© May 2024 | IJIRT | Volume 10 Issue 12 | ISSN: 2349-6002

Green Sight: Ai Enhanced Plant Care Crop Recommendations and Tailored Fertilisation

DR. N SREE DIVYA[1], MANISH VUTUKURU[2], RAHUL BHARGAV[3], VIKAS GOUD YARKALA[4]

[1] *Assistant professor, Department of IT, Mahatma Gandhi Institute of Technology, JNTUH, Hyderabad, India*

[2, 3 ,4] *UG Student, Department of IT, Mahatma Gandhi Institute of Technology, JNTUH, Hyderabad, India*

Abstract— The project aims to develop an agricultural decision-support system that utilizes convolutional neural networks (CNNs) and machine learning (ML) algorithms to revolutionize crop management practices. Employing CNN architectures like VGG16, ResNet9, and EfficientNetV2, the system extracts meaningful features from crop images, enabling it to accurately classify crops, identify diseases, and assess nutrient deficiencies. Additionally, ML algorithms like logistic regression, random forest, decision tree, SVM, and KNN are employed to build predictive models for crop selection and fertilizer recommendation, trained on extensive datasets. The system is deployed as a user-friendly website, allowing farmers to seamlessly upload crop images from their mobile devices. The system then analyses the images and provides comprehensive recommendations, including crop suggestions, disease identification, and fertilizer application advice, aiming to optimize yields and minimize environmental impact in precision agriculture. The crop recommendation module employing XG Boost algorithm gives an accuracy score 0f 99.3% and disease prediction module with Resnet 9 architecture gives an accuracy score of 99.2%.

I. INTRODUCTION

Modern agriculture is undergoing a transformative shift towards precision farming, leveraging cutting-edge technologies to optimize crop yield, reduce resource usage, and enhance overall agricultural productivity. The 'Green Sight' project represents a significant stride in this direction by proposing an integrated Agricultural Decision Support System. The primary objective of Green Sight is to provide farmers with a holistic solution for crop management, disease identification, and precise fertilizer recommendation. By integrating state-of-the-art deep learning models for image analysis and classical ML algorithms for predictive analytics, Green Sight aims to address the multifaceted challenges faced by farmers in making informed decisions about crop selection, disease prevention, and optimal fertilizer usage. In the contemporary agricultural landscape, farmers grapple with the complexities of choosing suitable crops, identifying and mitigating diseases, and optimizing fertilizer application. Green Sight proposes to streamline these processes by offering a user-friendly web-based platform where farmers can access real-time insights derived from robust CNN architectures and ML algorithms. This platform empowers farmers to make informed decisions, promoting sustainable farming practices, and ultimately contributing to increased crop yield and economic viability. In summary, Green Sight represents a forward-looking initiative that harnesses the synergy of deep learning and traditional machine learning to address the complexities of modern agriculture. By providing farmers with an intuitive and accessible decision support system, Green Sight aims to foster sustainable agricultural practices, optimize resource utilization, and contribute to global food security.

Objective

The primary objective of this project is to develop a comprehensive agricultural decision-support system that leverages CNNs and ML algorithms to assist farmers in making informed decisions regarding crop selection, disease identification, and fertilizer application. The system aims to optimize crop yields while minimizing environmental impact through precision agriculture practices.

Motivation

The motivation behind this project is to address the challenges faced by farmers in crop management, leverage advanced technologies like CNNs and ML, and provide an accessible and user-friendly solution that can optimize yields, reduce environmental impact, and promote sustainable precision agriculture practices.

Problem Statement

The current state of agriculture faces challenges such as suboptimal crop choices, inadequate disease identification, and imprecise fertilizer application. Farmers lack a comprehensive decision support system that integrates advanced technologies like CNN and ML algorithms. This project seeks to bridge this gap by developing an Agricultural Decision Support System (ADSS) that leverages the capabilities of CNN architectures and ML algorithms to provide precise crop recommendations, accurate disease identification, and tailored fertilizer recommendations.

Existing System

The system integrates CNN for plant disease detection and ML for making crop recommendations based on soil analysis. Specifically, the Support Vector Classifier (SVC) is chosen as the preferred classifier due to its superior performance compared to alternative classifiers such as K-Nearest Neighbours (KNN), Logistic Regression, Random Forest, and Decision Trees.

The system functions by correlating soil-crop data, establishing a connection between the soil's nutrient levels and optimal crop choices. By leveraging SVC, the system achieves superior performance in classifying and recommending crops, ensuring accurate predictions based on the intricate relationships within the dataset.

Limitations

1. The existing system does not discuss the potential limitations or drawbacks of using CNN for plant disease detection or machine learning for crop recommendation
2. It does not address the potential challenges or limitations in obtaining accurate soil nutrient data for crop recommendation and considerations regarding the usability or accessibility of the proposed system for farmers or end-users
3. It does not mention any limitations or considerations regarding the scalability or generalizability of the proposed system to different crops or regions

Proposed System

This endeavour effectively addresses contemporary agricultural challenges by ingeniously harnessing computer vision, machine learning, and agricultural science. The nucleus of the project entails progressive disease identification with prominent CNN models like VGG16, ResNet9, and EfficientNetV2, coupled with a versatile crop recommendation module. Notably, the project introduces personalized fertilizer suggestions tailored to soil attributes, enhancing nutrient efficiency and sustainability. Thorough experimentation validates precise disease detection, reliable crop recommendations, and pertinent fertilizer advice. The proposed system focuses on improving the usability and accessibility of the system, such as developing a user-friendly interface for easy access by farmers. It emphasizes on conducting a thorough study of available fertilizers and their relationship with soil and climate to provide accurate fertilizer recommendations. It explores the scalability and generalizability of the proposed system to different crops and regions, considering the variations in disease patterns and soil.

Advantages

- The proposed system focuses on improving the usability and accessibility of the system, such as developing a user-friendly interface for easy access by farmers.
- It emphasizes on conducting a thorough study of available fertilizers and their relationship with soil and climate to provide accurate fertilizer recommendations.
- It explores the scalability and generalizability of the proposed system to different crops and regions, considering the variations in disease patterns and soil characteristics

II. LITERATURE SURVEY

[1] Raj Kumar, Neha Shukla, Princee Chandra "Plant Disease Detection and Crop Recommendation Using CNN and Machine Learning", 2022 International Mobile and Embedded Technology Conference (MECON), 168-172
The proposed system successfully detects diseases in plants using CNN and recommends suitable crops based on soil quality, improving the efficiency rate of the model. The study demonstrates how deep learning using CNN may be used to classify images in order to detect plant diseases. The software maps the soil and crop database and suggests appropriate crops based on the soil's available nutrient levels to assist farmers in making better decisions. This research proposes a system for crop recommendation and plant disease detection. CNN is used to detect diseases, while machine learning is used to recommend crops. It uses CNN to identify illnesses and machine learning to suggest crops. 54,306 photos of healthy plant leaves in a dataset that is used to identify diseases. For training classification models, the KNN method is employed. Crop dataset that is used to assess soil characteristics and recommend crops. Support vector machines and artificial neural networks are employed in the identification of diseases. CNN deep learning models include AlexNet, Google Net, and VGG16 Net. It suggests using visual symptoms to identify plant diseases using an automated approach. Proposed system detects diseases in plants using CNN and recommends crops based on soil quality using ML.
[2] Shivesh Tiwari, Somesh Kumar, Sunil Tyagi, Minakshi Poonia "Crop Recommendation using Machine Learning and Plant Disease Identification using CNN and Transfer-Learning Approach" 2022 IEEE Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI)
The paper aims to develop a website focusing on agriculture, specifically addressing crop recommendation and plant disease identification issues. The study utilizes deep learning techniques, specifically Convolutional Neural Networks (CNN), for plant disease detection, comparing different CNN architectures like VGG16, ResNet50. The paper provides a comparative analysis of different algorithms used for crop recommendation and disease detection, showcasing advancements in the field.

[3] Swati Shilaskar, Shripad Bhatlawande, Saumitra Godbole, Dhananjay Joijode, Prajwal Jadhav "Artificial Intelligence based Crop Recommendation and Plant Leaf Disease Detection System, 2022 3rd International Conference for Emerging Technology (INCET)
The approach described in the paper uses the Random Forest Algorithm for crop recommendation and Convolutional Neural Network (CNN) for plant disease diagnosis. The 22 crops in the crop recommendation system each include 100 rows of crucial areas and seven criteria that work together to give accurate recommendations. Disease detection is done on three crops, with a detailed breakdown of the amount of diseases and pictures trained for each crop. ReactJS is used to construct an online marketplace and discussion forum on a user-friendly website that makes communication and navigation easier. The backend of the website is a chat engine.

III. METHODOLOGY

3.1 Proposed Work
This endeavour effectively addresses contemporary agricultural challenges by ingeniously harnessing computer vision, machine learning, and agricultural science. The nucleus of the project entails progressive disease identification with prominent CNN models like VGG16, ResNet9, and EfficientNetV2, coupled with a versatile crop recommendation module. Notably, the project introduces personalized fertilizer suggestions tailored to soil attributes, enhancing nutrient efficiency and sustainability Thorough experimentation validates precise disease detection, reliable crop recommendations, and pertinent fertilizer advice

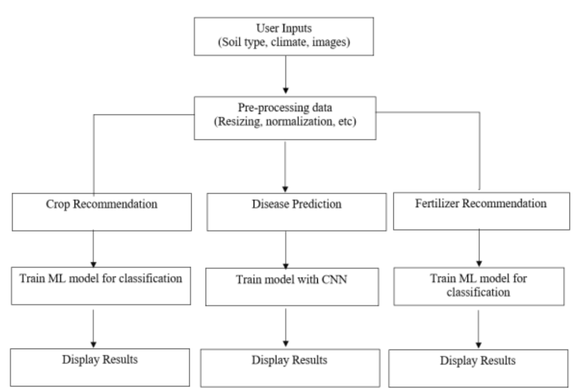

Figure 3.1 Proposed Architecture

3.2 Data Collection

The datasets are taken from Kaggle and can be used by anyone under an open license. The dataset for the crop recommendation task consists of a CSV file with 2200 entries with features like temperature, pH, humidity, rainfall and soil condition. The second dataset consists of 70,000 plant images having various diseases. It is a 5GB dataset. The third dataset used for fertilizer recommendation consists of 23 entries with features like N, P, K values and crop type.

3.3 Data Pre-processing

All the irrelevant and corrupted images are removed from the dataset. Duplicate images are also eliminated to avoid bias in training. All the images were resized to a standard size (265x265) to ensure uniformity and reduce computational complexity during training. The crop recommendation dataset and the fertilizer recommendation dataset were combined to form the final dataset for crop recommendation.

3.4 Algorithms

Machine Learning

Logistic Regression

While it is used to solve classification tasks, logistic regression is comparable to linear regression. The sigmoid function, which provides a value between 0 and 1, is the function utilised in the logistic regression.

Decision Tree

Decision trees are versatile tools that can be used for both classification and regression problems. These models use a tree-like structure to visualize the flow of predictions that result from a series of feature-based splits. decision trees use the concept of entropy, which quantifies the degree of uncertainty or disorder in a dataset, to determine the choice made by leaves at the root of the tree. On the other hand, information gain quantifies the amount of uncertainty reduced by a particular characteristic and is an important consideration when deciding which attribute to use as the decision node or root node.

Support Vector Machine

Support Vector Machine, or SVM, is a supervised machine learning technique that is most frequently used for classification tasks, while it can also be used for regression problems. As part of the SVM technique, each data point is plotted as a point in an n-dimensional space, where n is the number of features and n-dimensional space is the number of dimensions. A specific coordinate is indicated by each feature value. Finding the hyper-plane that most clearly distinguishes the two classes is the next stage in the classification process.

Random Forest

An ensemble learning technique called Random Forest is built by combining several decision trees. A random subset of the input data is used to train each decision tree, and the aggregate outputs of all the trees yield the final result. Because random forest can manage high-dimensional data and minimise overfitting, it frequently performs exceptionally well as a classifier.

Naive Bayes

The Naive Bayes algorithm is widely used for text classification tasks like spam detection and sentiment analysis. The "naive" assumption implies that features are independent of each other given the class label, which simplifies the computation of the conditional probability of a class given the features. To estimate the parameters, it uses minimal training data and is computationally efficient. However, its performance can suffer if the independence assumption doesn't hold, and it may not capture complex relationships between features.

XG Boost

XGBoost, or Extreme Gradient Boosting, is a sophisticated and incredibly effective gradient boosting technique implementation. XGBoost works by sequentially adding decision trees to an ensemble, where each new tree corrects the errors made by the previous ones. XGBoost incorporates several enhancements to improve performance, including parallelization, regularization techniques to prevent overfitting, and a sophisticated loss function that optimizes both prediction accuracy and model complexity.

Convolutional Neural Networks

VGG16

VGG16 is a convolutional neural network (CNN) architecture known for its simplicity and effectiveness in image classification tasks. Developed by the Visual Geometry Group (VGG) at the University of Oxford, VGG16 consists of 16 convolutional layers, followed by fully connected layers and SoftMax for classification. It employs 3x3 convolutional filters with stride 1 and same padding throughout the network, resulting in a deep but easy-to-understand architecture. Despite its relatively large number of parameters, VGG16 has shown impressive performance on various benchmark datasets like ImageNet, demonstrating its robustness and generalization capability.

ResNet9

ResNet-9 is a convolutional neural network (CNN) architecture specifically designed to address the challenges of training very deep networks. It is particularly beneficial for tasks with limited resources. These connections bypass some layers in the network and add the original input directly to the output. This approach helps alleviate the vanishing gradient problem, a common issue in deep networks that hinders training effectiveness. The network primarily consists of eight convolutional layers. Each layer extracts features from the input image, progressively learning more complex representations. Following each convolutional layer, ReLU (Rectified Linear Unit) activation is typically used to introduce non-linearity and improve model performance. Some implementations of ResNet-9 may incorporate batch normalization layers after convolutions.

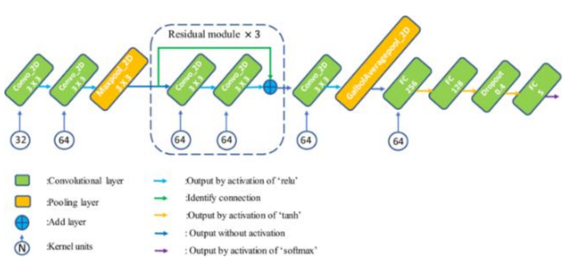

Figure 3.2 Resnet 9 Architecture

- EfficientNetV2

EfficientNetV2 builds on the success of EfficientNet, a family of CNNs known for their efficiency in terms of training speed and parameter count. Neural Architecture Search (NAS) is an automated technique to find optimal network architectures. EfficientNetV2 uses a special type of NAS that considers training speed during the search process. This ensures the discovered architectures not only perform well but also train efficiently. Scaling refers to creating a family of models with varying sizes and complexities. EfficientNetV2 utilizes a compound scaling method to adjust the width, depth, and resolution of the base network while maintaining its efficiency. Regularization techniques like dropout and data augmentation are crucial for preventing overfitting. EfficientNetV2 uses adaptive methods to adjust these techniques during training, balancing fast training with good accuracy.

IV. RESULTS

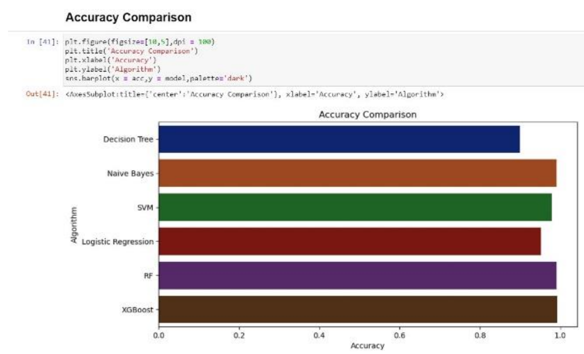

Figure 4.1 Accuracy Comparison of ML Algorithms

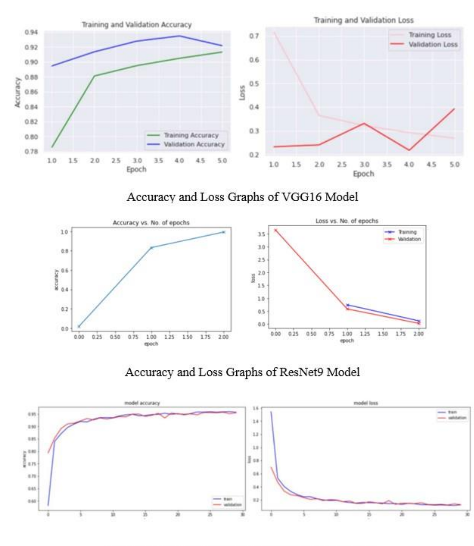

Figure 4.2 Accuracy and Loss Graphs of CNN models

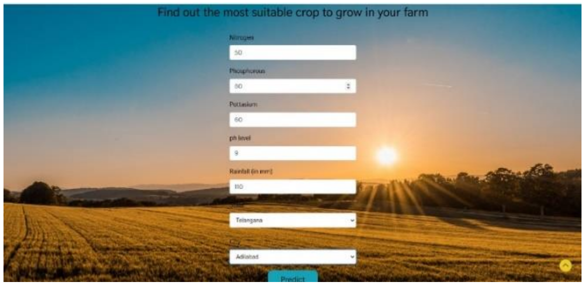

Figure 4.2 Enter the suitable values for crop recommendation

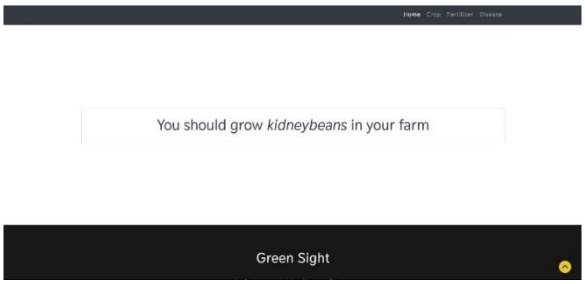

Figure 4.3 Resultant crop recommendation

Figure 4.4 Enter suitable values for fertilizer recommendation

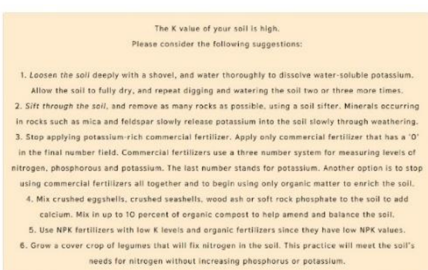

Figure 4.5 Suitable suggestions for the fertilizer are given

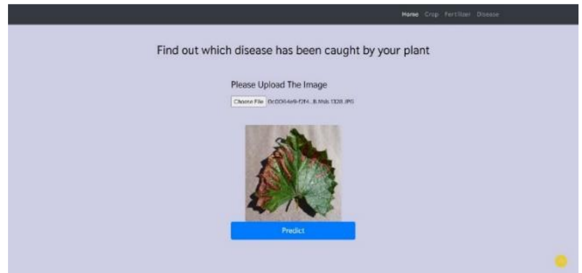

Figure 4.6 Provide photo of the diseased plant

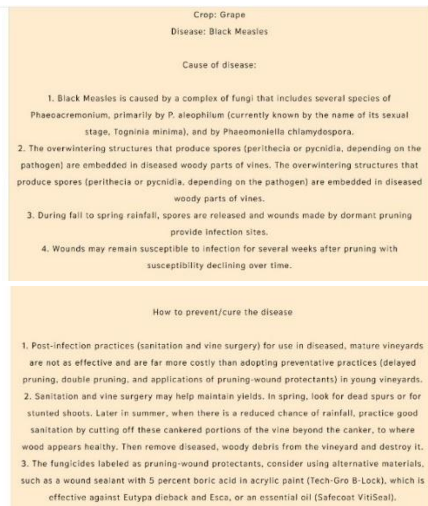

Figure 4.7 Disease is identified and measures to be taken are given

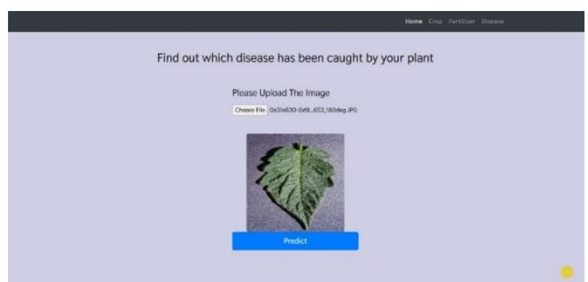

Figure 4.8 Provide photo of a healthy plant

Figure 4.9 No disease is identified

V. FUTURE SCOPE

The future scope of Green Sight is vast and promising. Enhancing the accuracy of algorithms through continuous refinement and the integration of advanced techniques like transfer learning or ensemble methods will be crucial. Expanding the project to cover a broader range of crops and regions, along with developing a mobile application version, can greatly increase accessibility. Integrating the project with precision agriculture technologies, such as drones or sensors, could enable more targeted and efficient application of fertilizers and pesticides. This could help reduce environmental impact and improve resource use efficiency. Developing a mobile application version of the project could make it more accessible to farmers who might not have regular access to a computer. This could involve creating a user-friendly interface optimized for mobile devices and incorporating features like image capture for disease identification. Additionally, implementing machine learning models for yield prediction and integrating the project with supply chain management systems can streamline agricultural operations and ensure quality control. Education and outreach initiatives will be essential for facilitating widespread adoption among farmers, ultimately contributing to improved agricultural productivity and sustainability.

CONCLUSION

This project successfully developed a web-based platform that empowers farmers through a three-pronged approach: crop recommendation, disease identification using convolutional neural networks, and fertilizer recommendation. By harnessing the power of convolutional neural networks and machine learning algorithms the project acts as a versatile tool with immense potential to revolutionize farming practices. This project signifies a paradigm shift towards data-driven decision-making in agriculture, where farmers can harness the power of AI to make informed choices about crop selection, disease management, and fertilizer application. The potential for positive impact is immense, as optimized farming practices not only lead to increased yields but also contribute to environmental sustainability by reducing chemical inputs and mitigating the spread of crop diseases. This user-friendly system simplifies decision-making for farmers, promoting informed crop selection, improved disease management, and potentially higher yields. Looking ahead, the project holds immense promise for further integration with real-time data, advanced AI techniques, and user-specific profiles. Ultimately, the success of Green Sight lies not only in its technological sophistication but also in its ability to empower farmers, foster sustainable agricultural practices, and ensure food security for generations to come.

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