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Plant Disease Detection Using Convolutional Neural Networks

Swathi S.[1], Kavin Shree V[2], Viveka S P[3], Harsavardhini D[4]
Department of CSE, Sri Sai Ram Institute of Technology

Abstract: Agriculture must complete a huge effort that involves finding plant diseases. This is something that the economy is extremely dependent on. Due to the prevalence of plant illnesses, finding infections inplants is a crucial task in the agriculture industry. It takes constant examination of the plants to spot infections in the leaves. To put it simply, monitoring the plants requires some form of planned method. The detection of damaged leaves is facilitated by program-based disease identification, which also saves time and human effort. Compared to current methods, the suggested algorithm distinguishes between plant diseases and accurately classifies them. Constant plant monitoring is labor-intensive and expensive to do by humans and it is time- consuming too.
Keywords: CNN, Neural network, drone technology, plant disease detection, machine learning.

I. INTRODUCTION

About 70% of the population in India is dependent on agriculture. For the purpose of preventing crop losses, it is crucial to identify plant diseases. Manually observing the plant diseases is really difficult. It requires a significant amount of effort, knowledge of plant diseases, and a significant amount of time. In order to identify plant diseases, image processing and machine learning models can be used. In this study, wehave described a method for identifying plant illnesses using images of the leaves. visual processing is a subset of signal processing that can extract useful information or visual features.

A component of artificial intelligence called machine learning performs tasks automatically or provides instructions on how to carry them out. Understanding the training data and incorporating it into models that should be helpful to people is the basic goal of machine learning. Consequently, it can help in makingwise selections and forecasting the right output using the vast training data. Leaf color, leaf damageseverity, leaf area, and leaf texture are utilized as classification criteria. In order to diagnose various plant leaf diseases with the greatest accuracy, we have examined many picture metrics or features. In the past, professionals used chemical techniques or visual inspection of the leaves to identify plant diseases. Thisrequires a sizable team of experts and ongoing plant monitoring, both of which are expensive when done with large farms. The suggested technique works well in these circumstances for keeping an eye on vastfields of crops.

It is easier and less expensive to automatically identifyillnesses by simply seeing the signs on plant leaves. Since the suggested approach combines statistical machine learning and image processing algorithms, it is computationally less expensive and takes less timeto predict than other deep learning based systems.

II. AIM OF THE PROJECT

In order to save time and money by preventing or reducing crop damages, it is crucial to use accurate detection and reliable diagnostic procedures to identify the etiological agents of disease. Plant diseases are to blame for significant yield losses and are a threat to the world's food production. In the past, diagnosing diseases relied on age-old techniques that were frequently irrational, wholly dependent on the observer, and generally slow and prone to error. Additionally, human scouting is costly and frequently impractical due to human mistake and/or the development of symptoms that are ambiguous when they are not mild, making early identification unattainable. Consequently, atechnologically advanced agricultural revolution is critical to finding long-term solutions to the issues outlined before at affordable costs with minimal negative effects on the environment.

Agriculture has evolved as a result of the ongoing adoption of recent advanced technologies including the Internet of Things, clever algorithms, sophisticated sensors, and contemporary machinery. Currently, it is being done by intelligent agricultural robots and machines instead of human employees. The development of intelligent agricultural robots and machinery has allowed for the early detection of plant illnesses while also keeping track of their long- distance migration. To find agricultural illnesses, numerous researchers have used high-resolution photos obtained from satellites, aircraft, on-the- ground equipment, and drones.

Large areas can be traversed quickly by satellites and aircraft. However, compared to drones, satellitesand aircraft have lower spatial and temporal imagingresolutions and are far more vulnerable to weather conditions that can impair overflight. Thus, aerial remote sensing (RS) employing drones (also known as unmanned aerial vehicles, or UAVs, or unmannedaerial systems, or UAS) equipped with sophisticated visual systems may be an effective and affordable solution for farmers to find crop and plant illnesses in a variety of agricultural.

Drones can detect plant illnesses at an earlier stage than satellite systems because they are equipped with digital, multispectral, hyper spectral, thermal, and fluorescent sensors. These sensors enable finer resolution of plant diseases. Drones maysimultaneously sample the atmosphere at different altitudes with their autonomous systems, collecting data that can subsequently be quickly expanded to produce forecasting models for entire continents, regions, and even fields.

Finally, farmers can receive information that will enable them to make the best choices possible for the prompt management of disease in rural fields.

Therefore, due to its low cost and adaptability during high-altitude flight, drone remote sensing technology may significantly help precision agriculture (Smart Agriculture). Numerous researches have been done on the use of drone platforms equipped with various sensors for the detection of plant diseases.

For instance, drones with hyper spectral image sensorswere able to capture a picture of winter wheat yellow rust and successfully detect it. Similar to this, myrtle rust on myrtles was investigated using multispectral imaging and a drone system, and infected maize plants were discovered utilizing drones using visible light photos from digital cameras in the greenhouse to the largest farm. Analyzing the photos captured by drones requires efficient algorithms.

Traditional machine learning techniques have drawbacks since they rely on labor-intensive manual feature extraction techniques, which perform poorly incomplicated situations. Recent developments in deep learning algorithms make them a possible new option for improving computer vision-based systems for autonomous crop disease surveillance. They can carry out autonomous feature extraction without any help from humans, giving farmers information that could increase crop yields and cut treatment costs.

The early and precise diagnosis of a wide range of plant diseases using computer vision techniques, deep learning algorithms, and drone-based platforms is a hot topic of research right now. Drones are extremely effective, inexpensive, adaptable, precise, and rapid at the field size, but their short flight times make them unsuitable for data collection over wide areas, andtheir capacity to carry bulky sensors is constrained. Toachieve the optimum performance, it is essential to select the right drone as well as the right sensors, software, algorithms, and settings for the drones.

The following sections have been added to this review in light of how crucial drones are for diagnosing plant diseases: Old and new generations of plant disease detection techniques are covered in the following sections:

1) Types of drones;
2) Types of sensors and cameras mounted ondrones;
3) Types of drones;
4) Novel plant disease detection techniqueswith a focus on drones; and
5) Applications for drones that use bothconventional and deep learning algorithms to detect plant diseases.

III. EXISTING SYSTEM

Experts can identify and detect plant problems with nothing more than their own naked eyes nowadays, according to the current approach for disease detection in plants. This requires a sizable team of experts and ongoing plant monitoring, both of which are quite expensive when dealing with huge farms. Meanwhile, in some nations, farmers lack access to sufficient resources and even know they can consult specialists. Because of this, consulting specialists is expensive and time-consuming.

The suggested method works well in these circumstances for keeping an eye on vast fields of crops. It is simpler and less expensive toautomatically identify diseases based just on their symptoms on plant leaves. The accuracy of those models is low, and the work using thoseclassification techniques is done with the mindset of detecting disease for only one species of plants, despite the fact that numerous systems have been developed to date using various machine learningalgorithms like Random Forest, Naive Bayes, and Artificial Neural Network. Few farmers in Karnatakahave used these works. Farmers still use their naked eyes to look for disease, which is a big problem because they don't know what kind of disease the plant has. Farmers are still dealing with problems, and the methods they use to find the disease take a long time.

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IV. PROPOSED SYSTEM

The proposed system involves the real-time detection of leaf diseases in crops using a deep learning model based on convolutional neural networks (CNN). The model will be built using TensorFlow and YOLO algorithms, and will be integrated with a drone to capture images of crops and detect any signs of disease. The captured images will be sent to a server where they will be processed and analyzed by the model. In addition to the drone, the system will also include a website for user interaction and tracking of the drone. Each user will be assigned a unique ID that will be used to login to the website. The website will provide real-time tracking of the drone, including its geographical location and the images captured by it. The server will store the location and time of the captured images, along with information about the disease detected and the possible pesticides that can be used.

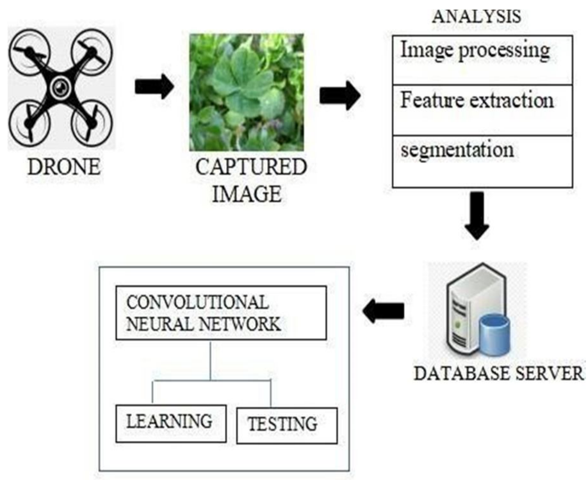
The system will also have a feature to spray pesticidesin the plants that are diseased from the location stored in the database.

This will help to minimize the spread of diseases and improve the overall health of the crops. Overall, the proposed system aims to provide an efficient and effective solution for the early detection and treatment of leaf diseases in crops, thus improving crop yield and reducing the use of pesticides.

A. Disease Detection

In our project, machine learning is used to detect plant diseases from the images or multispectral data captured by the drone. A diverse and representative dataset of plant images showing healthy plants and various diseased conditions is collected. This dataset serves as the basis for training the machine learning model.

The collected images are pre-processed to improve their quality and ensure consistency. This includes resizing, cropping, normalization or other techniques to standardize the data for effective training. Machine learning algorithms, such as Convolutional Neural Networks (CNN), are used to train the disease detectionmodel. The model is trained on the pre-processed dataset, learning to recognize patterns and features associated with different plant diseases.



Architecture diagram
Fig 1: Architecture Diagram

The trained model is able to extract meaningful features from the input images so that it can distinguish between healthy and diseased plants. In this process, the image is analyzed at different levels of abstraction to identify specific features associated with diseased plants. Once the features are extracted,the model classifies the input images into different disease categories or provides a probability score foreach disease class. This classification helps identify the specific disease affecting the plants (Fig 1).

The trained model is evaluated against separate validation or test datasets to measure its performance, such as accuracy, precision, recognition. If necessary, the model is optimized by adjusting hyper parameters, increasing the size of the data set or applying techniques such as data augmentation toimprove its performance. The trained model can analyse the images or multispectral data captured by the drone in real time. It processes the input data and provides immediate feedback on the presence or absence of diseases in the crops. This allows farmers to quickly detect and control plant diseases, leading totimely intervention and better crop health.

B. Drone Technology

A drone that has the capability to capture high- quality images or multispectral data, high flight time and a good battery life is selected for our project. The drone flights over the agricultural field to capture the required data. Use of specialized software or applications like DJI Go, Pix4Dcapture, or Drone Deploy to define the flight path, altitude, and image overlap for optimal data collection. The drone will capture multispectral data of the crops and affected areas, providing a detailed visual representation of the field. Once the data is collected, processing the images using software like Pix4D or Drone Deploy. These tools offer features for stitching imagestogether, generating ortho mosaic maps, creating digital elevation models (DEM), and generating 3D maps or point clouds.

QGIS (Quantum GIS) is a free and open- source GIS software that has been be used to analyse and visualize the collected drone data. By importing the generated maps into QGIS further analysis and interpretation can be done. The Analysis of multispectral data, such as near-infrared (NIR) imagery, will be performed by NDVI analysis. NDVI (Normalized Difference Vegetation Index) helps to assess the health and vigor of crops by analyzing the reflectance of different wavelengths.

Before conducting any advanced analysis, primary processing of the images is performed. This includes tasks like image enhancement, color correction, and noise reduction. Software like Adobe Photoshop, GIMP, or specialized remote sensing tools are used for this purpose.

C. Website

The QGIS captured images is further imported toour website and the images can be viewed by the farmers. The website has variety of facilities like, the farmers can view their diseased plant images and the type of disease that crop has been affected. It also prescribes pesticides in order to eradicate the diseases and make it healthy. This website also showsthe percentage of healthy plants in the farm land. Our website is built using HTML, CSS and java script (JS). Every authorized user can sign up or if they already have an account they can log into the website. The users can keep track of their past activities. Our website will be user friendly and is available in Indian regional languages.

V. FUTURE ENHANCEMENT ANDCONCLUSION

Integration of additional sensors: In addition to the camera, other sensors such as infrared sensors, moisturesensors, or temperature sensors could be added to provide more comprehensive data about the crop health.

Integration with precision farming technologies: System could be integrated with precision farming technologies, such as GPS-guided tractors or drones, to further optimize crop management practices, can also use the drone or tractors as automatic pesticide sprayers in future.

Development of a mobile application: A mobile application could be developed to allow farmers to access the information and insights provided by the system from anywhere, at any time.

A comprehensive solution for real-time leaf disease detection in crops using drone technology and machine learning. By integrating deep learning algorithms, such as Convolutional Neural Networks (CNN), with the capabilities of drones, we have developed an efficient andaccurate system for early detection and prevention of plantdiseases.

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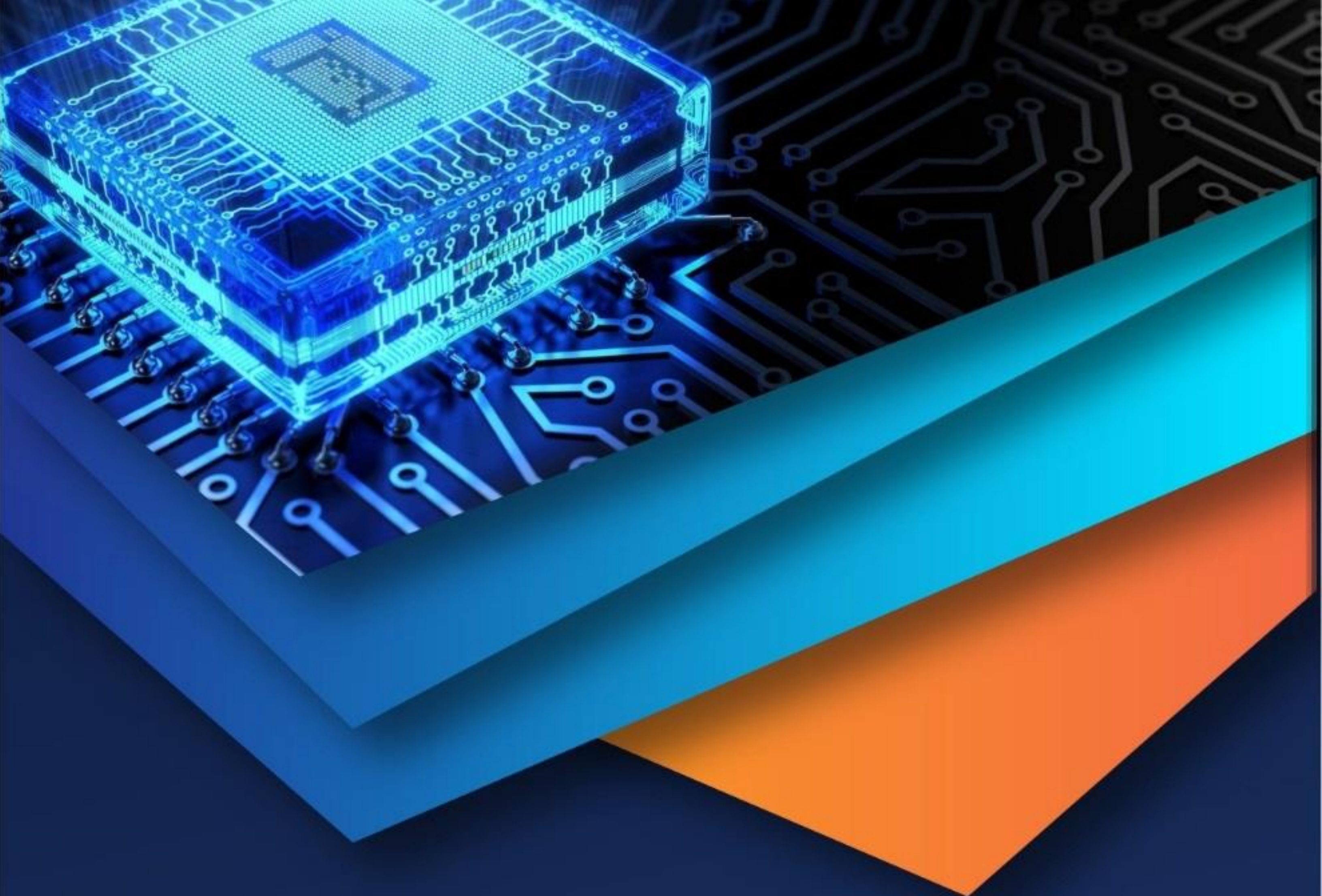

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