Rice Plant Leaf Disease Detection

A Project Report submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING
(Specialization in Artificial Intelligence & Machine Learning)

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VISAKHAPATNAM

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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DECLARATION

I hereby declare that the project report entitled "Rice Plant Leaf Disease Detection" is an original work done in the Department of Computer Science and Engineering, GITAM School of Technology, GITAM (Deemed to be University) submitted in partial fulfillment of the requirements for the award of the degree of B.Tech. in Computer Science and Engineering/Computer Science and Engineering (AI&ML/DS/CS/IoT).The work has not been submitted to any other college or University for the award of any degree or diploma.

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CERTIFICATE

This is to certify that the project report entitled "Rice Plant Leaf Disease Detection" is a bonafide record of work carried out by Dev Varma Rajasagi(VU21CSEN0300066), Kesavapatnam Abhinava Srinivas (VU21CSEN0300130), Rambha Shanmukha Dinesh(VU21CSEN0300117), Patnaikuni Praveen(VU21CSEN0300123) students submitted in partial fulfillment of requirement for the award of degree of Bachelors of Technology in Computer Science and Engineering (AI&ML).

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Abstract

Accurate diagnosis of rice plant diseases is crucial in mitigating the harmful effects of disease outbreaks that occur in farming which adversely effects crop production. The currently available methods are inefficient, and imprecise. This project overcomes these challenges by developing a MobileNetV2 architecture system which predicts rice leaf diseases. The model is built with the aid of Python and its libraries like Keras and TensorFlow. The proposed model is trained using an image dataset from kaggle, which has more than 3000 images of rice leafs with four destructive diseases and healthy rice leafs. It classifies a rice leaf image into one of the four types of rice diseases: bacterial leaf blight, brown spot, rice blast, and sheath blight or classifies the leaf as healthy. The MobileNetV2 model has been used for its lightweight nature, which provides increased efficiency.

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Introduction

Rice is an important staple crop, with over 50 percent of the world's population making it a part of their daily diet. Diseases in rice plants, particularly in their leaves, can spread fast and significantly reduce crop yield. Early detection of these diseases is crucial for preventing widespread damage. Traditional methods like manual inspection by experts, is time-consuming and often subject to human error. With advancements in machine learning and image processing, there is a need for an automated solution that can quickly and accurately detect diseases in rice plant leaves. This system would not only reduce the time needed for diagnosis but also ensure precision and scalability, being particularly useful in large agricultural settings. This greatly enriches both farmers and consumers, by maximizing the crop's yield.

Various advancements have been made within machine learning to increase the accuracy and reduce error within the models. A variety of Machine Learning and Deep Learning architectures have been employed to accomplish this task. ResNet50, InceptionNet, and YOLO are examples of such architectures. Rice leaf diseases, such as Bacterial Leaf Blight, Leaf Blast, and Brown Spot, pose significant threats to crop yields. Models are being trained on these diseases to increase their performance and efficiency. Accuracies differ from model to model and disease to disease. This study aims to provide a viable and scale model, upon which the rice plant disease detection can be performed.

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Literature Review

Convolutional neural networks, deep learning, and machine learning, have served as the backbone of automated disease detection. Within these, researchers have worked with various network models, to increase the effectiveness of feature extraction and overall prediction accuracy. Researchers have used the ResNet-50 model, a widely used CNN architecture that has been applied to categorize 14 different rice diseases in the Philippines [1]. They have reported an overall accuracy of 90%. However, the model faced difficulties in classifying diseases like Bacterial Leaf Blight and Rice Blast, which negatively impacted its performance. Similarly, In a study by Ghosal and Sarkar, the VGG16 CNN architecture was used to classify rice plants into four categories, brown spot, rice leaf blast, rice leaf blight, and healthy [2]. This model contributed greatly to the further use of transfer learning techniques in rice disease detection. Nanxin Zeng utilized the InceptionV4 CNN architecture to categorize rice diseases into four classes: brown spot, bacterial blight, tungro, and blast. The model achieved an average accuracy of 95.57% [3]. Enhanced YOLO networks have also been employed by researchers with an accuracy of 94% in a timeframe of 40 seconds [4]. YOLOs real time detection capabilities have been a game changer in real-time complex and varied scenarios. The analysis and breakdown between deep learning models and their accuracies in classification have also been broken down in a 2024 study [5]. A Bangladeshi research group trained the model on a range of different machine learning algorithms including that of KNN(K-Nearest Neighbour), J48(Decision Tree), Naive Bayes and Logistic Regression [6]. Decision tree algorithm achieved the best accuracy of over 97% after 10-fold cross validation. There have also been notable successes with hybrid models, where the strengths of multiple models are leveraged [7]. The feature extraction ability and models and their capability of forming patterns on features such as leaf color and texture have also been the subject discussion [8] .These studies have emphasized viability and the ability of these model architectures to perform complex disease classification tasks.

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Table 1.1: Literature Review Table

S.no	Research Paper	Model Used	Accuracy	Remarks
1	Detection of Philippine Rice Plant Diseases: A ResNet50 CNN Approach	ResNet-50 model	90%	Difficulties in classifying diseases like Bacterial Leaf Blight and Rice Blast
2	Rice Leaf Diseases Classification Using CNN With Transfer Learning	VGG16 CNN	92.46%	Limited Dataset
3	YOLO Network-Based for Detection of Rice Leaf Disease	Enhanced YOLO	94% Performed better in comparison with Inception-ResNet-V2	Requires a 40 second timeframe. Some prevalent diseases and dynamism is missing
4	A Comprehensive Analysis of Various Deep Learning based Multi Class Plant Disease Classification Techniques	EfficientNetB0 InceptionV3 VGG16	97.58% 96.83% 94.35%	EfficientNetB0 architecture outperformed the rest.
5	An Accurate Classification of Rice Diseases Based on ICAI-V4	ICAI-V4 with Inception-V4 as the backbone	95.57 (Strong ability to deal with interference and noise)	Limited rice disease samples collected and tested.
6	Rice Leaf Disease Detection Using Machine	Logistic Regression	70.83	Decision Trees outperformed the

	Learning Techniques	KNN Decision Trees Naives Bayes	91.66 97.91 50.00	other ml models.
7	Classification of Rice Leaf Diseases Based on Texture and Leaf Colour	GLCM and K-NN	89%	
8	Identification and Classification of Rice Plant Disease Using Hybrid Transfer Learning	Hybrid CNN-based deep learning technique	90.8	Limited Dataset

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Problem Identification & Objectives

Traditional models for rice plant leaf disease detection are typically require heavy amounts of computational resources to give high levels of accuracy. Traditional models also struggle to classify or predict diseases in a varied environment. Where there are differences in disease symptoms, picture quality, noise, and field environment. Therefore, there is need for a robust system which can extract meaningful features in a varied environment. To address these challenges, MobileNetV2 architecture will be utilized. It is a deep learning model that can extract meaningful features, while being efficient and lightweight. MobileNetV2 architecture has been specifically designed to perform and excel in resource-constrained environments, while maintaining high accuracy.

Objectives:-

- Develop a **MobileNetV2-based CNN model** to classify rice plant diseases from leaf images.
- Fine-tune the **MobileNetV2 model** to improve detection accuracy with limited labeled data.
- Optimize the model to handle predictions with varying image conditions and varied symptoms, ensuring real-world applicability.
- Evaluate the model's performance and compare it with traditional methods to demonstrate its effectiveness.

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Existing System

Traditional Systems utilize a machine learning algorithm and architecture such as Convolutional Neural Network to make predictions. Firstly, the image dataset is preprocessed to make the data suitable for analysis and training. Image dataset reflects the types of diseases the model must classify. Then the data is split between training and testing data. The model is then trained and deployed with a web application.

Drawbacks of Existing System:-

- Existing systems struggle with limited feature extraction capabilities, with methods like SVM and KNN often requiring manual feature extraction.
- These approaches struggle to generalize across different conditions leading to poor accuracies.
- Traditional models require large amounts of labeled and annotated datasets for training.
- Training from scratch: Without transfer learning, training CNNs from scratch is computationally expensive and time-consuming.
- Models run the risk of over fitting, leading to exceptional accuracies, but poor performance in real-world scenarios.
- Traditional approaches require heavy computational resources to run.

. **Proposed System**

The proposed system addresses the shortcomings of traditional rice disease detection methods by utilizing the MobileNetV2 architecture, a lightweight and efficient convolutional neural network model. MobileNetV2 was initially designed for mobile and resource-constrained environments, making it effective in low-resource environments. The proposed model also contains the traditional steps of image processing, where firstly the rice leaf image dataset is preprocessed to enhance image quality. Then the data is split among training and testing datasets. The data is then sent to the deep learning model, which in this case is the MobileNetV2 model.

At its core MobileNetV2 model, is to efficiently feature extract with fewer parameters and lower computational cost. This makes it ideal for deployment in real-world agricultural settings. MobileNetV2 uses inverted residual blocks and linear bottlenecks to extract meaningful features from rice leaf images. This inverted structure and bottlenecks force the model to perform its convolutions in a compact and limited space for efficiency purposes. The proposed system is designed to achieve high accuracy while requiring minimal computational resources. This limited resource requirement makes the model suitable for mobile applications or field devices. This ability of MobileNetV2 to work well in edge devices ensures wider application in the field of agriculture as farmers are able to utilize the model with their available devices.

By leveraging the power of CNNs through MobileNetV2, the system also ensures that it does not compromise its accuracy for the sake of efficiency. The system’s performance is evaluated using standard metrics such as accuracy, precision, recall, and F1-score, ensuring that it meets high standards of reliability and effectiveness in real-world scenarios.

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System Architecture

The system architecture for the MobileNetV2 based rice disease detection model begins with input image acquisition, where rice leaf images are collected for analysis. These images undergo preprocessing, including resizing and noise reduction, to enhance quality and to make it suitable for disease diagnosis. The preprocessed images are then given to the MobileNetV2 model for feature extraction and classification. The model then outputs its prediction regarding the presence of diseases. If a disease is present it must then classify the disease as either bacterial leaf blight, brown spot, rice blast, or sheath blight. Finally, the system evaluates its performance using metrics like accuracy, precision, and recall. The model is further refined based on its performance, to create a more reliable system.

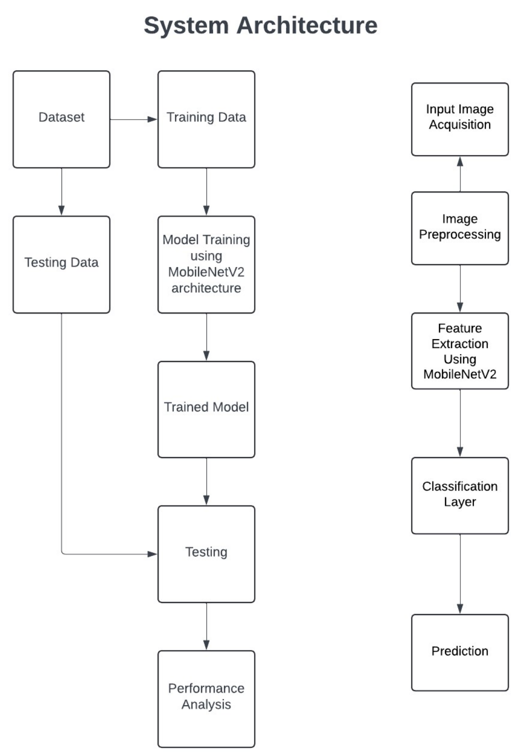

Figure 1: System Architecture

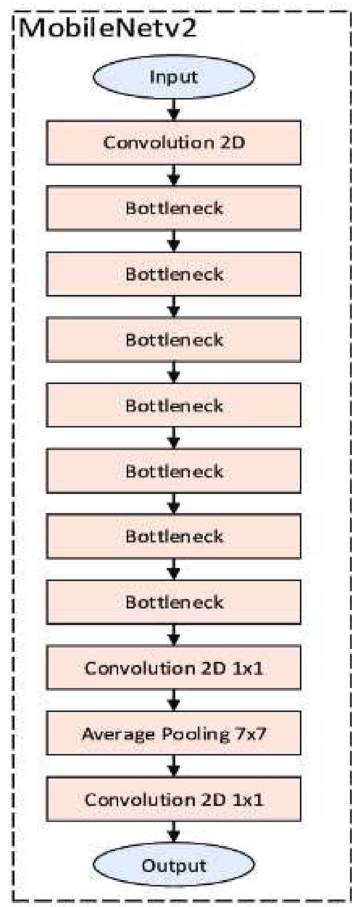

Figure 2: MobileNetV2 Architecture

. **Tools/Technologies Used**

1. **MobileNetV2 Architecture**: A Lightweight convolutional neural network (CNN) architecture optimized for mobile and embedded devices. It performs efficient feature extraction and classification of rice leaf diseases.
2. **Python**: The core programming language used for development of this system, it provides great flexibility and its wide range of libraries is essential for machine learning and image processing.
3. **TensorFlow/Keras**: TensorFlow is an open-source library that can perform machine learning tasks. On the other hand Keras is a high-level API integrated with TensorFlow, suited for designing neural networks. It is the base library which helped with the creation of MobileNetV2 network.
4. **OpenCV**: A powerful library used for image processing tasks. It was used to preprocess the rice leaf images.
5. **NumPy**: A library for numerical computation in Python, essential for handling image arrays and performing mathematical operations during data preprocessing and model training.
6. **Pandas**: Used for data manipulation and analysis, particularly for handling metadata and organizing image datasets in a structured format.
7. **Matplotlib/Seaborn**: Visualization libraries in Python used to plot performance metrics, such as accuracy and loss curves, as well as confusion matrices to evaluate the model's performance.
8. **Jupyter Notebook**: The primary development environment used for writing and executing the code. It provided an interactive environment for testing, visualization, and documentation of the model development process.

These tools and technologies helped in the creation and development of this project.

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Conclusion

The MobileNetV2-based rice disease detection system shows promise in effectively addressing the limitations of traditional methods. It provides a lightweight model that is still capable of accurately classifying rice leaf diseases. Through its ability to efficiently feature extract in varying real-world conditions, this system demonstrates potential in assisting farmers diagnose diseases quickly. This can greatly help farmers in increasing rice plant yield.

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