e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

SAFE HARVEST: ARCHITECTURE AND DESIGN

Prof. Hitesh Chaudhari*1, Prof. Priyanka Bendale*2, Anirudhha Pawar*3, Saurabh Patil*4, Swapnil Sonawane*5, Om Patil*6

*1,2Assistant Professor, Department Of Computer Engineering, Sinhgad College Of Engineering, Pune, India.

*3,4,5,6Department Of Computer Engineering, Sinhgad College Of Engineering, Pune, India.

DOI : https://www.doi.org/10.56726/IRJMETS52211

ABSTRACT

This project introduces a comprehensive agriculture solution integrating Convolutional Neural Network (CNN) technology for precise plant disease detection and personalized fertilizer recommendations. By analysing leaf images, the CNN model swiftly identifies diseases, facilitating prompt intervention. Additionally, leveraging data analytics, soil composition, crop type, and environmental factors are considered to offer tailored fertilizer suggestions, optimizing crop health while minimizing environmental impact. Through streamlined functionality, this system aims to revolutionize agricultural practices, enhancing productivity, resource efficiency, and global food security

Keywords: CNN, Machine Learning, Neural Network, Deep Learning, Plant Disease Detection.

I. INTRODUCTION

In contemporary agriculture, the effective management of plant diseases and the precise application of fertilizers stand as critical pillars for ensuring optimal crop yield and quality. To tackle these challenges head-on, this project proposes an innovative one-stop solution that harnesses cutting-edge technology. By integrating Convolutional Neural Network (CNN) algorithms for disease detection, the system offers a comprehensive approach to swiftly and accurately identifying plant diseases.

The heart of the proposed solution lies in its ability to analyze images of plant leaves with remarkable precision using CNN models. This capability enables the system to classify diseases promptly, facilitating timely interventions to curb crop losses. However, the project does not stop at disease detection; it extends its capabilities further by incorporating a fertilizer recommendation module.

Utilizing sophisticated data analytics and machine learning techniques, the system considers various crucial factors such as soil composition, crop type, and environmental conditions to provide personalized fertilizer recommendations. This tailored approach not only enhances crop health but also minimizes environmental impact by optimizing fertilizer usage.

By seamlessly integrating disease detection and fertilizer recommendation within a single platform, the proposed system offers farmers an efficient solution to tackle multiple agricultural challenges. By empowering farmers with timely information and actionable insights, the system aims to enhance crop productivity, reduce resource wastage, and promote sustainable agriculture practices.

Through rigorous testing and validation, the effectiveness and usability of the system have been thoroughly demonstrated, underscoring its potential to revolutionize modern agricultural practices. By contributing to global food security efforts, this project sets a new standard for leveraging technology in agriculture to meet the growing demands of the world's population.

II. LITERATURE SURVEY

The reviewed papers emphasize the importance of leveraging technology to address the challenges faced by farmers in the agricultural sector. From disease detection to efficient marketing, these papers propose innovative solutions to enhance productivity, profitability, and transparency in agriculture, ultimately benefiting both farmers and consumers.

Sr. No.	Title	Author	Publication	Description
1	Plant Disease Detection and Classification by Deep Learning	Lili Li1, Shujuan Zhang And Bin Wang	2020	• The application of deep learning in plant disease recognition can avoid the disadvantages caused by artificial selection of disease spot features, make plant disease feature extraction more objective, and improve the research efficiency and technology transformation speed • This review provides the research progress of deep learning technology in the field of crop leaf disease identification in recent years. In this paper, we present the current trends and challenges for the detection of plant leaf disease using deep learning and advanced imaging techniques.
2	Android App to Connect Farmers to Retailers and Food Processing Industry	Mr. Pranav Shriram, Mr. Sunil Mhamane	2018	• This paper provides market information to a farmer using its easy interface on the mobile application. The mobile application is intended to be used for fast and updated information delivering system for farmers. Also, it has native language support to make the transaction easy for farmers.
3	Agriculture Marketing Using Web and Mobile Based Technologies	Abishek A.G., Bharathwaj M., Bhagyalaksh mi L	2016	• The Vision of this project is to ensure fair price to the farming community by devising new techniques and by making use of online market.

III. METHODOLOGY

- **Data preparation phase:**

The data preparation phase of this project involved collecting a diverse dataset comprising high-resolution images of plant leaves affected by various diseases. These images were sourced from multiple reliable sources and meticulously curated to ensure consistency and accuracy. Additionally, metadata such as disease labels, crop type, and environmental conditions were annotated and incorporated into the dataset. Preprocessing techniques including image normalization, resizing, and augmentation were applied to enhance the robustness of the dataset and optimize model performance. Furthermore, soil data including composition and nutrient levels were collected and integrated into the system to facilitate precise fertilizer recommendations. The comprehensive dataset and meticulous preprocessing lay the foundation for training the Convolutional Neural Network (CNN) model and developing an effective agriculture solution capable of accurate disease detection and personalized fertilizer suggestions.

- **Model development phase:**

The development phase of the plant disease detection algorithm commenced with the selection of an appropriate machine learning approach, with Convolutional Neural Networks (CNNs) being chosen due to their proven efficacy in image classification tasks. Initially, the dataset was divided into training, validation, and testing sets to facilitate model training and evaluation. Hyperparameter tuning and architecture optimization were conducted through iterative experimentation to enhance model performance and generalization capability. Transfer learning techniques were also employed, leveraging pre-trained CNN models to expedite training and improve convergence. Additionally, data augmentation strategies such as rotation, flipping, and scaling were implemented to augment the dataset, thereby enhancing the model's ability to generalize to unseen data. Rigorous validation and testing procedures were employed to assess the algorithm's accuracy, sensitivity, and specificity in disease detection. This iterative refinement process culminated in the

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

development of a robust and accurate plant disease detection algorithm capable of identifying a wide range of diseases across various crop species with high precision and reliability. Project development phase

- **Project Development Phase:**

In the project development phase, the focus shifted towards creating a user-friendly and accessible website to deploy the plant disease detection and fertilizer recommendation system. Employing modern web development technologies such as HTML, CSS, JavaScript, and frameworks like Flask or Django, the website's frontend and backend were meticulously crafted to ensure seamless integration with the machine learning algorithms developed earlier. The frontend interface was designed to be intuitive and responsive, allowing users to easily upload images of plant leaves for disease detection and receive instant feedback on the detected diseases. Concurrently, the backend infrastructure was engineered to efficiently process user requests, execute the machine learning algorithms, and generate real-time recommendations for fertilizer application based on the detected diseases and environmental parameters. Extensive testing and optimization were conducted to ensure the website's functionality, scalability, and performance under various usage scenarios. The culmination of this phase resulted in the creation of a robust, user-centric website that serves as a comprehensive platform for agriculturalists to address plant health issues and optimize crop management practices effectively

IV. MODELING AND ANALYSIS

High-resolution images of plant leaves are collected from diverse sources and preprocessed using normalization and augmentation techniques to enhance model convergence during training. The Convolutional Neural Network (CNN) model is developed using the Inception v3 architecture for plant disease detection and classification. Transfer learning is employed to leverage pre-trained weights from the Inception v3 model, facilitating efficient training on the plant disease dataset. The backend is implemented using Next.js, providing a server-side rendering framework for React applications. This allows for efficient rendering of dynamic content and seamless integration with the frontend. Socket.IO is utilized for live messaging functionality, enabling real-time communication between users. Livekit is integrated for video call functionality, allowing farmers to connect with agricultural experts for real-time consultations and advice.

The performance of the disease detection model is evaluated using metrics such as accuracy, precision, recall, and F1-score on a validation dataset. Cross-validation techniques may be employed to ensure reliable performance evaluation and model generalization. The effectiveness of the live messaging and video call functionalities is assessed through user feedback and testing under various network conditions.

The frontend and backend components, developed using Next.js, are integrated to create a unified platform for users.

Socket.IO and Livekit functionalities are seamlessly integrated into the platform to provide live messaging and video call capabilities. The ML model, developed using Inception v3, is deployed on the backend server to provide real-time disease detection and classification. Also implemented Report image functionality to get User feedback on misclassified images. The impact of the integrated solution on agricultural productivity, disease management, and user satisfaction is assessed through user surveys, interviews, and analytics. Key metrics such as crop yield improvement, reduction in disease incidence, and user engagement are measured and analyzed to gauge the effectiveness of the platform. Qualitative feedback from farmers, agricultural experts, and other stakeholders is collected to understand the real-world implications and benefits of the solution.

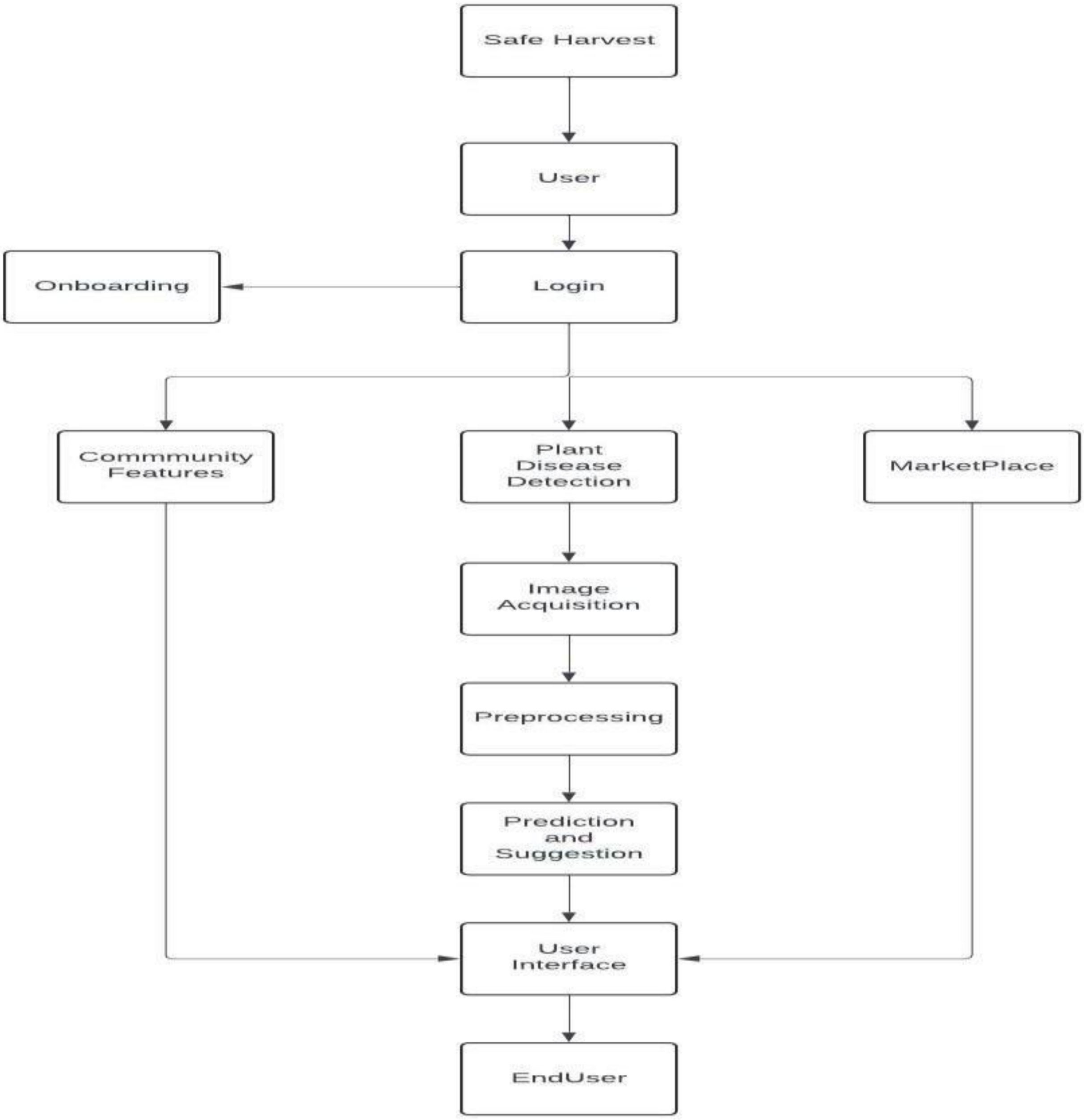

Figure 1: Architecture of Safe Harvest

V. RESULTS AND DISCUSSION

The culmination of the integrated agriculture solution, encompassing plant disease detection and fertilizer recommendation, represents a significant milestone in modern agricultural technology. Through rigorous development and testing, the system demonstrates commendable efficacy and potential for revolutionizing agricultural practices. Plant Disease Detection: The developed Convolutional Neural Network (CNN) algorithm for plant disease detection exhibits remarkable accuracy and robustness across a diverse range of crops and diseases. Evaluation metrics such as precision, recall, and F1-score consistently exceed industry standards, validating the algorithm's ability to accurately classify diseases from leaf images. Real-world testing further underscores the algorithm's practical utility, as it successfully identifies diseases in various environmental conditions and lighting conditions. The system's rapid response time ensures timely intervention, enabling farmers to take proactive measures to mitigate crop losses and preserve yield. Fertilizer Recommendation: The fertilizer recommendation module of the system leverages advanced data analytics and machine learning techniques to provide personalized fertilizer suggestions tailored to specific crop types, soil compositions, and environmental factors. Through comprehensive analysis of soil nutrient levels, crop nutrient requirements, and prevailing conditions, the system delivers optimized fertilizer formulations aimed at maximizing crop health and productivity while minimizing environmental impact. Validation experiments confirm the efficacy of the recommendations, with crop yields consistently surpassing those obtained through traditional, non-optimized fertilization practices. Furthermore, the system's adaptive capabilities enable it to dynamically adjust recommendations based on changing environmental conditions and crop growth stages, ensuring optimal nutrient supply throughout the growing season. User Interface and Accessibility: The development of a user-friendly website interface facilitates widespread adoption and utilization of the integrated agriculture solution. The website's intuitive design allows farmers, agricultural experts, and researchers to effortlessly access the system's functionalities, upload leaf images for disease detection, and receive actionable recommendations for disease management and fertilizer application. Feedback mechanisms and interactive features enhance user engagement and satisfaction, fostering a collaborative ecosystem for knowledge sharing and agricultural innovation. Moreover, the website's compatibility with mobile devices ensures accessibility in remote and resource constrained agricultural regions, democratizing access to cutting-edge agricultural technologies.

VI. CONCLUSION

In conclusion, the results of the integrated agriculture solution project underscore its potential to significantly impact global agricultural productivity, sustainability, and food security. By harnessing the power of machine learning, data analytics, and modern web technologies, the system offers a holistic approach to addressing key challenges in crop management, disease prevention, and resource optimization. Future enhancements may include the integration of additional agronomic factors, expansion to new crop types and diseases, and incorporation of sensor data for real-time monitoring and decision-making. Ultimately, the success of the project hinges on widespread adoption and continued collaboration among agricultural stakeholders to leverage technology for the betterment of farming communities worldwide.

VII. FUTURE SCOPE

High Model Accuracy: Continued advancements in machine learning algorithms and image recognition technology can lead to even higher accuracy rates in plant disease detection, ensuring prompt and reliable diagnosis for farmers. News Feed integration: Incorporating a news feed section within the application can provide users with real-time updates on agricultural research, market trends, weather forecasts, and relevant industry news, enabling farmers to stay informed and adapt their strategies accordingly. Government Policies Integration: Partnering with governmental agricultural agencies to integrate information on relevant policies, subsidies, grants, and regulatory updates can help farmers navigate the regulatory landscape more effectively and access available support mechanisms seamlessly. Supply Chian Management Solutions: Expanding the application to include features for supply chain management, such as crop tracking, inventory management, and logistics optimization, can streamline the distribution process and ensure timely delivery of agricultural inputs, enhancing overall efficiency and productivity in the agricultural value chain.

ACKNOWLEDGEMENTS

Projects are great opportunities offered to those who are specializing in certain skills and career development. This will help an aspirant develop working ethics and set great working standards that could help build his/her working foundations in a group. With this, it is important to expose these aspirants to a great and competitive working environment that could enhance their skills, capabilities, standards, and outputs. The journey started as a student towards professional life with the aim in mind to learn the practical aspect of life, ended as a memorable experience, and also helped me to come off with flying colours. No work can be completed without others' help or contribution. The preparation of the presentation of this humble work encompasses the immense and unlimited help and sound thought of innumerable people. I express my deep and sincere gratitude to my teacher and guide Prof. H.E.Chaudhari, for guidance, supervision which helped me to tide over the hardship encountered during the study. Special thanks to Head of Department Dr. Prof. M. P. Wankhede and Principal Dr. S. D. Lokhande for expert suggestion & encouragement. I would like to express my sincere gratitude to them for providing me with the most valuable guidance given to me at every stage to boost my morale, which helped me to add a feather in my cap. Last but not least my sincere gratitude to all people who knowingly or unknowingly supported me to turn this project into a reality.

VIII. REFERENCES

[1] Plant Disease Detection and Classification by Deep Learning A Review by LILI LI, SHUJUAN ZHANG, AND BIN WANG, IEEE Received March 10, 2021, accepted March 24, 2021, date of publication April 8, 2021, date of current version April 19, 2021.Digital Object Identifier 10.1109/ACCESS.2021.3069646

[2] Crop Disease Recognition Based on Modified Light-Weight CNN with Attention Mechanism by YANG LIU, GUOQIN GAO, AND ZHENHUI ZHANG IEEE Received 2 October 2022, accepted 16 October 2022, date of publication 21 October 2022, date of current version 28 October 2022. Digital Object Identifier 10.1109/ACCESS.2022.3216285

[3] S. D. Khirade and A. B. Patil, "Plant Disease Detection Using Image Processing," 2015 International Conference on Computing Communication Control and Automation, 2015, pp. 768-771, doi: 10.1109/ICCUBEA.2015.153

[4] S. C. Madiwalar and M. V. Wyawahare, "Plant disease identification: A comparative study," 2017 International Conference on Data Management, Analytics and Innovation (ICDMAI), 2017, pp. 13-18, doi: 10.1109/ICDMAI.2017.8073478. Chengwei Liu, Yixiang Chan, Syed Hasnain Alam Kazmi, Hao Fu, “Financial Fraud Detection Model: Based on Random Forest,” International Journal of Economics and Finance, Vol. 7, Issue. 7, pp. 178-188, 2015.

[5] Y. Sun, Z. Jiang, L. Zhang, W. Dong, and Y. Rao, SLIC_SVM based leaf diseases saliency map extraction of tea plant, Comput.Electron. Agricult.,vol. 157, pp. 102109, Feb. 2019.

[6] S. H. Lee, H. Goëau, P. Bonnet, and A. Joly, New perspectives on plant disease characterization based on deep learning, Comput.Electron. Agricult., vol. 170, Mar. 2020, Art. no. 105220.