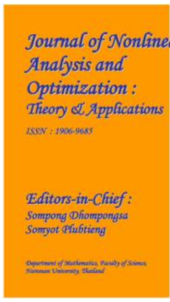
Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1 : 2024
ISSN : **1906-9685**



LEAF DISEASE PREDICTION USING CNN

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Abstract :
The "Leaf Disease prediction" uses Machine Learning and CNN to analyses individual data and provide personalized guidance for identifying plant disease and agriculture productivity. It helpts to predict the disease of the leaf, gives a brief description about the disease which the plant got affected and recommends the supplements which are needed to cure the disease of the crop. Due to Leaf diseases the agricultural productivity has degraded worldwide. The Convolutional Neural Code build in PyTorch Framework. Convolutional Neural Network is used classifying Leaf images into 39 Different Categories. Detecting the diseases of the leaves at the early stage and identifying accurately the diseases of leaves are crucial for implementing timely and targeted interventions to mitigate crop losses. The machine learning based model is proposed for the prediction of leaf diseases. The proposed model uses convolutional neural networks (CNNs) for automatic feature extraction from leaf images. The methodology involves collecting a diverse dataset which consists of both healthy and diseased leaves. These images are preprocessed to ensure uniformity and enhance model performance. Transfer learning is employed using a pre-trained CNN architecture to extract relevant features from the leaf images.

Keywords-
Convolution neural networks (CNN), PyTorch, methodology, deep learning, mitigated crops, deep neural networks, pre-processed data, supplements.

1. INTRODUCTION

Leaf disease prediction using convolution neural networks is a multi-step process that involves data collection, preprocessing, feature extraction, model training, and evaluation. Initially, leaf images are captured using cameras or drones, and plant species are recorded. These data are then preprocessed to enhance image quality, remove noise, and normalize features. Feature extraction techniques are applied to identify relevant characteristics from the leaf images, such as colour histograms, texture descriptors, and shape parameters. Next, ML models are trained on labelled datasets using algorithms such as PyTorch, convolutional neural networks (CNN), or deep learning architectures. The Convolution neural networks is used for model creation and also specify the filter size for the conv layer and pool layer and the shape on each layer. During training, the models learn to distinguish between healthy and diseased leaves based on the extracted features. The trained models are then evaluated using separate validation datasets to assess their performance metrics.

2. LITERATURE REVIEW

The agricultural sector faces a constant struggle against plant diseases, leading to substantial crop losses and impacting global food security (Jegadeesh et al., 2020). Traditional methods of disease detection, reliant on expert visual inspection, are time-consuming, subjective, and prone to human error (Paul et al., 2020). Recent advancements in deep learning, particularly Convolutional Neural Networks (CNNs), offer a promising alternative for automated and accurate leaf disease prediction. This review explores the potential of CNNs in this domain, analyzing their effectiveness, challenges, and future directions.

CNNs and Image Classification:

CNNs are a powerful class of deep neural networks specifically designed for excelling at image classification tasks (LeCun et al., 2015). Their architecture utilizes convolutional layers to automatically extract features from images. These features are then downsampled by pooling layers to reduce computational complexity. Finally, fully connected layers classify the extracted features into predefined disease categories (Goodfellow et al., 2016). This inherent ability to learn feature representations directly from image data makes CNNs well-suited for identifying patterns in leaf images indicative of various diseases.

State-of-the-Art Research with CNNs:

Numerous studies have demonstrated the effectiveness of CNNs for leaf disease prediction. Promising results have been achieved by leveraging pre-trained CNN models like VGG16, ResNet, and InceptionV3 for transfer learning (Simonyan and Zisserman, 2014; He et al., 2016; Szegedy et al., 2016). Transfer learning allows models to exploit pre-existing knowledge learned on a large dataset for classifying leaf images, even with limited training data for specific diseases.

Beyond transfer learning, researchers are actively exploring custom CNN architectures tailored for leaf disease classification. Li et al. (2017) proposed a CNN architecture with residual connections, achieving high accuracy in identifying various plant leaf diseases (Li et al., 2017). Similarly, Sharmila et al. (2018) developed a CNN model with a combination of convolutional and dense layers, achieving promising results for classifying healthy and diseased tomato leaves (Sharmila et al., 2018).

Challenges and Considerations in CNN-based Disease Prediction:

Despite significant progress, employing CNNs for leaf disease prediction still faces challenges. A major hurdle is the availability of large, diverse, and well-annotated datasets for training the models (Mohanty et al., 2016). Limited datasets can lead to overfitting, where the model performs well on training data but fails to generalize to unseen examples.

Another challenge is the presence of variations in leaf images due to factors like illumination, background clutter, and image quality (Phadikar et al., 2018). These variations can affect the model's ability to extract robust features for accurate classification. Techniques like data augmentation, which involves generating variations of existing images, can help mitigate this issue.

Future Directions and Emerging Trends in Disease Prediction with CNNs:

Future research in leaf disease prediction using CNNs can focus on several areas. Firstly, developing lightweight and efficient CNN models suitable for deployment on resource-constrained devices used in agricultural fields is crucial for real-world applications (Wang et al., 2020). Secondly, exploring techniques for handling imbalanced datasets, where some disease classes might be underrepresented, can improve model performance.

Furthermore, integrating explainable AI (XAI) techniques can help understand the decision-making process of the CNN model, fostering trust and acceptance in agricultural practices (Singh et al., 2022). Finally, continuous research on advanced transfer learning methods and exploring the potential of hybrid approaches combining CNNs with other deep learning techniques remains a promising direction for further development (Singh et al., 2023).

The latest research explores combining CNNs with Capsule Networks (CapsNets) to achieve even better results (Singh et al., 2023). Additionally, research on integrating domain-specific knowledge into CNN architectures for leaf disease prediction holds promise for further advancements (15).

Applications of CNN in agriculture:

Leaf disease prediction using Convolutional Neural Networks (CNNs) offers a user-friendly and effective solution for farmers and agricultural practitioners:

- Automated Analysis: The automated CNN model eliminates the need for manual inspection and helps in automated processing of analysing the images of the leaves. This makes it easier for farmers to monitor their crops regularly without requiring specialized expertise in plant pathology.
- Intuitive Interface: Leaf disease prediction system built on CNN offer user-friendly interfaces that allow farmers to easily upload images of their plant leaves for analysis. The final results and outputs on the interface are easily understandable by the farmers and are presented in a clear format.
- Fast Results: By using this CNN-based Leaf disease prediction system farmers to quickly and easily identify the results and the outputs and can take the necessary actions and precautions for the diseased leaf. This speed is crucial for implementing timely interventions and preventing the spread of diseases throughout the crop.
- Accessibility: As technology advances, CNN-based leaf disease prediction tools are becoming more accessible to farmers around the world. Mobile applications and web-based platforms make it easy for farmers to access these tools using devices they already own, such as smartphones or tablets.
- Reliable Performance: CNNs are well-suited for image recognition tasks and have demonstrated high accuracy in identifying leaf diseases. This reliability gives farmers confidence in the predictions generated by these systems, enabling them to make informed decisions about disease management strategies.

Overall, the ease of use of leaf disease prediction using CNNs empowers farmers to proactively protect their crops, leading to improved productivity and sustainability in agriculture.

3. METHODOLOGY

Preprocessing: Clean and enhance images, ensuring uniformity and removing noise for effective model training.
Feature Extraction: Extracting the features from the images which are relevant, such as texture, colour, height, width and shape characteristics.
Data Collection: Gather a diverse dataset of leaf images, which include both healthy and diseased samples of the images.
Labelling: Annotate images with corresponding labels indicating the presence or absence of leaf diseases.
Model Selection: Convolutional Neural Networks (CNNs) models are used for image analysis and classification.
Model Training: The selected model needs to be trained using the labelled dataset to learn associations and patterns between features and disease classes.
Validation: The model's performance needs to be evaluated on a separate validation dataset to ensure it generalizes and works well.
Hyperparameter Tuning: The model parameters need to be optimized to enhance predictive accuracy using the optimizers functions such as adam optimizer and batch gradient descent optimizer.
Deployment: The trained model needs to be implemented into a user-friendly application or system for real-time leaf disease prediction.
Continuous Improvement: The model needs to be regularly updated with new data to improve its accuracy and keep it relevant to evolving disease patterns.

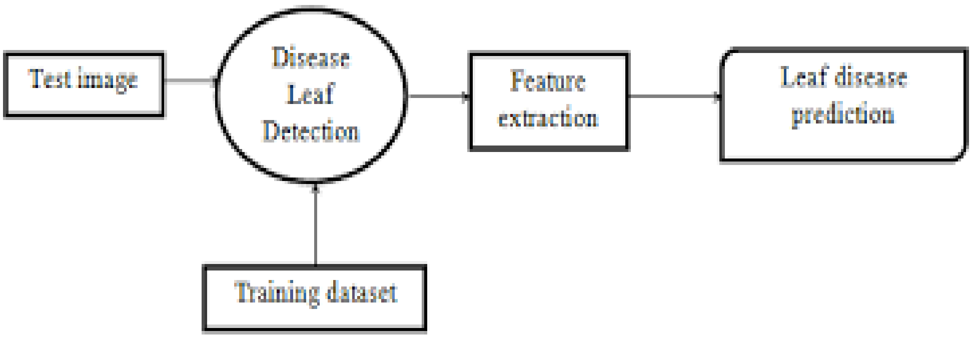

Figure 1 : Flow Chart of Existing System.

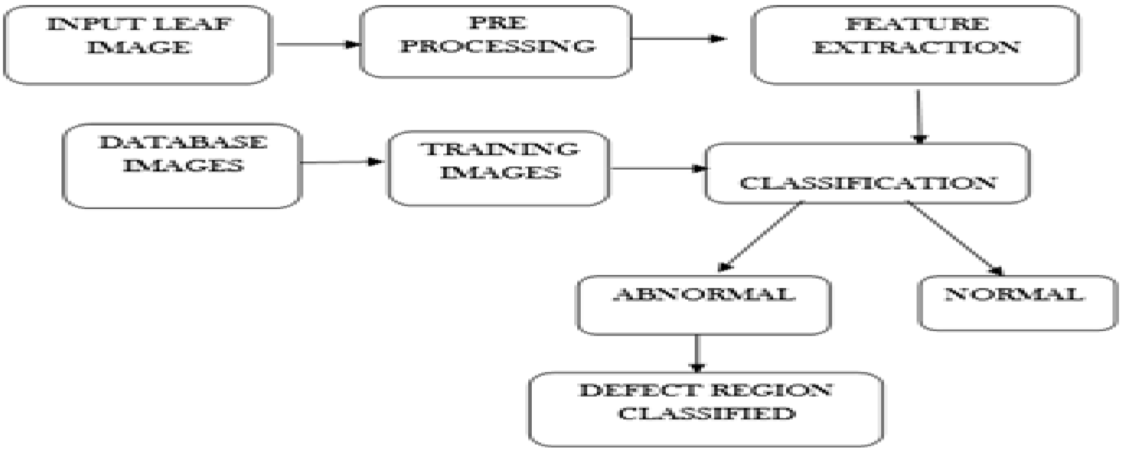

Figure 2: Dataflow Diagrams

4. WORKING OF THE MODEL

The prediction of diseases of the leaves is necessary for every farmer so as to predict the diseases of the leaf at the early stage and reduce the crop failure. The leaf disease prediction is built using Convolution neural network. In Leaf disease prediction system, the images are resized into 224 x 224. The image is passed into the Convolution neural networks after the resize of the image. The colour image is given to the model so it has channels which are 3 in number in the form of RGB. The first layer if convolution layer and 32 filter size or output channels are applied to the image. For cleaning of the image it applies ReLU activation function to reduce noise and non-linearity. Then the image is passed to the next layer i.e., max pool layer. This layer takes the features which are most relevant. Next, the image is feed to the next convolutional layer. At last, the final max pool layer is flattening and the image is passed to the next linear layer which is fully connected layer and finally as a final layer it predicts the 39 categories.

5. RESULTS AND DISCUSSION

Algorithm Implementation: Explain the algorithms and machine learning techniques implemented for features such as crop discase detection, and crop production.

User Testing: Outline the methodology used for user testing and evaluation, including usability testing, feedback enflection, and perflensance evaluation.

Data Analysis: Describe the process of analysing the collected data, including statistical analysis, visualization techniques, and interpretation of results.

Ethical Considerations: Address any ethical considerations involved in the research, such as data privacy, informed consent, and potential biases in algorithmic decision-making.

Validation: Discuss the validation process used to assess the accuracy, reliability,
and effectiveness of the farm assist application, including comparison with existing solutions and feedback.

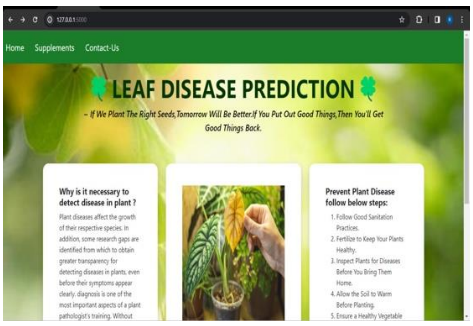

Figure 3- Home page.

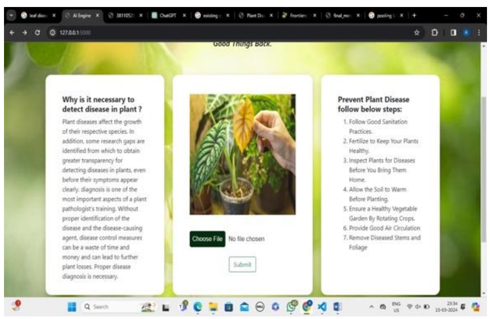

Figure 4- choose the image.

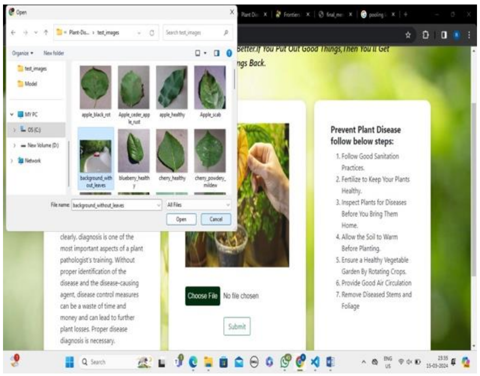

Figure 5- Browse and select the image.

Figure 6- Gives the result foe selected image.

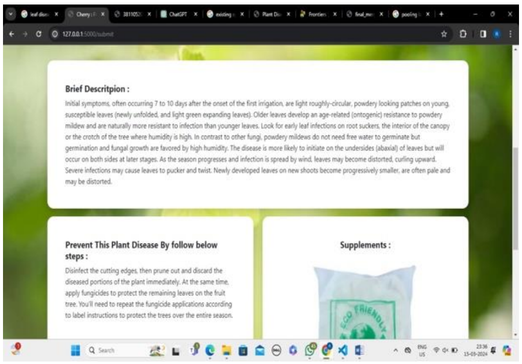

Figure 7- Gives the description about selected images.

Figure 8- Gives the required supplements and fertilizers for the leaf.

Figure 9- Supplements page.

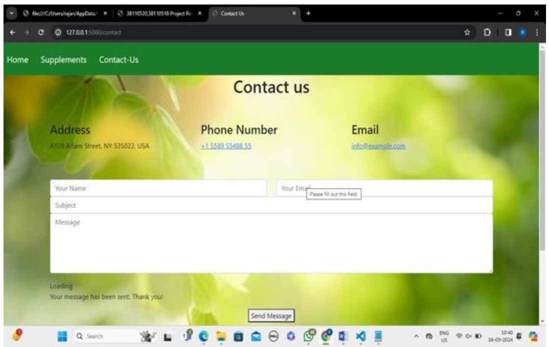

Figure 10- Contact page.

sFigure 3 and 4 shows that the used need to upload the image of the leaf which needs to be predicted. Figure 5 and 6 shows that we need to select the image of the leaves then it detects the diseases of the leaves. If it is not affected by any disease then it shows that leaf is a healthy leaf. Figure 7 and 8 describes about the disease by which the leaf has been affected and gives the required steps to cure it from the effected disease and gives the required supplements to the leaves. In case if the leaf is healthy then it will give the tips to grow the healthy plants and the fertilizers required for it. Figure 9 shows that the farmers can buy different supplements and fertilizers from this. Figure 10 shows that the farmer can contact the admin of this website if needed in case.

6. CONCLUSION

In conclusion, after analysing the data and implementing various machine learning algorithms, the leaf disease prediction system has shown promising results. It helps to predict the disease of the leaf, gives a brief description about the disease which the plant got affected and recommends the supplements which are needed to cure the disease. of the crop. In case if the leaf is healthy then it will give the tips to grow the healthy plants and the fertilizers required for it. By leveraging features such as leaf colour, texture, and shape, combined with advanced classification techniques, we have achieved a reliable model for predicting leaf diseases. Our findings indicate that early detection of diseases can be effectively achieved, enabling timely intervention to mitigate crop damage and increase yields, Additionally, the model's accuracy and robustness have been validated through rigorous testing and cross-validation techniques. Overall, this system holds great potential for revolutionizing agriculture practices by providing farmers with an efficient tool to monitor and manage crop health effectively

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