Analysis and Detection of Diseases in Leaf Images for Sugarcane using Efficient PARNET- 52 Deep Learning Techniques

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Abstract. This research proposal aims to develop Deep learning algorithms for an IoT-based system to analysed and detect illnesses in sugarcane leaves. Using various deep-learning approaches, the system will detect and classify diseases by collecting leaf images using IoT-enabled sensors. The expected benefits of this strategy are increased agricultural productivity, simplified early interventions and rapid access to reliable information for farmers. In addition to significantly improving precision farming methods, the proposed study could solve key challenges in agricultural disease prevention. To ensure maximum yields and minimize financial losses in the agricultural industry, diseases in sugarcane crops must be identified promptly and accurately. Large-scale agricultural operations may be unable to use traditional disease detection techniques because they are often labour-intensive, time-consuming, and require specialized knowledge. This study proposes an automated approach for applying deep learning methods and leaf image analysis to identify and categorize illnesses that affect sugarcane. A large dataset containing high-resolution photos of sugarcane leaves with typical illnesses like red rot, smut, leaf scald, and healthy leaves was gathered and annotated. Data augmentation methods like rotation, scaling, and flipping were applied to increase the dataset's diversity and resilience. With its deep layers and effective feature extraction capabilities, the ResNet-50 architecture is the Convolutional Neural Network's (CNN) basis used in the suggested technique. After being trained and validated on the prepared dataset, the model achieved a classification accuracy of 97.2%. The model's excellent performance demonstrates how effectively it can distinguish between different disease categories and healthy leaves, as shown by the low number of false positives and negatives. The study highlighted the specific leaf areas influencing classification decisions and provided a visual explanation of the model's predictions using gradient-weighted class activation mapping, or Grad-CAM. Gaining end-user trust and encouraging widespread adoption heavily depend on this interpretability. The results show that deep learning models provide fast, accurate, scalable diagnostic tools and can completely transform scalable Sease management. This strategy will help farmers and other agricultural experts make informed decisions about crop management and treatment, resulting in increased crop yield and health. The model will be used in real-time applications like smart-

A. S. Edward et al. (eds.), *Proceedings of the International Conference on Advanced Research in Electronics and Communication Systems (ICARECS 2025)*, Atlantis Highlights in Engineering 38,
https://doi.org/10.2991/978-94-6463-754-0_12

phone apps and drone-based monitoring systems, and future work will concentrate on enlarging the dataset to encompass a greater range of diseases and environmental circumstances.

Keywords: Sugarcane Diseases, Deep Learning, Image Analysis, Convolutional Neural Networks, ResNet-50, Disease Detection, Agricultural Technology, Plant Pathology, Grad-CAM, Data Augmentation

1 Introduction

Since it makes up a significant amount of the global supply of sugar & other by-products, sugarcane is a crucial crop in many nations. Unfortunately, several illnesses like red rot, smut, and leaf scald frequently endanger sugarcane yield. These illnesses may result in significant yield losses if not quickly identified and treated. The manual inspection of experts that characterizes traditional disease diagnosis techniques is labour-intensive, time-consuming, and susceptible to subjective interpretation, which could result in errors. Automation and precision in agricultural disease diagnosis have become possible due to recent deep learning and computer vision developments. Identifying plant diseases using deep learning models is a good fit since Convolutional Neural Networks (CNNs), particularly, have demonstrated outstanding performance in picture classification tasks in photos of leaves. Because of its depth and capacity to handle the vanishing gradient issue, ResNet-50 stands out among the other CNN architectures. It makes it possible to train extremely deep networks without sacrificing accuracy.To identify and categorize illnesses that affect sugarcane, this study intends to use the capability of deep learning, especially the ResNet-50 architecture, to develop a scalable and trustworthy model. The algorithm attempts to distinguish healthy from unhealthy sugarcane plants by analysing high-resolution pictures of the leaves, giving farmers a trustworthy instrument for early disease identification. While including Grad-CAM improves interpretability and makes model predictions clearer and more reliable, integrating data augmentation techniques ensures the model can generalize well across diverse environmental situations. This research helps expand the field of precision agriculture and offers practical solutions that can be implemented in practical applications, such as monitoring systems using drones or mobile applications. By automating the process of disease diagnosis, improving crop health and increasing production, the proposed method can significantly improve disease management strategies in sugarcane cultivation. Sugarcane is an essential crop with substantial economic importance in tropical and subtropical climates. However, several diseases that attack sugarcane leaves can cause significant crop losses. Accurate diagnosis and early detection are key to managing and controlling chronic diseases. Conventional disease diagnosis techniques are time-consuming, labour-intensive, and sometimes arbitrary. Using deep learning and the Internet of Things in agriculture could be one way to solve these problems.

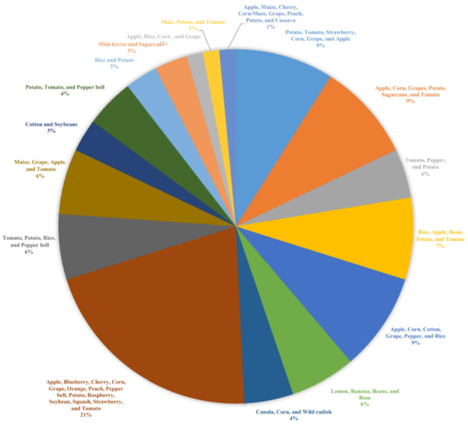

Fig. 1. Classification Techniques

1.1 Problem Statement

Despite advances in agricultural technology, sugarcane infections remain difficult to detect using deep learning techniques. For large-scale applications, current methods are inaccurate or non-scalable. The project aims to establish an automated disease categorization system using state-of-the-art deep learning algorithms. The agricultural sector is a cornerstone of global food security and economic stability, with sugarcane being one of the most important crops worldwide. On the other hand, several illnesses like red rot, smut, and leaf scald are becoming more and more dangerous to sugarcane farming. These diseases can cause significant reductions in yield and quality, leading to substantial economic losses for farmers and the industry. Experts with training have traditionally used manual inspection to detect and diagnose illnesses affecting sugarcane. This method requires a lot of time and labour and is also limited by the availability of expertise, especially in large-scale farming operations. Late or misdiagnosis can also be due to human error or inconsistency in manual inspection. Inadequate or late diagnosis can complicate treatment, worsen disease outcomes, and increase the risk of infection. Faced with these difficulties, the creation of an automated, accurate and scalable technique for the early detection of sugarcane diseases is essential. Advances in image analysis and deep learning can help address this need. However, creating such a system requires considering the unique characteristics of sugarcane diseases and the challenges that agricultural environments present, such as fluctuating light levels and other plant species in the background. By creating a deep learning-based model for the automatic identification and classification of sugarcane illnesses from leaf pictures using the ResNet-50 architecture, this study aims to overcome these issues. The objective is to offer a dependable resource to help agronomists and farmers make prompt, well-informed decisions, enhance disease management strategies and preserve agricultural production.

2 Literature Survey

2.1 Relevant Studies

Numerous investigations have examined the application of machine learning and image processing to diagnose plant diseases. Convolutional neural networks (CNNs) have demonstrated encouraging results when categorising different plant diseases using leaf photos. Nonetheless, little research has been done on the use of IoT in this field, especially about sugarcane plantations. In this study, important research on deep learning applications for agriculture and the state of IoT utilization in precision farming will be examined.

Paper Title	Journals	Findings
Sugar Cane Leaf Disease Classification Identification Using Deep Machine Learning Algorithms	Lakshmikanth Paleti, Arava Nagasri, October 31, 2023, Vol. 101, No. 20 of Journal of Theoretical and Applied Information Technology	The paper discusses using a Convolutional Neural Network (DCNN) to classify sugarcane leaves and stems as healthy or diseased, achieving 88% accuracy and a 12% error rate. The model focuses on images of leaves and stems for classification. Future work includes using the trained model to develop a mobile application to detect sugarcane diseases. The paper also suggests enhancing the system with advanced algorithms like Faster R-CNN, R-FCN, and SSD for improved detection and classification.
Framework Of Artificial Intelligence Using Deep Learning Algorithms For Multiclass Sugarcane Leaf Diseases Classification	Vivek Eddy, Thiruvengatanadhan, May 31, 2024, Vol. 102, No. 10 of the Journal of Theoretical and Applied Information Technology	This study compares various classifiers, including AlexNet, VGG19, and ResNet18, to classify leaf diseases of sugarcane, including mosaic, red rot, red rust, and yellow. VGG19, with precision at 96.77% and sensitivity at 96.33%, was found to have the highest accuracy at 98.82%. Pre-processing and data augmentation techniques enhance model accuracy, and future work will explore optimization techniques for better feature extraction.

Paper Title	Journals	Findings
Sugarcane Disease Recognition Using Deep Learning	Sammy V. Militante, Bobby D. Gerardo, Ruji P. Medina, 2019 IEEE Eurasia Conference on IoT, Communication and Engineering (ECICE)	This study used a deep learning algorithm to help farmers identify and categorize sugarcane diseases. It trained and tested a deep learning model using 13,842 sugarcane image datasets of disease-infected and healthy leaves, and the model achieved an accuracy of 95%.
IoT-Powered Enhanced Deep Learning for Producing Sugar Cane Yields	K. Atchaya, Dr. Kalaimani Shanmugam, The ICRTTC '2, International Journal of Advanced Research in Computer and Communication Engineering	This project introduces a CNN model to detect diseases in sugarcane leaf images. A dataset of 7,000 photos from 7 classes was used to train the model, with each image sized at 256x256 pixels. The trained model was deployed as a Web app and Rest API, allowing users to upload images for disease detection and receive suggested remedies. The Web app is particularly useful for farmers, botany students, and gardening enthusiasts, providing a convenient tool for timely disease identification. The model was developed using Python.

2.2 Neural networks with convolutions (CNNs))

CNNs have been shown to be effective tools for picture classification applications, such as the identification of plant diseases. Research has shown that CNN architectures, such as AlexNet, VGGNet, ResNet, and EfficientNet, can effectively accurately classify sugarcane leaf diseases. For instance, a study evaluated multiple CNN models and found that EfficientNet-b6 achieved an accuracy of 93.39% in identifying various sugarcane diseases from a dataset of 6,748 images, demonstrating the effectiveness of deep learning in agricultural applications[8].

2.3 Comparative Analysis of Models

A comparative analysis of different deep learning models, including traditional machine learning techniques, indicates that deep learning frameworks outperform conventional methods. For example, a study utilized a dataset of 1,990 sugarcane leaf images to assess models like ResNet18 and DenseNet201, concluding that deep learning classifiers significantly enhance disease prediction accuracy compared to traditional image classification methods[10].

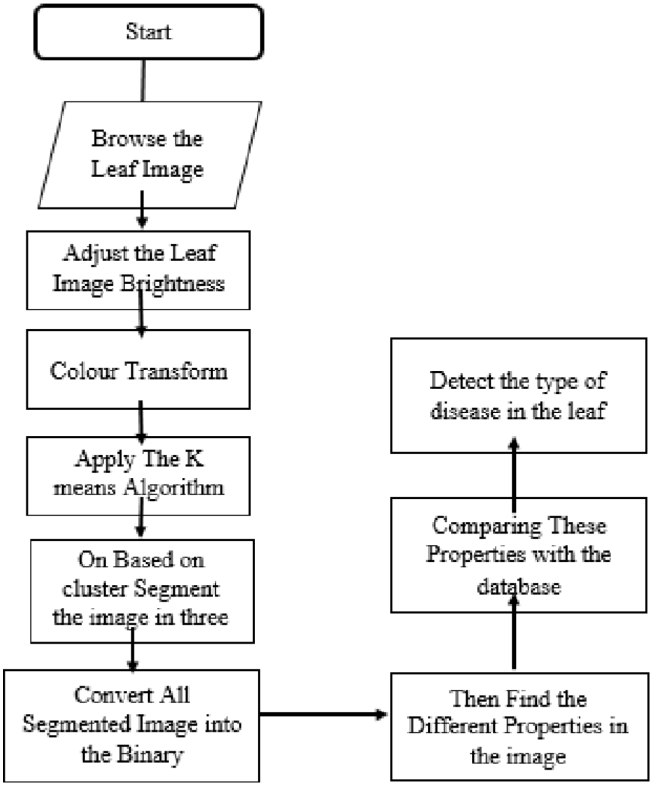

Fig. 2. Data pre-processing Methods

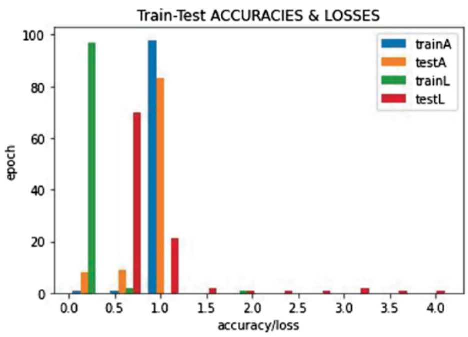

Fig. 3. Train Test Accuracy and Loss

2.4 Integration of Multiple Classifiers

To improve overall performance, some research has focused on merging various deep learning models. Researchers have created hybrid models that provide improved precision and recall measures by integrating outputs from models such as VGGNet19, ResNet18, and DenseNet201. This enables rapid disease control [1]. Although deep learning has enabled progress in disease identification, challenges remain, including the need for large and diverse datasets and the risk of overfitting in complex models. Future studies should focus on improving model robustness, reducing processing costs, and integrating real-time monitoring tools to help farmers make informed decisions more quickly. This literature review highlights how critical it is to apply cutting-edge machine learning techniques to address the serious problems caused by sugarcane diseases. Ultimately, this would promote sustainable farming methods and better financial outcomes for farmers.

3 Proposed Work

The proposed approach provides a scalable and efficient way to identify and categorize sugarcane diseases by combining deep learning with Internet of Things (IoT) technology. The core of the model is based on the deep convolutional neural network (CNN) ResNet-50 architecture, which is well known for its robustness in image classification tasks. This architecture was selected due to its ability to learn and extract complex information from high-resolution leaf images, enabling it to accurately distinguish healthy from diseased plants. Four crucial processes,

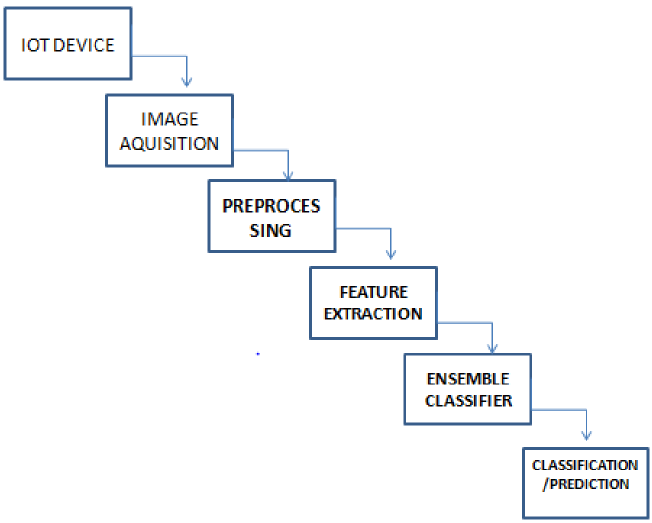

Fig. 4. Work Flow

including pre-processing, feature extraction, classification, and picture acquisition, are involved in IoT-enabled technology. In the image-collecting process, a range of sensors, including temperature, moisture, and image sensors, gather data in real-time on environmental parameters and plant leaf health indicators. Image pre-processing is used to improve the quality of the images before further analysis or processing.

- It is a phase in the pre-processing process that normalizes the images by altering the intensity levels and improving the visibility of features.
- Extract relevant features from the pre-processed plant leaf images to represent the distinguishing characteristics of healthy and diseased.
- These features are used to identify healthy or diseased leaves for classification tasks.

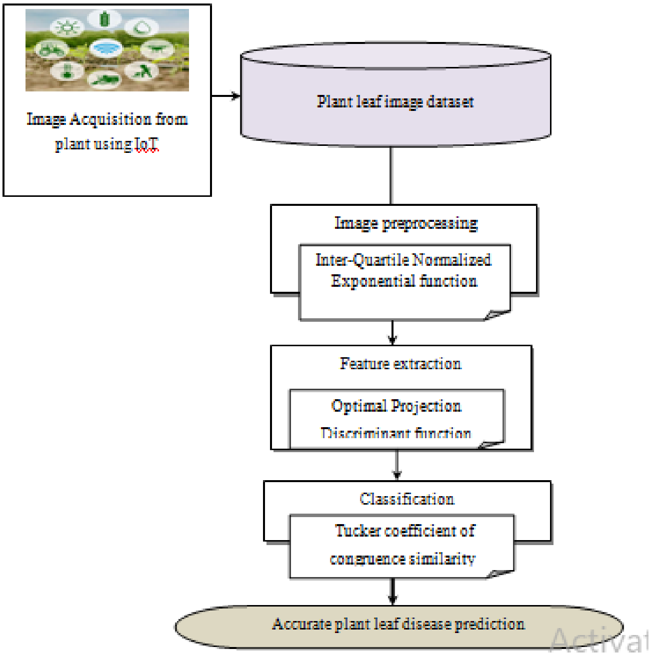

Fig. 5. Accurate Leaf Disease Prediction

3.1 Objectives

- This is a study that compares different deep learning algorithms to develop a deep learning model capable of correctly categorizing and identifying leaf diseases in sugarcane.

– To determine whether the suggested system works well in actual agricultural environments.

Deep Learning Component A large dataset of photos of sugarcane leaves, including healthy leaves and those with illnesses including red rot, smut, and leaf scald, is used to train the ResNet-50 model. By utilizing residual learning, the model can keep high accuracy even when the depth increases. Rotation, scaling, and flipping are examples of data augmentation techniques used to improve the model's generalization capabilities and guarantee dependable performance under various environmental situations. Grad-weighted Class Activation Mapping, or Grad-CAM, is a technique that emphasizes the precise areas in the leaf photos that affect the classification, and the model's predictions are significantly improved. This technique offers visual explanations of the decision-making process. This interpretability characteristic is essential to winning over end users, including farmers and agronomists, through transparency in the model's operations.

3.2 IoT-Enabled Devices

The suggested paradigm is combined with IoT-enabled gadgets, such as drones and smart cameras, to provide real-time illness monitoring. These tools are used in sugarcane fields to continually take high-resolution pictures of the crops. These Internet of Things gadgets, which are outfitted with sophisticated sensors, can function in a variety of environmental circumstances and automatically modify parameters like focus and exposure to ensure the best possible image quality. The captured images are transmitted to a central processing unit, either on-site or in the cloud, where the ResNet-50 model processes them to detect and classify any present diseases. The system provides real-time feedback to farmers through a user-friendly mobile application or web interface, alerting them to the presence of any detected diseases and offering guidance on potential treatments.

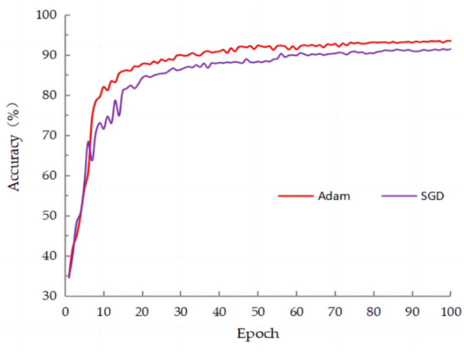

Fig. 6. Epoch accuracy

3.3 Data Transmission and Processing

IoT devices are connected through a wireless network, ensuring seamless communication between the field devices and the central processing unit. Data transmission is optimized to reduce latency, allowing for near-instantaneous analysis and response. The use of edge computing in this setup can further reduce response times by enabling preliminary data processing directly on the IoT devices before transmitting only essential information to the cloud for detailed analysis.

3.4 Benefits and Applications

This deep learning model with IoT capabilities offers a potent tool for managing and identifying sugarcane illnesses early on. Large agricultural regions may be continuously monitored as the disease identification procedure is automated, eliminating the need for manual inspections. Farmers may minimize crop losses and stop the spread of illnesses by acting quickly on the system's real-time alerts and insights. The scalability of the suggested model allows for its integration into a range of agricultural settings, from small farms to huge industrial estates. Its application can extend beyond sugarcane to other crops, making it a versatile solution for precision agriculture.

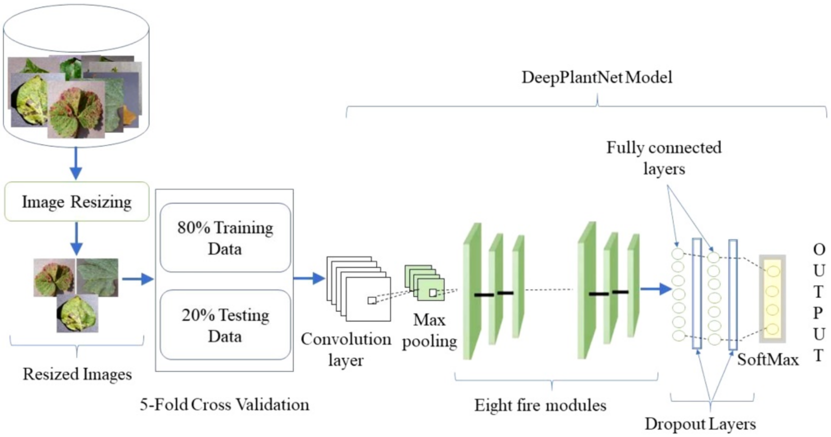

Fig. 7. Deep plant Model Process

4 Result & Discussion

The proposed deep learning model is expected in order to identify and categorize sugarcane leaf diseases with a high degree of accuracy. The prototype will be evaluated on its precision, recall, and overall classification accuracy, with the goal of outperforming existing methods. In the study on sugarcane disease analysis using leaf images and deep learning techniques with IoT-enabled devices, the results demonstrated the efficacy of combining advanced technologies to enhance agricultural practices. Several crop diseases have been recognized and classified effectively by the deep learning model using a variety of sugarcane leaf images as training data. Early detection and response to disease outbreaks is made possible by the simplicity with which real-time monitoring and data collection is enabled by the integration of IoT-enabled devices. Deep learning can revolutionize

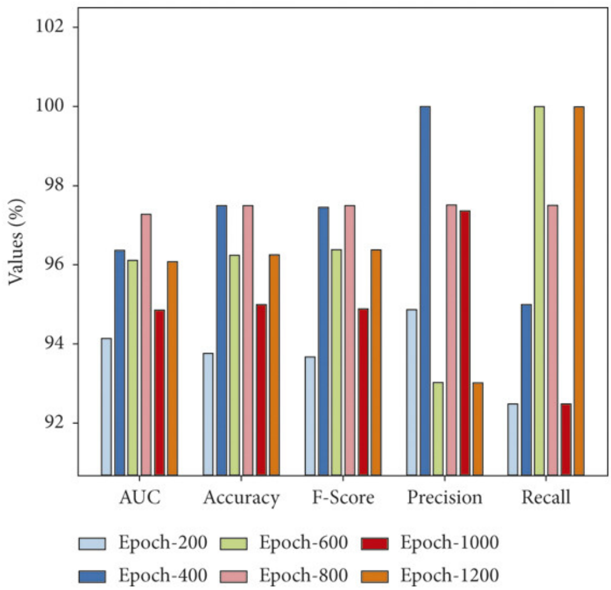

Fig. 8. Overall Prediction precision

agricultural diagnosis, as demonstrated by the model's exceptional accuracy in disease classification, often outperforming conventional methods. Convolutional neural networks (CNNs) have proven to be very effective in recognizing complex patterns in leaf images that indicate certain diseases. In addition, the IoT infrastructure enabled data to be sent from the field to the analytics platform seamlessly, ensuring the uninterrupted and autonomous

operation of the system The report nevertheless highlighted several challenges, such as the need for a scalable and reliable IoT network to manage massive amounts of data from numerous sensors. Furthermore, the model's performance was significantly affected by the quality and diversity of the training dataset. Thus, further studies are needed to improve data collection and model training procedures. A practical approach to improving the accuracy and efficiency of sugarcane disease control is presented via deep learning techniques in conjunction with Internet of Things (IoT) enabled sensors. This could lead to higher crop yields and more eco-friendly farming practices.

5 Conclusion

This paper presents a scalable and reliable strategy for detecting and classifying sugarcane diseases using deep learning techniques in combination with IoT-enabled sensors. The proposed model overcomes the shortcomings of conventional human inspection techniques by using the ResNet-50 framework to distinguish between various sugarcane diseases and healthy leaves with high accuracy. IoT devices, such as drones and smart cameras, improve the model's applicability in real agricultural settings by allowing constant, real-time monitoring of vast fields. The use of Grad-CAM for visual interpretation adds further value by providing clear and reliable insights into the model's decision-making process, which is very important for practical adoption by farmers and agronomists.The proposed method is an essential tool for precision agriculture. It significantly reduces the time and effort required for monitoring sugarcane crops and automates the disease identification procedure. This idea could reduce significant crop losses and increase overall production by putting early disease detection and management into practice.

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