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Development of Unmanned Aerial Vehicle (UAV) for Agricultural Plant Analysis

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Abstract - Agriculture becomes extremely important as a main source of food production to feed the population in this planet. On the other hand, agriculture provides a lot of benefits to the country such as food and non-food product, transportation and balancing the environment. The demand for food security creates pressure to the decision maker to ensure our world has sufficient food for the entire world. Thus, the usage of the unmanned aerial vehicle (UAV) is an alternative to manage a farm properly to increase its yield. In order to promote the use of UAV in agriculture to support its sustainability, this project provides an understanding towards the usage of UAV and its applications in agriculture. The objective of this project is to review the usage of UAV in agriculture applications. Based on the literature, we found that a lot of agriculture applications can be done by using UAV. In the methodology, we used a comprehensive review from other researches in this world. As a result, from the revision, we found that different sensors give different analysis to the agriculture applications. Thus, the purpose of the project needs to be investigated before using the UAV technology for better data quality and analysis.

Key Words: Quadcopter, Plant Health, Convolutional Neural Network (CNN), RC UFO app.

1. INTRODUCTION

Current methods in the agricultural sector for monitoring Plants' health involve manually visiting each part of the field and analyze the area. However, with the use of Unmanned Aerial Vehicle (UAV) and vegetation index algorithms, Farmers can monitor the health of the plants overview of the field from the images captured by the UAV.

Remote sensing supported drones (UAV- Unmanned Aerial Vehicle) are a rapidly developing field of technology, which permits new possibilities for monitoring of the Environment. Due to technological advancements, multi sensors have been developed which can be carried even by small to medium-sized drones.

The UAV applications can comprise precision agriculture, vegetation monitoring and Forest monitoring. The Drone-based system enables us to observe the agricultural lands with high resolution, which further enables us to detect even small vegetation anomalies. Such anomalies in vegetation/ plants may be caused by, for example, drought-induced uneven germination and growth, seedling loss caused by flooding, disease outbreak and pest invasion. These systems, coupled with the Vegetation Index algorithms, provide a good estimate of plant health by using various parameters like soil moisture, amount of greenness etc.

The integration of Unmanned Aerial Vehicles (UAVs) in agriculture has revolutionized modern farming practices. UAVs, commonly known as drones, offer an efficient and cost-effective means of analyzing plant health, monitoring crop growth, and optimizing resource management. Traditional methods of agricultural analysis often involve time-consuming manual inspections or satellite imagery, which can be expensive and less precise. UAV technology, equipped with advanced sensors and imaging capabilities, bridges this gap by providing real-time, high-resolution data on plant conditions.

This project explores the development of UAVs specifically designed for agricultural plant analysis. It examines the technological advancements in drone hardware, including multispectral and hyperspectral imaging systems, thermal sensors, and machine learning-based data processing techniques. The benefits of UAV-based plant analysis, such as early disease detection, precise nutrient assessment, and improved yield predictions, are also discussed. Additionally, challenges related to battery life, regulatory restrictions, and data interpretation will be addressed. Since 21st century, influenced by kinds of factors such as climate warming, cropping system changes, frequent international trade, increasing pesticide resistance, etc., Asian crop pests and diseases show many new characteristics: the frequency of the outbreak of pests is increasing year by year; migratory pests appear continuously; epidemic crop pests and diseases happens rampantly; regional disaster pests often break out resistant pests burst seriously; quarantining pests invade violently.

Meantime, the new circumstances of modern agricultural construction are those making agriculture realize the goal of high yield, high quality, high efficiency, ecology and safety, realizing green consumption and sustainable development, and building resource-saving and environmental-friendly agriculture. Therefore, in order to adapt these new circumstances, agricultural UAV is developed quickly in Asia, providing powerful support for promoting agricultural production security, ssquality and safety of agricultural products, agricultural ecological security and agricultural trade security.

2.1 METHODOLOGY

The block diagram illustrates a sequential process involving a quadcopter, mobile control, image capture, processing, and the final outcome. Initially, the quadcopter serves as the primary device for aerial operations. It is controlled through a mobile control system, which allows for remote navigation and execution of commands. Once the quadcopter is in position, it captures an image, leading to the captured image stage. The collected image is then subjected to image processing, where various techniques such as filtering, enhancement, or analysis are applied to improve or extract relevant information. Finally, after processing, the system delivers the final outcome, which could be a processed image, analyzed data, or actionable insights based on the application.

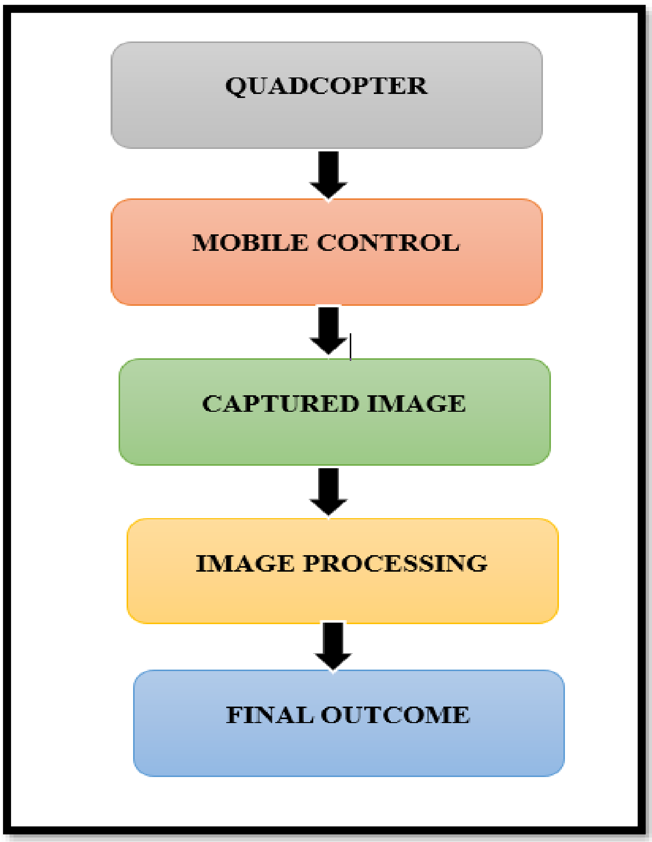

Fig-1: Unmanned Aerial Vehicle (UAV) for agricultural plant analysis

2.2 WORKING PRINCIPLE

The use of Unmanned Aerial Vehicles (UAVs), commonly known as drones, has gained significant traction in the field of precision agriculture. Their ability to cover large areas quickly and capture high-resolution data makes them ideal tools for monitoring plant health. The development and working of such a UAV system for plant health analysis involve several key components.

The system starts with a quadcopter, which is an unmanned aerial vehicle (UAV) with four rotors. It is equipped with a camera and necessary communication modules. Its main function is to hover and navigate to desired locations for data (image) collection. The quadcopter is controlled using a mobile device (such as a smartphone or tablet) through a dedicated app (WIFI_CAM) or software interface. The user can manoeuvre the quadcopter to the required location, adjust the camera angle, and command it to capture images or video footage. Communication may use Wi-FiOnce the quadcopter reaches the desired location, it captures images through its drone camera. These images are then stored either on the quadcopter or transmitted back to the mobile device in real time. The captured image is subjected to image processing techniques to extract meaningful information. This may involve: Noise reduction, object detection pattern recognition, edge detection, colour filtering, software or algorithms (CNN algorithms).The final step involves interpreting the processed data to generate a result or take action. This outcome could be: analyzed data report, object identification, area mapping surveillance output, agricultural or structural analysis. It gives the classified plant diseases, and for this diseases it recommended the fertilizer is added to the plant growth.

2.3 RESULTS

The outcome of this project is that classification of the healthy and unhealthy tomato plant. The system can use more powerful deep learning models trained on large, diverse agricultural datasets. This project helps to classify tomato plant species, detect multiple disease types simultaneously, identify weed infestations, and even distinguish between similar symptoms.

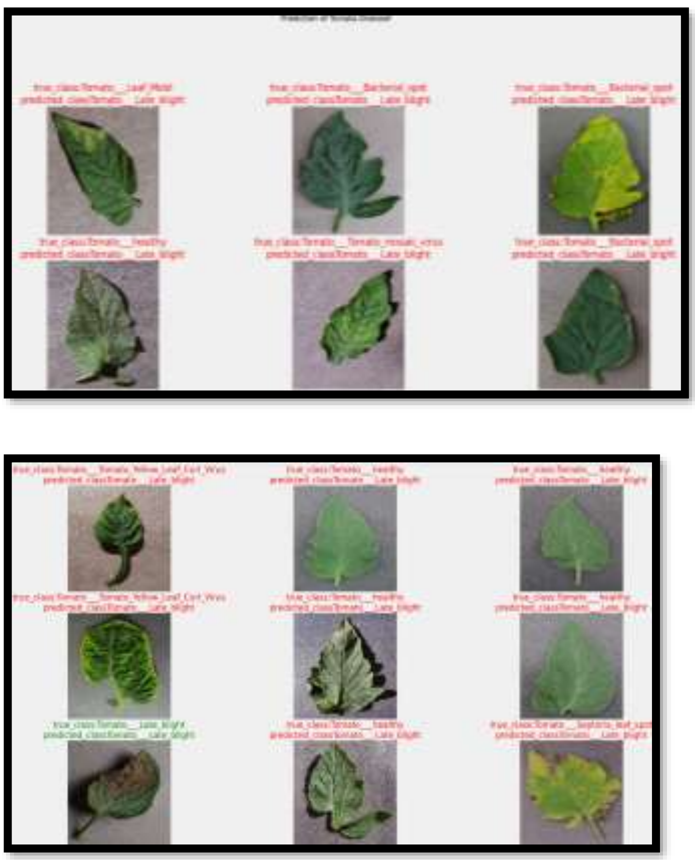

Fig-2: Prediction of Tomato plant Diseases

This Fig-2. represents the classification results of a machine learning model designed to detect tomato plant diseases by analyzing leaf images. It showcases fifteen tomato leaf samples, each labelled with both the actual disease and the model's prediction. The true labels include a variety of conditions: Leaf Mold, Bacterial Spot, Healthy, and Tomato Mosaic Virus. However, in all fifteen cases, the model incorrectly predicted the disease as "Tomato Late blight," regardless of the actual condition. The leaves that are actually affected by "Tomato Yellow Leaf Curl Virus", "Tomato Septoria leaf spot", or are "healthy" are incorrectly predicted as having "Late blight". This consistent misclassification highlights a serious issue with the model, suggesting it may be over fitting to the "Late blight" class potentially due to an imbalanced training dataset or insufficient feature discrimination between different disease types. The image effectively illustrates the need for improving the model's learning strategy, data diversity, and overall evaluation to achieve more accurate and robust disease predictions.

3. CONCLUSIONS

The integration of Unmanned Aerial Vehicles (UAVs) into agricultural practices marks a transformative shift toward smart and precision farming. This project successfully demonstrates how UAV technology can be harnessed for efficient and accurate plant analysis across large agricultural landscapes. By equipping the UAV with high-resolution imaging systems and intelligent data processing algorithms, farmers are empowered to monitor crop health, detect plant diseases at an early stage, assess growth patterns, and evaluate the effectiveness of irrigation and fertilization techniques.

Compared to traditional manual inspection methods, this UAV system offers faster data collection, greater coverage, and higher accuracy, significantly reducing labor costs and time. The ability to access real-time or near-real-time data enables farmers to make proactive and informed decisions, improving overall crop yield and quality while minimizing resource wastage. Additionally, by using targeted interventions based on data insights, the system promotes eco-friendly farming practices, reducing the excessive use of pesticides, herbicides, and fertilizers.

This project lays the foundation for scalable and cost-effective solutions in agricultural technology. With the development such as integrating machine learning for predictive analysis, automating flight missions, and improving image classification models the UAV can evolve into a fully autonomous and intelligent farming assistant. As the agricultural industry faces increasing demands and environmental challenges, innovations like this UAV system will play a critical role in building a sustainable, productive, and technologically advanced future for global agriculture.

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