracy on the testing dataset. In addition to detecting diseases, it also suggested suitable pesticides to be used on the crop according to the disease detected. The success of this project could lead to increased yields, reduced costs, and improved sustainability in the agricultural industry.

VII. FUTURE SCOPE

In future, following improvements and additions could be done:

1) The system can be extended to include diseases for other crops by using appropriate data.
2) A mobile application of the system can be developed for use by the farmers. This will eliminate the need of laptop/desktop to be purchased by the farmers
3) A PWA of the system can be developed so that the farmers can also use the system on low power and low capacity mobile devices
4) Personalized notifications and suggestions can be given to each and every farmer based on their use of the application
5) A feature of consulting a domain expert can be provided within the application if the farmer wishes to do so
6) A feature of generating a detailed report of the condition of crops can be made available
7) A feature of connecting farmers from different locations can be made available for carrying out discussions about crops and its diseases. For example, a forum can be made where users can ask and answer questions

VIII. ACKNOWLEDGMENT

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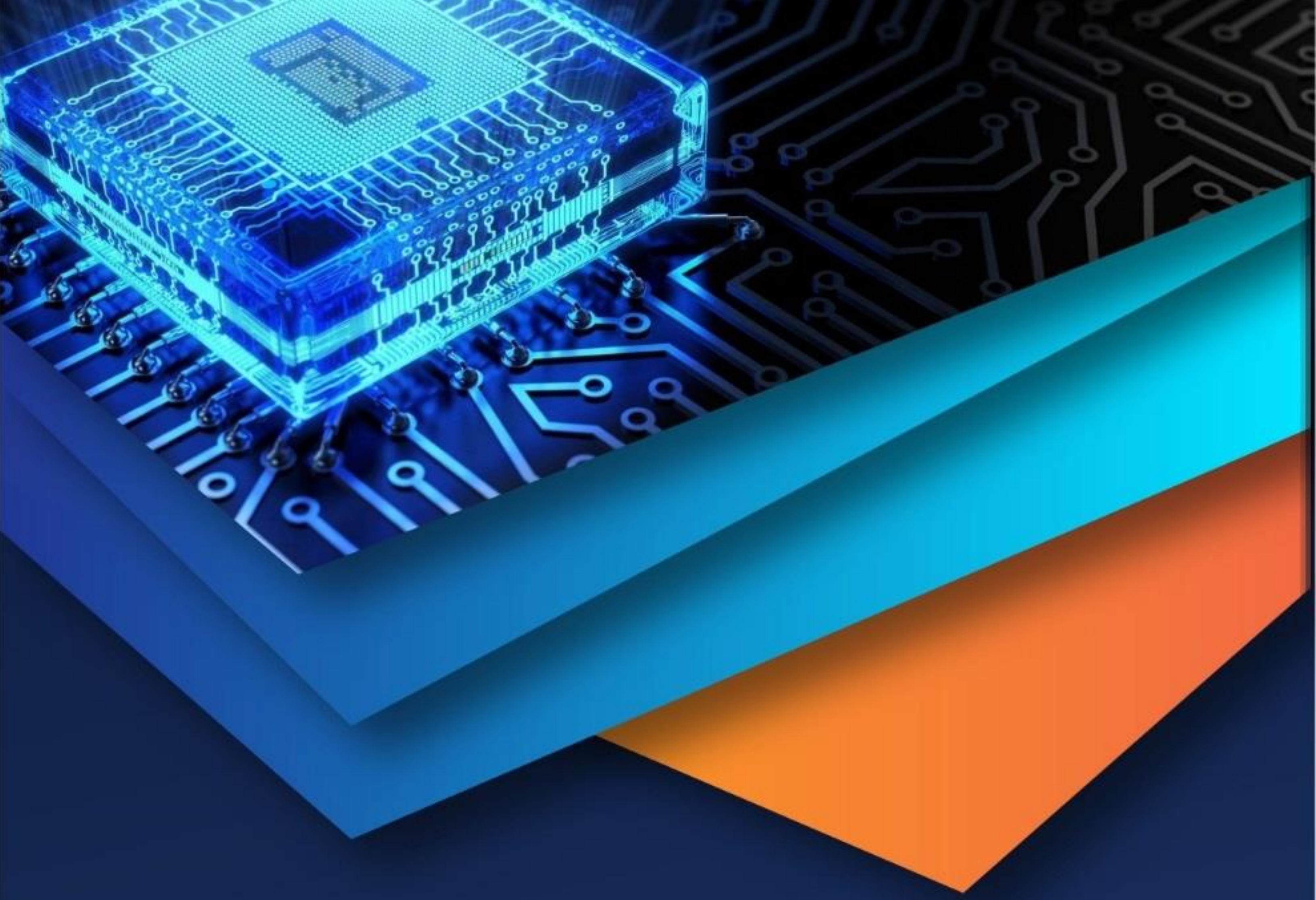

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