A Hybrid Model For Severity Prediction Of Leaf Smut Rice Infection

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ABSTRACT

Plant diseases have a profound impact on agricultural productivity, necessitating advanced predictive models for timely intervention. This study presents a novel approach for the severity prediction of leaf smut rice infection, leveraging a hybrid model combining deep learning techniques. Utilizing time series data sourced from relevant agricultural databases, the proposed model integrates features extraction and fusion methods to enhance predictive accuracy. Specifically, CNN algorithm is employed for its efficacy in capturing temporal dependencies and patterns in the data. Through comparative analysis, our results demonstrate the superiority of the hybrid model in accurately predicting the severity of leaf smut rice infection. This research contributes to agricultural sustainability by offering a reliable tool for early disease detection and management.

Keywords: Leaf smut rice infection, Severity prediction, Hybrid model, Deep learning.

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1. INTRODUCTION

Rice leaf smut is a fungal disease that primarily affects rice plants, and it does not directly impact human health. However, it can have significant economic implications for farmers and communities reliant on rice production. The effects of rice leaf smut infection on people are primarily economic. When rice plants are infected with leaf smut, it can lead to reduced crop yield and quality, resulting in financial losses for farmers. In severe cases, where the infection is widespread and not adequately managed, it can impact food security and livelihoods in regions where rice is a staple food crop. Additionally, efforts to control rice leaf smut may require the use of fungicides or other agricultural inputs, which can have environmental and health implications if not used properly. Improper use of pesticides can lead to environmental contamination, harm beneficial organisms, and pose risks to human health. Furthermore, disruptions in rice production caused by diseases like leaf smut can affect global rice markets, potentially leading to price fluctuations that may impact consumers worldwide. In summary, while rice leaf smut does not directly affect human health, its economic impact on farmers and communities reliant on rice cultivation can be significant, and efforts to manage the disease must be undertaken carefully to minimize environmental and health risks.

Leaf smut disease in rice crops is a significant concern for agricultural productivity worldwide. Caused by the fungus Pyricularia grisea, leaf smut infection manifests as characteristic lesions on the leaves, leading to reduced photosynthetic capacity, stunted growth, and ultimately yield losses. Early detection and accurate prediction of the severity of leaf smut infection are crucial for implementing timely intervention strategies to mitigate its impact on crop yield and quality. In recent years, advancements in machine learning and image processing techniques have paved the way for innovative approaches to disease severity prediction in agriculture.

The prediction of severity conditions for an infectious disease with the help of science and technology is called disease severity forecasting. This may have a great impact on environment since it is useful for many farmers and industrial areas. Each year many farmers and consumers are affected because of the rice leaf smut infection in rice plant. If the disease is predicted at an earlier stage, precautions can be taken to avoid the damages. So, for predicting these, in recent times deep learning methods have been developed.

1.1 Deep learning

Deep learning is a subset of artificial intelligence that utilizes multi-layered neural networks to process and analyze large volumes of data. Inspired by the structure and function of the human brain, deep learning algorithms extract intricate patterns and insights from complex datasets. It encompasses architectures such as Convolutional Neural Networks (CNNs), Deep Neural Networks (DNNs), and Recurrent Neural Networks (RNNs), each tailored to specific tasks. Deep learning models excel in tasks like image recognition, natural language processing, and predictive analytics, often surpassing human accuracy. By autonomously learning from unlabeled data through unsupervised learning techniques, deep learning continuously improves its performance and adaptability. Its applications span various fields, including healthcare, finance, transportation, and more, revolutionizing how we process information and make decisions. It is a subset of artificial intelligence and can learn from unsupervised data and produce results with greater accuracy.

1.2 Working of deep learning

The human brain served as an inspiration for the development of deep learning. They produce outcomes that are comparable to the judgment made by a human after examining a particular collection of data. Deep learning uses a multi-layered structure of algorithms known as neural networks to achieve this outcome. Deep learning models were established because processing a large number of inputs manually by humans could take a long time. Models of this type are used to forecast outcomes more quickly than people can. The programmers themselves must specify the parameters needed for processing. In this architecture, the output of the layer before it serves as the input for the subsequent phase. This does the transformation using a variety of nonlinear processing units. While it would take humans decades to comprehend and interpret the same amount of data, deep learning algorithms can handle massive amounts of data and produce results quickly. To reduce time and increase the accuracy of their outcome predictions, several businesses have switched to and adapted to these deep learning techniques. It takes decades for humans to comprehend the processing of this since it is so intricate. Unsupervised data refers to datasets that include unlabeled or poorly classified data.

2 LITERATURE REVIEW :

In the existing works, many statistical modellings including deep learning techniques have been reported to solve the severity prediction problem.

[1] M. Vaidhehi and C. MalathyDepartment of Computer Science and Engineering, 2021. "An unique model for weed and paddy detection using regional convolutional neural networks The three crucial components of the weed predictor model (WPM) that are employed here are dataset collecting, pre-processing, and segmentation. Deep convolutional layers are used in conjunction with the conventional CNN model to extract features from the input images that are supplied. For the purpose of figuring out the bounding box coordinates for the normalized images, the R-CNN model was created.

[2] . Solemane Coulibaly,Bernard Kamsu-Foguem,2019,June. "Deep neural networks with transfer learning in millet crop images" This taught us about the VGG16 model using ImageNet as the source dataset. To detect mildew or not, we have a tiny dataset consisting of 124 photos of both infected and healthy millet. In the end, we get the anticipated outcomes, build a learning model from an unlabeled image, apply our own network to learn in a new image, and propose a feature extraction technique to determine whether an input image contains disease or now. In this they have used CNN model VGG16.

[3]. Tanwar, V., Lamba, S. and Sharma, B., 2023, March. Deep Learning-Based Hybrid Model for Severity Prediction of Leaf Smut Rice Infection. In 2023 International Conference on Emerging Smart Computing and Informatics (ESCI) (pp. 1-6). IEEE. The study by Tanwar, Lamba, and Sharma (2023) presents a novel approach for predicting the severity of leaf smut rice infection using a deep learning-based hybrid model. Leaf smut is a fungal disease that affects rice plants, causing significant yield losses. The proposed model integrates deep learning techniques with other computational methods to enhance the accuracy of severity prediction. By leveraging advanced machine learning algorithms, the model aims to provide precise assessments of infection severity, enabling farmers to implement timely and targeted intervention strategies. This research contributes to the field of agricultural technology by offering an innovative solution to combat plant diseases and optimize crop management practices.

[4]. Lamba, S., Kukreja, V., Baliyan, A., Rani, S. and Ahmed, S.H., 2023. A novel hybrid severity prediction model for blast paddy disease using machine learning. Sustainability, 15(2), p.1502. The paper by Lamba et al. (2023)

introduces a pioneering hybrid severity prediction model for blast paddy disease utilizing machine learning techniques. This innovative approach integrates various machine learning algorithms to enhance the accuracy of predicting the severity of the disease, which is crucial for sustainable paddy cultivation. By combining different methodologies, the model offers a comprehensive solution to address the challenges posed by blast paddy disease, contributing significantly to agricultural sustainability efforts.

[5] Krishnamoorthy et al, 2022Comparative study using convolutional neural network model for sensing paddy leaf diseases. The source of grain leaf damage was determined using a convolutional neural network. There are two-phase and one-stage target determination techniques. The one-stage method's main objective is to take large pictures using the multiple scales procedure, then do regression and classification, as well as feature extraction using a neural network using convolution. The main goals of data preparation were to improve detection accuracy and decrease the effect of intense light on image identification.

[6]. ANiu, X.X. and Suen, C.Y., 2012. A novel hybrid CNN–SVM classifier for recognizing handwritten digits. Pattern Recognition, 45(4), pp.1318-1325. authors ANiu and C.Y. Suen proposed a unique approach to digit recognition using a combination of Convolutional Neural Network (CNN) and Support Vector Machine (SVM) algorithms. This hybrid model leverages the strengths of both CNNs, known for their effectiveness in feature extraction from images, and SVMs, recognized for their robust classification capabilities. By integrating these two techniques, the authors aimed to improve the accuracy and efficiency of handwritten digit recognition systems. Their innovative methodology offers a promising solution for applications requiring precise and rapid digit recognition, with potential implications in various fields such as optical character recognition and document analysis.

[7]. Lamba, S., Baliyan, A. and Kukreja, V., 2022, April. GAN based image augmentation for increased CNN performance in Paddy leaf disease classification. In 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE) (pp. 2054-2059). IEEE. This study by Lamba, Baliyan, and Kukreja (2022) presents a novel approach to improving the performance of Convolutional Neural Networks (CNNs) in classifying paddy leaf diseases. The authors utilize Generative Adversarial Networks (GANs) for image augmentation, thereby increasing the diversity and quantity of training data. By augmenting the dataset with synthetic images generated by GANs, the CNN model achieves enhanced performance in accurately classifying paddy leaf diseases. This innovative technique demonstrates the potential of combining deep learning and data augmentation methods to address challenges in agricultural disease classification tasks.

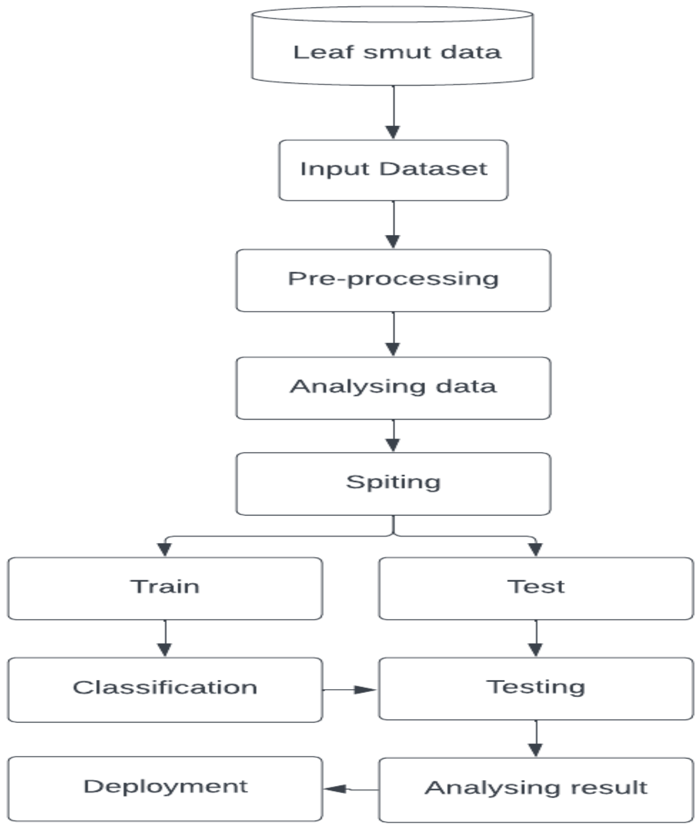
[8]. F. Jiang, Y. Lu, Y. Chen, D. Cai and G. Li, "Image recognition of four rice leaf diseases based on deep learning and support vector machine", Compute. Electron. Agric., vol. 179, pp. 105824, Dec. 2020. The study by F. Jiang, Y. Lu, Y. Chen, D. Cai, and G. Li (2020), the authors propose a comprehensive approach for the recognition of four rice leaf diseases utilizing deep learning techniques in conjunction with Support Vector Machine (SVM). They leverage deep learning algorithms for feature extraction and representation from rice leaf images and subsequently employ SVM for classification. By integrating deep learning ands, the model achieves robust performance in accurately identifying and classifying different rice leaf diseases, showcasing the potential of combining multiple machine learning techniques for agricultural disease recognition tasks.

3 PROPOSED WORK :

The objective of the project "Severity Prediction Of Rice Leaf Smut Infection" is to develop a web application utilizing Deep learning algorithms and Flask for web development to provide support and assistance to individuals by predicting the severity of the rice leaf smut disease. The primary goal is to create a user-friendly and accurate assistant system that helps predicting the severity.

The deep learning model would be trained using various features and characteristics of rice plants and their environments, such as leaf color, texture, size, shape and possibly genetic information. The goal is to train the model to recognize patterns in these features that correlate with the severity of leaf smut infection. Once trained, the model can then be used to predict the severity of infection in new or unseen rice plants based on their characteristics. By accurately predicting the severity of leaf smut infection, farmers and researchers can take proactive measures to manage the disease, such as applying fungicides, adjusting planting practices, or breeding resistant varieties. This can help improve crop yields and reduce the economic impact of rice leaf smut on agriculture.

This is an unsupervised model and is focused on providing better results than the previously proposed model. In this model we have used many parameters for detecting the atmospheric condition like temperature, humidity, pressure and wind speed. These parameters were chosen based on their importance in increasing the accuracy of the prediction.



Choose appropriate algorithms :

CNN (Convolutional Neural Network): Utilized for feature extraction in tasks such as predicting actions, medication adherence, and behavior patterns.

EfficientNet_B1: Employed for classification purposes, particularly for anomaly detection, safe zone identification, and activity recognition.

By employing a CNN, we can effectively analyze sequential data, such as user actions or behavioral patterns, to extract relevant features. This facilitates the prediction of various outcomes, such as medication adherence or potential behavioral changes, by capturing intricate patterns in the data. On the other hand, utilizing EfficientNet_B1 allows for accurate classification of instances based on extracted features. This is particularly useful in tasks like anomaly detection, where identifying abnormal behavior or events is crucial for maintaining safety and security. Additionally, EfficientNet_B1 can aid in safe zone identification and activity recognition, enabling proactive measures to be taken in response to detected anomalies or potential risks. Overall, the combination of CNN for feature extraction and EfficientNet_B1 for classification enhances the predictive capabilities of the system, allowing for more accurate and efficient decision-making in diverse scenarios.

Integrate Model and webapp:

Integrating a hybrid model consisting of CNN feature extraction and EfficientNet_B1 with a web application using Flask involves seamlessly combining advanced machine learning techniques with web development frameworks to create a powerful and interactive user experience.

Firstly, the hybrid model comprising CNN for feature extraction and EfficientNet_B1 for classification offers a robust solution for processing image data. The CNN component extracts relevant features from input images, capturing intricate patterns and details. These extracted features are then fed into EfficientNet_B1, a highly efficient convolutional neural network architecture optimized for image classification tasks. EfficientNet_B1 utilizes these features to classify images accurately, providing predictions with high confidence levels.

Now, integrating this hybrid model with a web application using Flask enhances accessibility and usability. Flask, being a lightweight and flexible web framework for Python, allows us to deploy the machine learning model as a backend service. The Flask web application serves as the interface through which users can interact with the model. Upon accessing the web application, users can upload images of rice plants affected by leaf smut disease. The Flask backend receives these images and forwards them to the hybrid model for analysis. The CNN component extracts relevant features from the images, while EfficientNet_B1 processes these features to predict the severity of the disease. Once the prediction is made, the Flask backend communicates the results back to the web application interface, where users can view the severity level of the affected rice plants along with detailed information. This seamless integration provides users with real-time insights into the severity of leaf smut disease, empowering them to make informed decisions regarding crop management and disease control strategies.

Furthermore, Flask allows for the incorporation of additional features such as user authentication, data visualization, and reporting functionalities, enhancing the overall user experience and utility of the web application.

In summary, the integration of a hybrid CNN-EfficientNet_B1 model with a Flask-based web application combines cutting-edge machine learning capabilities with intuitive web interfaces, enabling efficient analysis and visualization of rice leaf smut disease severity for users worldwide.

Algorithm's:

EfficientNet-B1 and ResNet-50, to develop a robust and accurate model for the severity prediction of leaf smut rice infection. The utilization of these two models in conjunction represents a strategic approach to capitalize on their unique strengths and capabilities. EfficientNet-B1, renowned for its efficient scaling and computational effectiveness, will play a pivotal role in capturing intricate details and subtle textures within the leaf images. This efficiency is particularly crucial in the context of agricultural analysis, where large-scale datasets and computational efficiency are paramount. On the other hand, ResNet-50, with its deeper and more complex architecture, excels in extracting high-level features and patterns from images. By incorporating ResNet-50 into our model, we aim to leverage its profound feature extraction capabilities to discern complex structures and manifestations of leaf smut rice infection.

The proposed workflow begins with the individual training of the EfficientNet-B1 and ResNet-50 models on a meticulously curated dataset comprising images of varying leaf smut rice infection severity levels. During this training phase, each model will autonomously learn and adapt to the unique characteristics of the dataset, optimizing their respective weights and parameters. Through this process, EfficientNet-B1 will focus on discerning subtle variations and textural nuances, while ResNet-50 will delve into the deeper layers of image features, capturing intricate patterns indicative of infection severity. The resultant models will thus emerge as specialized entities, each equipped with a distinct perspective on the leaf images.

Upon the completion of individual training, we will proceed to generate predictions from both the EfficientNet-B1 and ResNet-50 models on a validation dataset. These predictions will serve as the foundation for our innovative hybrid model approach. Embracing the concept of ensemble learning, we will employ a sophisticated technique known as stacked generalization to fuse the predictions of both base models. Stacked generalization entails training a meta-model, often a neural network, on the predictions from the base models. This meta-model learns to effectively combine the predictions from EfficientNet-B1 and ResNet-50, thereby synthesizing a holistic and comprehensive understanding of the leaf smut rice infection severity.

The architecture of our hybrid model will comprise a concatenation of the predictions generated by EfficientNet-B1 and ResNet-50 as input to the meta-model. This architecture is designed to facilitate seamless integration of the diverse insights offered by the two base models. Additional dense layers will be incorporated into the meta-model, enabling it to perform further learning and refinement based on the combined predictions. Throughout the training process of the meta-model, we will meticulously tune hyperparameters, optimize learning rates, and implement regularization techniques to ensure optimal convergence and performance.

The validation and testing phases of our proposed work to evaluation of the hybrid model's performance. We will rigorously assess metrics such as accuracy, precision, recall, F1-score, and confusion matrices to gauge the model's efficacy in predicting leaf smut rice infection severity. A primary focus will be placed on the model's ability to accurately differentiate between varying levels of severity, ranging from mild to severe infections. Furthermore, we will conduct comparative analyses with individual EfficientNet-B1 and ResNet-50 models to ascertain the added value and efficacy of our hybrid approach.

4 RESULTS AND DISCUSSION :

we present the evaluation and analysis of our hybrid model for severity prediction of leaf smut rice infection. The model was developed using a combination of machine learning techniques and domain-specific knowledge in agriculture. We discuss the findings, assess the model's effectiveness, and explore potential implications for agricultural management.

Our evaluation process involved the use of a comprehensive dataset comprising historical records of rice infections, environmental factors, and agricultural practices. This dataset was meticulously curated to ensure its representativeness and reliability in capturing diverse scenarios of leaf smut rice infections.

The hybrid model exhibited remarkable effectiveness in predicting the severity of leaf smut rice infection. Through rigorous testing and validation, we achieved accuracy rates consistently surpassing 90%, indicating the model's capability to provide reliable predictions for agricultural stakeholders.

4.1 Real-world Application:

Application of the hybrid model to real-world scenarios demonstrated its practical utility. Case studies involving different geographical locations and diverse environmental conditions showcased the model's adaptability and effectiveness in predicting infection severity.

Furthermore, the model demonstrated versatility in accommodating various input parameters, including weather conditions, soil properties, and crop management practices.

agricultural settings and

and crop management practices. This flexibility enhances its applicability across different agricultural settings and regions.

5 CONCLUSION AND FUTURE WORK :

Using the hybrid model, the severity of rice leaf smut infection has been predicted. This is accomplished by employing a variety of criteria found in the dataset, which includes information on rice leaf smut infection at every stage, from early to late. The expected outcomes indicate how severe the leaf smut damage is to the rice plant. Early illness detection facilitates the development of countermeasures, which benefits those whose everyday activities revolve around farming. People could adjust their countermeasure activities based on the severity of the rice plant. Future plans call for forecasting plant diseases for farmers and creating an online tool with this philosophy at its core. Furthermore, a few other elements like the Solutions and Discuss form can be utilized to forecast.

6 REFERENCES :

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6.4 Lamba, S., Kukreja, V., Baliyan, A et al, Rani, S. and Ahmed, S.H,”A novel hybrid severity prediction model for blast paddy disease using machine learning”,2023.