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Monitoring diverse crop activities using Machine Learning Approach

Chetan V M[1], Dhanush P[2], Lokesh N[3], Sagar P[4], Poornima H N[5]

Student, Artificial Intelligence and Machine Learning, K S Institute of Technology, Bengaluru, India[1-4]

Professor, Artificial Intelligence and Machine Learning, K S Institute of Technology, Bengaluru, India[5]

Abstract: Agriculture is a significant occupation for a large portion of the Indian population. Crop production plays a crucial role in our economy. The quality of crop production can suffer due to improper crop selection for specific soil types or lack of knowledge about different crops' growth requirements. The proposed system makes use of machine learning to recommend crops based on historical soil parameter data, reducing the risk of soil degradation and promoting crop health. Factors like Sulphur, potassium, calcium, temperature, humidity, rainfall and soil ph. levels are analyzed using neural networks to suggest suitable crops for cultivation. One of the main reasons for low crop yield is the presence of infections caused by microorganisms, viruses, and fungi. Plant disease analysis is a key task in agriculture and can be prevented by utilizing plant disease detection techniques. Manual monitoring and management of plant diseases are labor-intensive and time-consuming, hence the use of image processing for disease identification. The objective of this study is to develop a model that can detect diseased crop leaves and predict plant diseases. This work is based on the convolution neural network(CNN).The detection of pests in agricultural field has attracted a lot of attention, which is helpful in achieving smart agriculture. In particular, the monitoring of crop pests is one of the key ways to manage and optimize agricultural resources. You Only Look Once (YOLO) based approaches have provided good results. Moreover, there is no large dataset for pest detection. In essence, this study puts forth a complete approach that tackle the ability of machine learning to revolutionize crop recommendation, disease detection, and pest detection in the agricultural sector. The primary objective is to optimize crop yield and foster sustainable practices. Through the integration of neural networks for crop recommendation, CNN for disease detection, and the challenges associated with pest detection, this research plays a crucial role in project the development of modern agricultural practices in India.

Index Terms: Machine learning Algorithms, Neural Networks, Convolution neural network, You Only Look Once(YOLO).

I. INTRODUCTION

Optimizing crop activities becomes essential in a nation like India, where agriculture is vital to the economy and the survival of millions of people. Indian agriculture has always relied heavily on traditional techniques, which are engrained in the country's history and culture. But given how quickly technology is developing and how urgently we need to boost sustainability and productivity, it becomes necessary to investigate new cutting-edge and effective methods.

The importance of agriculture in India, the value of conventional farming practices, their drawbacks, and the reasons that a machine learning (ML) approach is a better option are all covered in this paper.

Agriculture's significance in India:

For generations, India's agriculture has been its vital force, making a substantial contribution to the country's GDP, employment, and food security. Its significance cannot be emphasized, since more than half of the world's population depends on agriculture either directly or indirectly for their living. India's agriculture supplies the country's food needs as well as those of numerous other industries, including textiles, manufacturing, and exports. Moreover, it guarantees rural development and stability and acts as an essential buffer against economic swings.

Importance of Conventional Agricultural Practices:

Indian agriculture has been nourished by traditional methods for many years, which combine local knowledge and ancient wisdom. Crop rotation, mixed cropping, organic farming, and other practices have proved essential to preserving soil fertility, biodiversity, and resistance to pests and diseases. These techniques have preserved native agricultural varieties and cultural history while also fostering a strong bond between farmers and their land.

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Traditional agricultural methods' drawbacks include:
Even with their historical importance, conventional farming practices have drawbacks. They frequently include expensive labor, inefficient use of resources, and constrained scalability. Furthermore, relying just on conventional wisdom might not be enough to manage contemporary issues like climate change, shifting consumer needs, and erratic weather patterns. Furthermore, the overuse of chemical pesticides and fertilizers in traditional techniques may occasionally contribute to environmental deterioration.

Benefits of the Machine Learning Method: A machine learning methodology offers a paradigm shift in agriculture management as opposed to conventional methods. Machine learning algorithms have the ability to generate actionable insights for crop activity optimization through the integration of automation, predictive modeling, and data analytics.

These insights cover a broad range of topics, such as resource allocation, pest detection, weather forecasting, soil health monitoring, and yield prediction. ML gives farmers the capacity to make well- informed decisions, increase productivity, reduce risks, and advance sustainability by utilizing real-time data and sophisticated analytics.

II. METHODOLOGY

The proposed approach mainly consists of three activities such as:

a. Crop Recommendation
b. Pest Detection
c. Plant disease detection

The methodology for above different crop activities involves several steps includes:

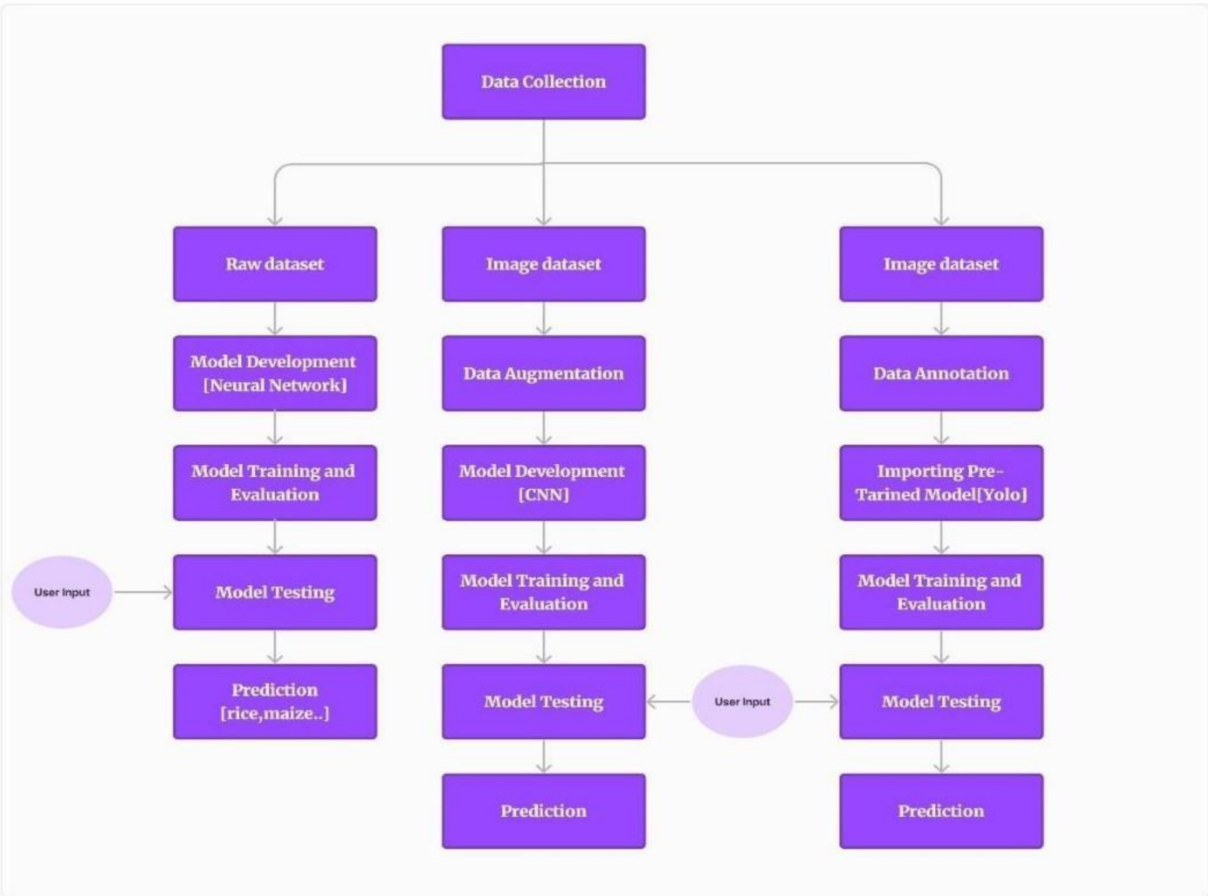

Fig1 data model

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A. Data Collection : The data collection is the most common approach for gathering and analyzing the information for various sources. Each activity is trained by their own datasets. The Crop Recommendation dataset have the following criteria will be considered for the recommendation : soil pH, humidity, NPK levels, crop data, temperature.

The disease detection dataset consists of 85,000 images the images are categorized into two groups which includes training set and testing set, the training set contained 70,243 images and testing set contained 14,800 images respectively. In each group contains of 28 classes. Pest detection dataset consists of 5,200images the images are categorized into two groups which includes training set and testing set, the training set contained 4200 images and testing set contained 1,000 images respectively. In each group contains of 9 classes. Datasets for each activity are collected from Kaggle.

B. Data pre-processing, Augmentation and Annotation:

The preliminary stage of data preparation involves clean and preprocess the collected data, including handling missing values, normalization, and feature engineering to extract meaningful information. For the disease detection and pest detection dataset to enhance the training efficiency the dataset's images necessitate data augmentation through the implementation of rotating, horizontal flipping, zooming, and height and width shifting, resulting in an augmented set of images for training and validation sets. Additionally, the dataset's images must be resized to 224 × 224 × 3 dimensions to ensure compatibility with the specified architecture. To train a YOLO (You Only Look Once) model using the annotated dataset to detect and localize pests within crop images.

C. Model Development:

Neural network model for crop recommendation model is divided into three layers. The first layer is a dense layer with 64 neurons, utilizing the ReLU activation function. It serves as the initial processing stage for the input data, which has a shape of 7 dimensions. The second layer is another dense layer with 32 neurons, also employing the ReLU activation function. This layer further refines the features extracted by the preceding layer. The final layer is a dense layer with 22 neurons, utilizing the SoftMax activation function. It produces probabilities for each of the classes in the classification task, with the number 22 adjusted to match the total number of classes in the dataset.

The CNN model is used for disease detection, model consists of several layers designed for image classification. Conv2D (Convolutional Layer 1): This layer applies 32 filters of size 5x5 to the input images. The activation function used is ReLU, which helps introduce non-linearity to the model's decision-making process. MaxPooling2D (Pooling Layer 1): Following the convolutional layer, a max-pooling operation with a pool size of 3x3 is applied to reduce the spatial dimensions of the feature maps while retaining the most important information. Conv2D (Convolutional Layer 2): Another convolutional layer is added, again with 32 filters, but this time with smaller filter size (3x3). The ReLU activation function is applied. MaxPooling2D (Pooling Layer 2): Similar to the first pooling layer, this layer applies max-pooling with a 2x2 pool size to further down sample the feature maps. Conv2D (Convolutional Layer 3): This layer increases the number of filters to 64 while maintaining the 3x3 filter size. ReLU activation is used. MaxPooling2D (Pooling Layer 3): Another max-pooling operation is performed with a 2x2 pool size. Flatten: The Flatten layer reshapes the 2D feature maps into a 1D vector, preparing the data for input into the densely connected layers. Dense (Fully Connected Layer 1): A fully connected layer with 512 neurons and ReLU activation is added to process the flattened feature vector. Dropout: To reduce overfitting, a dropout layer is added, randomly dropping 25% of the neurons during training. Dense (Fully Connected Layer 2): Another fully connected layer with 128 neurons and ReLU activation follows. Dense (Output Layer): The final layer consists of num classes neurons, each representing a class in the classification task. The softmax activation function is applied to produce probability distributions over the classes.

The YOLO (You Only Look Once) model is used for pest detection. This is a pre-trained deep learning model trained using imageNet dataset. To train a YOLO (You Only Look Once) model using the annotated dataset to detect and localize pests within crop images.

D. Model training and Evaluation:

Train a neural network model using the preprocessed data to learn the complex relationships between input features (such as soil type, climate, etc.). The neural network model was trained with fixed set of hyperparameters namely 200 epochs, batch size 32 with Adam optimizer. Validate the trained model using test dataset. Train the CNN model using the augmented dataset to learn to classify images into healthy or diseased crops. The model was trained with fixed set of hyperparameters namely 15 epochs, learning rate 0.0001, batch size 32 with Adam optimizer. Evaluate the trained model's performance on the validation set and fine-tune hyperparameters if necessary to improve its accuracy. Train a YOLO (You Only Look Once) model using the annotated dataset to detect and localize pests within crop images.
Validate the trained YOLO model using validation datasets and fine-tune model parameters to improve detection accuracy.

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FOR CROP RECOMMENDATION

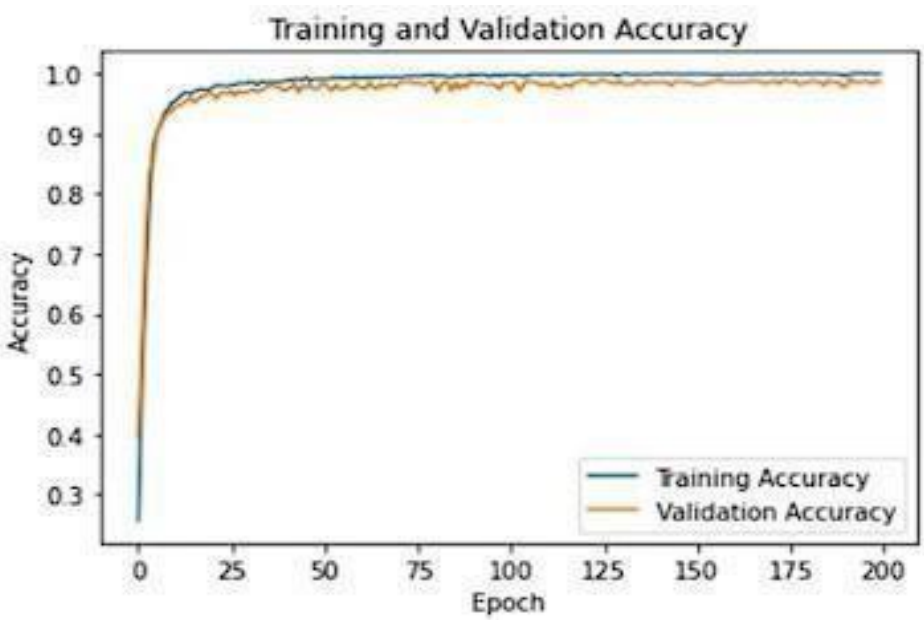

Fig. 2. Training and Validation Accuracy

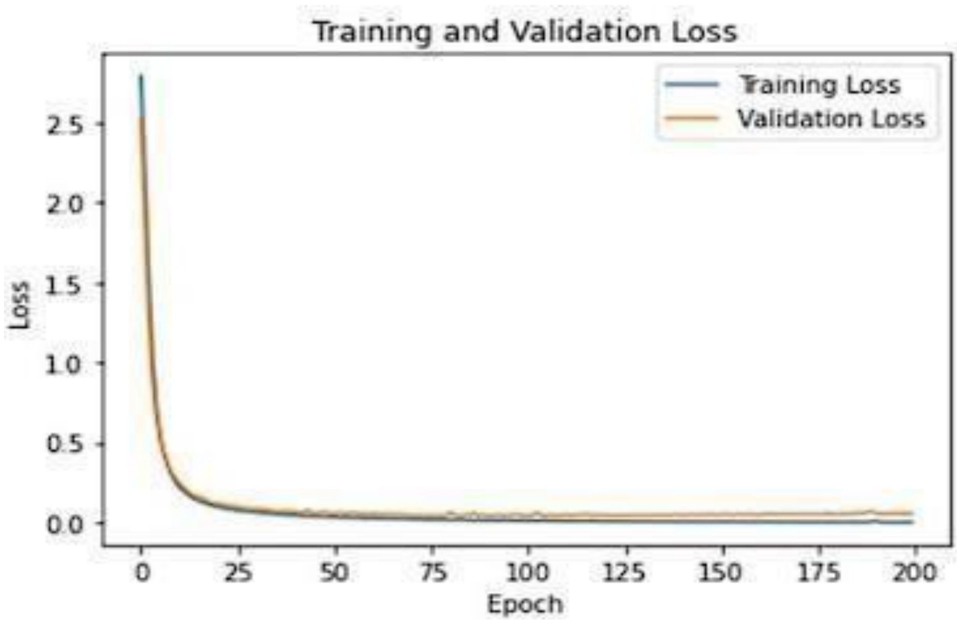

Fig. 3. Training V/S Validation Loss

III. RESULTS

Soil parameters and a crop database are used in the proposed model. The ideal crop for the specific soil is recommended using machine learning algorithms.

The convolutional neural network is experimented for the identification of leaf diseases with an expection of improved accuracy. The 70/30 splitting ratio is used to divide the database into two datasets i.e. training and testing. CNN detects leaf is healthy or diseased if so predicts the class of disease as well. CNN model was trained using the initial learning rate 0.001 in 10 epoch.

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SNAPSHOTS:

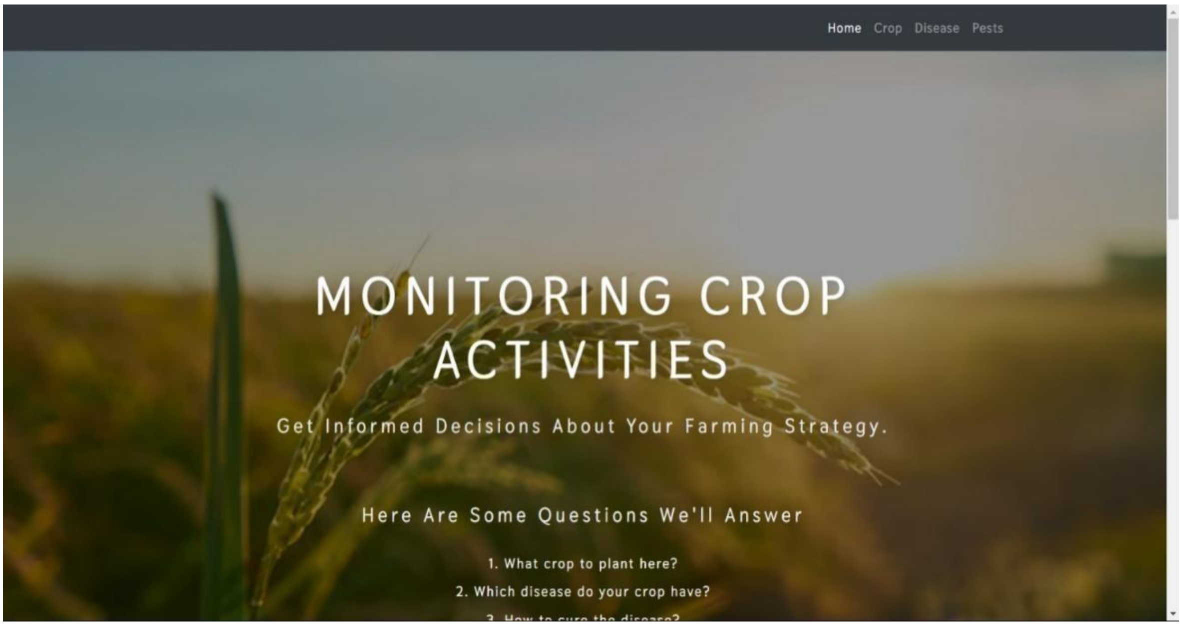

Fig 4 home page

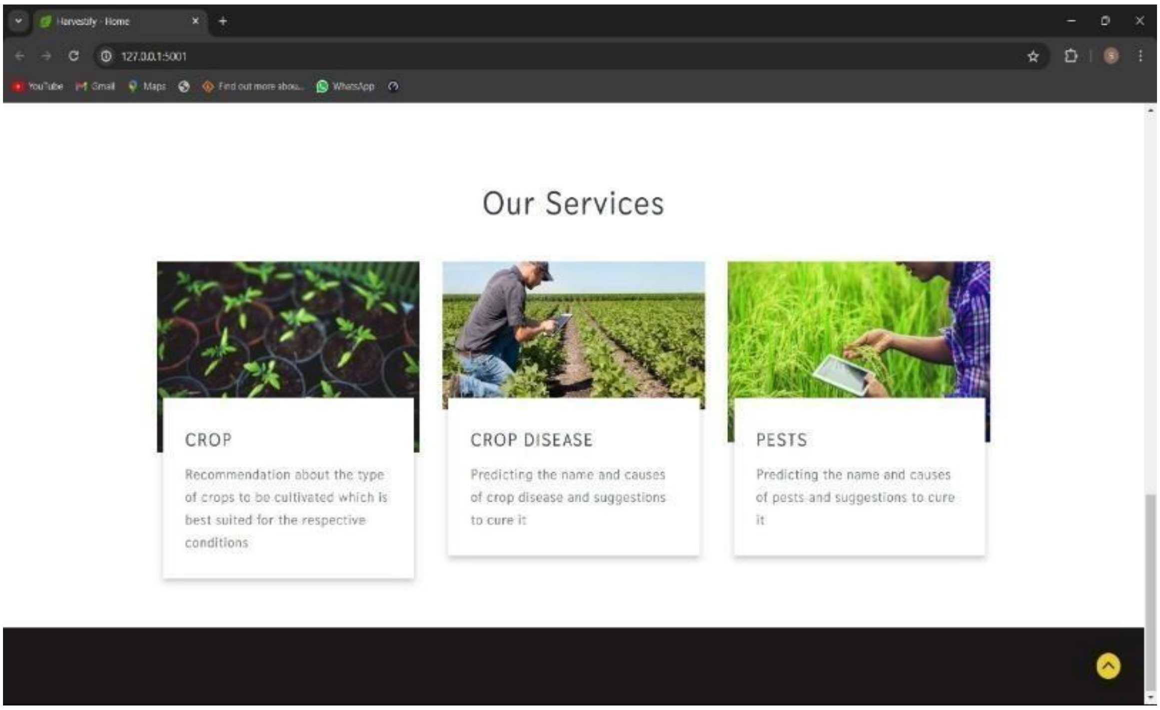

Fig 5: services page

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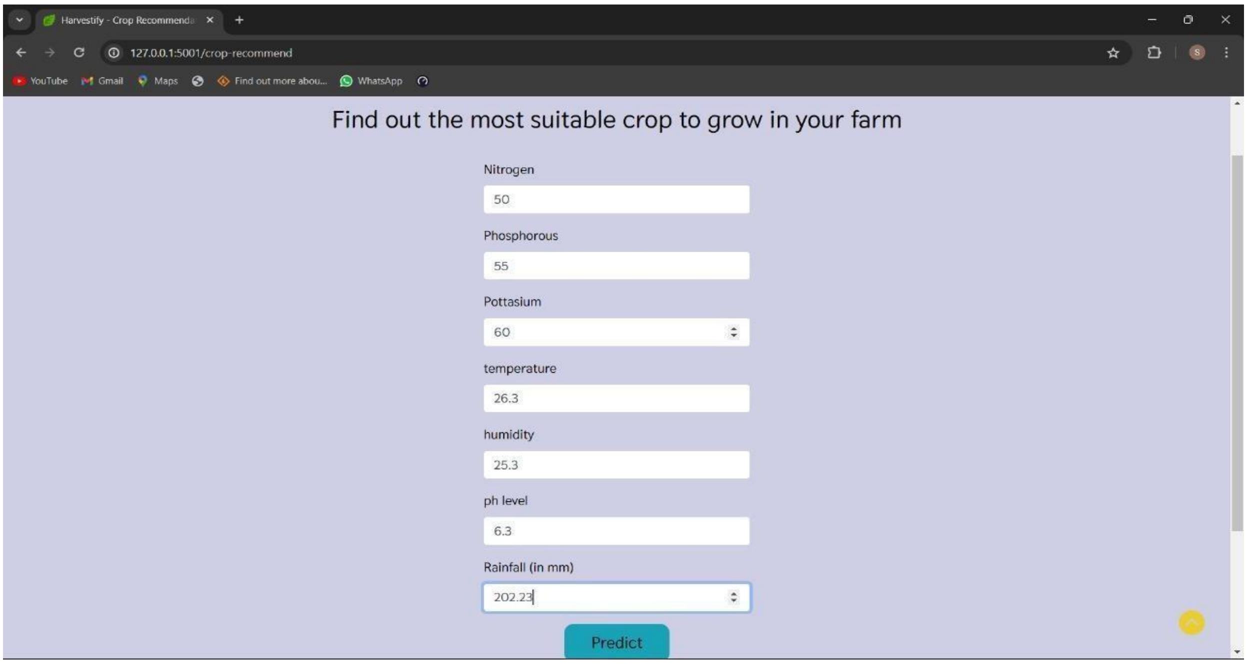

Fig 6: Inputs For crop recommendation

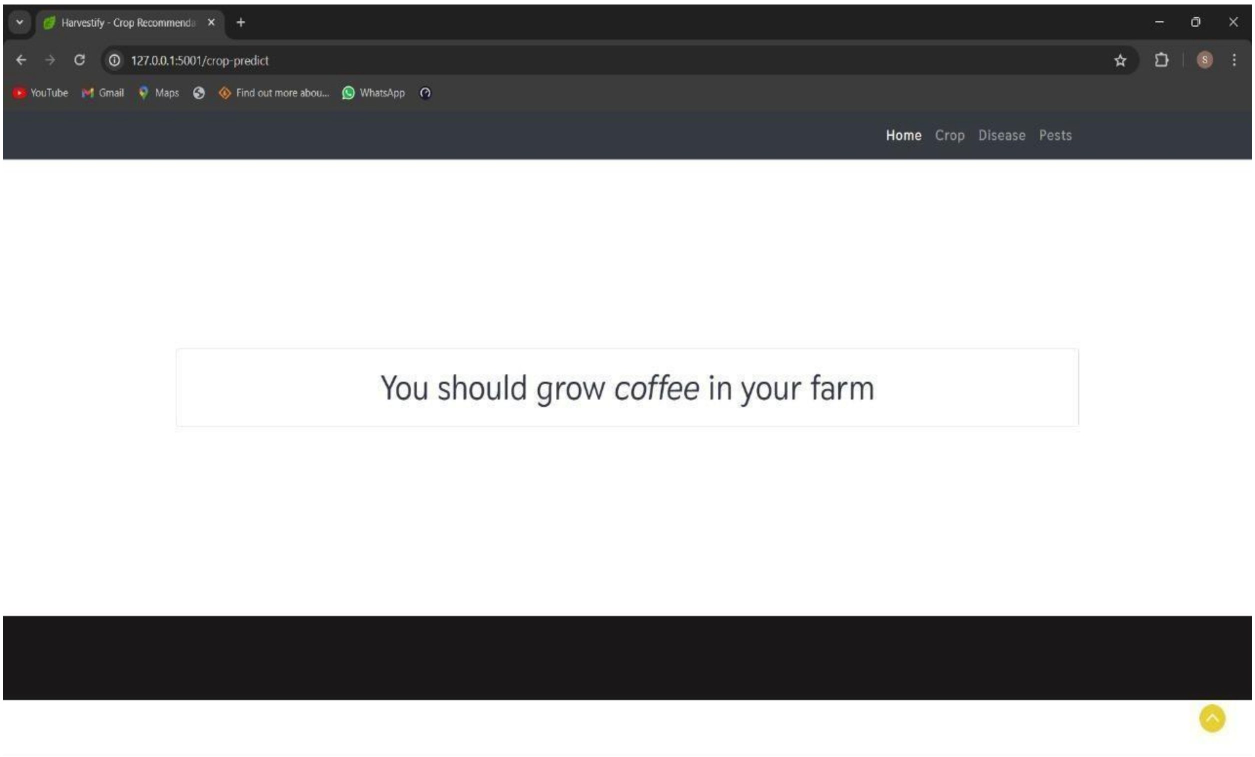

Fig7: Results Of Crop Recommendation

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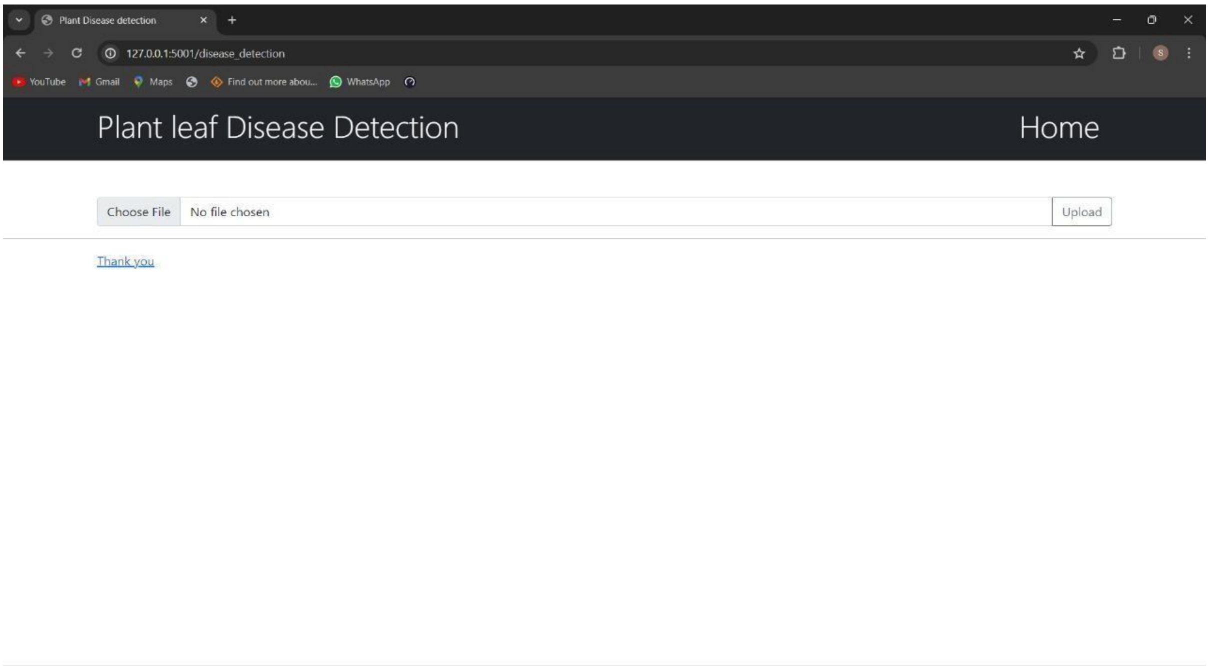

Fig 8: Input for plant leaf disease detection

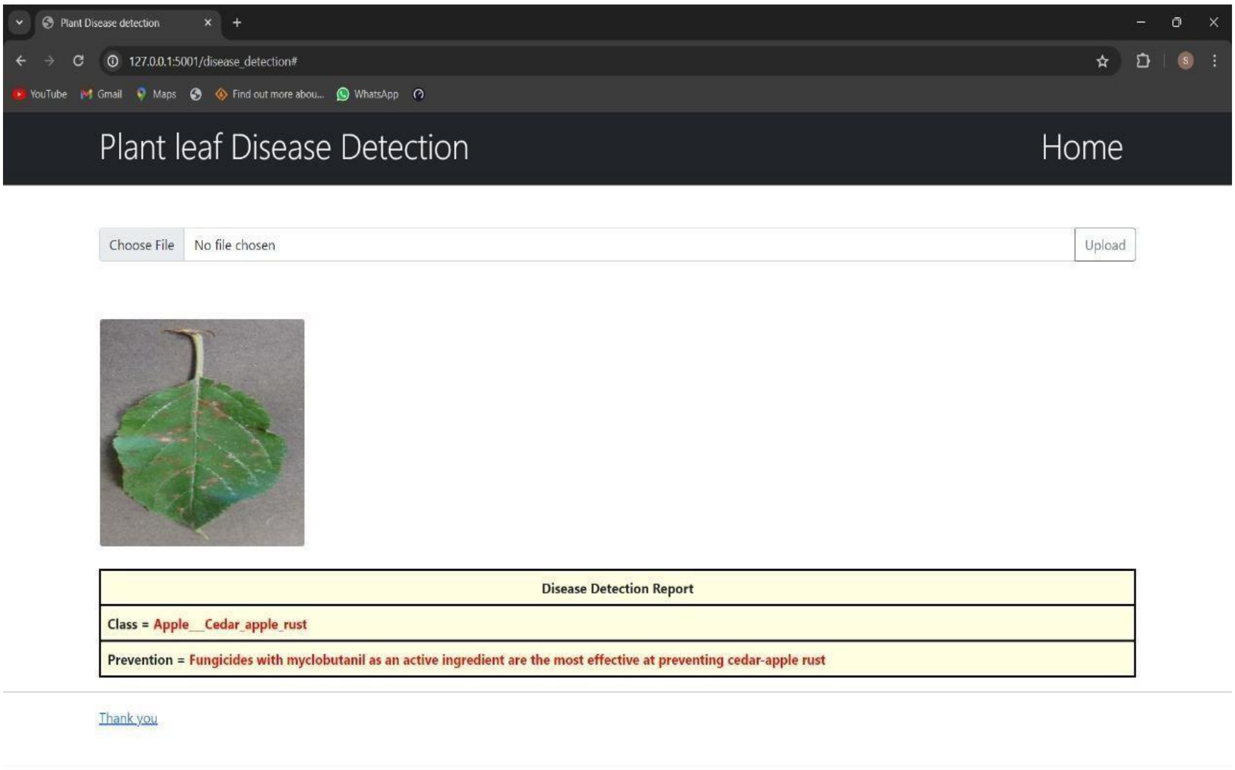

Fig 9: Output of plant leaf disease detection

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Accuracy of the three models

Activities	Models	Accuracy
Crop recommendation	Neural network	97.43%
Disease detection	CNN	98.06%
Pest detection	YOLOv9	98.86%

IV. CONCLUSION

This work achieves significant milestones in the field of agriculture technology by integrating advanced neural net- work techniques. Leveraging neural networks, specifically CNN and YOLO architectures, we address critical agricultural challenges including crop recommendation, disease detection, and pest identification.

Our model demonstrates impressive accuracies of 97.43% for crop recommendation, 98.06% for disease detection, and 98.86% for pest detection, showcasing its robustness and reliability in assisting farmers with informed decision-making processes. Through the fusion of cutting-edge technology and agricultural expertise, this aims to enhance crop management practices, optimize resource utilization, and ultimately contribute to global food security.

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