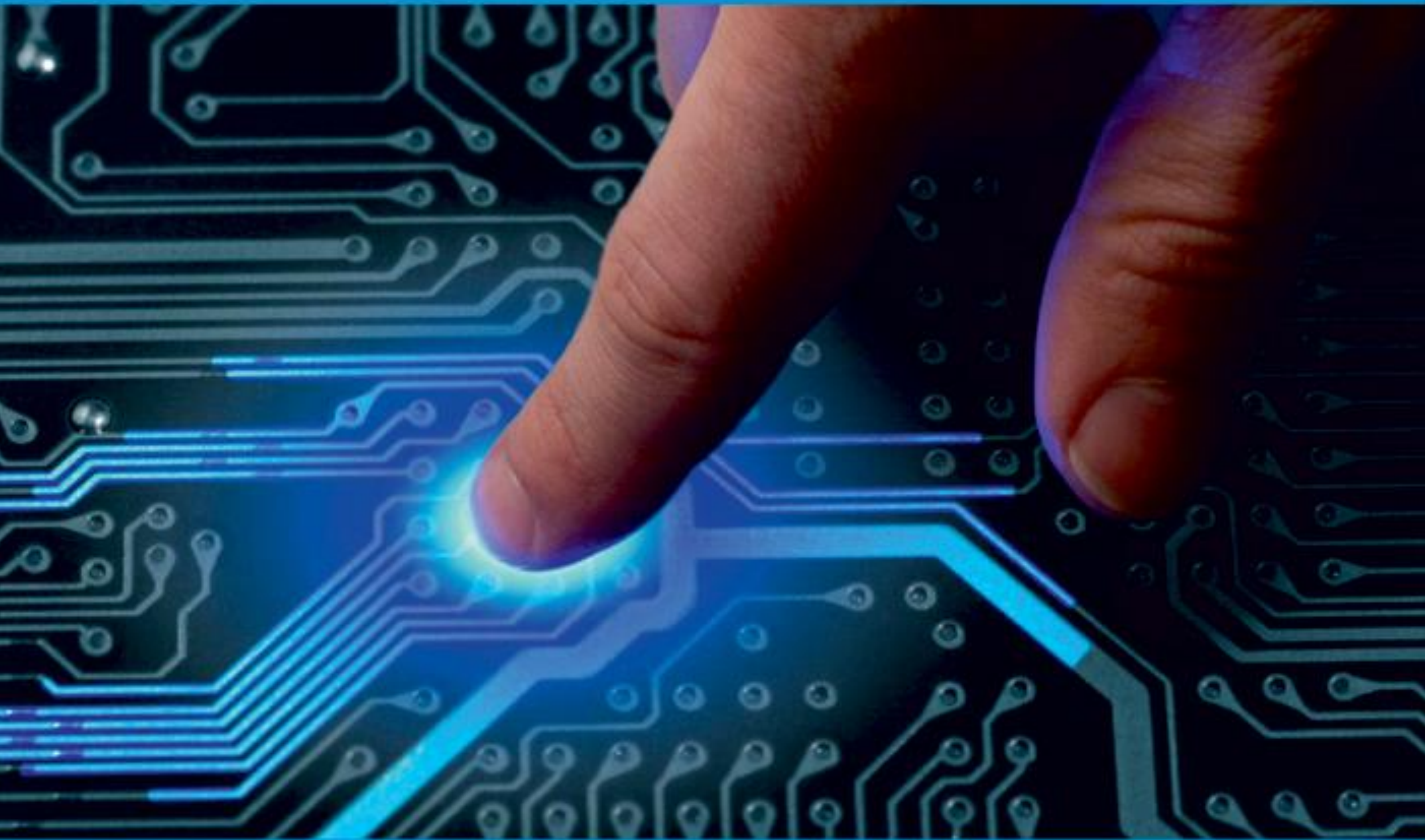
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1205307 |

NEXA Cultivate: Navigating Challenges and Pioneering AI-Driven Agriculture

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ABSTRACT: This project aims to revolutionize agriculture by integrating advanced technologies such as machine learning and deep learning. Leveraging datasets containing environmental factors, we employ the LightGBM algorithm to provide tailored crop recommendations, optimizing selection for better yields and sustainability. Additionally, we address plant disease detection and recognition using the Inceptionv3 algorithm, fine-tuning it via transfer learning for early disease intervention. To enhance user interaction, we introduce a chatbot interface for farmers to access real-time assistance on crop recommendations, disease detection, and agricultural insights. Our comprehensive solution empowers agriculturalists to make informed decisions, fostering innovation and sustainability in agriculture.

KEYWORDS**:** Agriculture revolution , Machine learning ,Deep learning, LihtGBM , Inceptionv3

I. INTRODUCTION

In response to today's agricultural challenges, our platform harnesses cutting-edge technology to provide holistic solutions. By utilizing machine learning algorithms, we address critical areas such as crop recommendation and plant disease detection. Through meticulous data handling, we train algorithms like LightGBM and Inceptionv3 to offer precise recommendations and revolutionize disease detection. With a user-friendly chatbot interface, we ensure accessibility and usability, empowering farmers with actionable insights. Our goal is to transform agricultural practices, empowering farmers and promoting sustainability in farming.

II. RELATED WORK

A. Crop Recommendation:

In recent years, several machine learning-based crop recommendation systems have been developed to assist farmers in making informed decisions about crop selection. Reddy et al. (2020) conducted a study using algorithms like K-Nearest Neighbor (KNN), Decision Tree (DT), Random Forest (RF), and Support Vector Machine (SVM) to predict the best crop for a given region based on factors like soil characteristics, climate, and topography. Their findings showed that the RF algorithm, with an accuracy of 96.5%, outperformed other algorithms. Similarly, Panda et al. (2021) proposed a crop recommendation system utilizing algorithms like Naive Bayes (NB), Decision Tree (DT), and Artificial Neural Network (ANN), achieving an accuracy of 90% with the ANN algorithm.

B. Crop Yield Prediction:

Sarfraz et al. (2012) initially investigated crop yield prediction using fuzzy logic to forecast wheat production, achieving an 84% prediction accuracy. Wang et al. (2020) employed deep learning methods, including convolutional neural networks (CNNs) and long short-term memory (LSTM) networks, to forecast maize crop yield based on satellite images and climate data. Their study demonstrated that the deep learning approach surpassed traditional regression models in accuracy.

C. Leaf Disease Detection:

Singh et al. (2020) presented a CNN- and transfer learning-based system for plant disease detection, achieving a 97.5% accuracy rate for spotting illnesses on tomato leaves. Amin et al. (2020) proposed a machine learning-based methodology for plant disease diagnosis using a hybrid feature extraction method and SVM classifier, achieving a 98.9% accuracy rate in detecting tomato leaf diseases.

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D. Pesticide Prediction:

Kumar et al. (2021) proposed a crop pesticide management system based on machine learning techniques like Support Vector Machine (SVM), K-Nearest Neighbor (KNN), and Decision Tree (DT). Their system forecasts the quantity of pesticide needed for a certain crop based on factors including soil type, crop type, and weather conditions, with the SVM system predicting pesticide needs with 88% accuracy. Bhatnagar et al. (2021) developed a pesticide management system using algorithms like Decision Tree (DT), Random Forest (RF), and Support Vector Machine (SVM), achieving an accuracy of 85.6% with the SVM algorithm, demonstrating its potential for use in pesticide management.

E. ChatBot

The chatbot harnesses advanced technologies like Random Forest and Artificial Neural Network for crop recommendation, fuzzy logic and deep learning for crop yield prediction, and deep neural networks for crop price prediction. For disease detection, it employs CNNs with transfer learning and hybrid feature extraction with SVM classifiers. In pesticide management, it utilizes Support Vector Machine and Decision Tree algorithms. Through natural language processing, the chatbot delivers tailored solutions, empowering farmers to optimize practices and enhance productivity sustainable.

III. PROPOSED ALGORITHMS

A. K-Nearest Neighbors (KNN) for Crop Yield Prediction:

In this proposed model, KNN is utilized for crop yield prediction based on user inputs like state name, district name, crop year, crop name, and area of the field. Similar to the Random Forest Regression approach, we scraped data from official government websites and applied various machine learning models. However, instead of Random Forest Regression, we employ KNN for its ability to find patterns in the data and make predictions based on similarity to neighboring data points. By calculating distances between data points, KNN estimates the yield in kilograms per hectare. Additionally, feature selection techniques like correlation coefficient and heatmap analysis are used to enhance model accuracy.

B. Support Vector Machine (SVM) for Crop Recommendation:

In this segment, we propose Support Vector Machine (SVM) as an alternative to Gaussian Naive Bayes for crop recommendation. By taking inputs like soil nutrient content, humidity, rainfall, and temperature, SVM is utilized to reduce the chance of wrong crop selection by farmers. SVM is chosen for its ability to handle high-dimensional data and find optimal hyperplanes to separate different classes. Feature selection techniques like correlation coefficient and heatmap analysis are employed to improve model accuracy.

C. VGG16 for Crop Disease Detection:

To complement the use of MobileNet, we introduce VGG16 as an alternative pre-trained model for crop disease detection. Similar to MobileNet, VGG16 is a convolutional neural network trained on the ImageNet dataset. By fine-tuning VGG16 on the collected dataset containing RGB images of healthy and diseased crop leaves, we aim to improve disease detection accuracy. The VGG16 model is trained and validated using a similar dataset split and achieves a validation accuracy of 93.2%.

D. Gradient Boosting Classifier for Pesticide Prediction:

For pesticide management, we propose Gradient Boosting Classifier as an alternative to Light Gradient Boosting Machine (LGBM). This model is trained on inputs such as estimated insect count, crop and soil categories, pesticide usage, and seasonal factors to predict crop health. By utilizing a dataset provided by the Government of India, the Gradient Boosting Classifier achieves an accuracy of 97.95% in classifying whether the crop is alive or damaged due to pesticides.

E. Chatbot:

The chatbot uses NLP to analyze user queries on agriculture, extracting key information like intent and topics through techniques such as tokenization and entity recognition. It then interacts with backend systems, employing machine learning algorithms to generate responses with actionable insights or recommendations. This streamlined process enables users to make informed decisions in agriculture.

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IV. RESULTS

A. Crop Yield Accuracy : Table 1 shows model name and MSE for crop yield.

Table 1. Crop Yield Accuracy

Model	Mean Square Error
KNN	0.11
Support vector regression	1.38
Linear regression	1.37

B. Crop Recommendation Accuracy : Table 2 shows model name and accuracy for crop recommendation.

Table 2. Crop Recommendation Accuracy

Model	Accuracy
Gaussian naïve Bayes	99.5%
Logistic regressions	94.5%
Support vector machine	96.1%
K-nearest neighbours	97.4%

C. Crop Disease Detection
Figure 1 shows training and validation curve for crop disease detection.

XGBoost	0.53

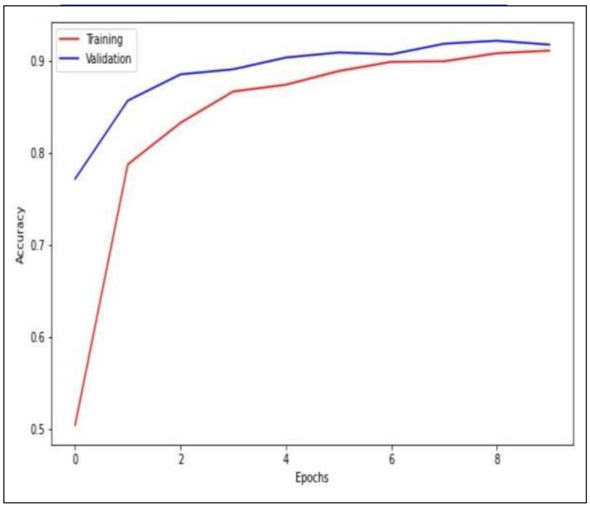

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Fig. 1. Training and validation comparison with respect to Accuracy and Epochs.

D. Pesticide Prediction

For Pesticide Management the model was able to achieve an accuracy of 97.9575% as shown in figure 2.

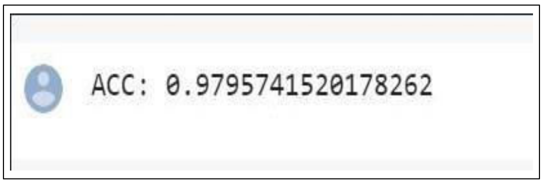

Fig. 2. Accuracy achieved using LGBM.

F . Integrated Web Application

We have developed an integrated web app that utilises all the proposed models and provides a all-in-one interface for all the features mentioned in this paper. Figure 3 and Figure 4 are some of the snippets of the web application developed.

V. CONCLUSION AND FUTURE ENHANCEMENT

In conclusion, our proposed system represents a comprehensive solution to address key challenges in modern agriculture, including crop recommendation and plant disease detection. By leveraging advanced technologies such as the LightGBM algorithm for crop recommendation and the Inceptionv3 algorithm for disease detection, we aim to empower farmers with data-driven insights and actionable recommendations. The integration of a user-friendly chatbot interface further enhances accessibility and usability, facilitating seamless interaction between farmers and the system. Through the collaborative efforts of data collection, preprocessing, model selection, training, and deployment, our system offers a holistic approach to agricultural decision-making, enabling farmers to optimize yields, mitigate risks, and foster sustainable practices. Moving forward, continued research and development in this field hold the potential to further revolutionize agriculture, paving the way for increased productivity, resilience, and food security on a global scale.

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