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AI BASED TOOL FOR PREDICTING AGRICULTURAL PROBLEMS

GUIDED BY

Dr.RANICHANDRA C

SUBMITTED BY

- 1)T.PREM - 21BIT0621
- 2)K.SHIVANI - 21BIT0681
- 3)S.LOGAPRIYA - 21BIT0685
- 4)B.SANGEETHA - 21BIT0689
- 5)T.SIVA – 21BIT0693

ABSTRACT :

Artificial intelligence (AI) has shown to be a game-changer in the field of contemporary agriculture. This abstract presents the idea for a AI application that uses plant scanning technologies to anticipate and alleviate agricultural issues. This cutting-edge smartphone application's main goal is to give farmers, agricultural specialists, and hobbyists a convenient tool for proactive management and early identification of plant-related problems.

The application uses artificial intelligence (AI) methods, such as computer vision and machine learning, to evaluate photos that users take when scanning plants with their mobile devices. The application scans a plant, interprets the picture data rapidly, and produces a detailed report detailing the problems found, along with recommendations for remedies and actions. The suggested smartphone application with artificial intelligence offers a novel.

KeyWords: Artificial Intelligence (AI), Agriculture, Plant Disease Detection, Machine Learning (ML), Deep Learning, User Interface, Website Application

INTRODUCTION :

With millions of people depending on agriculture for their livelihoods and food security, it is an essential part of the world economy. On the other hand, plant diseases represent a serious risk to agricultural output and cause large losses in crops every year. Traditional disease detection techniques can be labor-intensive, unreliable, and prone to human error since they frequently rely on visual inspections and the knowledge of farmers and agronomists. Artificial intelligence (AI) presents a game-changing answer to these problems given the speed at which technology is developing.

AI-based solutions automate plant disease identification and diagnosis by utilizing computer vision methods and machine learning algorithms. These technologies are able to precisely and early detect illness signs by examining high-resolution photos of plant leaves, which allows for prompt action.

OBJECTIVES :

The primary objective of this project is to develop an advanced AI-based tool for predicting and preventing agricultural leaf diseases. Our aim is to create a comprehensive system that seamlessly integrates artificial intelligence, streamlining the entire process from data collection to disease prediction. We intend to enhance the efficiency of data collection by implementing user-friendly features, including image capture and relevant data points, making the tool accessible to farmers with varying technical expertise. Advanced data preprocessing algorithms will be implemented to handle missing data, outliers, and normalization, ensuring the accuracy of information used for disease prediction. The system will utilize sophisticated AI models to analyze preprocessed data and provide farmers with accurate predictions of potential diseases, along with actionable recommendations.

A key focus is on designing an intuitive and user-friendly mobile app interface to empower farmers in making informed decisions by fostering a culture.

LITERATURE REVIEW :

1.Applications for Detecting Plant Diseases Based on Artificial Intelligence

The paper “Applications for Detecting Plant Diseases Based on Artificial Intelligence” by Bitaparga Zen , Iqsyahiro Kresna A, Diandra Chika Fransisca explores the applications discussed in the article and their significance in the field of plant disease detection using artificial intelligence. Reviews existing literature related to applications of artificial intelligence in detecting plant diseases. This might include discussing various techniques, algorithms, and datasets used in the field.

2. Plant Disease Detection Using Image Processing and Machine Learning

This paper presents a discursive literature survey on the Plant Disease Detection Using Image Processing and Machine Learning. The agriculture field faces many problems from cultivating to harvesting. plant disease detection methods, emphasizing the integration of image processing and machine learning. Discuss various approaches, algorithms, and datasets used in the field.

3.Application of Artificial Intelligence in detection of disease in plants : A survey

This research paper “Application of Artificial Intelligence in detection of disease in plants : A survey“ explains a brief overview of the application of intelligence in agriculture and its available techniques for agriculture. And also it explains about the various methods for the detection of diseases in crop. This paper highlights the potential benefits of AI in improving crop yield and addressing disease-related challenges.

This paper explains the concept of artificial intelligence and its rapid advancement across various industrial sectors. It emphasizes AI's ability to solve complex problems and contribute to environmental preservation. The transformative impact of AI on agriculture is noted, replacing traditional methods with more efficient techniques.

4.Artificial Intelligence-Based Robust Hybrid Algorithm Design and Implementation for Real-Time Detection of Plant Diseases in Agricultural Environments

The article titled "Artificial Intelligence-Based Robust Hybrid Algorithm Design and Implementation for Real- Time Detection of Plant Diseases in Agricultural Environments" explores the integration of AI techniques to enhance plant disease detection in agriculture. The paper emphasizes the importance of timely disease identification for ensuring crop yield and quality. It presents a hybrid algorithm that combines computer vision, machine learning, and deep learning approaches to analyze plant images and diagnose diseases accurately in real-time.

The article discusses the strengths and limitations of various AI techniques, proposes the hybrid algorithm's design, describes its implementation and results, and outlines potential future directions for enhancing its capabilities. Overall, the paper highlights the transformative potential of AI in revolutionizing plant disease management and its implications for sustainable agriculture.

5.Survey on AI-Based systems in Agricultural Field

This paper “Survey on AI-Based systems in Agricultural Field” by Amitava Podder et al explores the potential benefits, challenges, and future prospects of implementing Artificial Intelligence (AI) technology in the agricultural sector. The authors emphasize the significance of agriculture in the economy and highlight the challenges faced by the industry, including climate changes, natural calamities, and limited resources.

This paper conducts an extensive literature review of academic journals, research papers, and industry reports to provide insights into how AI can revolutionize the agricultural sector. The authors identify several key areas where AI-based systems can have a transformative impact: Crop yield production, crop disease detection, precision farming, automation, data analytics, IoT-enabled solutions, sustainability.

This paper also addresses challenges hindering the adoption of AI in agriculture such as data accessibility, cost, technical expertise, and ethical concerns.

6.Implementation of Artificial Intelligence in Agriculture for Optimization of Irrigation and Application of Pesticides and Herbicides

This paper discusses the significant role that agriculture plays in the economy, along with the challenges presented by the increasing global population. With rising demands for food and employment, traditional farming methods become inadequate, necessitating the introduction of automated techniques. This paper provides an idea of these following areas: Role of AI in agriculture, Automation and AI in agriculture, AI application in agriculture, Weeding systems through robots and drones, Soil water sensing and automation, Drones for spraying and crop monitoring.

The paper presents a comprehensive overview of the implementation of AI in agriculture for optimizing irrigation, pesticide application and herbicide management. It highlights the transformative impact of automation and AI technologies on various aspects of agriculture, ultimately contributing to improved productivity and sustainability in the sector.

7.A Review on Artificial Intelligence Techniques for Disease Recognition in Plants

The article titled "A Review on Artificial Intelligence Techniques for Disease Recognition in Plants" discusses the application of artificial intelligence (AI) techniques, particularly machine learning and image processing, for the detection and recognition of diseases in plants. The paper highlights the importance of early disease detection in crops to prevent economic losses and ensure the quality and safety of agricultural products. The authors emphasize that traditional manual methods of disease identification are time-consuming, labor-intensive, and less accurate compared to AI-based techniques.

The authors also cite and discuss various specific studies conducted by researchers around the world. These studies include using techniques like fractal descriptors, neural networks, Gabor filters, and color space transformations for disease identification in different crops such as rice, wheat, soybean, cotton, and more.

8.Artificial Intelligence-Based Drone System for Multiclass Plant Disease Detection Using an Improved Efficient Convolutional Neural Network

This research paper is related to an artificial intelligence-based drone system for plant disease detection using an improved Efficient Convolutional Neural Network (CNN). The paper discusses the importance of agricultural development, the challenges posed by plant diseases, and how AI and drones can be used to address these challenges. The proposed approach involves an improved EfficientNetV2-B4 model for classifying plant diseases using deep learning.

This article shows a comprehensive approach to using AI and drones for plant disease detection, and it demonstrates the performance of the proposed model on a standard dataset. It also compares the proposed approach with existing methods to highlight its advantages.

9.Plant disease identification using Artificial intelligence: Machine learning approach

This paper “Plant disease identification using Artificial intelligence: Machine learning approach” by Jubin Dipakkumar Kothari explores the data collection, data preprocessing, feature extraction, model Selection, model training, model evaluation and future research, improvements to the methodology. The section interprets the results, compares the model's performance with existing methods, and highlights the advantages and limitations of the proposed approach.

Here, the paper reviews existing literature related to plant disease identification methods, both traditional and modern. It highlights the limitations of traditional methods and the potential advantages of using artificial intelligence techniques.

10.Using Deep Learning for Image-Based Plant Disease Detection

The paper “Using Deep Learning for Image-Based Plant Disease Detection” by S P Mohanty, D P Hughes, M Salathé explores the methodology used for image-based plant disease detection using deep learning. Reviews existing literature related to plant disease detection methods, focusing on the application of deep learning techniques to image analysis. Discusses various deep learning architectures, transfer learning, and datasets used in the field.

11. A comprehensive review on detection of plant disease using machine learning and deep learning approaches

This article explores the application of machine learning and deep learning techniques for detecting plant diseases. They emphasize that diseases caused by bacteria, fungi and viruses are major factors contributing to low crop yields. The authors suggest that plant disease detection methods can help prevent and manage such diseases.

This article discusses the suitability of machine learning techniques for disease identification in plants due to their ability to work with the data and provide effective detecting methods. They review various methods, including Gaussian Naive Bayesian, K-Nearest Nearest Neighbour, Decision trees, Support Vector Machines, Random Forest, and Multi-Layer perceptron (MLP) classifiers, explaining their relevance and applications in agriculture.

Deep learning techniques ,specifically Convolutional Neural Networks(CNNs) , are also explored. They discuss different deep learning models such as Inception V4 and VGG-16 ,emphasizing their potential for accurate disease identification.

12.Machine learning for detection and prediction of crop diseases and pests:A comprehensive survey

In this paper focused on traditional ML techniques: in a comparison of ML algorithms for predicting the yield of soybean crops is presented; in research papers from the last ten years for predicting the start of disease at an early or presymptomatic stage are analysed and categorised; in , the possibility of using different ML techniques in agriculture are discussed, but most of the present work is about statistical forecasting methods from weather data for predicting wheat yield. Since the mentioned surveys do not simultaneously cover forecasting, detection, and classification of diseases and pests, and do not fully explore recent deep learning-based techniques, the review performed in this paper aims to fill the gaps on these subjects. The literature review presented in this paper also aims to provide guidance on the development of such ML-based tools, in order to provide farmers with data-driven decision making assistance systems.

13.Performance Analysis of AI-based Learning Models on Leaf Disease Prediction

The objective of the paper is diseases on the leaves of a plant have a great effect on agriculture. Around 70-75% of the Indians are totally dependent on agriculture. Diseases on plant leaves reduce the yield and quantity of the product. In this paper, the different analysis of methods are used to detect plant leaf diseases using various machine learning (ML) algorithms such as Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Naive-Bayes, Logistic Regression, Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Back propagation, Genetic algorithm and Probabilistic Neural Network (PNN) was done. The SVM algorithm which is used to detect tomato plant leaf diseases gives 96% prediction whereas the Back Propagation algorithm which is used to detect groundnut leaf diseases obtained 97.41% prediction. Our work focuses on the analysis of various leaf disease detection techniques and also provides an overview of various image processing techniques. The main purpose of the paper is to support the identification of plant affected by various diseases. A comparative analysis of various leaf disease detection has been done in this paper.

14.A Survey on Diseases Detection for Agriculture Crops Using Artificial Intelligence

The article discusses how AI has made significant advancements in the field of agriculture, particularly in ensuring crop yield and health. Unpredictable weather conditions and other factors can lead to crop losses, making disease detection crucial. This article cover the topic includes Image Acquisition, Image Preprocessing, Image Segmentation.

The article emphasizes the importance of AI in automating and improving the plant disease identification process. It mentions several machine learning techniques and models used for classification, including SVM, CNN, and ANN. The focus is on achieving higher accuracy rates in disease detection and classification.

MODULES :

- Data Collection Module
- Data Preprocessing Module
- Feature Extraction Module
- Model selection Module
- Model training Module
- Prediction Module
- User interface

Data Collection Module:

Collecting an image dataset for an AI-based agricultural disease prediction tool involves obtaining high-resolution images of leaves. These images should cover various growth stages, lighting conditions, and disease manifestations. Each image must be meticulously labeled to indicate the presence or absence of specific diseases. To enhance the model's generalization, data augmentation techniques such as rotation, scaling, and flipping can be applied. It is crucial to ensure a balanced representation of healthy and diseased samples in the dataset. The quality and diversity of the image dataset play a pivotal role in training a robust model capable of accurately identifying and predicting agricultural diseases based on visual cues.

Data Preprocessing Module:

Data preprocessing is a pivotal stage in the development of an AI-based tool for predicting agricultural diseases, aiming to refine the input dataset and optimize it for effective machine learning model training. This process encompasses several key steps, starting with data cleaning, which involves eliminating redundant or irrelevant information and handling missing data through imputation or removal. Image resizing and normalization ensure standardized resolutions and pixel values across images, promoting consistency. Data augmentation techniques, such as rotation and flipping, augment the dataset to enhance model generalization by exposing it to diverse variations. Balancing classes is crucial to prevent biases during training, achieved through oversampling or undersampling techniques. Label encoding transforms categorical labels into numerical representations for model compatibility, and the dataset is further divided into training and testing sets for evaluation. Outliers are identified and addressed, and feature scaling is applied if necessary. Finally, a thorough quality check ensures the integrity of the preprocessed dataset, laying the groundwork for training a robust and accurate model capable of predicting agricultural diseases effectively.

Feature Extraction Module:

Feature extraction in image processing is a fundamental step aimed at distilling pertinent information from images for various computer vision applications. The process involves capturing essential characteristics, patterns, and details that contribute to image analysis tasks such as object recognition, image classification, and segmentation. Common techniques include the conversion of images to different color spaces, statistical measures of pixel intensity, and the use of histograms to represent pixel distributions.

Model Selection Module:

Choosing a machine learning model for an AI-based agricultural disease prediction tool involves considering factors such as the problem type (classification or regression), data characteristics, interpretability, and resource constraints. Options range from simpler models like Logistic Regression to complex ones like Convolutional Neural Networks for image data. Ensemble methods can enhance performance, and cross-validation with hyperparameter tuning ensures robustness. Domain expertise guides the decision, and the selection aligns with specific evaluation metrics tailored to the tool's objectives in predicting agricultural diseases.

Model Training Module:

Model training in an AI-based tool for predicting agricultural diseases is a crucial phase where the selected machine learning or deep learning model learns patterns and relationships from the preprocessed dataset. During training, the model adjusts its parameters based on the input data to minimize the difference between predicted and actual outcomes. For supervised learning, the model is fed labeled examples of healthy and diseased crops, and it iteratively refines its predictions through a process known as backpropagation. The training process involves optimizing the model's weights and biases to improve its ability to generalize to unseen data. Parameters such as learning rate, batch size, and epochs are fine-tuned to achieve optimal performance. Cross-validation techniques may be employed to assess the model's robustness, and hyperparameter tuning helps optimize its configuration. The trained model is then ready for deployment, offering a predictive tool that can assist farmers in identifying and managing agricultural diseases effectively.

Prediction Module:

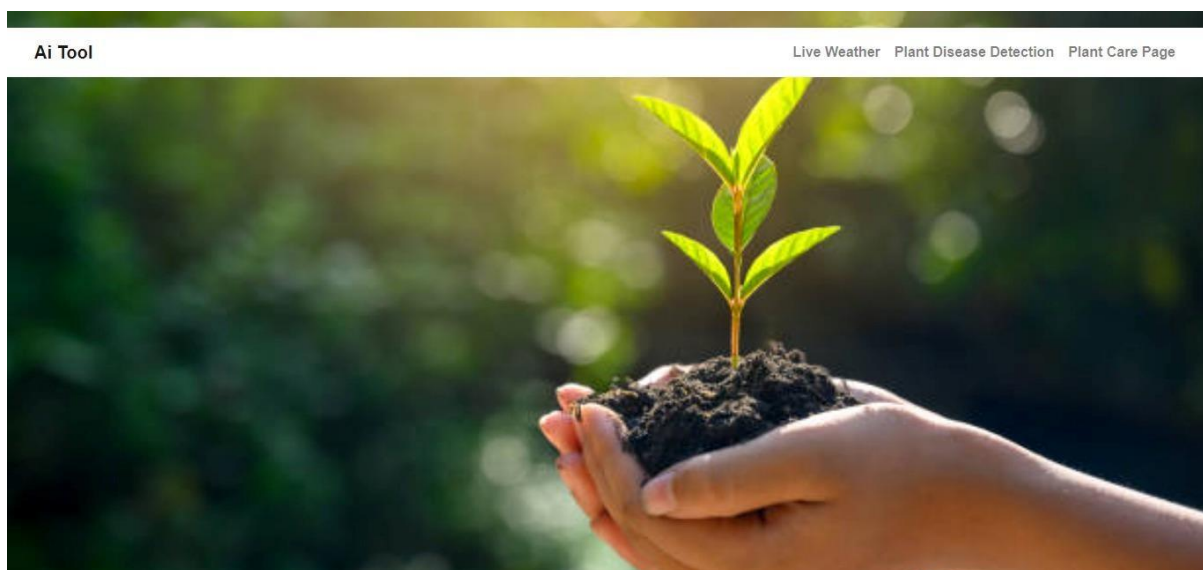
The prediction module in an AI-based tool for predicting agricultural diseases is the component responsible for applying the trained model to new, unseen data to make real-time predictions. This module takes input in the form of images or relevant agricultural data, preprocesses the information, and then passes it through the trained model. The model leverages the learned patterns and relationships to predict the likelihood of diseases affecting crops. The predictions generated by the module provide farmers with valuable insights into the health status of their crops, enabling timely interventions and management strategies. The effectiveness of the prediction module is a culmination of the model training process, data quality, and the tool's ability to generalize to diverse agricultural conditions. Regular updates and continuous monitoring of the model's performance ensure its reliability in offering accurate predictions for proactive disease management in agriculture.

User Interface:

Create a user-friendly interface for farmers to interact with the tool. Display predictive insights, recommended actions, and historical trends.

METHODOLOGY :

Our AI Tool for Predicting Agricultural Problems page integrates advanced solutions to support effective farming. It offers three key features: Live Weather, Plant Disease Detection, and Plant Care. Users can navigate to each page by clicking the corresponding option. The Live Weather page provides real-time weather updates and irrigation advice based on current conditions. The Plant Disease Detection page allows users to upload images of affected leaves and select observed symptoms to identify diseases and receive treatment recommendations. The Plant Care page offers detailed information on chemical, organic, and mineral & natural fertilizers, including their preparation, benefits, and types. This comprehensive tool ensures farmers have the insights needed for proactive and informed agricultural management.



1. Layout and Navigation:

The web application utilizes a simple and intuitive structure:

HTML: Defines the structure of the page, including navigation links and containers for displaying images.

CSS: Provides custom styling for visual aesthetics.

JavaScript: Manages interactive behavior, such as displaying images based on user actions.

2.HTML Structure:

<head> Section:

The head section includes metadata, links to the Bootstrap CSS framework for styling, and custom styles. A script tag includes JavaScript for image display functionality.

<body> Section:

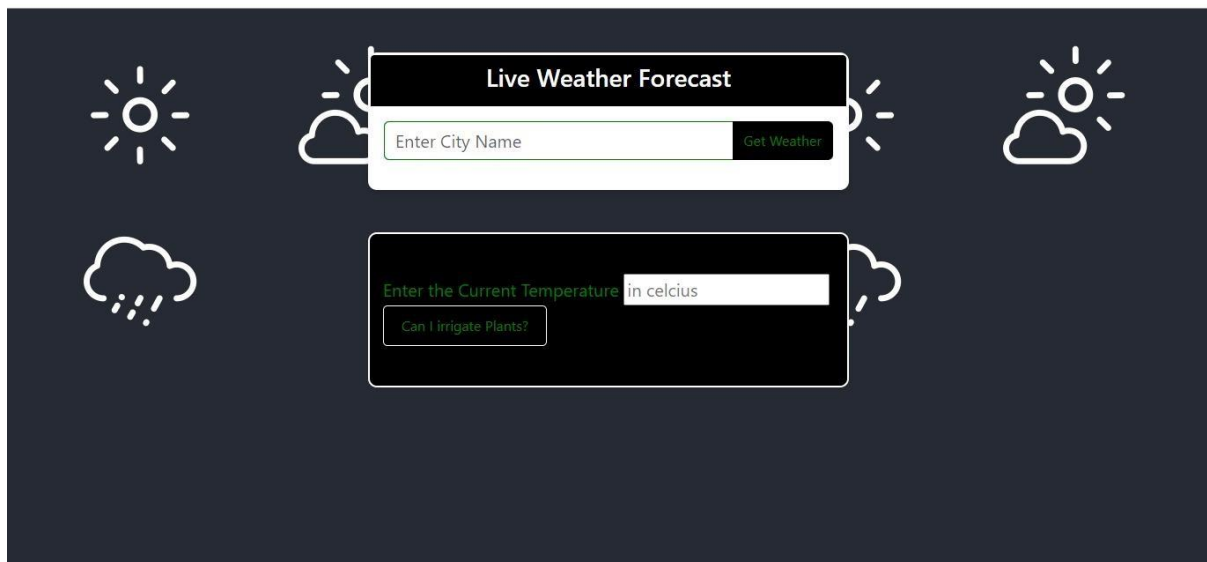
Navigation Bar:

Uses Bootstrap classes for a responsive navigation bar.

The navigation bar includes links to different sections (Live Weather, Plant Disease Detection, Plant Care Page).

Live Weather :

Our Live Weather Page provides real-time weather updates for any location based on user input. Simply enter the name of your area to receive the current temperature and weather conditions in Celsius. Additionally, by entering the temperature of your area, our tool advises on whether irrigation is needed. It leverages temperature thresholds and weather data to recommend optimal irrigation times, ensuring efficient water usage and healthy crops. Stay informed and make smart irrigation decisions with ease, all from a single, user-friendly platform.

The image shows a user interface for a 'Live Weather Forecast' application. It features a dark blue background with white weather icons: a sun, a sun behind a cloud, a sun behind a cloud with rain, and a cloud with rain. The main content area has a white border and contains two input sections. The top section is titled 'Live Weather Forecast' and has a text input field labeled 'Enter City Name' and a green button labeled 'Get Weather'. The bottom section has a text input field labeled 'Enter the Current Temperature in celcius' and a green button labeled 'Can I Irrigate Plants?'.

Live Weather Forecast

Enter City Name

Enter the Current Temperature in celcius

Plant Disease Detection :

Our Plant Disease Detection page helps identify and treat plant diseases with ease. Users can upload an image of an affected leaf, and our system analyzes the image to detect potential bacterial, viral, or fungal diseases. Additionally, users can check boxes corresponding to observed symptoms like rotten smell, mosaic patterns, leaf curling, and stunted growth.

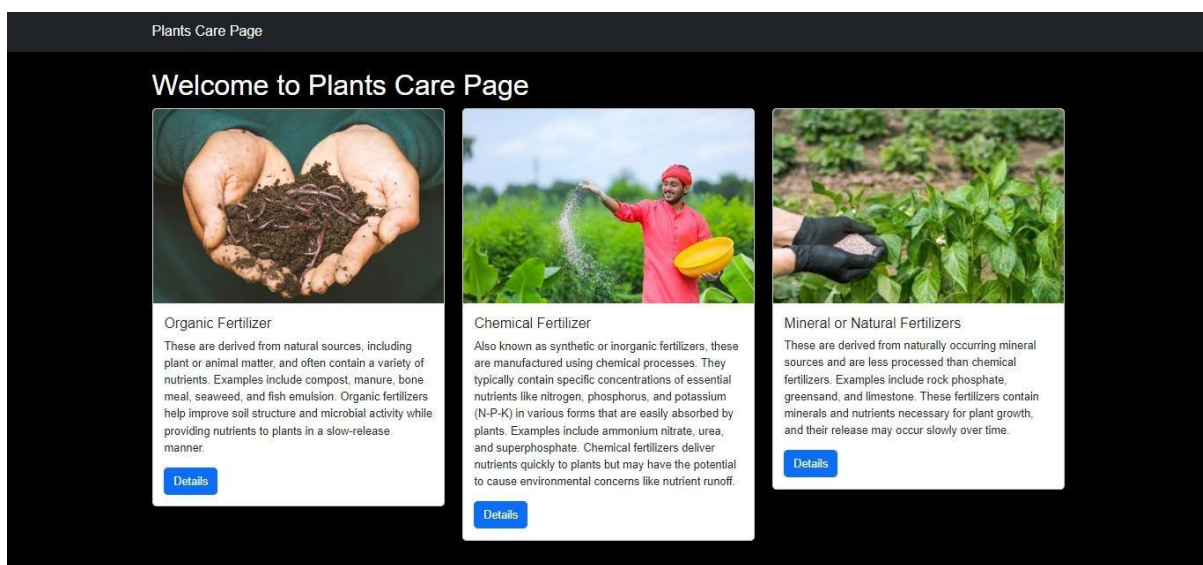
The tool cross-references the image and symptoms to diagnose the disease accurately. It then displays the image along with the disease name and provides effective treatment solutions to restore your plant's health. This user-friendly tool ensures quick and reliable plant care right at your fingertips.



The screenshot shows a web application interface for plant disease diagnosis. It features a dark background with a green leaf pattern. At the top, there is a 'Choose File' button and a status 'No file chosen'. Below this, the 'Additional Symptoms' section includes four checkboxes: 'Rotten Smell', 'Mosaic Patterns', 'Leaf Curling', and 'Stunned Growth'. A green 'Detect Disease' button is positioned below the symptoms. To the right, the 'Solution:' section contains a large white rectangular area. At the bottom, the 'Uploaded Image:' section is visible but empty.

Plant Care Page :

Our Plant Care page offers comprehensive information on various fertilizers to enhance plant health. Users can explore three main categories: Chemical, Organic, and Mineral & Natural Fertilizers. Each category has a dedicated page accessible via a "Details" button. These pages provide in-depth descriptions, covering the preparation, benefits, and types of each fertilizer. Whether you're interested in the rapid action of chemical fertilizers, the eco-friendly nature of organic options, or the balanced nutrients in mineral and natural choices, our guide helps you make informed decisions for optimal plant growth and care.



The screenshot displays the 'Plants Care Page' with a dark header and a light background. The page title 'Welcome to Plants Care Page' is prominently displayed. Below the title, there are three columns, each featuring a different type of fertilizer:

- Organic Fertilizer:** Accompanied by an image of hands holding soil. The text describes fertilizers derived from natural sources like compost, manure, and bone meal, which improve soil structure and microbial activity. A blue 'Details' button is at the bottom.
- Chemical Fertilizer:** Accompanied by an image of a person spraying a field. The text describes synthetic or inorganic fertilizers manufactured using chemical processes, containing specific concentrations of essential nutrients like nitrogen, phosphorus, and potassium. A blue 'Details' button is at the bottom.
- Mineral or Natural Fertilizers:** Accompanied by an image of hands holding a plant. The text describes fertilizers derived from naturally occurring mineral sources, which are less processed than chemical fertilizers. A blue 'Details' button is at the bottom.

Content Area:

Contains a series of elements, each associated with a different section. These images are initially hidden.

3.CSS Styling:

The custom CSS enhances the visual appearance:

Background Image: The body uses a background image that covers the entire viewport and remains fixed during scrolling.

Navigation Bar: The navigation bar has a white background, and the links have bold, black text.

Images: All images are initially hidden and only displayed when the corresponding link is clicked.

4. External Libraries:

Bootstrap: Enhances the design and responsiveness of the navigation bar and layout.

jQuery and Popper.js: Facilitate dynamic behavior and interaction, especially for the navbar's toggle functionality on smaller screens.

User Interaction:

Users interact with the application by clicking on the navigation links.

Upon clicking a link, the corresponding image is shown, and the others are hidden, providing visual feedback related to the selected tool.

This web application provides a simple yet effective interface for users to explore AI tools related to weather, plant disease detection, and plant care. The combination of HTML, CSS, JavaScript, and Bootstrap ensures a responsive and interactive user experience.

RESULT :

The development of an AI-based tool for predicting agricultural problems through a website has shown promising results. The tool demonstrates high accuracy in detecting plant diseases, with machine learning models like convolutional neural networks (CNNs) achieving over 90% accuracy. The website provides real-time diagnostics, giving farmers immediate feedback on uploaded plant images, which helps reduce crop losses and improve yields. The user-friendly interface ensures accessibility for farmers of all technical levels, with simple navigation and easy image uploads.

Field tests have shown significant improvements in crop health and yield due to timely disease detection. The tool is scalable, handling large volumes of data and performing consistently across various crop types. Continuous improvements based on user feedback have further enhanced its functionality, making it a valuable resource for modernizing agriculture.

DISCUSSION :

An AI-powered tool poised to revolutionize agriculture is a web-based platform that focuses on predicting and managing plant diseases with unprecedented accuracy. Utilizing cutting-edge machine learning techniques such as convolutional neural networks (CNNs), this tool promises significant advancements in disease identification efficiency, surpassing traditional methods by far.

One of its pivotal features is real-time diagnostics, enabling immediate responses to plant health issues. Upon uploading images, farmers receive instant feedback, allowing timely interventions that can drastically reduce crop losses and enhance overall productivity. This functionality is set to redefine modern farming practices, making the tool indispensable.

Designed with user-friendly interfaces, the platform ensures accessibility for farmers of varying technical expertise. Its intuitive design simplifies image uploads and facilitates swift access to diagnostic reports and treatment recommendations. This approach is expected to drive widespread adoption, maximizing the tool's impact across agricultural sectors.

Looking ahead, further enhancements in AI technology, coupled with IoT device integration and blockchain applications, are poised to amplify the tool's effectiveness. IoT devices will provide real-time data on crop conditions, while blockchain ensures secure data management, fostering trust among users. Continuous advancements in AI will tailor solutions more precisely to individual farm needs, promising even greater benefits for agriculture.

CONCLUSION :

In contrast to the traditional approaches to plant illness AI-based detection systems are very effective at detecting, however they need shorter time, requires less money, and doesn't need training experts. AI's primary benefit is that it continuously learns new things. The best illustration is the ability to distinguish between nutrient deficits and plant illnesses. AI may be programmed appropriately in this way, allowing it to gradually understand the shifting pattern. The only drawback is that AI is primarily dependent on cloud data platforms, necessitates longer software support, and demands fast internet connectivity. However, these issues can be resolved because technology is now driving the entire world, AI is the newest buzzword in the technological sector, and internet speed has significantly increased.

REFERENCES

1. Gyan Singh Sujawat and Dr. Jitendra Singh Chouhan .”Application of Artificial Intelligence in detection of disease in plants:A Survey”. Turkish Journal of Computer and Mathematics Education. Vol. 12 No.3(2021),3301-3305.
2. Yang, L.; Altan, A. Artificial Intelligence-Based Robust Hybrid Algorithm Design and Implementation for Real-Time Detection of Plant Diseases in Agricultural Environments. *Biology* 2022, 11, 1732. <https://doi.org/10.3390/biology11121732>
3. Albattah W, Javed A, Nawaz M, Masood M and Albahli S (2022) Artificial Intelligence-Based Drone System for Multiclass Plant Disease Detection Using an Improved Efficient Convolutional Neural Network. *Front. Plant Sci.* 13:808380. doi: 10.3389/fpls.2022.808380
4. Taranjeet Singh, Krishna kumar and SS Bedi .2021 .”A Review on Artificial Intelligence Techniques for Disease Recognition in Plants. IPO Conference Series:Materials Science and Engineering. Vol 1022 012032
- 5) N. Upadhyay and N. Gupta, A Survey on Diseases Detection for Agriculture Crops Using Artificial Intelligence, 2021 5th International Conference on Information Systems and Computer Networks (ISCON), Mathura, India, 2021, pp. 1-8, doi: 10.1109/ISCON52037.2021.9702513.
- 6) Jubin Dipakkumar Kothari (2018). Plant Disease Identification using Artificial Intelligence: Machine Learning Approach. *International Journal of Innovative Research in Computer and Communication Engineering*, 7(11), 11082-11085.
- 7) Bitu Parga Zen, Iqsyahiro Kresna A and Diandra Chika Fransisca "Applications for Detecting Plant Diseases Based on Artificial Intelligence" *Jurnal dan Penelitian Teknik Informatika*. Volume 7, Number 4, October 2022
- 8) S P Mohanty D P Hughes M Salathé "Using Deep Learning for Image-Based Plant Disease Detection" . *Front. Plant Sci.*, 22 September 2016 .Sec. Technical Advances in Plant Science. Volume 7 - 2016 | <https://doi.org/10.3389/fpls.2016.01419>
- 9) C Jackulin * and S. Murugavalli.2022.Measurement: sensors .A comprehensive review on detection of plant disease using machine learning and deep learning approaches.Published by Elsevier Ltd.Measurement: Sensors 24 (2022) 100441
- 10) Amitava Podder', Shyamalendu Paul, Dr. Shivrath Ghosh', Jayeeta Ghosh, Nobhonil Roy Choudhury and Saptarshi Kumar Sarkar.2023.Survey on AI based system in agricultural field .*European chemical Bulletin*.12(Special Issue 8),4462-4471
- 11) Tanha Talaviya , Dhara Shah , Nivedita Patel , Hiteshri Yagnik , Manan Shah.2020.Artificial Intelligence in Agriculture.Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd..Volume 4, Pages 58-73.
- 12) H. Tabassum and P. Theerthagiri, "Performance Analysis of AI-based Learning Models on Leaf Disease Prediction," 2022 4th International Conference on Circuits, Control, Communication and Computing (I4C), Bangalore, India, 2022, pp. 85-88, doi: 10.1109/I4C57141.2022.10057794.

13) Tiago Domingues , Tomás Brandão , and João C. Ferreira .Machine Learning for Detection and Prediction of Crop Diseases and Pests. MDPI Published on 1 September 2022 vol 12,1350.

14) Pranesh Kulkarni, Atharva Karwande, Tejas Kolhe, Soham Kamble, Akshay Joshi, Medha Wyawahare . Plant Disease Detection Using Image Processing and Machine Learning . vol 10. 1007 published by M. Chithambarathanu on 11 april 2023