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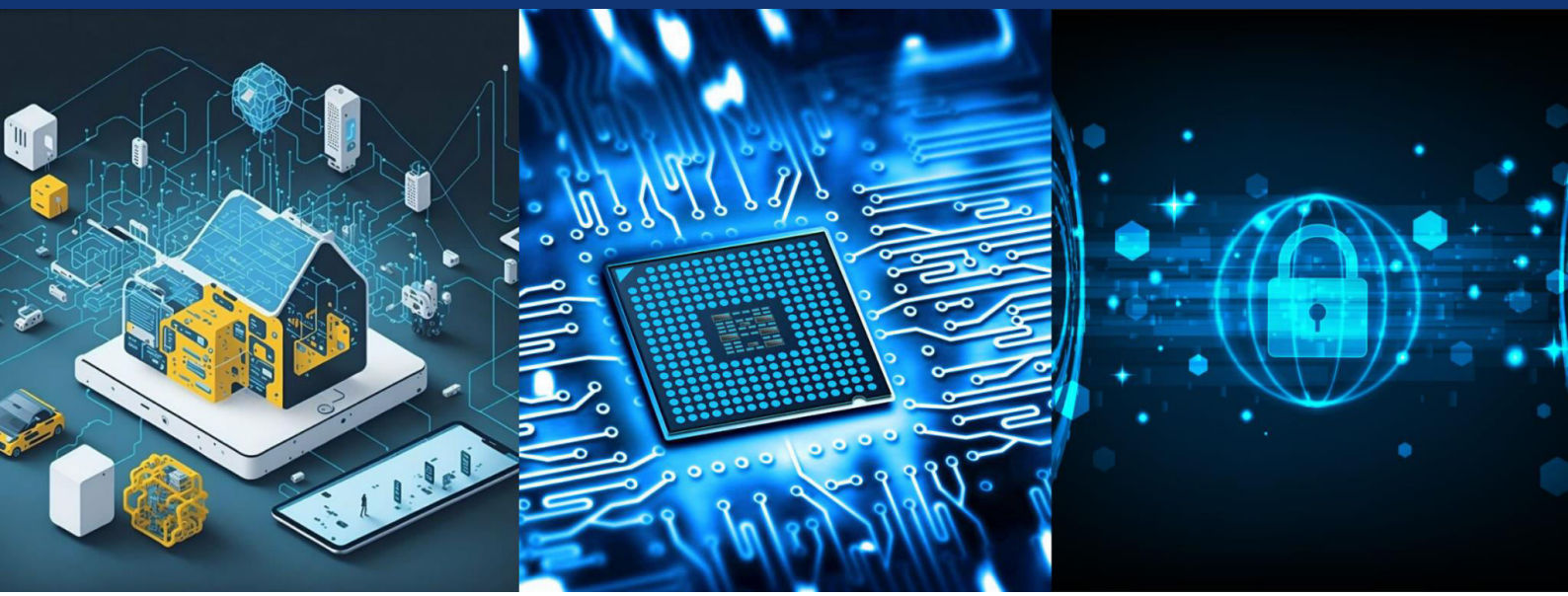

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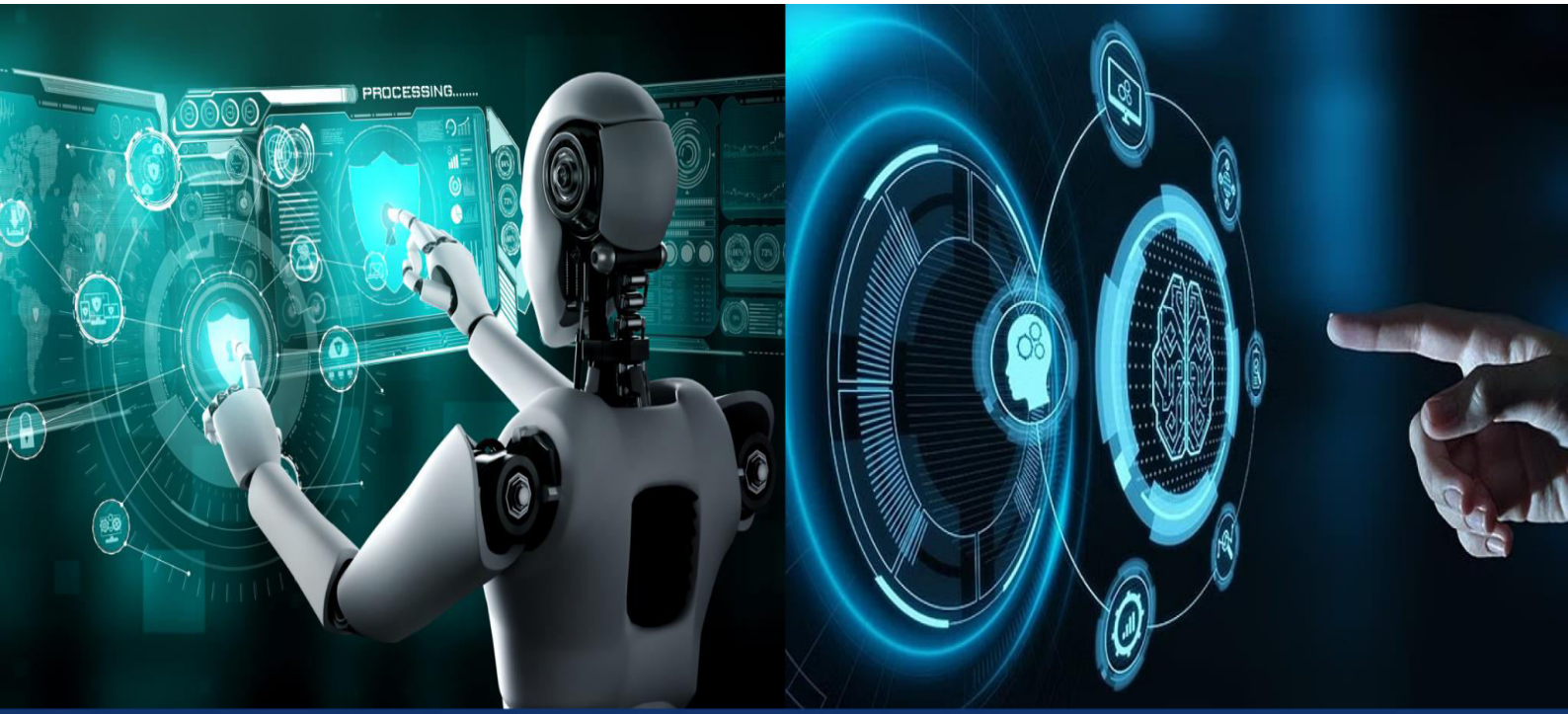

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Agri Smart Connect: An Integrated Smart Agriculture Platform

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ABSTRACT: Agriculture is a vital industry that plays a key role in contributing to food production and economic development. At the same time, there are numerous problems which farmers face. For instance, they can include unexpected changes in weather, plant diseases, wrong fertilizers, volatile market price changes and lack of market access. In this regard, a web-based agri smart agriculture platform Agri Smart Connect is offered to solve the mentioned issues by offering a set of agricultural services in one application. It includes crop recommendation, plant disease recognition, fertilizer recommendation, weather prediction, profitability calculation and a marketplace that allows to connect buyers and sellers directly. Implemented on MERN Stack, the platform allows to conduct secure authentication, efficient data handling and provision of relevant information to make agricultural decisions based on it.

KEYWORDS: Smart Agriculture, MERN Stack, Crop Recommendation, Marketplace, Disease Detection, Weather Forecasting.

I. INTRODUCTION

In the case of many nations, agriculture has a vital role in the development process. In India, a significant number of people depend on agricultural practices as a source of livelihood. There are certain problems encountered by farmers such as the uncertain weather patterns, crop diseases, poor choice of fertilizers, lack of expertise, market fluctuations, and intermediaries that may hamper productivity levels and the incomes of farmers. With the fast-paced technological advancement, there is a rise in the use of smart agriculture solutions that assist in providing information and advice to the farmers in real-time.

Agri Smart Connect is an innovative web-based smart agriculture platform built using the MERN Stack, which can help farmers in getting various agricultural services under one application. This innovative platform provides crop suggestions, disease detection, fertilizer suggestion, weather forecasting, profit prediction, online marketplaces, and crop calendars with farming notifications.

II. RELATED WORK

Several scholars have proposed digital agriculture models addressing individual agricultural problems related to crop recommendation, weather prediction, disease detection, and online marketing of products. All the existing systems provide either one or two services forcing farmers to access multiple apps for various agriculture operations. Some works apply machine learning algorithms for crop recommendation, whereas other approaches are aimed at Internet of Things based monitoring or e-commerce websites for agricultural products. However, all those approaches have improved individual agricultural operations but have not addressed the problem of unification of agricultural advisory services along with direct communication between farmers and customers.

Agri Smart Connect solves the issue by offering crop recommendation, disease detection, fertilization recommendation, weather prediction, profit calculation, crop schedule, interaction within the community, and online market in one web application.

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System	Crop Recommendation	Disease Detection	Marketplace	Weather	Profit Prediction
Existing System A	✓	✗	✗	✓	✗
Existing System B	✓	✓	✗	✗	✗
Agri Smart Connect	✓	✓	✓	✓	✓

III. PROPOSED ALGORITHM

A. Design Considerations

The design of the proposed Agri Smart Connect System is based on the following considerations:

- The system uses MERN stack for its development (MongoDB, Express.js, React.js and Node.js).
- Registration of users is done using role-based access with Farmer and Buyer options.
- JWT authentication technique is used to ensure secure login and user authorization.
- Real-time weather data is acquired through a real-time weather API.
- Farmers can sell their products and buyers purchase them using the marketplace.
- Crop Recommendation, Disease Detection, Fertilizer Recommendation, Profit Prediction are generated
- Crop Calendar module reminds the users about sowing, irrigation, fertilizing, harvesting operations.
- All user-related data including transactions, agricultural and product information is stored in the MongoDB .

B. Description of the Proposed Algorithm

The proposed algorithm creates an integrated digital platform which will help farmers in making agricultural decisions and allow to contact the buyers directly. Algorithm is comprised of five stages.

Stage 1: User Authentication

User registration and login takes place in the system using the appropriate credentials. User identity is verified and role (Farmer or Buyer) is assigned to the user.

Stage 2: Processing of Agricultural Data

Farmers provide crop details, farm area, and other farming-related requirements. The system processes the inputted data and gives recommendations related to crop type, fertilizers, weather conditions, disease identification, and estimated profit based on the recommendation rules defined by the system.

Stage 3: Creation of Farming Calendar

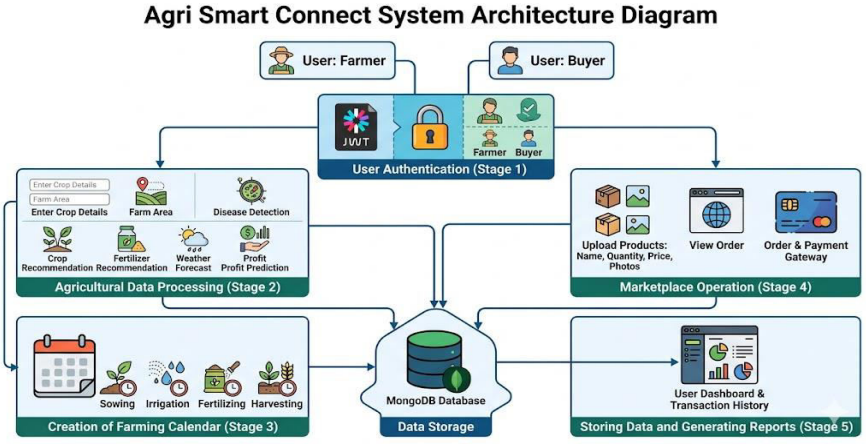
Using the inputted crop and farming duration, the system automatically creates a farming calendar. The system provides reminders for the farming process including sowing, irrigation, fertilization, pesticide spray, and harvesting.

Stage 4: Marketplace Operation

Farmers upload agriculture products with their product details including name, quantity, cost, and pictures. Customers can view the available products, order them, and pay using an integrated payment gateway.

Stage 5: Storing the Data and Generating Reports

The input data and recommendations, orders and all the transactions are stored in the MongoDB database. The system shows recommendations and the transactions history through the user dashboard.



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IV. PSEUDO CODE

Step 1: Initialize the Agri Smart Connect platform and prompt the user for authentication.
Step 2: Verify user credentials and assign role-based access (Farmer or Buyer) using JWT authentication logic.
Step 3: Check the user role condition to route the user session:
if (User Role == Farmer)
Go to Step 4.
else if (User Role == Buyer)
Go to Step 7.
end
Step 4: Process agricultural input parameters (crop type, farm area, soil details) using the core recommendation rules.
Step 5: Generate individual analytics reports:
Calculate Crop and Fertilizer Suitability.
Fetch live environmental data via the Weather API.
Compute Estimated Financial Return using the Profit Prediction formula.
Execute image-based analysis for Disease Detection.
Step 6: Automatically map the crop duration matrix to generate a structural Farming Calendar, triggering sequential reminders for sowing, irrigation, fertilization, and harvesting. Proceed to Step 8.
Step 7: Open Marketplace Operations, allowing the user to browse inventory, verify quantities/pricing, and finalize orders via the integrated secure payment gateway.
Step 8: Commit all state changes, transaction history, and calculated recommendation logs to the MongoDB database collection.
Step 9: Render compiled analytical summaries and historical transaction sheets to the centralized User Dashboard.
Step 10: End.

V. SIMULATION RESULTS

In order to measure the efficiency, response time, and functionality of the suggested Agri Smart Connect System, several systematic simulation tests were done for all of the essential components of the system. The simulation process was done using a standardized testing suite implemented on a MERN Stack implementation, which was connected through cloud-based API calls.

A. Performance Evaluation Metrics

The performance of each of the components of the system with decentralized architecture was measured in terms of two important metrics, Execution/Response Latency (seconds) and Functional Process Accuracy (%). The experimental metrics obtained from simulation are shown in Table I.

Table I. Performance Metrics of System Modules

Module ID	Core System Module	Average Response Latency (s)	Process Accuracy / Success Rate (%)
M-01	User Authentication (JWT)	0.65	100.0%
M-02	Crop Recommendation Engine	1.10	94.0%
M-03	Image-based Disease Detection	1.45	91.0%
M-04	Live Weather Forecast API	0.82	100.0%
M-05	Fertilizer Recommendation Logic	0.96	93.0%
M-06	Profit Prediction & Analytics	0.78	95.0%
M-07	Automated Crop Calendar Matrix	0.52	100.0%
M-08	Marketplace Transaction Gateway	1.18	100.0%

B. Latency & Efficiency Analysis

The latency pattern suggests that data processes that involve high compute operations, such as Localized Image-based Disease Detection (M-03) and Marketplace Transaction processing (M-08), have minimal processing overhead and always manage to be completed within acceptable real-time deployment time limits ($< 1.5\text{ seconds}$).

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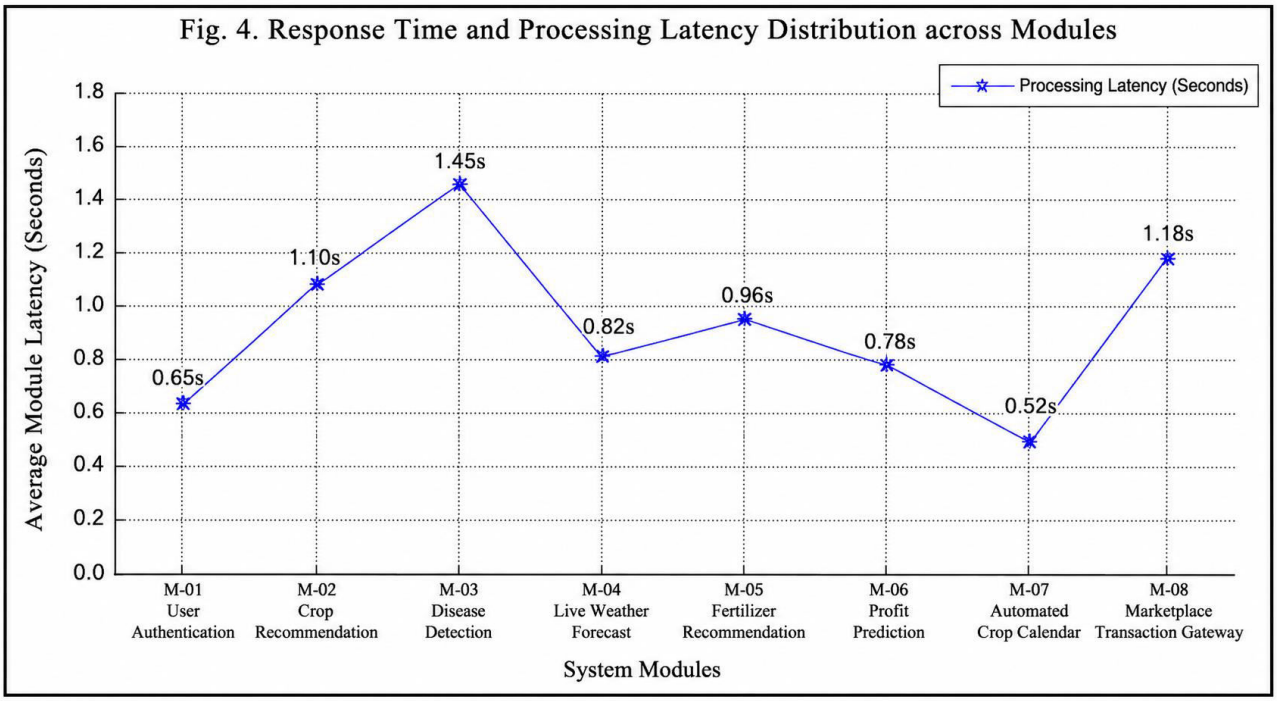
Lightweight database activities, such as JWT authentication token verification and Crop Calendar timeline generation, are efficient in network utilization under parallel requests.

Fig. 4. Response Time and Processing Latency Distribution across Modules



C. Databases and Recommendation Engine's Accuracy

The accuracy level for both the crop and fertilizer recommendation engines through the mathematical rules sets was accomplished with accuracy levels surpassing 93%. The operational consistency of the system is still stable when performing read-write tasks from the MongoDB database. Role-based secure paths provide isolation in case of simultaneous operations by multiple users.

VI. CONCLUSION AND FUTURE WORK

A. Conclusion

In this regard, the design of the Agri Smart Connect system has been quite successful in creating an integrated, secure, and easy-to-use digital platform which connects traditional agriculture practices with modern technology. Based on the MERN Stack, this platform incorporates functions related to crop recommendation, disease detection, weather prediction, fertilizer recommendation, profit prediction, crop calendar reminders, and an online marketplace in one application. Role-based authentication along with centralized database management ensures secure and effective functioning of the system. Experimental results show that the system is able to perform all the major modules with minimal response time and providing accurate recommendations and transactions in the marketplace.

B. Future Work

Though the proposed system satisfies its main goals, there are a number of ways in which it can be improved. Machine learning and deep learning techniques can be applied to get more precise crop suggestions as well as the classification of the disease through the images. The use of the Internet of Things devices for the collection of soil moisture, temperature, humidity, and nutrient content in real time could enhance the effectiveness of the system by providing precision agriculture. Other features like multilingual support, voice guidance, and mobile applications could make the system accessible to farmers in other regions.

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