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INSECT, DISEASE DETECTION AND CLASSIFICATION IN FIELD CROP USING MACHINE LEARNING

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ABSTRACT

This paper presents an approach for insect and disease detection, as well as classification in field crops using machine learning techniques. Early detection of pests and diseases is critical for enhancing crop yield and quality, as these factors can cause significant damage to agricultural production. Traditional methods of pest and disease identification rely on visual inspection, which is time-consuming and requires expert knowledge. To address these challenges, machine learning models such as support vector machines (SVM), k-nearest neighbors (KNN), random forests (RF), and convolutional neural networks (CNN) are employed to detect and classify pests and diseases in field crops. The proposed system integrates image processing techniques for feature extraction, followed by classification models that accurately identify different pest species and crop diseases. Experimental results demonstrate high classification accuracy and low computational time, offering a reliable solution for early intervention in agriculture. By automating the detection process, this method significantly reduces manual labor and enhances the ability to respond quickly to crop threats, contributing to improved crop health and sustainable agricultural practices.

Keywords: Insect Detection, Disease Detection, Field Crops, Machine Learning, Crop Classification, Convolutional Neural Networks (CNN), Support Vector Machines (SVM), Image Processing, Feature Extraction, Agricultural Technology, Pest Detection, Smart Farming, Early Disease Detection, Precision Agriculture.

I. INTRODUCTION

Agriculture is a key part of the economy, influencing both growth and living standards. However, pests and diseases are major challenges that harm crops and reduce their quality. Traditional methods of identifying pests are time consuming and need experts. Recently, machine learning has been used to make pest and disease detection faster and more accurate. This paper focuses on detecting and classifying insects in crops like sugarcane, pomegranate, guava using machine learning techniques like SVM, KNN, NB, and CNN. The insect detection system uses image processing to find and classify insects quickly, helping farmers identify problems early and improve crop quality and yield.

II. LITERATURE SURVEY

Title:

Agriculture Pest Detection System Based on Machine Learning.

Author:

Shanshan Zhang, Junsheng Zhu.

Description:

This paper talks about a system that uses machine learning to detect agricultural pests. It combines two types of neural networks—Feature Pyramid Network (FPN) and Convolutional Neural Network (CNN)—to identify 27 types of common pests with an average accuracy of 92.5%. The system is built using a client-server (C/S) architecture. Compared to older methods that rely on sample features, this system is more reliable and accurate. It helps farmers quickly find pests, take action early, and improve crop production.

Title:

Precision Agriculture: ML and DL-based Detection and Classification of Agricultural Pests.

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Author:

Shantilata Palei, Rakesh Kumar Lenka, Rohan Mohanty.

Description:

In this paper, we found that combining deep learning (DL) and machine learning (ML) models gives much better results than using them separately. We reached a high accuracy of 96.7% by combining two models: EfficientNetB0 and XGBoostClassifier. EfficientNetB0 extracts different features from pest images, and XGBoostClassifier uses those features to classify the pests.

If farmers use this model in real life, they could detect pests earlier, saving them a lot of time and effort. Future researchers can improve on this by training the model with more pest images to make it even better.

Title:

Insect Pest Image Detection and Classification using Deep Learning.

Author:

Niranjan C Kundur, P B Mallikarjuna.

Description:

The proposed Faster R-CNN models, utilizing EfficientNet B4 and EfficientNet B7, demonstrate high accuracy in detecting and classifying insect pests, particularly with the Faster R-CNN EfficientNet B7 achieving outstanding classification accuracies of 99.00%, 96.00%, and 93.00% for 5, 10, and 15 classes, respectively. The results show that these models outperform existing methods while requiring less computational time. These findings indicate that the Faster R-CNN models can be effectively applied to pest detection, leading to improved crop protection and agricultural productivity.

III. OBJECTIVE

The primary goal of this research is to apply machine learning algorithms for automating the process of pest and disease detection in field crops. By integrating image processing and classification models, the system aims to accurately recognize different pest species and crop diseases, even in complex environments. This will help farmers take preventive actions sooner, improving crop yield, minimizing pesticide usage, and promoting sustainable agricultural practices.

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This work seeks to enhance the precision and speed of insect and disease detection in field crops through advanced machine learning methods. By leveraging models such as SVM, CNN, and KNN, the system can process large amounts of crop data to identify pests and diseases with minimal human intervention. The objective is to provide farmers with a reliable tool that reduces manual monitoring efforts, ensures early detection, and promotes healthier crops, ultimately leading to increased agricultural efficiency and sustainability.

The research focuses on developing a robust framework for the real-time detection and classification of pests and diseases in various field crops. By utilizing state-of-the-art machine learning techniques and extensive datasets, the study aims to create a user-friendly application that can be employed by farmers and agricultural practitioners. This system will not only facilitate immediate identification of threats to crop health but also provide insights and recommendations for effective management strategies, thereby contributing to the overall resilience of agricultural systems and ensuring food security.

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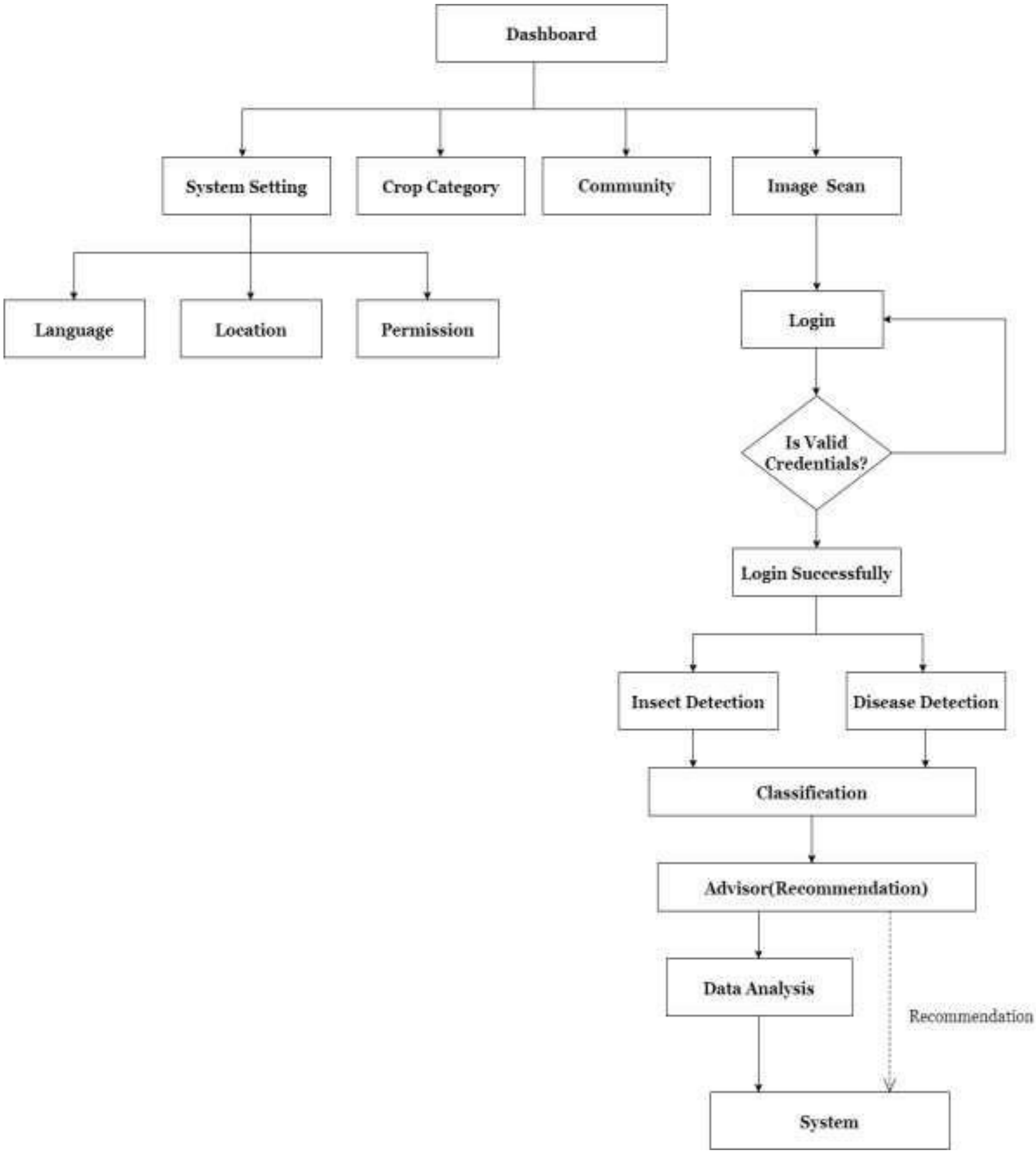
IV. ARCHITECTURE



V. PROPOSED SYSTEM

The proposed system for insect and disease detection in field crops utilizes advanced machine learning techniques to automate the identification and classification of agricultural threats. It begins with the collection of a diverse dataset of insect and disease images, which undergoes preprocessing to enhance quality through noise reduction and augmentation. Feature extraction methods are applied to capture key characteristics from the images. Various machine learning models, including Support Vector Machines (SVM), k-Nearest Neighbors (KNN), Artificial Neural Networks (ANN), and Convolutional Neural Networks (CNN), are then trained and optimized for real-time detection. The user-friendly application allows farmers to upload images for immediate analysis, providing feedback on potential threats and actionable insights for effective management. The system incorporates a feedback mechanism to continually improve its accuracy and effectiveness, ultimately enhancing crop health and promoting sustainable agricultural practices.

VI. RESULT ANALYSIS

The result analysis for the proposed insect and disease detection system focuses on evaluating the performance of the employed machine learning models, including SVM, KNN, and CNN, through various metrics such as accuracy, precision, recall, and F1-score. Cross-validation techniques, like k-fold cross-validation, ensure the models generalize well to unseen data, while a comparative analysis highlights the strengths and weaknesses of each algorithm in terms of classification performance and computational efficiency. User feedback collected from farmers assesses the system's practicality and accuracy, providing insights for improvements. Additionally, error analysis identifies common misclassifications, allowing for targeted enhancements in feature extraction and model training. Real-world testing in agricultural settings further evaluates the system's effectiveness, measuring its impact on pest management efficiency, crop yield, and overall quality. This comprehensive result analysis aims to ensure that the system effectively assists farmers in managing pests and diseases, contributing to sustainable agricultural practices.

VII. CONCLUSION

In Conclusion, various insect datasets were categorized and identified using machine learning and pest detection algorithms, and the results were compared. All the insect images were resized, processed, and enhanced to expand the dataset, which improved accuracy. It is challenging to classify insects accurately in real-time fields due to the presence of shadows, leaves, dirt, branches, flower buds, and other obstacles in major crop fields. The classification accuracy was compared across different machine learning methods such as ANN, SVM, KNN, Naive Bayes, and CNN. The results showed that the CNN model achieved the highest classification accuracy: 91.5% for 9 insect classes and 90% for 24 insect classes from the Wang and Xie datasets. This improved classification accuracy helps reduce processing time, making insect recognition faster. The detection of insects from the Wang, Xie, Deng, and IP102 datasets was done using a pest detection algorithm that required less processing time. In the future, deep learning techniques will be applied to recognize multiple insects and track their growth stages in agricultural crops. The pest detection algorithm will be integrated into a deep CNN model to classify insects across larger datasets more effectively.

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VIII. REFERENCE

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