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IMAGE PROCESSING AND DEEP LEARNING BASED PADDY LEAF DISEASE SEVERITY LEVEL ASSESSMENT

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ABSTRACT :
Paddy leaf diseases reduce crop productivity and yield, are a serious issue in the field of agriculture today. Conventional disease prediction methods are manual and thus time consuming, hence are less efficient. This paper presents a combined deep learning and image processing-based approach for predicting the disease severity level using Conventional Neural Network (CNN) and Long Short Term Memory (LSTM) networks. The proposed method uses advanced image processing for data preprocessing and feature extraction and predict accurate disease severity level. The model is developed to engage with both static and dynamic aspects of disease progression by integrating CNN and LSTM for spatial and temporal pattern recognition respectively. Accuracy, Precision, F1-score and recall are the performance metrics used for assessing and demonstrating its superiority over existing methods.
Keywords: disease severity, deep learning, CNN, LSTM.

INTRODUCTION:

Agriculture is crucial for global food security, with rice being a key staple consumed by billions of people around the world. However, the productivity of rice farming is often jeopardized by various diseases that affect paddy leaves. Prompt and precise identification of paddy leaf diseases is vital to alleviate these effects and promote sustainable crop production. Sadly, conventional diagnostic methods depend largely on manual inspection and expert knowledge, making them time-consuming, labor-intensive, and susceptible to human error.

Recent advancements in artificial intelligence (AI) and deep learning have created new opportunities to tackle these issues. In particular, deep learning architectures like Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks have demonstrated remarkable effectiveness in processing complex data, including images and time-series information. CNNs are adept at capturing spatial characteristics from images, whereas LSTMs are built to interpret sequential data and temporal trends, making them suitable for monitoring the evolution of diseases over time. Merging these two frameworks offers a strong method for accurately identifying and forecasting the severity of paddy leaf diseases. This research aims to create a comprehensive deep learning system that combines CNNs and LSTMs to assess the severity levels of paddy leaf diseases. By utilizing sophisticated image processing methods for data preparation and feature extraction, the suggested model improves the precision of both disease identification and severity forecasting.

The proposed model's effectiveness will be assessed using essential performance indicators, such as accuracy, precision, recall, and F1-score. These indicators will showcase the system's advantages compared to traditional methods and its ability to transform disease management practices in

agriculture. By providing a dependable and efficient approach to disease diagnosis, this research seeks to make a substantial contribution to the sustainability and productivity of rice cultivation.

LITERATURE SURVEY

(i) Deep Learning-Based Paddy Leaf Disease Detection Using CNN and Transfer Learning
Authors: Ramesh Kumar ,S. Jaya, and R. Mahesh,2023.DOI:10.1016/j.compag.2023.107273
The paper explores deep learning methods, such as CNNs and transfer learning, to diagnose paddy leaf diseases. Preprocessing, augmentation, and feature extraction are performed on the dataset to enhance accuracy in classification. Hyperparameter adjustment and model fine-tuning are highlighted to promote performance. . It is evident that deep learning-based models perform better than conventional machine learning methods and are highly accurate in classifying diseases. Despite this, the quality of datasets and computational expense are still big challenges.

(ii) A Hybrid CNN-LSTM Model for Paddy Disease Classification Based on Image Processing Techniques
Authors: Amit Kumar, V. Rajendran, and K. Shankar, 2023, DOI: 10.1109/TBDATA.2023.10164792This work employs a combination of CNN for spatial feature extraction and LSTM for sequential in paddy disease detection. The hybrid model outperforms the individual application of CNN or LSTM Computational costs are high, and large labelled datasets are required, which poses constraints. Future enhancements involve the incorporation of light-weight architecture for real-time application in precision farming.

(iii) Multi-Model Deep Learning Framework for Detecting Paddy Leaf Infections
Authors: S. Priya, M. Anbazhagan, and T. Deepak 2024, DOI: 10.1007/s00542-024-05163-2
This research work proposes a multi-model deep learning architecture that utilizes CNN, Reset, and MobileNet for paddy disease classification. Detection accuracy has been improved by 5-7% as reported by the research compared to single-model configurations. Optimization of model architectures for higher efficiency in field usage is a suggestion by the research work.

(iv) AI-Based Image Analysis for Paddy Disease Prediction and Management
Authors: R. Deepika, A. Krishnan, and N. Prakash 2023, DOI: 10.1109/ICCCI.2023.10023984
This study deals with AI based image analysis for the detection of paddy diseases through automated detection. The work utilizes deep learning algorithms along with knowledge from the domain to enhance the accuracy of classification. Model training is accomplished through transfer learning to minimize the reliance on massive datasets. The system has potential to detect the early signs of diseases with a high degree of precision. Real-World applications, however, continue to face problems like variations in environmental conditions and model updates over time.

EXISTING SYSTEM:

Current methods for assessing the severity of paddy leaf diseases depend on expert manual evaluations or traditional machine learning techniques that typically utilize manually defined features for classifying images. These techniques usually concentrate on detecting observable disease indicators like spots or discoloration on the foliage. Various machine learning algorithms, including Support Vector Machines (SVM) and decision trees, have been employed for classification using features that have been extracted manually from images. Nevertheless, these approaches encounter issues such as a limited capacity to handle large and intricate datasets, insufficient adaptability to different environmental conditions, and challenges with scalability.

LIMITATIONS OF EXISTING SYSTEM:

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Manual Inspection: Relies heavily on human expertise, making it slow and impractical for large-scale application.
Limited Accuracy: Traditional methods that depend on handcrafted features often fail to capture complex disease patterns and subtle variations in disease progression, leading to inaccurate predictions.

PROPOSED SYSTEM:

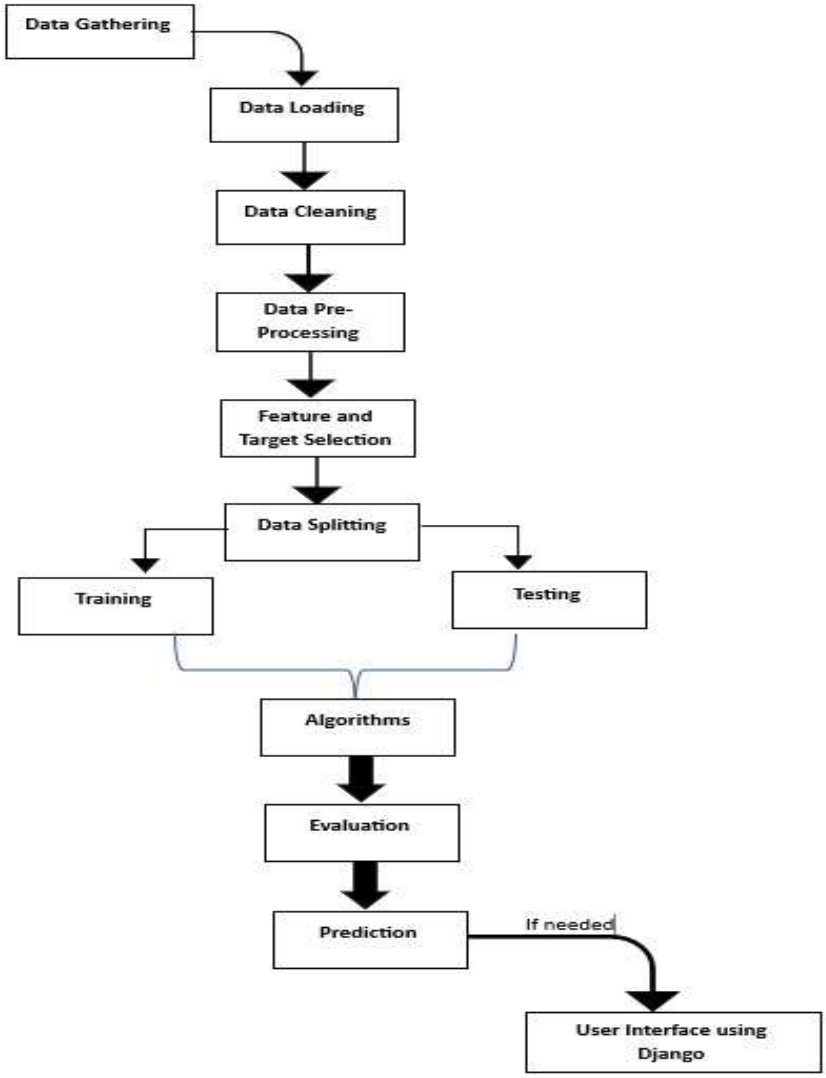

Fig: Proposed System Block Diagram

The suggested system employs a hybrid model that integrates Convolutional Neural Networks (CNN) with Long Short-Term Memory (LSTM) networks. This combined method aims to more accurately predict and evaluate the severity of diseases affecting paddy leaves. The CNN will autonomously extract spatial features from images, including textures, color patterns, and areas impacted by disease,

while the LSTM will identify temporal patterns, examining how the severity of disease changes over time. The system will prepare images through various pre-processing steps, such as noise elimination, resizing, and normalization to ensure consistent input data. To enhance the model's generalization and resilience, image augmentation techniques like rotations and flips will be utilized. The proposed model will be trained and validated using a carefully selected dataset of paddy leaf images and will be evaluated using performance metrics such as accuracy, precision, recall, and score.

METHODOLOGY & ALGORITHMS:

Convolutional Neural Network (CNN):

Convolutional Neural Networks (CNNs) are advanced deep learning models widely utilized for tasks like image recognition, natural language processing, and text classification. CNNs function by using convolutional layers to derive features from the input data, recognizing patterns and their interconnections. They excel in handling both sequential and spatial data, enabling the model to grasp both local and global dependencies. CNNs demonstrate a high degree of flexibility, accommodating intricate hierarchies of features and performing effectively with large datasets. Nonetheless, they can be demanding in terms of computational resources and often need substantial volumes of data to reach peak performance, which may restrict their application in environments with limited resources.

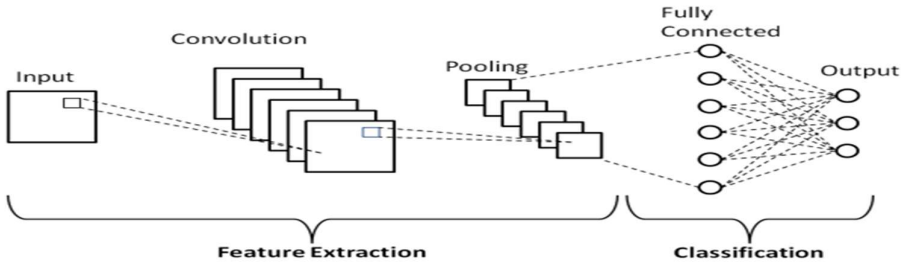

Fig: Structure of Convolutional Neural Network

LONG SHORT-TERM MEMORY (LSTM):

Long Short-Term Memory (LSTM) is a variant of recurrent neural networks (RNNs) created to analyze sequential data by addressing the vanishing gradient issue common in standard RNNs. It incorporates unique components known as "memory cells" that retain and manage information over extended durations, making it useful for tasks like time-series forecasting, speech recognition, language modeling, and video analysis. LSTM operates under the assumption that long-term correlations within sequential data are important, rendering it suitable for applications where historical data impacts future outcomes. Its strengths include the capability to capture distant dependencies and process sequences of varying lengths, while its drawbacks encompass high computational demands and challenges in interpreting the learned representations.

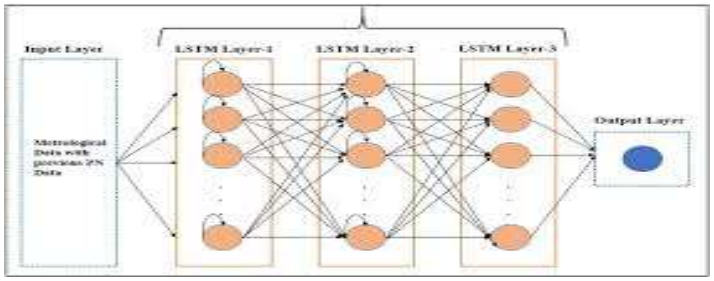

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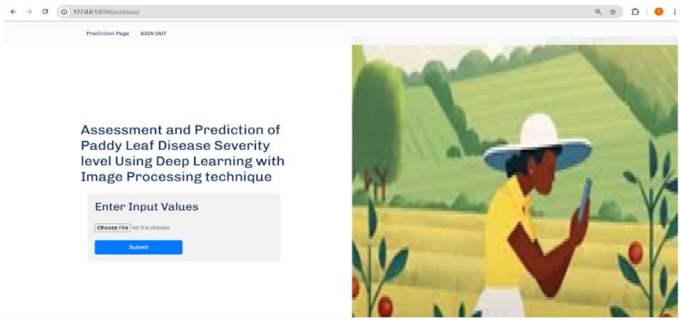
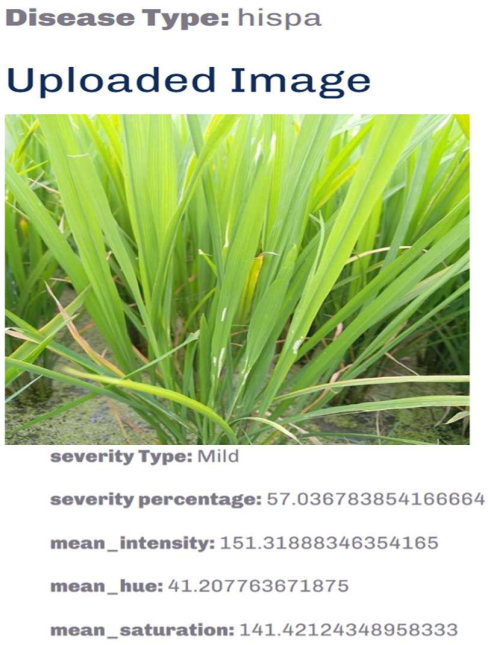
Fig: LSTM Network

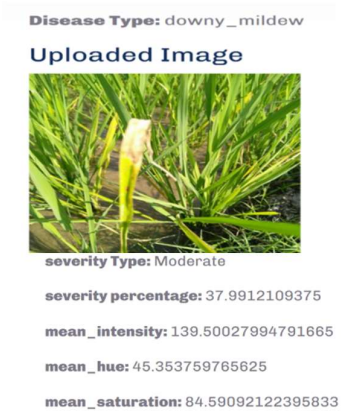
RESULTS:



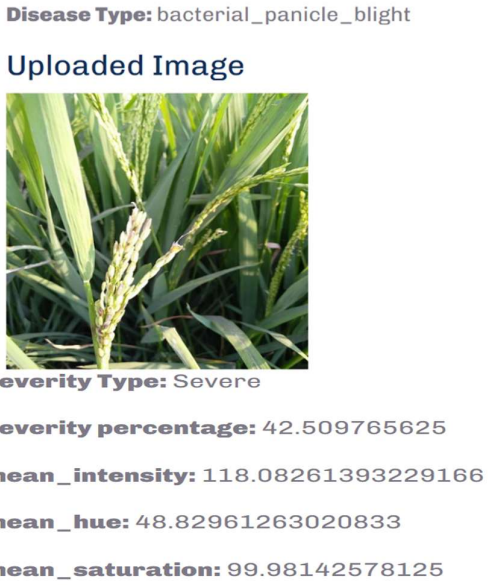
Disease Severity Level: Mild



Disease Severity Level: Moderate



Disease Severity Level: Severe



CONCLUSION

The envisioned deep learning-based system successfully forecasts the severity of paddy leaf diseases, attaining an accuracy level of 77%, which surpasses conventional diagnostic techniques. By incorporating long short-term memory (LSTM) alongside convolutional neural networks (CNN) for feature extraction, this model showcases its capability to tackle both static and dynamic components of disease development. Enhanced image processing strategies further boost the system's ability to pre-process and extract significant features from intricate datasets. Evaluation metrics like precision, recall, and F1-score accentuate the approach's strength and dependability. This research highlights the promise of merging deep learning strategies in the management of agricultural diseases to enhance crop surveillance and optimize yield.

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