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PRECISON AGRICULTURE DRONE EQUIPPED WITH IMAGE ANALYSIS

[1]Gouri D Malgi, [2]D Tejaswani, [3]Dweep Sharma, [4]Khushi Singh, [5]Jyothi

[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Electronics and communication engineering,
[1]AMC Engineering college, Bangalore, India

Abstract: This project is driven by the imperative need to address a critical challenge faced by farmers worldwide: Leaf disease. This project outlines the development of a comprehensive solution for precision agriculture aimed at enhancing crop health management through drone-based leaf disease detection and classification and pesticide spraying. Leveraging advanced imaging technology and machine learning algorithms, our system enables real-time identification of leaf diseases. By integrating with pesticide spraying systems, our solution offers precise treatment, minimizing environmental impact and optimizing resource utilization. Additionally, considerations such as cost-effectiveness, scalability, and user-friendliness are addressed to ensure practical feasibility and adoption by farmers and agricultural stakeholders. Through the integration of drone technology, machine learning, and precision agriculture techniques, this project showcases a promising solution for combating leaf diseases and optimizing pesticide application in crop management, ultimately contributing to increased crop yields, reduced environmental impact, and enhanced food security.

Keywords—Drone, Leaf disease detection, Pesticides spraying, Machine learning, Crop management, Food security.

I. INTRODUCTION

Manual work is used in traditional farming practices, which may be labour-intensive, and time-consuming. For example, walking through the farm to find the diseased crop and then spraying the pesticide takes lot of time and would raise labor costs and decrease productivity.

Numerous illnesses that can negatively impact productivity and quality provide serious obstacles to tomato growing need to be recognized and dealt with. Conventional disease detection techniques are frequently labor- and time-consuming. We investigate how well deep learning systems perform detection process. Plant diseases are a major danger to agricultural output, and managing them effectively requires early identification. In order to increase the efficacy of current deep learning models in identifying plant leaf diseases. Our method seeks to increase disease detection efficiency and accuracy in order to let farmers take prompt action to safeguard their crops. Plants with nutrient deficits are more susceptible to diseases, which lowers agricultural production. Many diseases may affect tomato plants, which can result in large financial losses for growers. Researchers have looked on automating the diagnosis of tomato leaf diseases using deep learning algorithms throughout the years. Our assessment seeks to shed light on the status of the field and suggest potential avenues for enhancing tomato plant disease detection.

The application of deep neural networks, machine learning, and image processing for tomato leaf disease detection has been used. Disease outbreaks provide serious obstacles to food security and agricultural production. We investigate how cutting-edge technology, such as machine learning and deep neural networks, may be used to automatically identify and categorize leaf diseases. Our study summarizes the body of research and addresses how these technologies may be used in precision agriculture.

The method for identifying leaf illnesses and suggesting pesticides with convolutional neural networks (CNNs) is presented in this study. For crop disease management to be effective, leaf disease diagnosis must be done promptly and accurately. In this paper, we provide an automated method for detecting leaf diseases from digital photos using CNN-based techniques. Furthermore, our approach helps farmers make educated decisions about crop protection by suggesting appropriate pesticides depending on the illnesses identified. Our solution leverages deep learning and agricultural knowledge to enhance the effectiveness and efficiency of agricultural pest management techniques.

Drones are used to spray pesticides, reducing labor costs, while machine learning algorithms detect leaf diseases with precision, enhancing crop health and productivity. The integration of these technologies promotes sustainability and efficiency in modern agriculture, paving the way for further advancements and improvements in farming practices.

II. LITERATURE SURVEY

A comparative study conducted on tomato plant disease detection using deep learning-based techniques, highlighted the efficacy of these methods in accurately identifying diseased plant [1]. Further enhanced deep learning algorithms for image recognition and plant leaf disease detection, presenting advancements in disease detection capabilities [2]. Explored the detection of healthy and diseased crops in drone-captured images using deep learning, demonstrating the potential of this approach for precision agriculture [3]. Similarly, proposed a methodology for leaf disease detection and fertilizer suggestion, emphasizing the integration of deep learning with agricultural practices [4]. David [5] provided a comprehensive literature review on disease detection in tomato leaves using deep learning techniques, offering insights into the state-of-the-art methodologies and challenges in the field. Bhosale. [6] presented a review on multi-plant and multi-crop leaf disease detection and classification, underscoring the importance of integrating deep neural networks, machine learning, and image processing for precision agriculture.

Gupta [7] explored the application of convolutional neural networks (CNNs) for the detection of crop diseases and weeds, demonstrating the effectiveness of CNNs in accurately identifying diseased plants. Kosamkar [8] proposed a CNN-based approach for leaf disease detection and recommendation of pesticides, highlighting the potential for automated pest management in agriculture. Furthermore, studies have addressed specific crop diseases, such as rice disease identification [9] and maize leaf disease detection [10], showcasing the versatility of deep learning techniques across different agricultural contexts. Recent advancements include computer-assisted plant disease diagnosis and severity estimation [11], emphasizing the importance of leveraging technology for precise disease assessment. Additionally, Saleem [12] proposed a deep learning-based approach for plant disease detection and classification, offering insights into the application of advanced machine learning techniques in agriculture.

Robotic detection system for combined detection of two major threats of greenhouse bell peppers: Powdery mildew (PM) and Tomato spotted wilt virus (TSWV).they have used the tech like Principal Component Analysis for PM ,Principal Component Analysis for TSWV, Coefficient of Variation of TSWV Symptom Pattern the result shows For TSWV, PCA based classification with leaf vein removal, achieved the highest classification accuracy (90%) while the accuracy of the CV methods was also high (85% and 87%). For PM, PCA-based pixel-level classification was high (95.2%) while leaf condition classification accuracy was low (64.3%) since it was determined based on the upper side of the leaf while disease symptoms start on its lower side [14]. In the paper [15] an FCM clustering and neural network classification-based approach is proposed to detect and quantify the severity for late blight disease of potato.[17] Image analysis and classification techniques for extraction and classification of leaf diseases.

III.HARDWARE AND SOFTWARE REQUIREMENTS

1.ESP32 Camera: ESP32-CAM is a low-cost development board with a WiFi camera and several features, including:
• Onboard Wi-Fi and Bluetooth
• OV2640 and OV7670 camera support
• Adjustable pixel
• MicroSD card slot
• Built-in PCB antenna
• General Purpose Input/Output (GPIO) pins
• White LED for camera flash, general illumination, strobe-light, or Morse code

2. L298N Motor Driver: The L298N motor driver is a dual H-bridge motor driver that can control the speed and direction of two DC motors at the same time. It can drive DC motors with voltages between 5 and 35V, with a peak current up to 2A. The L298N is ideal for robotic applications and can be connected to a microcontroller.

3. ESP32 Board: The ESP32 is a versatile and powerful microcontroller and system-on-chip (SoC).It features a dual-core processor, Wi-Fi and Bluetooth connectivity, a rich set of peripheral interfaces, and robust security features. With its low power consumption, extensive development ecosystem, and affordability, the ESP32 is widely used in IoT applications ranging from home automation and smart devices to industrial automation and wearable technology.

4.DenseNet 121: DenseNet121 consists of several dense blocks, each containing multiple convolutional layers. Fig 1 shows DenseNet 121.
Within each dense block, the output feature maps of all preceding layers are concatenated and fed as input to subsequent layers.
This dense connectivity pattern allows feature reuse and facilitates information flow throughout the network.
Transition layers, consisting of batch normalization, 1x1 convolution, and 2x2 average pooling operations, are inserted between dense blocks to down-sample feature maps and control the number of parameters.
The final layers include global average pooling and a fully connected layer followed by softmax activation for classification.

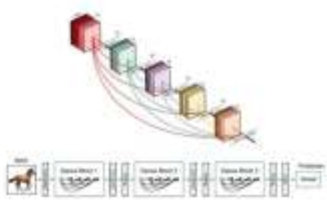


Fig 1: DenseNet 121

5. Arduino IDE: The Arduino Integrated Development Environment (IDE) is a software platform designed for programming and developing projects using Arduino microcontrollers. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. Key features include a text editor with syntax highlighting, a serial monitor for debugging, a library manager for easy access to pre-written code, and a board manager for installing support for different Arduino-compatible boards. The Arduino IDE simplifies the process of creating embedded electronics projects, making it accessible to beginners and experienced developers alike. In this system Arduino is used for the spraying function.

6. Android Studio: Android Studio is Google's official Integrated Development Environment (IDE) for creating Android applications. It offers a user-friendly interface, a powerful code editor, visual layout editor, built-in emulator for testing, debugging tools, performance profiler, version control integration, and a Gradle build system. This comprehensive toolset streamlines the development process, making it easier for developers to design, build, test, and deploy high-quality Android apps.

IV. PROPOSED METHODOLOGY

The flowchart in Fig2 represents the basic workflow of the proposed system that starts from capturing the images through ESP32 camera and that will preprocessed and passed through the trained model which will classify whether the image has healthy leaf or diseased leaf and the message will be sent to the operator. If the leaf is diseased the sprayer will spray the pesticide.

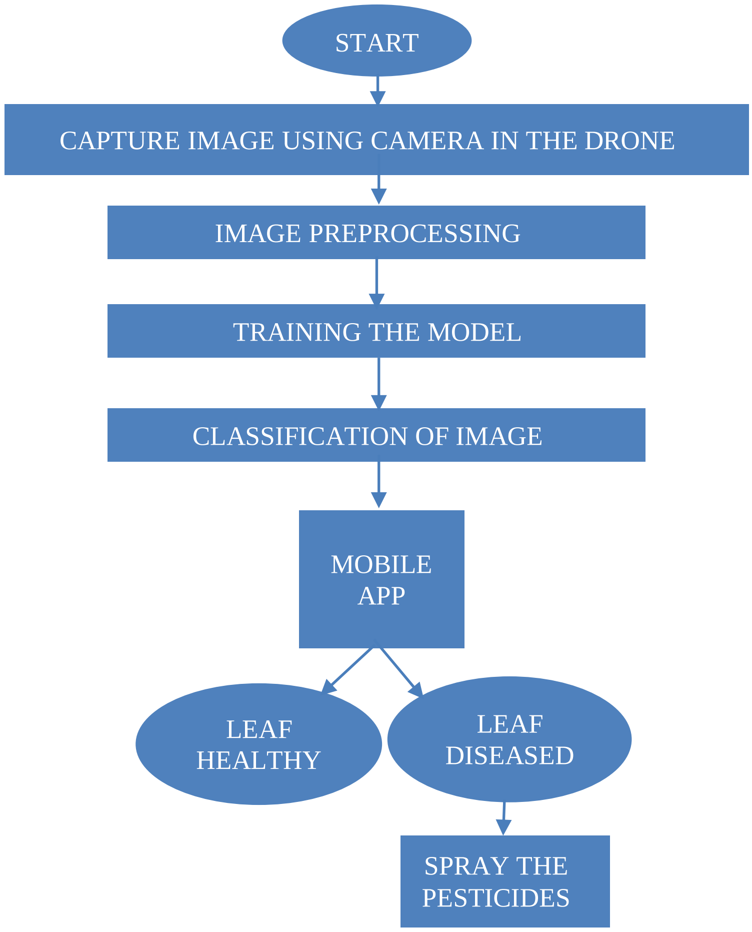


Fig 2. Workflow

A. *Image Capturing*

The ESP32 camera which is embedded in the drone will capture real time images. These images are then sent through java web services i.e. tomcat server to server side system on which pre-processing is done and later on the trained model test that particular image.

B. Image Preprocessing

Image captured must be preprocessed before sending the image to DenseNet 121 for training. The images are resized to a standard size of 100 × 100. The image captured is converted from RGB format to grayscale. The brightness is adjusted and image is zoomed.

C. Convolutional Neural Network

The CNN used in this project is DenseNet 121. After preprocessing is done, the DenseNet 121 used to build the model is trained using the dataset collected. Once the model is trained, few images are given to the model for validation. After validation the model is ready and we can start using it for classification.

D. Android Application

The android application is used to display to the operator the images of the plants as well as their health condition.

E. Pesticide Sprayer

Once the image captured is identified as a diseased leaf sprayer embedded in the drone will start spraying the pesticides.

V. RESULTS AND DISCUSSION

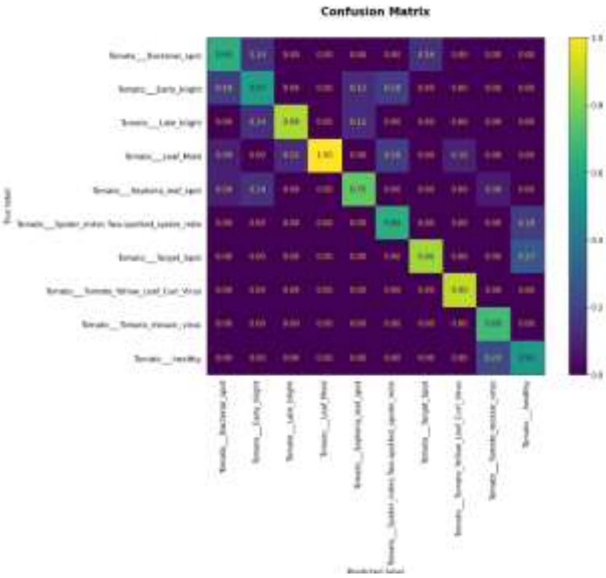


Fig 3: Confusion Matrix

A. Confusion Matrix

This matrix is used to describe the performance of a classification model on a set of test data for which the true values are known. The above Fig 3 consists of two dimensions. One with the true value and the other with the predicted value.

From the above Fig 3 we can conclude that:

- For Yellow Leaf Curl Virus our model showed 90% true positive and 10% misclassified as Leaf Mold.
- For Target Spot our model showed 86% true positive and 10% misclassified as Spider Mite.
- For Septoria Leaf Spot our model showed 83% true positive and 17% misclassified as Late Blight.

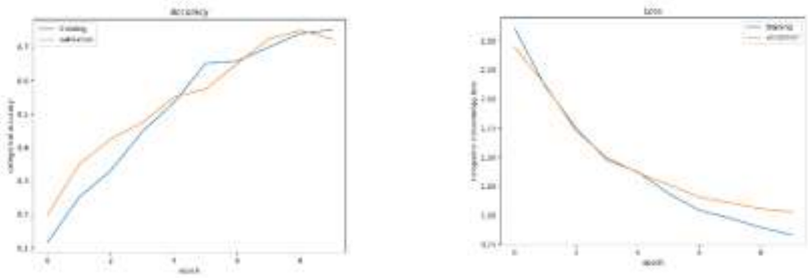


Fig 4: Accuracy vs Epoch and Loss vs Epoch

B. Graphs

Fig 4 shows two graphs that depicts the accuracy and loss vs epoch during prediction from our model.

The accuracy in the model increases with the increase in the epoch. The loss in the model decreases with the increase in the epoch. Also, the validation data has more accuracy and less loss than testing data.

C. Predicted Output

Table 1 below shows the input images and the corresponding predicted outputs.

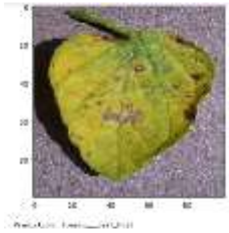
INPUT IMAGE	PREDICTED OUTPUT
	
	
	

Table 1: Input images and the predicted outputs

D. Android Application

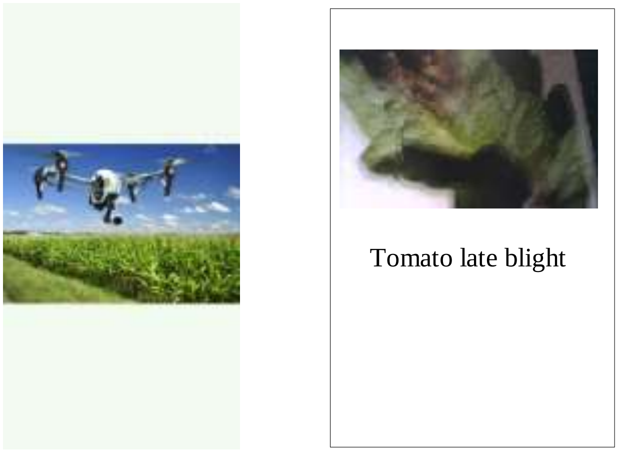


Fig 5

The above Fig 5 depicts the android application where the operator of drone will get to know about the leaf disease and what type of disease.

V.CONCLUSION

The combination of drones to spray pesticides accurately and machine learning algorithms to identify leaf disease signals a revolutionary era in agricultural innovation. Farmers can now quickly and correctly detect leaf diseases by utilizing machine learning, which enables focused creativeness and seriousness actions. This will reduce disease and improves crop health management, which in turn increases yields and helps to farmers. In addition, using drones to spray pesticides brings a level of efficiency and accuracy to agricultural techniques never seen before. Drones that are fitted with pesticide spraying mechanisms have the ability to precisely apply treatments, reach difficult-to-reach regions, and navigate fields with ease. And the careful planning is needed for the implementation of drone technology in order to handle regulations, operational logistics, and financial concerns. The combination of drone technology and machine learning offers hope for agricultural sustainability in the face of these barriers. This integrated strategy has the potential to transform farming practices and lead the way for a more food-secure future by promoting robustness in the face of changing agricultural problems by going on study, development, and unity. Overall, this precision agriculture technique will help farmers to grow healthy crop.

VI. FUTURE SCOPE

Precision agriculture Developments in technology have made it easy for farmers to find and treat crop issues early on, as machine learning algorithms are now able to accurately recognize a variety of leaf diseases. Using Drone technology for spraying pesticides has many advantages, such as targeted and exact application, less environmental impact, a reduction in labor costs, improve in yield. By maximizing the use of resources, boosting crop health, and ultimately supporting environmentally friendly farming practices, merging these technologies has the ability to completely change agriculture. The complete approach is a strong answer for modern farming since it promotes sustainability along with improving productivity. This all-encompassing strategy is an effective way to address modern agriculture since it supports environmental management and higher efficiency. Drones can be used to spray pesticides, reducing labor costs, while machine learning algorithms detect leaf diseases with precision, enhancing crop health and productivity. The integration of these technologies promotes sustainability and efficiency in modern agriculture, paving the way for further advancements and improvements in farming practices.

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