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AGRICZEN - INTEGRATED AGRICULTURAL DECISION SUPPORT SYSTEM

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ABSTRACT

The Agriczen is an innovative platform designed to improve crop production by providing farmers with easy access to agricultural information, resources, and tools. The portal offers a wide range of features including weather forecasts, pest and disease management tips, soil health assessment, crop planning tools, and market prices. This technical paper outlines the development and implementation of the Agriczen, highlighting its features and functionalities. The paper also explores the benefits of the portal for farmers, including increased productivity, improved decision-making, and enhanced profitability. The platform is built on a robust technology platform that is scalable and adaptable to the needs of farmers of different sizes and geographies. It is designed to be user-friendly and accessible on multiple devices, including mobile phones and tablets. The Agriczen represents a significant step forward in the use of technology in agriculture. By providing farmers with easy access to information and resources, it has the potential to transform the way they farm and improve crop production across the globe.

Keywords: Agricultural platform , Crop production ,Agricultural information , Tools ,Weather forecasts , Pest management , Disease management , Crop planning , Market prices

1. INTRODUCTION

Agriculture is the backbone of any country, and it has become the most significant growing sector all over the world because of increasing the population. About 60% of our country's population works in agriculture which contributes more to our country's GDP and employment. The main challenge in the agriculture industry is to improve farming efficiency and quality to fulfill the speedily increasing demand for food. Apart from the mounting population, the climate circumstance is also a huge challenge in the agricultural industry. In our project, we will make use of Machine Learning and Deep Learning algorithms to assist farmers to know future crop yield predictions and favorable weather predictions. It also assists the farmers to sell the crops directly to the customers.

2. EXISTING SYSTEM

The current agricultural ecosystem relies heavily on traditional methods of selling agricultural products, which often involve intermediaries like wholesalers or middlemen. In this system, farmers typically market and sell their produce through local markets, agricultural cooperatives, or directly to buyers within their communities. While these methods have been the backbone of agricultural trade for generations, they come with inherent challenges and limitations. One major drawback is the limited reach of these traditional channels, which restricts farmers' access to broader markets and potentially lucrative opportunities outside their immediate vicinity. Furthermore, the reliance on intermediaries can lead to price fluctuations and reduced profitability for farmers, as middlemen often take a significant portion of the profits. Additionally, the lack of real-time market intelligence and data-driven insights hinders farmers' ability to make informed decisions regarding crop pricing, timing of sales, and market trends. This can result in suboptimal outcomes such as selling crops below market value or missing out on peak demand periods. Moreover, the traditional system may not adequately support farmers in adopting and implementing best practices for crop production, sustainability, and quality assurance. As a result, there is a growing need for modernized solutions that empower farmers with direct access to markets, real-time data analytics, and tools for optimizing production, pricing, and profitability.

3. LITERATURE REVIEW

[1] According to analysis, the most used features are temperature, rainfall, and soil type, and the most applied algorithm is Artificial Neural Networks in these models. The author used parameters like State, district, season, and area. The user can predict the yield of the crop in which year the user wants. The paper uses advanced regression techniques like Kernel Ridge, and Lasso to predict the yield and uses the concept of Stacking Regression for enhancing the algorithms to give a better prediction.

[2] In this paper, the author says, yield prediction was performed by considering farmers' experience on a particular field and crop. Different Data Mining techniques are used and evaluated in agriculture for estimating the future year's crop production. This is achieved by applying association rule mining on agriculture data. This research focuses on the creation of a prediction model which may be used for future prediction of crop yield. This paper presents a brief analysis of crop yield prediction using a data mining technique based on association rules for the selected region.

[3] The author describes how the old farming data can be utilized to depict the future expectation of harvests and yield. It likewise proposes to the ranchers what kind of yield can be developed utilizing the climate station data and gives the appropriate data to incline toward the precise season for cultivating. The curse on the harvest yield is broken down by utilizing different ecological elements and Regression Analysis (RA), Linear Regression (LR) Algorithms utilizing the various data mining strategies how to improve harvest production.

[4] This paper uses machine learning algorithms, direct relapse demonstrated from insights, and two enhancement techniques, the Normal condition strategy, and the Gradient plunge technique to anticipate the weather based on a couple of parameters. this work utilizes the ordinary condition model's speculation and contrasts it and the angle plunge model to give a superior thought of the productivity of the models. This paper is about the use of machine learning

[5] We describe an approach to yield modeling that uses a semiparametric variant of a deep neural network, which can simultaneously account for complex nonlinear relationships in high- dimensional datasets, as well as the known parametric structure and unobserved cross-sectional heterogeneity. We show that this approach outperforms both classical statistical methods and fully nonparametric neural networks in predicting the yields of years withheld during model training. Our approach is less pessimistic in the warmest regions and the warmest scenarios.

[6] In this paper, we can predict the things like rainy, windy, sunny, stormy, floods and variations in temperature, etc. Nowadays, the weather is making a bad impact, as society is growing more and more, causing much damage, injury, and loss of life for farmers. Weather forecasting is very important for agriculture and terrace gardening. Weather forecasting will help remote areas for better crop production. In this paper, a low-cost solution for weather forecast prediction is discussed

[7] This paper predicts the yield of almost all kinds of crops that are planted in India. This script makes novel by the usage of simple parameters like State, district, season, area and the user can predict the yield of the crop in which year he or she wants to. The paper uses advanced regression techniques like Kernel Ridge, Lasso, and ENet algorithms to predict the yield and uses the concept of Stacking Regression for enhancing the algorithms to give a better prediction.

4. PROPOSED METHODOLOGY

The proposed methodology for developing an agricultural platform involves a multi-faceted approach combining front-end and back-end development, integration of machine learning and deep learning algorithms, and a focus on user-centric design and functionality. In terms of front-end development, the use of HTML and Bootstrap4 ensures a responsive and visually appealing user interface that is optimized for various devices. The back-end development entails selecting a suitable web framework like Xampp and PhpMyAdmin, integrating a robust database system such as MySQL for data storage, and connecting with external APIs to access real-time weather data, market intelligence, and other relevant information. The core functionality of the platform includes a direct selling platform where farmers can list their products, set prices, and sell directly to consumers without intermediaries, thus improving their profitability and market reach. Machine learning algorithms are leveraged for crop yield prediction based on historical data, weather patterns, and soil conditions, while deep learning models are utilized for accurate weather forecasting to assist farmers in planning their agricultural activities effectively. Market intelligence tools powered by ML algorithms provide insights into market trends, pricing strategies, and demand-supply dynamics, enabling farmers to make informed decisions and optimize their production and sales strategies. User authentication mechanisms, data analytics tools, and communication channels such as chat or messaging are also integrated to enhance user experience, security, and engagement on the platform. The deployment of the web application on a cloud platform ensures scalability, reliability, and seamless access for users, while regular updates and optimization efforts based on user feedback and analytics data ensure the continuous improvement and relevance of the agricultural portal in meeting the evolving needs of farmers and stakeholders in the agriculture industry.

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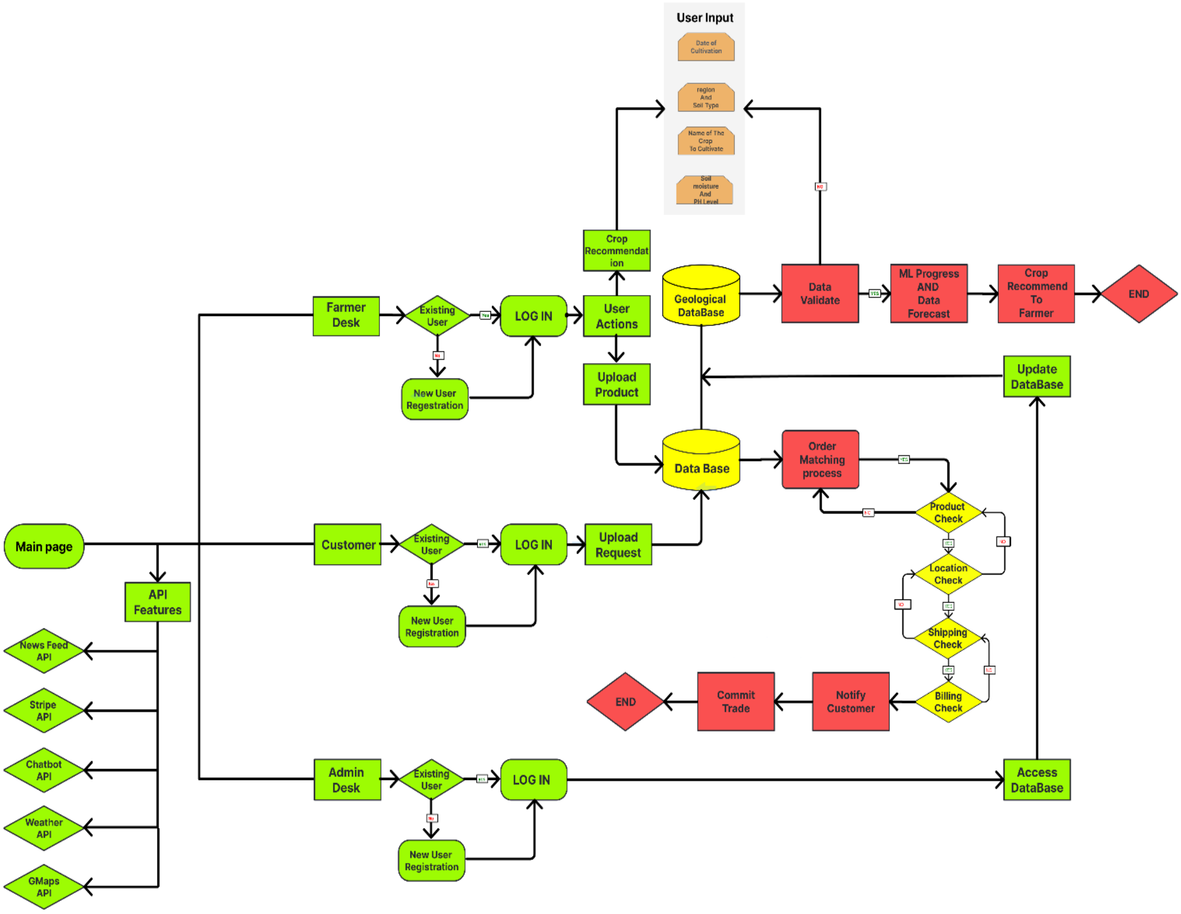

Figure 4. 1: Flowchart of the Application

Below are the problems faced by the farmers these days:

- Weather prediction
- Yield prediction
- Crop selection
- Rainfall Prediction
- Disease Detection
- Tools
- Pesticides Recommendation
- Difficulty in selling the crop at the right time to the customers.

Our project aims at minimizing these problems and looks forward to easing the activities of the farmers.

5. METHODOLOGY OF THE SYSTEM

The methodology of developing and deploying a machine learning model, which typically involves the following steps: data acquisition and preprocessing, model development, model training, model testing, and deployment.

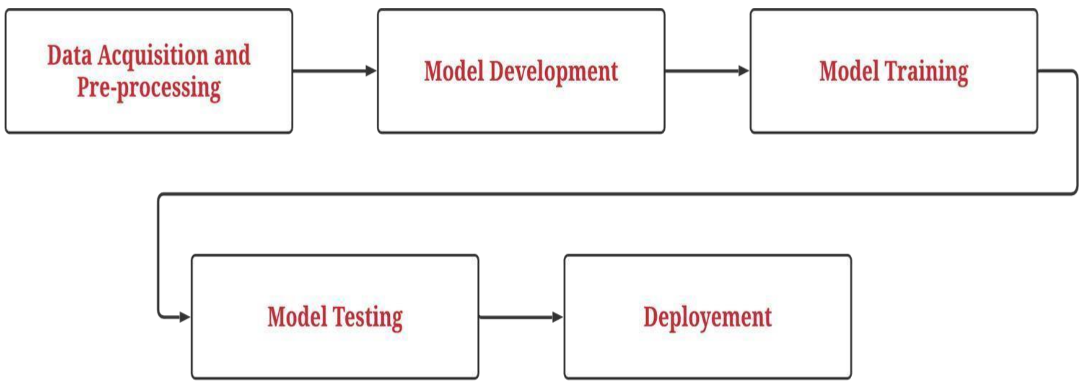

Figure 5.1 : Methodology

1. Data Acquisition and Preprocessing:

- Identify the problem statement and the type of data required to solve it.
- Collect the necessary data from various sources such as databases, APIs, or web scraping.
- Clean the data by removing any irrelevant or inconsistent entries, handling missing values, and dealing with outliers.
- Preprocess the data by performing tasks like normalization, feature scaling, feature engineering, and encoding categorical variables.

2.Model Development:

- Choose an appropriate machine learning algorithm or a combination of algorithms based on the problem type (classification, regression, etc.) and the nature of the data.
- Split the preprocessed data into training and validation sets. The training set is used to train the model, and the validation set is used to tune its parameters and evaluate performance during development.
- Define the model architecture or structure, including the number and type of layers (in the case of neural networks) or the configuration of the algorithm.
- Set hyperparameters, such as learning rate, regularization strength, and batch size, which Control the learning process.
- Implement the model using a suitable programming language or a machine learning library/framework.

3. Model Training:

- Feed the training data into the model and use an optimization algorithm (e.g., gradient descent) to update the model's parameters iteratively.
- Monitor the model's performance on the validation set during training to detect overfitting or underfitting and adjust hyperparameters accordingly.
- Continue training until the model achieves satisfactory performance on the validation set or converges to a stable state.

4. Model Testing:

- Once training is complete, evaluate the trained model's performance on a separate, unseen test dataset.
- Calculate various evaluation metrics (accuracy, precision, recall, F1 score, etc.) to measure the model's performance and assess its suitability for the problem at hand.
- Analyze the model's performance and make any necessary adjustments or improvements based on the evaluation results.

5. Deployment:

- Prepare the model for deployment by packaging it in a format suitable for the chosen deployment environment (e.g., a serialized model file or a containerized application).
- Integrate the model into the target system, which may involve writing code to handle input/output, data preprocessing, and interacting with other components of the system.
- Test the deployed model thoroughly to ensure it functions correctly in the production environment.
- Monitor the model's performance and collect feedback from real-world usage to continuously improve and update the model if necessary.

6. MACHINE LEARNING ALGORITHMS

1) Crop Prediction -Decision Tree (ID3 Algorithm) for Crop Prediction

The ID3 (Iterative Dichotomiser 3) algorithm is a classic decision tree algorithm used for classification tasks, including crop prediction in agriculture. It operates by recursively selecting the best attribute of the dataset to split the data at each step, with the objective of maximizing Information Gain.

2) Crop Recommendation – Random Forest Classifier

The Random Forest Classifier is a powerful ensemble learning algorithm commonly used for crop recommendation in agriculture. It leverages the collective wisdom of multiple decision trees to predict the most suitable crop for a given set of agricultural parameters, providing valuable insights to farmers.

3) Fertilizer Recommendation – Decision Tree Classifier

Select relevant features such as soil type, crop type, climate zone, and nutrient levels. Preprocess categorical features using label encoding to convert them into numerical values for model training. Traverse the tree from the root node to a leaf node to predict fertilizer recommendations for specific soil-crop-climate-nutrient combinations. Output personalized fertilizer recommendations based on the path taken through the decision tree and conditions met at each node. Provide recommendations on the types and quantities of fertilizers suitable for the input agricultural parameters.

4) Yield Prediction- Random Forest Regressor

Random Forest Regressor is an ensemble learning method that combines the predictions of multiple decision trees to improve the accuracy and robustness of yield predictions.The training dataset containing historical yield data and corresponding agricultural parameters is used to train the Random Forest Regressor .During training, each decision tree in the Random Forest learns to map the input features to yield predictions, optimizing for minimum variance or mean squared error. To predict crop production yield, new data instances representing current agricultural conditions are input into the trained Random Forest Regressor model.

7. PERFORMANCE OF ML MODELS

1) Crop Recommendation

The Following Crop recommendation results show that Random Forest achieved the highest accuracy of 99.31% and F1-Score of 0.99, outperforming other algorithms like Logistic Regression, Decision Tree, SVM, and Multilayer Perceptron. These metrics demonstrate the superior performance of Random Forest in the evaluated task.

2)Fertilizer Recommendation

The Following Crop recommendation results show that Random Forest achieved the highest accuracy of 99.31% and F1-Score of 0.99, outperforming other algorithms like Logistic Regression, Decision Tree, SVM, and Multilayer Perceptron. These metrics demonstrate the superior performance of Random Forest in the evaluated task.

Table 7.1: Comparision Between Different Machine Learning Models

Algorithm	Accuracy	Precision	Recall	F1-Score
Logistic Regression	94.54	0.95	0.95	0.94
Decision Tree	97.72	0.98	0.98	0.98
SVM	9.09	0.59	0.09	0.11
Multilayer Perceptron	95.22	0.96	0.95	0.95
Random Forest	99.31	0.99	0.99	0.99

Table 7. 2 : Comparision Between Different Machine Learning Models

Algorithm	Accuracy	Precision	Recall	F1-Score
Xgboost	92.34	0.93	0.93	0.92
LightGBM	97.72	0.96	0.97	0.97
Decision Tree	99.39	0.99	0.099	0.99
Random Forest	99.02	0.98	0.99	0.98

8. DEEP LEARNING ALGORITHMS

The dataset consists of 87,000 RGB images depicting healthy and diseased crop leaves, segmented into 38 specific classes for classification tasks. With an 80/20 split between training and validation sets, it maintains the directory structure for efficient data management. This rich and diverse collection of images serves as a comprehensive resource for training machine learning models to accurately identify and classify various plant diseases. The dataset's size and granularity enable thorough model evaluation and optimization, essential for improving crop health and yield prediction in agricultural applications.

8.1 PROCESS OF MODEL BUILDING

1. **Data Preparation:** Organize training and validation data directories and apply data augmentation techniques for improved model generalization.
2. **Model Initialization:** Load a pre-trained model suitable for the task, such as EfficientNetV2, and freeze its base layers to retain learned features.
3. **Model Customization:** Preprocess input data and add custom layers on top of the pre-trained model for fine-tuning and classification.
4. **Model Training:** Compile the model with appropriate optimization parameters and train it using the training dataset while validating its performance on the validation set.

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5. **Model Saving:** Save the trained model to a file for future use, deployment, or further experimentation.
6. **Training Progress Visualization:** Monitor and visualize training progress by plotting metrics like loss and accuracy over epochs to assess model performance and convergence.

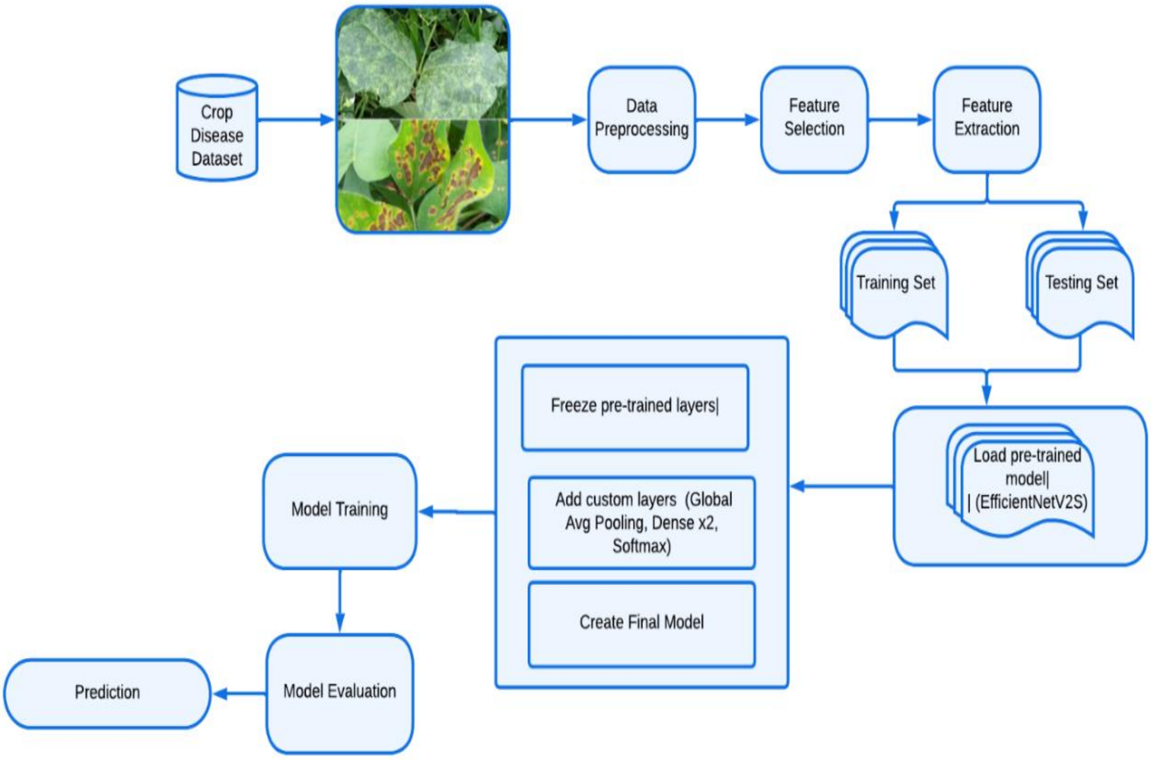

Figure 8.1 : EfficientNet Pretrained Model

8.2 MODEL TRAINING & VALIDATION

1. **Training Loss and Training Accuracy:**

- Training Loss: This represents the error of the model on the training dataset during the training process. It measures how well the model's predictions match the actual target values in the training data. The goal during training is to minimize the training loss.
- Training Accuracy: This measures the proportion of correctly classified samples in the training dataset. It indicates how well the model is learning to classify the training data correctly. The goal during training is to maximize training accuracy.

2. **Test Loss and Test Accuracy:**

- Test Loss: This represents the error of the model on a separate test dataset that was not seen during training. It measures how well the model generalizes to unseen data. The goal is to minimize the test loss.
- Test Accuracy: This measures the proportion of correctly classified samples in the test dataset. It indicates how well the model performs on new, unseen data. The goal is to maximize test accuracy.

3. **Interpretation:**

- Overfitting: If the training loss continues to decrease while the test loss starts to increase or plateau, it indicates overfitting. The model is memorizing the training data but fails to generalize well to unseen data.
- Underfitting: If both training and test losses are high, it indicates underfitting. The model is too simple to capture the underlying patterns in the data.
- Good Fit: Ideally, we want to see both training and test losses decrease, while training and test accuracies increase. This indicates that the model is learning effectively from the training data and generalizing well to unseen data.

4. **Plotting:**

- These metrics are often plotted over epochs during training to visualize the model's learning process.
- Decreasing training loss and increasing training accuracy over epochs indicate that the model is learning from the training data.

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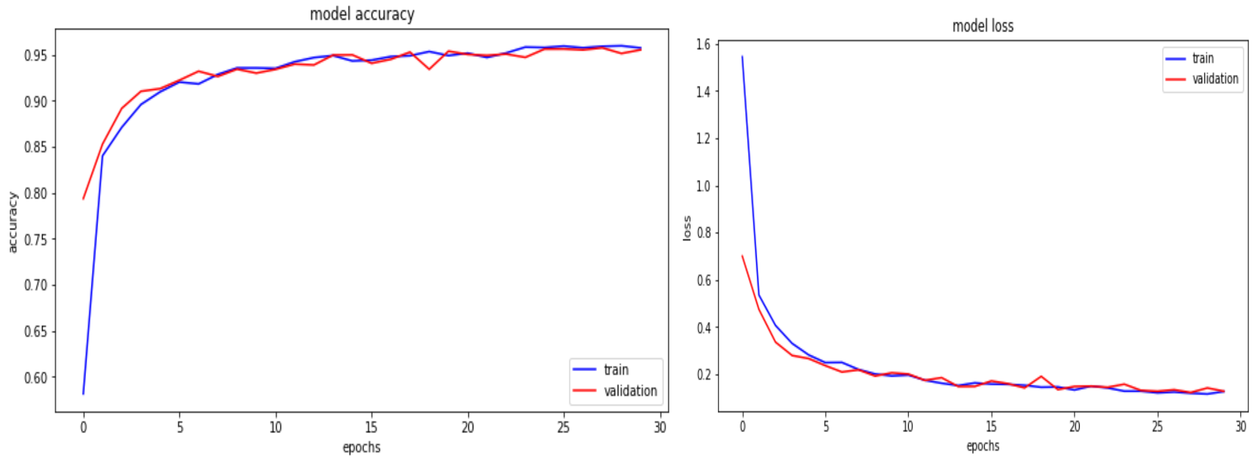

Figure 8.2. Model Training and Validation

8.3 PERFORMANCE OF DL MODELS

The performance of different architectures in plant disease detection, namely VGG16, ResNet50, and EfficientNetV2, was evaluated based on their training, testing, and validation accuracies. Among these architectures, ResNet50 and EfficientNetV2 showed higher accuracy rates compared to VGG16. Specifically, ResNet50 achieved a training accuracy of 96.02%, testing accuracy of 95.41%, and validation accuracy of 95.53%. On the other hand, EfficientNetV2 performed slightly better with a training accuracy of 96.06%, testing accuracy of 95.53%, and validation accuracy of 95.83%. These results indicate that both ResNet50 and EfficientNetV2 are effective in accurately detecting plant diseases, with EfficientNetV2 showing a slight edge in validation accuracy.

Table 8.3 : Comparision Between Different Deep Learning Models

Architectures	Training Accuracy	Testing Accuracy	Validation Accuracy
Vgg19	92.18	91.33	91.78
ResNet50	96.02	95.41	95.53
EfficientNetV2	96.06	95.53	95.83

9. FUNCTIONAL REQUIREMENTS

1. Farmer should be able to:

- Get recommendations for crop and fertilizers.
- ➢ Under the recommendation option, crop recommendation and fertilizer recommendation will tell which crop to be grown and which fertilizer to be used.
- Get predictions for crop, yield, and rainfall.
- ➢ Under the prediction option, crop prediction will predict the crop to be grown, yield prediction will predict the yield of the crop, and rainfall prediction will predict the rainfall for that area in millimeters.
- Get predictions for crop disease and Recommendations
- ➢ Get the type of disease affected as well as get the recommendation of the pesticides
- Do trading.
- ➢ The farmer will be able to trade crops, check the crop stocks and see the selling history.
- Able to access additional tools.
- ➢ This consists of a chatbot, news feed, and weather forecast which will help the farmer.

2. Customer should be able to:

- Check crop stocks.
- ➢ Stock for each crop is visible to the customer so that he can buy accordingly.
- Buy crops.
- ➢ The customer can select the crop and the quantity needed and buy it online.

3. Admin should be able to:

- See the customer’s list.
- ➢ A list of all the registered customers is visible to the admin.

- See the farmer's list.
- ➢ A list of all the registered customers is visible to the admin.
- See the queries.
- ➢ A list of all the queries is visible to the admin to answer them.

10. NON - FUNCTIONAL REQUIREMENTS

1. Performance requirements

➢ Response time should be minimum. The application should be responsive.

2. Security requirements

➢ User information should be kept secure. Unauthorized users should not be able to access the data. OTP-based authentication is provided to register through a mobile number.

3. Usability requirements

➢ The interface should be user-friendly. The application environment should be easy to use. It should be adaptable to all kinds of platforms.

4. Reliability requirements

➢ The system should behave consistently in a user-acceptable manner when operating within the environment for which the system is intended.

11. CONCLUSION

This paper presents the various machine learning algorithms for predicting the yield of the crop on the basis of weather and other conditions. This project develops a website for predicting crop yield, weather, and fertilizer recommendation using machine learning algorithms. The decision tree is found to provide the most accurate predictions for crop yield, weather, and fertilizer recommendation. The prediction system takes the inputs from the user and provides the best and most accurate predictive analysis for crop yield. The website also provides information on the best crop that is suitable and also which particular fertilizers are required for that crop. Results also revealed that the Random Forest classifier gives the highest weather prediction and fertilizer recommendation accuracy. These will not only help farmers maintain the proper crop supply to grow but also in cost management also it can be helpful. It will empower farmers to make informed decisions regarding crop selection, fertilizer usage, and overall cost management. The robustness and reliability of our system have been validated through experiments conducted on a reliable dataset.

12. FUTURE ENHANCEMENT

As a future scope, the web-based application can be made more user-friendly by targeting more populations by including all the different regional languages in the interface and providing a link to upload information instead of entering the test value manually. This research work can be enhanced to a high level by building a recommender system of agriculture production and distribution for farmers. By which farmers can make their own decision like which season which crop should sow so that they can get better profit. This system works for structured datasets or databases.

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