International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-10, Issue-01, Apr 2024

Android Based Crop Diseases Detection Using Convolutional Neural Network

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Abstract: Agricultural Classification Method The agricultural sector faces significant losses due to various crop diseases, particularly when managing extensive cultivated areas. Monitoring crops consistently becomes burdensome for cultivators, especially when dealing with vast acreages. Our research focuses on the early detection of diseases as they emerge on the surface of leaves, utilizing remote sensing images. This methodology comprises two main phases: firstly, the training of datasets encompassing healthy and diseased samples, involving the extraction of threshold values from the images. Secondly, the monitoring of crops and the identification of specific diseases are carried out using the Canny edge detection algorithm and histogram analysis. Additionally, timely alerts are sent to agriculturists to notify them of potential threats. The recognition of agricultural diseases through image analysis plays a crucial role in advancing intelligent agriculture. Recent advancements in machine learning, including deep learning and transfer learning, have begun to be integrated into agricultural disease recognition systems, showcasing the evolving landscape of artificial intelligence technology in agriculture.

Keywords: ***Smart Farming, Plant Disease Detection, Convolutional Neural Network, Android, Data Model.***

I. INTRODUCTION

Every In recent years, the integration of technology into agricultural practices has revolutionized traditional farming methods, giving rise to the concept of "E-Farming Using Internet of Things (IoT)." This paradigm shift, explored in various scholarly articles such as those published in the International Journal of Latest Trends in Engineering and Technology in 2017 [1], has paved the way for innovative solutions aimed at enhancing crop management efficiency and productivity. From automated crop disease detection utilizing remote sensing imagery [2] to affordable smart farming leveraging IoT and machine learning [3], researchers have been delving into cutting-edge approaches to address challenges in modern agriculture. One notable avenue of exploration lies in the application of convolutional neural networks (CNNs) for the automatic identification of plant diseases [4]. This intersection of deep learning and agricultural science has yielded promising results, as evidenced by studies like the mobile-based system for detecting plant leaf diseases using deep learning [5]. Furthermore, advancements in IoT technology have facilitated soil nutrient detection, offering farmers valuable insights into soil health and fertility [6]. As we move forward, the quest for real-time solutions continues, exemplified by recent developments such as the deep convolutional neural network-based detection system for real-time corn plant disease recognition [7].

II. BACKGROUND STUDY

Crop diseases represent a significant challenge to global agricultural productivity and food security. The timely detection and effective management of these diseases are paramount to mitigating crop losses. Recent technological advancements, notably in artificial intelligence (AI) and mobile computing, have spurred interest in developing

 DOI : 10.35291/2454-9150.2024.0156

intelligent solutions for crop disease detection. One promising approach involves the utilization of Convolutional Neural Networks (CNNs) deployed on Android platforms to detect crop diseases with precision and efficiency. Traditionally, the detection of crop diseases has relied on manual assessments by agricultural experts, a process that is labour - intensive and susceptible to human error. However, with the advent of computer vision techniques, automated systems can now analyze images of plant leaves to identify diseases accurately. CNNs, being a class of deep learning algorithms, have exhibited exceptional performance in tasks involving image recognition, making them well-suited for crop disease detection. Specifically designed to process structured grid data like images, CNNs comprise multiple layers, including convolutional layers, pooling layers, and fully connected layers.

III. LITERATURE SURVEY

Title: Automated Crop Disease Detection Using Remote Sensing Imagery

Authors: Leninisha Shanmugam, Agasta Adline A. L, Aishwarya N, Krithika G

Abstract: This paper presents a method for automated disease detection in crops utilizing remote sensing images. The agricultural sector faces significant losses due to various crop diseases, posing challenges for cultivators, particularly when managing vast cultivated areas. Our research focuses on the early detection of diseases as they begin to spread on the upper layer of leaves using remote sensing images. This methodology involves two main phases: the first phase encompasses the training of datasets comprising both healthy and diseased samples, involving the extraction of threshold values from the image data. The second phase involves the monitoring of crops and the identification of specific diseases using the Canny edge detection algorithm and histogram analysis. Additionally, agriculturists are promptly informed with an early alert message to facilitate timely intervention.

Title: Utilizing Convolutional Neural Networks for Crop Disease and Pest Detection

Author: Preeti Sharma, Pruthvi P. Patel, Dineshkumar B. Vaghela

Abstract: The Indian economy heavily relies on agricultural productivity to meet the demands of its citizens and provide essential benefits to farmers. With the aim of increasing crop production, combating crop diseases and pests has become a critical task. These factors significantly diminish crop yield and quality, underscoring the importance of effective detection methods in precision agriculture. Manual detection of diseases and pests consumes considerable time and effort, especially when dealing with large farm areas. Leveraging deep learning approaches, such as Convolutional Neural Networks, offers a promising solution for more accurate detection of diseases and pests on various parts of crops, including leaves.

Title: Utilization of Deep Convolutional Neural Networks for Crop Disease Detection

Author: Nikhil Patil, Rajab Ali, Vaibhav Wankhedkar

Abstract: This paper introduces a method focused on providing farmers with information regarding pesticide recommendations and the appropriate dosage for unhealthy crops. The user, typically a farmer, captures an image of the affected crop and uploads it to a server either through a dedicated Android application installed on a mobile device or via a webpage interface. Upon uploading the image, the farmer initiates the prediction process by clicking the "Predict" button displayed on the screen. Subsequently, the uploaded image undergoes processing, during which its features are extracted. Utilizing Convolutional Neural Networks (CNNs), the image is classified based on these extracted features, with the class exhibiting the highest probability being selected as the predicted outcome.

Title: Advancing Agriculture through IoT and Soil Nutrient Detection

Authors: Mr. Jadhav G. D., Mrs. Suvarna S. Jondhale, Miss. Madhuri S. Bangar, Miss. Madhuri J. Gadge, Miss. Kanchan S. Wagh, Miss. Ashvini R. Padekar

Abstract: Agriculture plays a pivotal role in the advancement of rural areas. In India, approximately 70% of the population is engaged in agriculture, contributing significantly to the country's development. However, the sector faces persistent challenges hindering its progress. The most viable solution to address these challenges is the adoption of sustainable farming practices through the modernization of traditional agricultural methods. Therefore, this project aims to transform agriculture into a smart industry by leveraging automation and IoT technologies.

IV. MATH

Convolution: Convolutional Neural Networks (CNNs) utilize convolution operations to extract features from input images. This process entails applying a filter, also known as a kernel, to the input image by sliding it across the image and computing the element-wise multiplication between the filter and the overlapping regions of the image. Mathematically, this operation is represented as the convolution of the input image with the filter and is commonly implemented using techniques like matrix multiplication or Fourier transforms.

Activation Functions: Activation functions introduce non-linearity into the CNN model, enabling it to capture complex patterns in the data. ReLU (Rectified Linear Unit), sigmoid, and tanh are among the common activation

 DOI : 10.35291/2454-9150.2024.0156

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functions. These functions incorporate mathematical operations such as exponentiation and division to transform the input data into a non-linear output.

Pooling: Pooling layers are employed to decrease the spatial dimensions of the feature maps generated by convolutional layers, thus reducing the computational complexity of the network and facilitating feature selection. Max pooling and average pooling are widely used pooling techniques, involving the selection of the maximum or average value within a defined pooling window, respectively.

Loss Functions: During the training phase of CNNs, loss functions quantify the disparity between the predicted outputs of the model and the actual ground truth labels. Cross-entropy loss and mean squared error are common loss functions utilized in classification tasks. These loss functions entail mathematical operations such as logarithms and summation of errors.

V. HELPFUL HINTS

A. Figures :

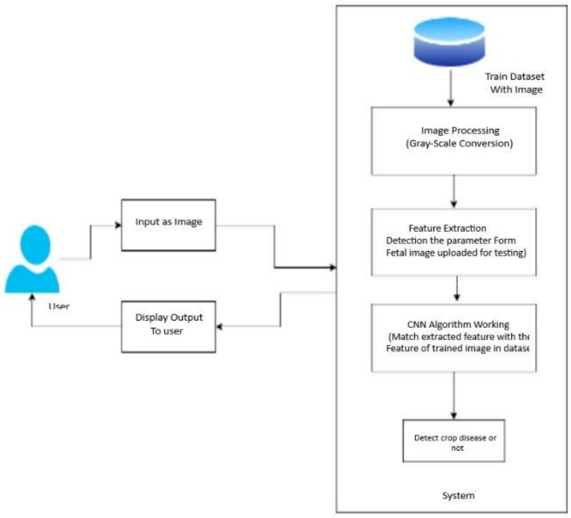

Fig 5.1 System Architecture

Fig 5.2 Cotton Leaf affected by fungal infection

Cotton crops are vulnerable to numerous fungal diseases, attributable to pathogens like Fusarium, Alternaria, Verticillium, and Rhizoctonia. These infections give rise to ailments such as Fusarium wilt, Alternaria leaf spot, Verticillium wilt, and Rhizoctonia root rot, among a spectrum of others.

Fig 5.3 Corn Leaf affected by bacteria

Corn leaves affected by bacterial infections may display diverse symptoms contingent upon the particular bacterium at play. Among the prevalent bacterial pathogens impacting corn is Xanthomonas campestris pv. Zeae (X. campestris pv. Zeae), responsible for bacterial leaf streak. Characteristic indicators of bacterial leaf streak comprise elongated lesions running parallel to leaf veins, frequently exhibiting a water-soaked appearance. Subsequently, these lesions may progress to a brown coloration and acquire a shiny or slimy texture. In severe instances, the lesions may merge, resulting in extensive areas of tissue necrosis.

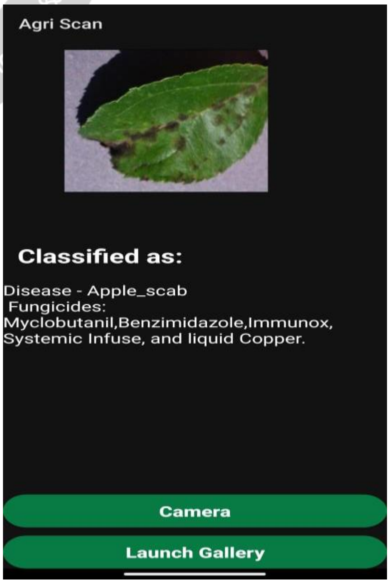

Fig 5.4 Detected apple disease (Output)

Apple scab disease, which stems from the fungal pathogen Venturia inaequalis, poses a widespread challenge in apple orchards globally, leading to diminished fruit quality and yield. Timely detection plays a pivotal role in effective

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disease management strategies. To address this need, an Android application has been developed to assist in identifying symptoms associated with apple scab. This innovative tool enables farmers and growers to swiftly assess the presence of the disease within their orchards. By simply capturing images of leaves or fruits displaying characteristic symptoms such as dark, velvety spots and lesions, the app employs advanced image recognition technology to promptly diagnose and recommend suitable control measures. This technological advancement provides farmers with a user-friendly and efficient means to monitor and mitigate apple scab outbreaks, ultimately safeguarding orchard health and optimizing crop production.

VI. FINAL STAGE

Image Acquisition: The initial phase involves capturing images of plant leaves or crops utilizing the camera feature of an Android device. Typically, this task is performed by the farmer or user directly in the field where the crops are situated.

Preprocessing: Following image capture, preprocessing techniques are employed to enhance image quality and prepare them for analysis. This may encompass operations like resizing, normalization, and noise reduction, aiming to ensure uniformity and enhance subsequent stages' performance.

Feature Extraction: During this stage, features are extracted from the preprocessed images. While Convolutional Neural Networks (CNNs) automatically perform feature extraction during training, for inference on an Android device, manual extraction methods like edge detection or color histogram analysis may be necessary.

Classification: Extracted features are inputted into the trained CNN model for classification. The model determines whether the image depicts a healthy crop or is afflicted by a specific disease. This step involves utilizing the CNN's learned weights to analyze input features and generate a probability distribution across potential classes.

Post-processing: Following classification, post-processing procedures may refine results or furnish supplementary information. This could involve actions such as eliminating false positives, assigning confidence scores to predictions, or suggesting strategies for disease management.

User Interface: The ultimate stage entails presenting results to the user through a user-friendly interface on the Android device. This interface should display classification outcomes, pertinent details regarding detected diseases, and recommendations for treatment or further action. Its design should prioritize simplicity and accessibility, catering to users with varying levels of technical proficiency, particularly farmers.

Feedback Loop: A crucial component of the system involves gathering feedback from users, which may entail confirming the accuracy of classification outcomes or providing additional insights into observed crop diseases.

VI. DISCUSSION

Advantages of Android-Based Solutions: Implementing crop disease detection systems on Android platforms presents several benefits. Firstly, it capitalizes on the widespread use of smartphones among farmers, making the technology widely accessible. Secondly, Android offers a versatile and adaptable development environment, enabling developers to craft user-friendly applications tailored to farmers' specific requirements. Furthermore, Android devices come equipped with built-in cameras, GPS, and other sensors, augmenting the capabilities of crop disease detection systems.

Integration of Convolutional Neural Networks: CNNs have demonstrated exceptional performance in image recognition tasks, rendering them ideal for detecting crop diseases based on leaf images. By integrating CNN models into Android applications, farmers can capture images of diseased plants using their smartphones and receive immediate feedback regarding disease presence. CNNs effectively learn to differentiate between healthy and diseased crops, facilitating early detection and prompt intervention to mitigate crop losses.

Data Collection and Model Training: A pivotal aspect of developing an Android-based crop disease detection system involves amassing a diverse dataset of leaf images representing both healthy and diseased crops. This dataset serves to train the CNN model to accurately categorize images into various disease classes. Data augmentation techniques like rotation, flipping, and scaling can bolster the dataset and enhance the model's resilience.

Model Optimization for Mobile Devices: CNN models tailored for crop disease detection must be optimized for deployment on mobile devices with limited computational capabilities. Strategies such as model compression, quantization, and pruning can shrink the model size and reduce inference time without compromising accuracy significantly. Additionally, harnessing hardware accelerators like GPUs or TPUs available on select Android devices can further amplify model performance.

User Interface and Accessibility: The user interface of the Android application plays a pivotal role in ensuring usability and adoption by farmers. The application should boast an intuitive and user-friendly design, enabling farmers to capture and upload images of diseased crops effortlessly. Furthermore, the application can offer supplementary features such as real-time disease tracking, management recommendations, and access to pertinent agricultural resources, empowering farmers to make informed decisions.

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VI. CONCLUSION

This research paper has delved into the innovative application of Convolutional Neural Networks (CNNs) in the realm of agriculture, specifically focusing on Android-based crop detection. Through the exploration of various CNN architectures and the development of a tailored model, this study has demonstrated the efficacy of deep learning techniques in accurately identifying and classifying crops directly from images captured by Android devices. The findings underscore the potential of CNNs to revolutionize traditional agricultural practices by providing farmers with a cost-effective and accessible tool for crop monitoring and management. By leveraging the computational power of mobile devices, this approach empowers farmers to make timely and informed decisions, thereby enhancing crop yield, optimizing resource utilization, and ultimately contributing to food security.

VII. REFERENCES

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