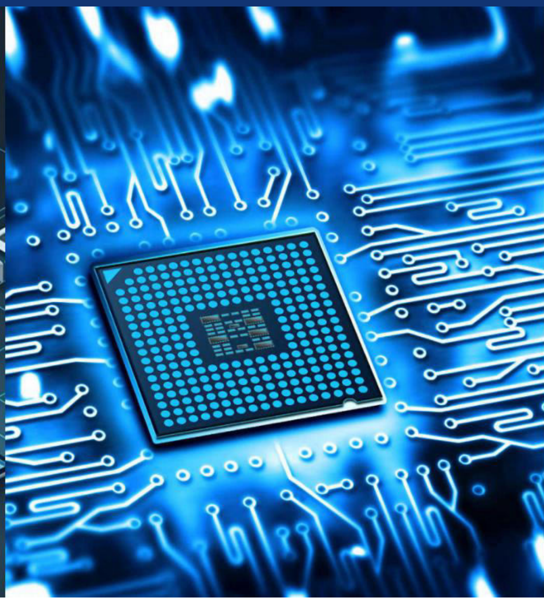
IJIRCCE

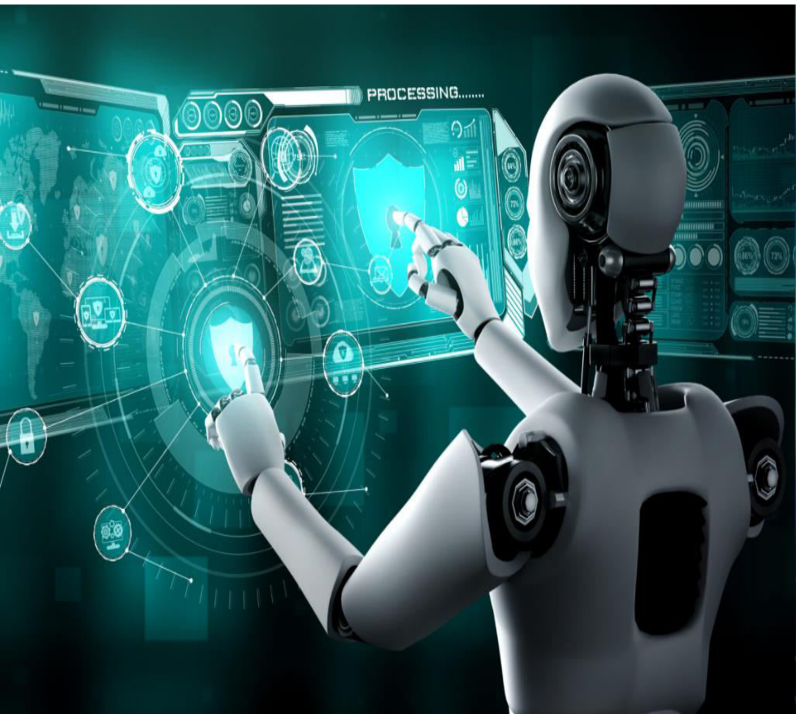
ISSN(O): 2320-9801

ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.771

Volume 13, Issue 4, April 2025

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© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI: 10.15680/IJIRCCE.2025.1304185

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Plant Disease Detection and Natural Pesticide Recommendation Using OpenCV and TensorFlow

P.Jyothi

Assistant Professor, Department of ECE, Sri Vasavi Institute of Engineering & Technology (Autonomous), Nandamuru, Pedana, A.P, India

M.Harshitha, V.Aswini, N.Sneha Poojitha, B.V.Gowtham Sai

Department of ECE, Sri Vasavi Institute of Engineering & Technology (Autonomous), Nandamuru, Pedana, A.P, India

ABSTRACT: Agriculture plays a crucial role in global food security, and plant health is a key factor in ensuring optimal crop yield. Early detection of plant diseases is essential for preventing significant agricultural losses. This project presents an AI-powered Plant Disease Detection and Natural Pesticide Recommendation System utilizing OpenCV and TensorFlow to analyse images of plant leaves and identify diseases in real time. The system is designed to provide a cost-effective and efficient solution for farmers, reducing reliance on chemical pesticides and promoting sustainable agricultural practices. The system is implemented using a Raspberry Pi Pico and an ESP32-CAM, which captures images of plant leaves and processes them using machine learning models trained on a dataset of plant diseases. The captured images are analysed using OpenCV for pre-processing, and TensorFlow is employed for deep learning-based classification. Once a disease is identified, the system recommends natural pesticides and remedies to mitigate the impact without harming the environment. The results are displayed on a monitor, providing an interactive interface for farmers to access real-time insights. This project aims to bridge the gap between traditional farming methods and modern AI-driven solutions, enabling farmers to detect plant diseases early and take necessary actions using natural pesticides. By integrating IoT and AI, this system enhances agricultural productivity while promoting eco-friendly farming techniques. The implementation of this solution can contribute to reducing crop losses, improving food quality, and fostering sustainable agriculture in various regions.

KEYWORDS: RASPBERRY PI PICO, ESP32 CAM, MONITOR

I. INTRODUCTION

Agriculture plays a vital role in global food security and economic stability. However, plant diseases significantly reduce crop yield and quality, leading to substantial losses for farmers. Early and accurate detection of plant diseases is crucial to prevent their spread and ensure effective treatment. Traditional methods of disease detection rely on manual observation, which is often time-consuming and requires expert knowledge. With advancements in artificial intelligence and computer vision, automated solutions have emerged as a reliable alternative. This project presents an AI-powered plant disease detection and natural pesticide recommendation system using OpenCV and TensorFlow. The system leverages Raspberry Pi Pico and ESP32-CAM to capture real-time images of plants, analyse them for disease symptoms, and classify them using deep learning techniques. The detected disease is then matched with a database to suggest eco-friendly, natural pesticides, reducing dependency on harmful chemical solutions. The ESP32-CAM module captures high-resolution images of leaves, which are processed using OpenCV for feature extraction. TensorFlow-based deep learning models classify the disease based on pre-trained datasets. The results are displayed on a monitor, providing farmers with immediate feedback and guidance. This automated approach enhances agricultural productivity by enabling precise disease diagnosis and sustainable pest control methods. By integrating AI with IoT, this project offers a cost-effective and scalable solution for real-time plant health monitoring. It not only supports farmers in making informed decisions but also promotes environmentally friendly agricultural practices. The proposed system represents a step forward in precision farming, helping to ensure healthier crops and increased yields with minimal environmental impact.

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II. PROPOSEDSYSTEM

The Plant Disease Detection and Natural Pesticide Recommendation System employs computer vision and deep learning to identify plant diseases and suggest appropriate natural treatments. This system integrates Raspberry Pi Pico, ESP32-CAM, and a monitor to provide real-time disease detection and pesticide recommendations. The methodology is divided into several key stages: image acquisition, preprocessing, disease classification, and recommendation generation.

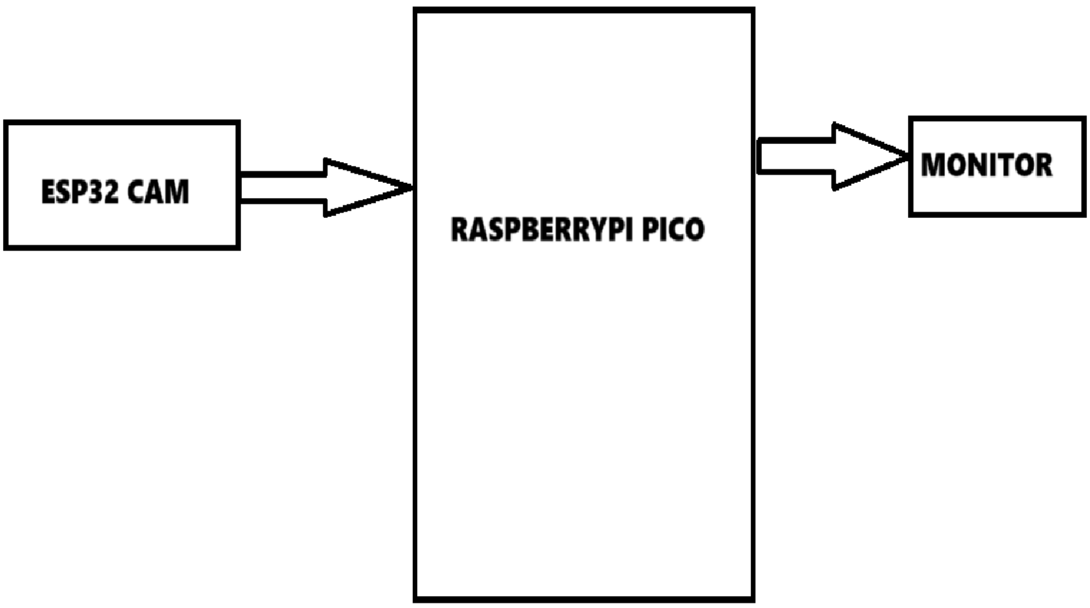
In the image acquisition stage, the ESP32-CAM captures high-resolution images of plant leaves, which are then transmitted to the Raspberry Pi Pico for further processing. The images are stored temporarily and displayed on a monitor for real-time observation. A database of diseased and healthy plant images, collected from open-source datasets and field samples, is used to train the deep learning model.

The preprocessing stage involves enhancing image quality using OpenCV techniques such as noise reduction, contrast adjustment, and segmentation. This step ensures that the input images are clear and optimized for feature extraction. The processed images are then fed into a deep learning model built with TensorFlow, which has been trained to recognize different plant diseases using a Convolutional Neural Network (CNN).

In the disease classification stage, the trained CNN model analyses the input image and classifies the plant condition as either healthy or diseased, further identifying the specific disease type if present. The classification output is displayed on the monitor, providing the user with immediate feedback.

Once the disease is identified, the system moves to the natural pesticide recommendation stage. A preloaded database containing information about organic and eco-friendly pesticides is accessed. Based on the disease classification, the system suggests natural remedies, such as neem oil, garlic extract, or baking soda solutions, to treat the plant effectively without harming the environment. These recommendations are displayed on the monitor for the user's reference.

The system also offers continuous learning and updates, allowing new disease data to be incorporated over time. Additionally, an IoT-based feature can be integrated to store disease occurrence data, helping farmers track trends and make informed decisions. This proposed method ensures real-time plant health monitoring, early disease detection, and sustainable farming practices using an AI-driven approach.



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III. EXPERIMENTAL RESULTS

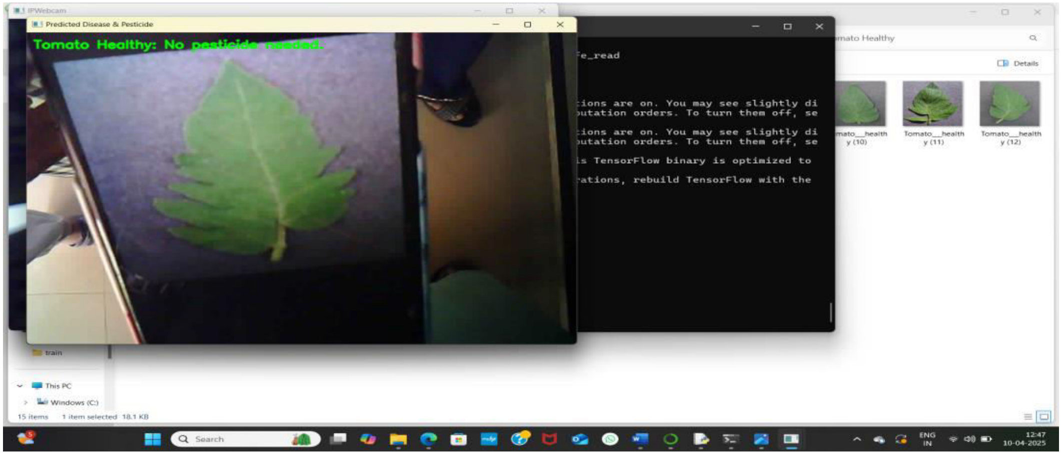

Fig.1: Output of Healthy Leaf

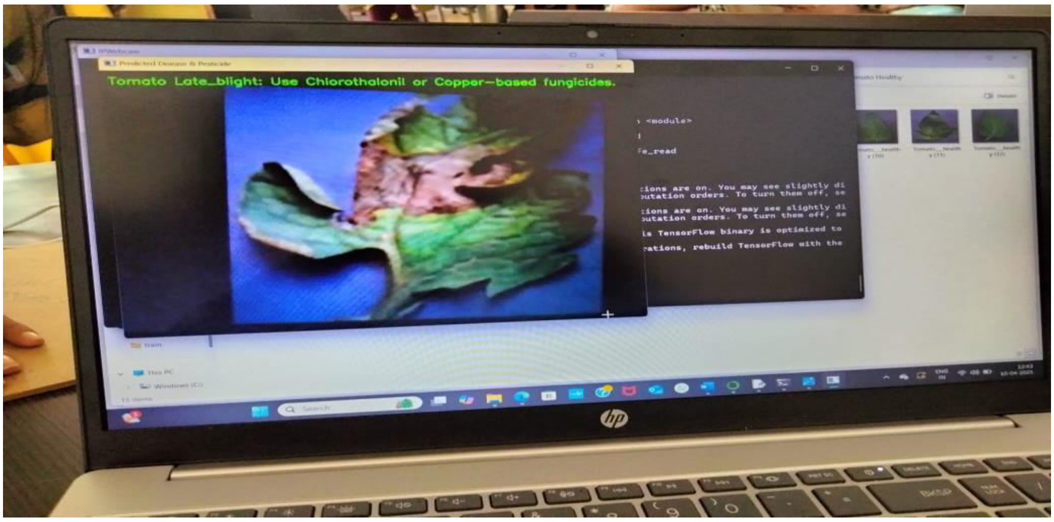

Fig.2: Output of Disease Leaf

IV. CONCLUSION

The Plant Disease Detection and Natural Pesticide Recommendation System integrates computer vision and machine learning to provide an efficient and automated solution for identifying plant diseases and suggesting eco-friendly treatments. By leveraging OpenCV and TensorFlow, the system processes images captured by the ESP32-CAM, classifies plant diseases, and displays the results on a monitor using Raspberry Pi Pico as the primary controller. This approach minimizes human intervention, ensuring accuracy and consistency in disease diagnosis. One of the key strengths of this system is its ability to promote sustainable agriculture by recommending natural pesticides rather than chemical-based alternatives. This reduces the environmental impact, safeguards soil health, and promotes eco-friendly farming practices. Additionally, the real-time detection mechanism allows for immediate action, helping farmers prevent the spread of diseases and improve overall crop yield. The implementation of AI-driven plant disease detection marks a significant step towards smart and precision agriculture. While the current system performs effectively, future enhancements can include an expanded dataset, cloud-based analysis, and integration with IoT for remote monitoring. Such improvements would make the system more robust, scalable, and adaptable to diverse agricultural conditions.

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Ultimately, this technology has the potential to revolutionize modern farming, ensuring food security and sustainable agricultural development.

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