Plant Prediction using CNN and Gardening Support System using IOT

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***Abstract* — This project introduces an innovative solution designed to revolutionize plant identification and optimize growth conditions for both gardening and agricultural applications. By harnessing cutting-edge image recognition algorithms, our system accurately identifies a wide array of plant species while furnishing detailed insights including scientific nomenclature, common pests, and associated diseases. Furthermore, it delivers personalized recommendations tailored to individual growth needs, factoring in crucial environmental variables like temperature, humidity, and sunlight exposure. Through empowering users with bespoke guidance, our system endeavors to elevate crop success rates, drive agricultural efficiency, and champion sustainability in plant cultivation practices. This endeavor marks a significant stride in plant care technology, furnishing an indispensable tool for gardening enthusiasts and industry professionals alike to achieve thriving and bountiful plant growth. Cutting-edge technology, bespoke guidance, and sustainability lie at the heart of this transformative project.**

***Keywords* — Agricultural Efficiency, Environmental Variables, Growth Optimization, Image Recognition, Personalized Recommendations, Plant Care Technology, Plant Identification, Sustainability.**

I. INTRODUCTION

The successful cultivation of plants necessitates meticulous attention to several pivotal factors. Initially, it is imperative to consider the specific light requirements of the plants, ensuring they receive adequate natural sunlight or appropriate artificial lighting. Equally crucial is the judicious management of watering schedules, comprehending the distinct needs of each plant to avoid the pitfalls of overwatering or insufficient hydration. Employing high-quality soil with optimal drainage capabilities is paramount, alongside a nuanced understanding of temperature and humidity preferences.[6] Fertilization should be executed judiciously, complemented by regular pruning and vigilant *monitoring* for potential pest infestations or diseases, promptly addressing any concerns that arise. Some plants may necessitate additional structural support or specialized training methodologies for their optimal growth, while a comprehensive grasp of seasonal care requirements is indispensable. Cultivating a patient approach, coupled with astute observation and diligent research into the unique needs of each plant, constitutes the cornerstone of successful gardening endeavors. It is essential to acknowledge that the art of gardening, when approached with meticulous care and attention to detail, can yield both gratification and enjoyment.[5]

A gardening support system represents an integrated platform designed to assist and guide gardening enthusiasts throughout the cultivation process. Utilizing advanced technologies such as *sensors*, *data analytics*, and *user interfaces*, this system collects real-time environmental data crucial for plant growth, encompassing factors like sunlight exposure, soil moisture content, ambient temperature, and humidity levels. Through comprehensive analysis of this data, the system generates tailored recommendations and actionable insights. These suggestions encompass various aspects of plant care, including appropriate watering schedules, optimal light exposure, soil enrichment techniques, and pest management strategies. By providing timely and accurate guidance, gardening support systems aim to empower users, enhancing their ability to cultivate healthy and thriving gardens while fostering a deeper understanding of plant needs and optimal horticultural practices.[3][4]

II. EXISITING SYSTEM

Within the domain of gardening systems, a notable advancement lies in the integration of machine learning (ML) techniques, ushering in innovative approaches to enhance plant care and cultivation practices. Among these pioneering systems, Plantix stands as a noteworthy example. This application harnesses ML algorithms to diagnose plant diseases and nutrient deficiencies through image analysis, thereby empowering users with accurate identification and tailored recommendations for effective treatments. Additionally, the landscape of smart gardening devices has seen remarkable developments, where sensors equipped with ML capabilities analyze environmental data, including soil moisture, light intensity, and temperature, providing personalized guidance for watering schedules and optimal plant care.[4][6]

Disadvantages of Existing Systems:

1. Inadequate soil analysis

Existing systems often overlook crucial soil nutrient factors, impacting accurate recommendations for plant nutrition and growth.

2. Limited real-time monitoring

Some systems lack continuous real-time monitoring, affecting their ability to dynamically adjust care recommendations to changing environmental conditions.

3. Tracking growth stages

Challenges persist in accurately tracking and analyzing plant growth stages, leading to generalized recommendations that may not meet specific plant development needs.

4. Reliance on user input

Systems heavily dependent on user-provided data or images for plant diagnosis may suffer from inaccuracies due to variations in input quality or interpretation.

III. PROPOSED SYSTEM

The proposed gardening support system represents an innovative leap in plant care and cultivation methodologies. Leveraging cutting-edge technology, this system integrates multiple state-of-the-art algorithms to enhance various facets of gardening. The utilization of the latest YOLO (You Only Look Once) model for plant disease and class recognition signifies a breakthrough in accurately identifying diseases and plant types through advanced image analysis. Moreover, employing a diverse array of algorithms such as Support Vector Machines (SVM), k-Nearest Neighbors(KNN), and Random Forest forsoil analysis and recommendation augments the system's capability to provide comprehensive insights into soil composition and nutrient requirements. A bespoke user-friendly dashboard ensures intuitive navigation and interaction, empowering users with a seamless experience in accessing personalized plant care recommendations. The incorporation of a robust notification system further enriches user engagement by providing timely updates and alerts on plant health, environmental changes, and recommended actions. This amalgamation of cutting-edge algorithms, a customized interface, and proactive notifications embodies a pioneering approach to revolutionizing gardening practices, offering users precise, adaptable, and user-centric tools for nurturing healthy and thriving plants.

Advantages of Proposed Systems:

1. Precision in recommendations

Our system, powered by advanced algorithms, ensures highly accurate plant care, disease identification, and soil analysis guidance.

2. Versatile plant support

From herbs to flowers to vegetables, our system caters to diverse plant varieties, offering tailored care for each type's specific needs.

3. Comprehensive soil analysis

Leveraging SVM, KNN, and Random Forest algorithms, our system provides detailed soil insights, optimizing plant health through tailored nutrient recommendations.

IV. SCOPE

The system aims to provide extensive support for both novice and experienced gardeners, or any other users who are interested in gardening by offering assistance in cultivating challenging plants. By integrating IoT devices, cloud computing, machine learning models, and real-time monitoring, our project brings advanced technology into gardening practices. The user-friendly web and mobile interface ensure easy access to personalized gardening information and recommendations for users of all expertise levels.

V. IMPLEMENTATION

1. System Architecture:

A. Flutter Frontend Application

The frontend application is developed using the Flutter framework, allowing it to run seamlessly on Android, iOS, web pages, and desktop platforms. Users interact with the application to capture plant images, receive identification results, and access personalized recommendations for optimal plant growth conditions.

B. Dockerized Image Recognition Model with FastAPI

The image recognition model is containerized using Docker for easy deployment and scalability. FastAPI is integrated into the Docker container to facilitate communication between the frontend application and the image recognition model. The Docker container is hosted on an AWS EC2 instance for reliability and accessibility.

C. Firebase Realtime Database

Firebase Realtime Database is utilized as the backend database to store user data, plant identification results, and personalized recommendations. The database is synchronized in real-time with Google Sheets via Google Apps Script, enabling seamless data syncing and management.

D. IoT Component with Nano PC and ESP32 Sensors

A Nano PC serves as the master data node in the IoT component, responsible for collecting and processing sensor data from ESP32 sensors. ESP32 sensors are deployed as data nodes to gather environmental variables such as temperature, humidity, and sunlight exposure. WebSocket communication protocol is utilized for real-time data transmission between the master node and data nodes.

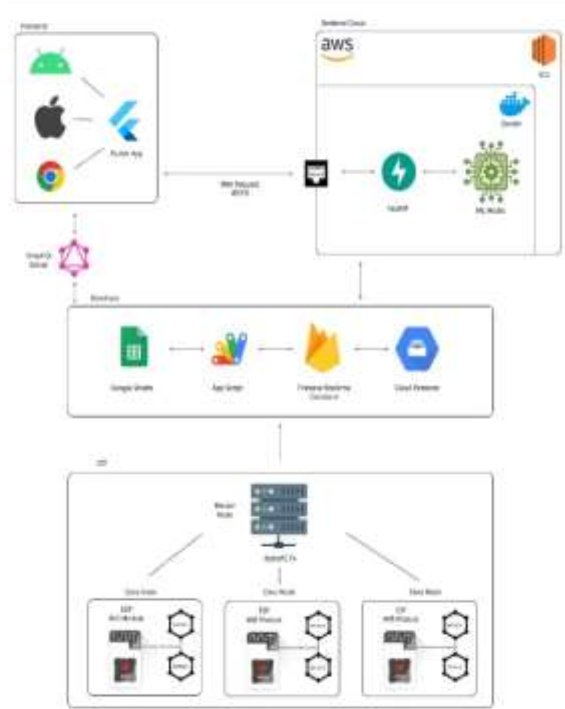

Figure 1: System Architecture

2. Use Case Diagram

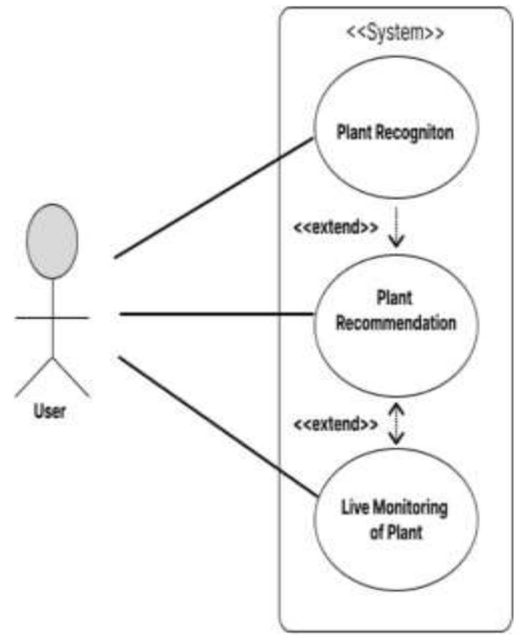

Figure 2: Use Case diagram

This use case diagram illustrates the Actor – User, Use cases – Plant Recognition, Plant Recommendation, and Live Monitoring of Plant, and System boundary containing all these use cases.

3. Dataflow Diagram

A. *Plant Recognition Dataflow*

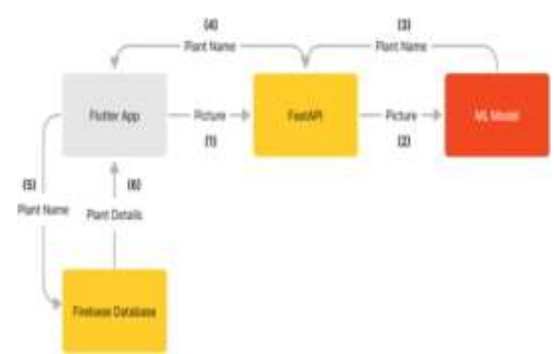

Figure 3: Data flow in Plant Recognition Module

This data flow ensures a seamless process for plant recognition and information retrieval within the application. By leveraging the ML model for plant identification and the Firebase Realtime Database for storing comprehensive plant details, users can quickly obtain accurate information about the plants they encounter, enhancing their gardening and agricultural experiences.

B. Plant Recommendation Dataflow

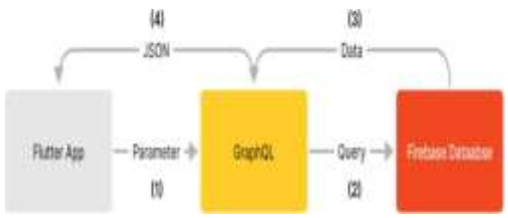

Figure 4: Data flow in Plant Recommendation Module

The Plant Recommendation Module facilitates the selection of suitable plant species tailored to users' preferences and environmental conditions. By leveraging GraphQL queries and interaction with the Firebase Realtime Database, users receive personalized recommendations that align with their specific requirements, enhancing their gardening and cultivation experiences.

C. Live Monitoring Module

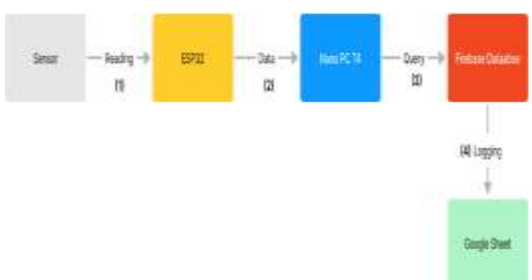

Figure 5: Data flow in Live Monitoring Module

The Live Monitoring Module facilitates real-time monitoring of environmental conditions through sensor data aggregation and presentation in the user interface. By leveraging ESP32 devices for data collection and a Nano PC as the master node, users can monitor changes in temperature, humidity, and other parameters in real-time. Additionally, the module ensures data accessibility by synchronizing sensor readings with the Firebase Realtime Database, enabling remote access and monitoring over the Internet.

VIII. PERFORMANCE EVALUATION

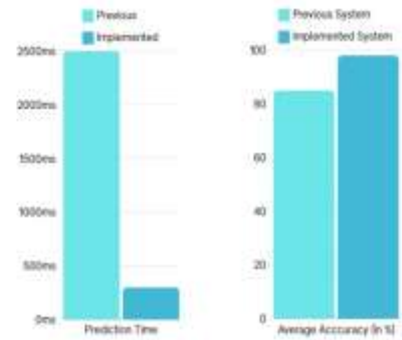

Figure 6: Comparision of systems

Our system not only had a very low prediction time but the accuracy was result were also significantaly improved.

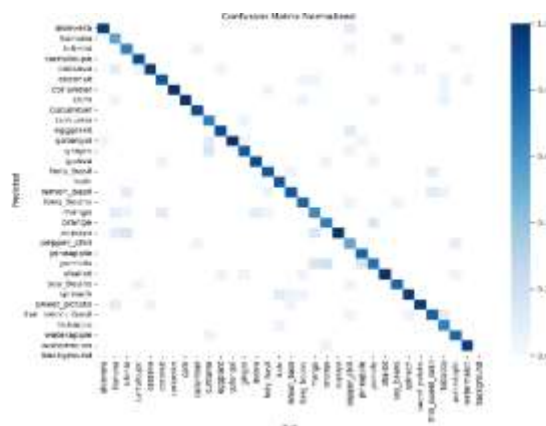

Figure 7: Confusion matrix (Normalized)

Above figure shows the confusion matrix of model, it is a table that shows the accuracy of a classification model in machine learning by displaying the number of true positives, true negatives, false positives, and false negatives.

IX. CONCLUSION

The project exhibits promising feasibility, with its compatibility across diverse platforms, cost-effective hardware requirements, and scalability for future expansion. By leveraging readily available technology and cost-efficient components, the proposed application offers a robust solution for data monitoring and analysis in various environments. This innovative project combines advanced image recognition algorithms with personalized recommendations to enhance plant identification and optimize growth conditions. By providing comprehensive information on plant species, pests, and diseases, the system empowers users to achieve healthier and more productive plant growth. With a focus on sustainability and agricultural efficiency, this technology represents a significant advancement in plant care.

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