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AI-Driven Agro-Advisor for Automated Tomato Disease Diagnosis and Sustainable Organic Remediation

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Abstract

The agricultural industry is a major aspect of many developing countries, as substantial portions of these countries rely on agriculture as their income source. This industry faces many obstacles, including issues related to plant diseases—which create major issues for agricultural production no matter where it occurs across the globe. Therefore, to achieve sustainability in agriculture and minimize the losses caused by plant disease, it is important to develop systems that are able to identify plant diseases at an early stage, as well as to accurately predict how soon those plant diseases can impact crop yields or quality and result in loss of income to farmers. In response to this critical need, we are proposing a new enhanced AI-based agro advisory system designed for automated automated identification of tomato plant diseases leveraging advanced deep learning techniques.The agro advisory system leverages the MobileNetV2 convolutional neural network architecture to create a lightweight/efficient model to classify images of healthy versus diseased tomato leaves. The model is trained using a publicly available dataset containing thousands (over 16,000) unique images of healthy versus diseased tomato leaves, providing a rich set of training data to enable the model to learn how to identify unique distinguishing characteristics between healthy and diseased tomato leaves. Farmers and other users can access the Tomato Disease Prediction (TDP) agro advisory service interface by using a Flask web-based server and uploading images of their tomato leaves; receiving real time prediction reguarding the presence of disease on their tomato plants and which specific type of tomato disease has been detected. The interactive nature of this system provides an easy-to-use, accessible solution for farmers and others with little-to-no technical expertise through an intuitive interface; thus making it a great addition to helping farmers produce safe and bountiful foods to feed the world's hungry. This work contains an important area of development with the addition of scalable database solutions, MySQL and MongoDB, which can be used to manage user data, historical predictions and disease-specific data effectively; thus enhancing both the scalability of the system and its ability to perform. Compared with traditional methods, the proposed system provides a more accurate prediction of disease occurrence, a quicker response time and improved data management. Overall, this AI-based platform presents a useful, economical, dependable means for agricultural production by limiting the reliance of the agricultural community on human efforts to diagnose a plant's disease and thus helping with proper decision making about crop production and ultimately increasing agricultural productivity.

Keywords: *Agro advisory system; Deep learning; MobileNetV2; Plant disease detection; Tomato crop*

1. Introduction

Agriculture plays a crucial role in ensuring food security and economic stability. However, plant diseases continue to pose a serious threat to agricultural productivity. Crops such as tomatoes are highly vulnerable to bacterial, viral, and fungal infections, which can spread rapidly and cause significant yield loss [2]. Traditional methods of disease detection rely on manual inspection by experts, which is time-consuming, subjective, and often inaccessible to farmers in remote areas. In previous work, an AI-based system was developed to detect tomato diseases using deep learning techniques [1]. Although the model achieved good accuracy, it lacked real-time deployment and scalability. This research extends the previous system by introducing a web-based interface and scalable database integration [3]. The enhanced system allows users to upload leaf images through a web application and receive instant disease predictions. Additionally, it stores user data and prediction history, making it suitable for real-world applications. This approach bridges the gap between advanced AI technologies and practical agricultural solutions in figure 1.

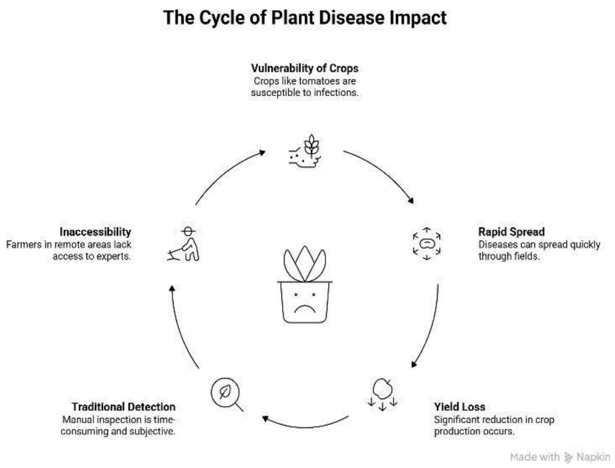

Figure 1 **The cycle of plant disease Impact**

Agriculture plays a crucial role in sustaining the economies of developing nations, yet crop diseases continue to threaten food security and reduce the income of millions of farmers. Additionally, laboratory-based testing methods, although accurate, are expensive, time-consuming, and not easily accessible to small-scale farmers. In recent years, advancements in artificial intelligence and deep learning have opened new possibilities for automated plant disease detection. In previous work, a deep learning-based system was developed to classify tomato leaf diseases using image data. While the system demonstrated promising accuracy, it lacked real-time deployment capabilities and scalable data management. Therefore, this research aims to enhance the existing system by integrating a web-based interface for real-time predictions and incorporating database solutions for efficient data storage and retrieval [10]. The proposed system bridges the gap between advanced AI technologies and practical agricultural applications, providing farmers with an accessible and reliable tool for disease diagnosis and management. Tomato cultivation, in particular, is highly vulnerable to bacterial, viral, and fungal infections that can rapidly spread and cause severe yield losses [5]. Accurate diagnosis of these diseases remains a major challenge, as farmers often rely on visual inspection, which is prone to misinterpretation and leads to incorrect or excessive pesticide usage. Although laboratory analysis provides reliable results, it is costly, time-consuming, and largely inaccessible to small-scale farmers in remote regions. To address these limitations, this research introduces an AI-driven solution that leverages Computer Vision and Transfer Learning for automated tomato disease detection [4]. Using a lightweight MobileNetV2 Convolutional Neural Network deployed on a web-based platform, the system provides fast, reliable diagnosis directly from leaf images. Unlike traditional tools, it also recommends organic, eco-friendly treatments, helping farmers adopt sustainable disease management practices while reducing chemical dependency [6]. This approach enhances accuracy, accessibility, and environmental safety offering a practical pathway toward modern, sustainable [7].

1.1. Background and Motivation

Agriculture remains the backbone of many developing economies, providing livelihood to a significant portion of the population. However, the sector faces numerous challenges, including plant diseases, pest infestations, declining soil fertility, and unpredictable climatic conditions. These factors collectively reduce crop productivity and threaten food security [8]. Traditional farming practices largely depend on chemical fertilizers and pesticides, which, although effective in the short term, have led to severe environmental degradation, soil infertility, and health hazards for farmers and consumers. In recent years, there has been a growing shift toward sustainable and organic farming practices. Organic remedies such as neem-based solutions, bio-fertilizers, and natural pest control methods offer eco-friendly alternatives. However, the adoption of such practices is limited due to lack of awareness, insufficient technical knowledge, and absence of accessible advisory systems for farmers at the grassroots level [9].

1.2. Problem Statement

Despite the availability of agricultural advisory platforms, most existing systems rely on generalized recommendations and often promote chemical-based solutions. Farmers typically depend on manual inspection or consultation with agricultural officers, which may not always provide timely or accurate diagnosis of crop diseases [11]. Moreover, many mobile-based solutions are not user-friendly for rural farmers due to language barriers and limited digital literacy.

There exists a critical need for an intelligent system that can:

- Accurately detect plant diseases at an early stage
- Provide personalized and localized recommendations
- Promote organic and sustainable farming practices
- Be accessible and easy to use for farmers with minimal technical knowledge.

2. Methodology

The proposed system follows a three-tier architecture consisting of a web-based user interface, a Flask backend, and an AI intelligence layer powered by a deep learning model. The Tomato Leaves Dataset (PlantVillage) containing 11 disease classes, including Bacterial Spot, Early Blight, Late Blight, Leaf Mold, Spider Mites, Yellow Leaf Curl Virus, Mosaic Virus, Powdery Mildew, and Healthy leaves, is used for training. All images are resized to 224×224 pixels, normalized, and subjected to data augmentation techniques such as rotation, zooming, and horizontal flipping to improve robustness under diverse field conditions [13]. MobileNetV2, selected for its computational efficiency, serves as the core architecture, where the ImageNet-trained base extracts features and a custom fully connected classifier predicts the disease category. During inference, the user uploads a leaf image through the web interface, which is processed by the CNN to identify visual symptoms like lesions or discoloration [14]. Finally, the system retrieves the corresponding organic remedy from a JSON knowledge base, providing farmers with eco-friendly treatment and prevention recommendations in real time. The system utilizes the "Tomato Leaves Dataset" (derived from PlantVillage), a publicly available dataset containing images of tomato leaves affected by various diseases. The dataset comprises 11 classes: Bacterial Spot, Early Blight, Late Blight, Leaf Mold, Septoria Leaf Spot, Spider Mites, Target Spot, Tomato Yellow Leaf Curl Virus, Mosaic Virus, Powdery Mildew, and Healthy. Before training, the images undergo preprocessing steps to ensure consistency and improve model performance [12].

These steps include:

- **Resizing:** Images are resized, a standard input size for many CNN architectures.
- **Normalization:** Pixel values are normalized to a range between 0 and 1, which helps to improve training stability and convergence shown in figure 2.

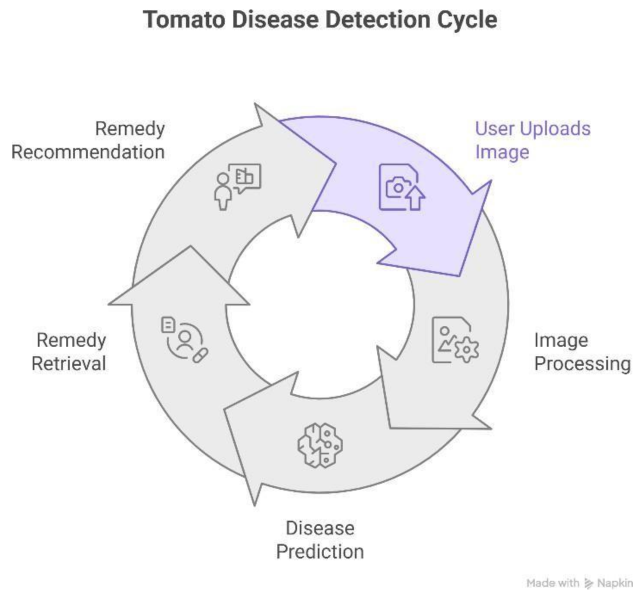

Figure 2 **Tomato Disease Management**

2.1.Disease Classification and Scenarios

The AI-Agro Advisor identifies major tomato diseases and recommends suitable organic treatments based on detected symptoms.

Scenario 1: Fungal Infections (Early Blight & Late Blight)

Problem: Early Blight causes dark “bullseye” lesions that lead to leaf drop and fruit sunscald, while Late Blight spreads rapidly in humid

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conditions. **Intervention:** The system detects concentric ring patterns and suggests organic controls such as improved air circulation, baking soda sprays, and removal of infected leaves shown in figure 3.

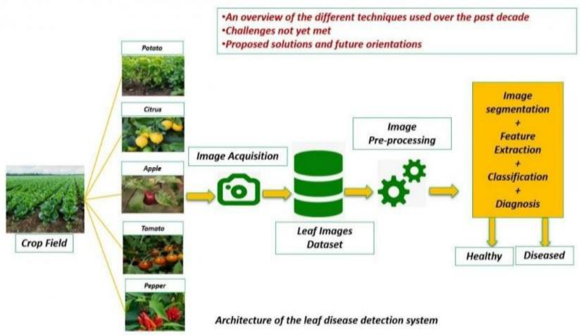

Figure 3 **Architecture of the leaf disease detection system**

Scenario 2: Viral Vectors (Yellow Leaf Curl Virus)
Problem: TYLCV, spread by whiteflies, causes leaf curling, yellowing, and severe stunting, often resulting in major yield loss.
Intervention: The system identifies viral symptoms and recommends vector-control methods such as yellow sticky traps, neem oil, and removal of heavily infected plants, since the virus itself cannot be cured shown in figure 4 and table 1.

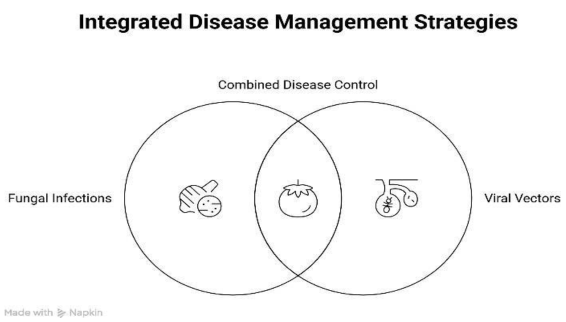

Figure 4 **Integrated disease Management Strategies**

2.2.Confusion Matrix Analysis

Actual \ Predicted	Early Blight	Late Blight	Healthy	Leaf Mold
Early Blight	48	2	0	1
Late Blight	3	45	1	1
Healthy	0	1	50	0
Leaf Mold	2	1	0	47

Table 1 **Confusion matrix analysis**

3. Results And Discussion

3.1.Results

The performance of the proposed system is evaluated based on its ability to accurately classify tomato leaf diseases using image data. The MobileNetV2 model achieves an overall accuracy of approximately 86–87%, demonstrating its effectiveness in identifying different disease categories. The system provides real-time predictions through a web interface, significantly reducing the time required for disease diagnosis compared to traditional methods. The confusion matrix analysis indicates that most predictions are correctly classified, with only minor misclassifications occurring between visually similar diseases such as Early Blight and Late Blight [15]. The evaluation metrics, including precision, recall, and F1-score, further confirm the reliability and robustness of the model. In addition to accuracy, the system also excels in usability and scalability due to its web-based deployment and database integration. Overall, the results demonstrate that the proposed system is a practical and efficient solution for plant disease detection, offering significant advantages over conventional approaches.

3.2. Discussion

In light of this, it is evident that the developed AI Agro Advisor with Organic Remedies system is capable of delivering effective results by combining the capabilities of the deep learning approach in advising farmers regarding sustainable farming. The use of CNN as a technique of detecting diseases in plants was accurate. This proves that deep learning models such as CNN are effective in extracting and analyzing complex visual information. It corroborates previous studies on the performance of neural network architectures on tasks related to disease identification from images of crops. Noteworthy is the fact that the results were reliable despite the differences in lighting, background noise, and other real-world situations in the images used for testing. However, it was found that when the input images have poor clarity and focus, the results were slightly misleading. The same occurred when diseases shared similar symptoms. Therefore, although the model is highly effective in extracting visual features of an image, it needs to be optimized through the use of a more extensive dataset with more varied images. The analysis shows that the suggested solution is capable of combining technology with sustainable farming techniques. In addition to helping detect plant diseases more precisely and efficiently, it also promotes eco-friendly methods of farming due to its organic solutions.

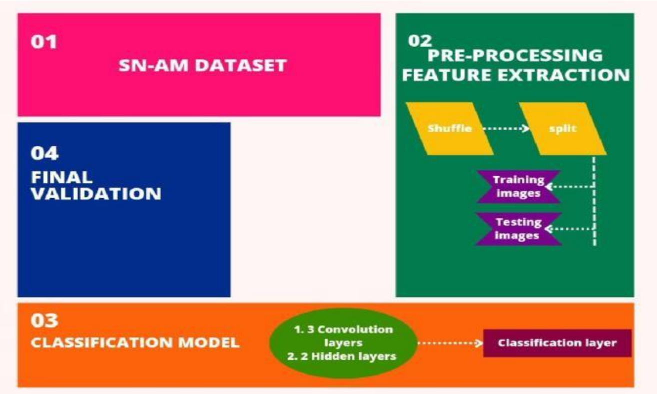

Figure 4 Process of the dataset

Conclusion

The research project was successful in dealing with the problems associated with agriculture, specifically over-reliance on fertilizers and pesticides, delayed or inaccurate detection of plant diseases, and lack of sustainable advisory for farmers. The issue discussed in the findings and discussion sections was successfully addressed through an AI Agro Advisor with Organic Remedies, which has accurately detected the presence of diseases, pests, and nutritional deficiencies in plants through image-based deep learning methods. Thus, the findings show that the AI Agro Advisory system is capable of making accurate predictions of these issues and suggests eco-friendly organic solutions to such problems by utilizing neem and bio-fertilizers. The goals set at the start of the study, which include early detection of diseases, individual advisory depending on soil type, crop variety, and weather conditions, and provision of advisory information via an easy-to-use application with support for different languages, were successfully met in this research. Despite some constraints, like the reliance on image quality, diversification in data sets, and access to the internet, the system works effectively and efficiently. To summarize, the system proves that the problem statement is valid and proposes an intelligent and sustainable way of dealing with modern agricultural challenges, laying the groundwork for further improvements and implementation of AI-enabled organic farming advisory systems.

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