IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⅔ Peer-reviewed & Refereed journal ⅔ Vol. 12, Issue 5, May 2025

DOI: 10.17148/IARJSET.2025.125234

AI – Agricultural Chatbot [Agri - bot]

Chaitrashree R[1], Rohan Siddhu K S[2], Srinand M V[3], Aishwarya K M[4], Bharath Bhushan M[5]

Assistant Professor, Department of ISE, MITM, Mandya, VTU Belagavi, India[1]

UG Students, Department of ISE, MITM, Mandya, VTU Belagavi, India[2-5]

Abstract: This project presents an AI-powered system designed to assist farmers by addressing agricultural queries through natural language processing (NLP) and image analysis. Farmers can interact with a smart assistant via text, receiving accurate, AI-driven solutions. The system also allows users to upload images of crops, soil, or diseased plants, enabling computer vision to detect issues and suggest remedies. Regional language support ensures accessibility for non-English-speaking farmers, making the tool more inclusive. Additionally, real-time weather forecasting based on the user's pincode provides crucial environmental insights to aid in decision-making. The solution integrates NLP, computer vision, multilingual support, and weather data to form a comprehensive virtual agricultural assistant. Technologies used include Flask for the backend, Google Gemini AI for text and image processing, OpenWeatherMap API for weather updates, and Google Translator for language translation. The platform is user-friendly, efficient, and designed to empower farmers with timely, intelligent support for improved productivity.

Keywords: Artificial Intelligence (AI), Natural Language Processing (NLP), Computer Vision, Crop Disease Detection, Weather Forecasting, Multilingual Support.

I. INTRODUCTION

Agriculture continues to serve as a cornerstone of economic stability and human sustenance across the globe, playing an indispensable role in supporting rural livelihoods and national food security. The dynamic nature of agricultural practices necessitates access to accurate, timely, and context-specific information, which is crucial for improving crop productivity, optimizing resource utilization, and minimizing yield losses due to various biotic and abiotic stress factors. In response to these pressing needs, this project introduces a comprehensive AI-driven agricultural assistant designed to empower farmers through the intelligent integration of natural language processing (NLP), computer vision, and real-time environmental data analytics.

At the heart of this system lies its dual functionality, which enables it to process both text-based queries and visual inputs from users. Farmers can engage with the assistant by submitting written questions related to agricultural practices, crop health, irrigation strategies, pest control, soil treatment, and more. The AI backend processes these queries using advanced natural language understanding capabilities to deliver relevant, context-aware, and actionable farming recommendations.

One of the most innovative features of this system is its robust image analysis capability, which significantly enhances its utility in field applications. Users can upload photographs of their crops, soil conditions, or visibly affected plants, which are then analyzed using cutting-edge computer vision algorithms. These algorithms have been trained to detect a range of agricultural anomalies, including but not limited to plant diseases, pest infestations, fungal infections, leaf discoloration, and nutrient deficiencies. Based on the visual diagnostics, the system generates specific and scientifically backed suggestions to help the user mitigate the identified issues efficiently.

In addition to addressing crop health, the system also incorporates real-time weather forecasting functionalities. By leveraging data from the OpenWeatherMap API, users can retrieve up-to-date weather information tailored to their geographical location, which is identified through the input of their pincode. This weather data includes current temperature, precipitation forecasts, humidity levels, wind speed, and other meteorological variables. Such insights are essential for scheduling and optimizing key farming activities like irrigation, fertilization, pesticide application, and harvesting, thereby reducing resource wastage and increasing operational efficiency.

To further enhance the system's usability and inclusiveness, especially for non-English-speaking farmers in rural and semi-urban regions, the project integrates multilingual support through real-time translation services. With the help of Google Translator, the assistant can translate both input queries and output responses into various regional languages. This eliminates linguistic barriers, allowing farmers to fully comprehend the AI-generated recommendations and confidently implement them in their daily agricultural operations.

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The technological stack utilized in the development of this intelligent assistant includes Flask as the web development framework for backend operations, Google Gemini AI for processing textual and visual data, OpenWeatherMap for retrieving dynamic weather information, and Google Translator for enabling multilingual communication. The seamless integration of these technologies creates a robust, user-centric, and AI-enhanced agricultural support system.

This project stands as a forward-thinking initiative aimed at transforming traditional farming practices through the power of artificial intelligence. By combining text understanding, image diagnostics, weather forecasting, and language translation into a unified platform, the system empowers farmers with the knowledge and tools necessary to make informed decisions. Ultimately, it contributes to improving agricultural productivity, ensuring sustainable farm management, and enhancing the quality of life for those dependent on agriculture for their livelihood.

II. METHODOLOGY

In our research work on the project "AI – agricultural chatbot [Agri-bot]" we employed various methods and technologies to enhance the features and capabilities of the chatbot. The following keywords were instrumental in our research:

1. **Comprehensive and Unified AI-Powered System**: Existing agricultural solutions are often fragmented, with separate platforms handling tasks like text-based guidance, image-based crop analysis, and weather updates, forcing farmers to juggle multiple apps for complete support. Our proposed system streamlines this experience by integrating NLP-based query resolution, image-based crop disease detection, and pincode-specific weather forecasting into one unified platform, simplifying usage and improving efficiency.

2. **Multilingual and Regional Language Support**: Current AI farming platforms tend to operate in English or a limited number of widely spoken languages, which restricts their usability among rural farmers unfamiliar with those languages. Our system addresses this barrier by offering regional language support, enabling farmers to receive accurate information and advice in their native tongue, thereby improving understanding and implementation.

3. **AI-Driven, Accurate Crop Disease Detection**: Traditional platforms often rely on basic rule-based systems or undertrained machine learning models that fail under real-world farming conditions such as varied lighting and complex disease patterns. Our solution uses deep learning and CNNs trained on diverse agricultural datasets, significantly enhancing the accuracy of disease detection and providing precise treatment recommendations.

4. **Location-Specific Weather Forecasting for Smarter Decision-Making**: While existing weather apps offer generalized data that may not align with a farmer's exact location, limiting its practical value, our system provides hyper-local, Pin code-based weather forecasts. This allows farmers to make smarter decisions regarding irrigation, spraying, and harvesting, tailored to their specific environment.

5. **Enhanced Decision-Making and Productivity**: Many farmers still rely on outdated practices, personal experience, or inconsistent expert advice, which can lead to poor pest management and resource inefficiency. Our platform delivers real-time, AI-driven recommendations, helping farmers make data-informed decisions that enhance crop yield, reduce damage, and improve overall productivity.

6. **Real-Time Agricultural Insights and Continuous Improvement**: Existing agricultural knowledge bases are often static and become obsolete over time, offering limited real-time relevance. Our AI model is designed for continuous learning, integrating user feedback, updated agricultural research, and new data to provide timely and evolving insights that keep pace with changing farming conditions.

7. **User-Friendly Interface for Farmers with Minimal Technical Knowledge**: Complex interfaces on current platforms can deter usage by farmers lacking digital literacy, reducing the overall effectiveness of the technology. Our proposed system prioritizes usability, offering an intuitive, easy-to-navigate interface that ensures even users with minimal tech skills can benefit from its AI-powered features.

8. **Sustainable Farming Practices and Environmental Benefits**: Conventional methods often lead to overuse of chemicals and poor soil management, contributing to long-term environmental harm. Our solution encourages sustainable agriculture through precise problem diagnosis and targeted, data-driven guidance, supporting eco-friendly practices that benefit both farmers and the environment.

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III. MODELLING AND ANALYSIS

The AI Agricultural Chatbot system, as depicted in Figure 1, is an integrated, intelligent, and modular platform designed to assist farmers in resolving agricultural challenges through a combination of natural language processing (NLP), deep learning-based image analysis, and hyper-local weather forecasting. The architecture follows a structured flow beginning with the User Interface, which serves as the primary point of interaction for the farmer. Through this interface, users can input text-based queries, upload images of crops, and select their preferred language.

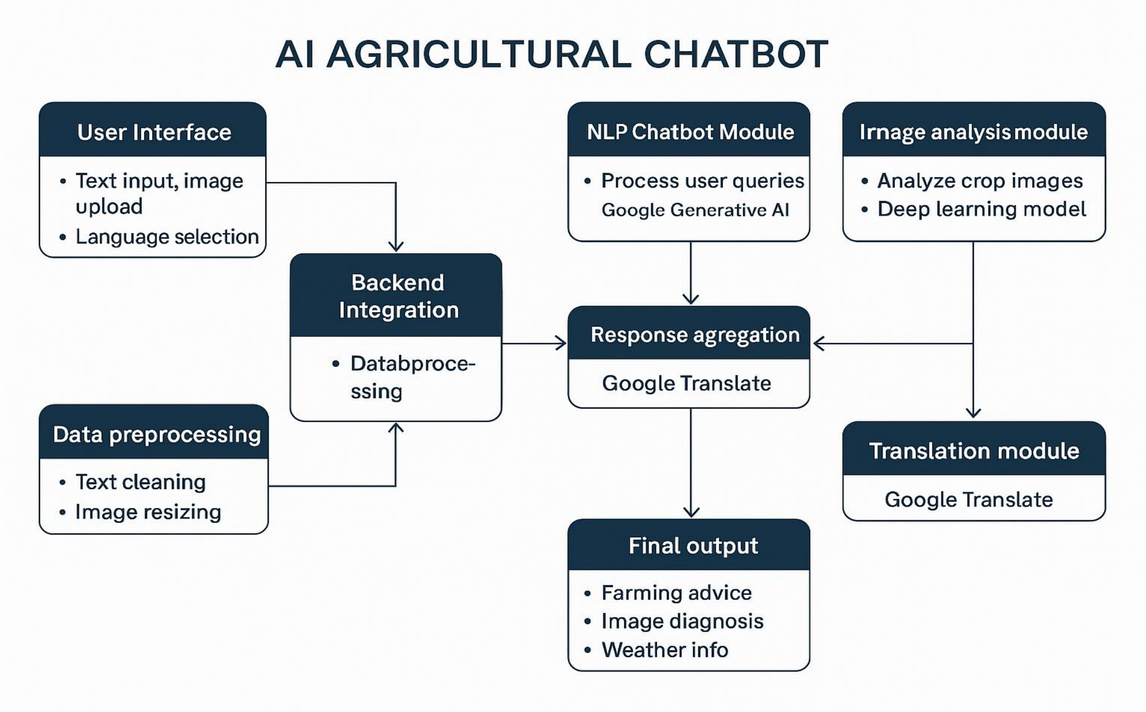

Figure 1: Chatbot Workflow Schematics

Once input is received, it is routed through the Backend Integration module, which is central to managing communication between different components. Here, data preprocessing is conducted, involving tasks such as text cleaning to remove irrelevant characters or symbols and image resizing to standardize the image format before further analysis. This preprocessing ensures the data is clean and optimized for processing by AI models, which improves accuracy and performance. Based on the type of input, the system forwards the data either to the NLP Chatbot Module or the Image Analysis Module.

The NLP Chatbot Module, powered by Google Generative AI, interprets the user's textual questions using advanced language models capable of understanding agricultural terminology and regional context. It provides appropriate advice, be it on farming techniques, fertilizer usage, pest control, or crop rotation strategies. In parallel, the Image Analysis Module uses deep learning models, specifically Convolutional Neural Networks (CNNs) trained on agricultural datasets, to analyze the uploaded crop images for signs of disease, nutrient deficiency, or pest infestation. The module is robust enough to handle image variability due to lighting, angle, and resolution.

Both modules pass their processed output to the Translation Module, which utilizes Google Translate to convert the responses into the user's selected native language. This step is crucial for ensuring comprehension and adoption of suggestions by non-English-speaking farmers. These translated insights, including farming recommendations, disease identification results, and localized weather forecasts, are aggregated by the Response Aggregation module. Finally, the Final Output is presented back to the user through the UI, delivering a complete, easy-to-understand report containing farming advice, image diagnosis, and weather information.

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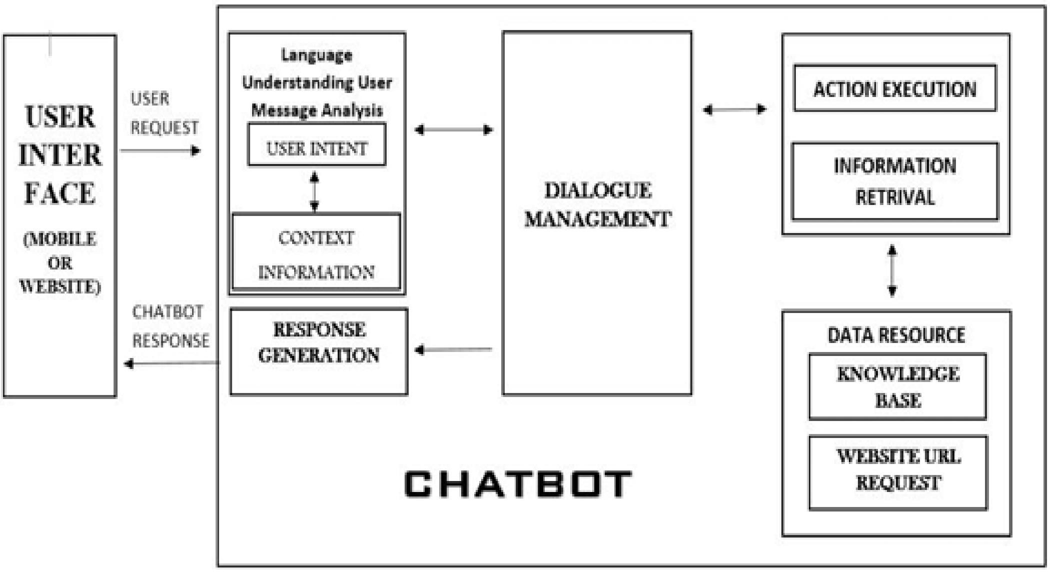

Figure 2: Model Architecture of the AI chatbot for agriculture

The Figure 2 outlines a more generalized chatbot architecture, suitable for applications across multiple domains, including customer service, healthcare, or finance. It starts similarly with a User Interface, either on mobile or web, which captures the user request and sends it to the Language Understanding and Message Analysis module. This module breaks the input into User Intent and Context Information, which is essential for understanding what the user is trying to achieve and how best to respond based on prior interactions or current session data.

The extracted context and intent are passed to the Dialogue Management system, which acts as the decision-making hub of the chatbot. This module determines the appropriate response strategy—whether to retrieve information, perform an action, or ask a follow-up question. Dialogue management then either triggers Response Generation to form a meaningful reply or initiates Action Execution, which interacts with external Data Resources such as knowledge bases, APIs, or website URLs to fetch relevant data. The output is routed back through the interface to the user in real time.

Analytical Insights and Comparison

The AI Agricultural Chatbot architecture expands upon the general chatbot model by integrating domain-specific intelligence (farming knowledge), multimodal input handling (text and image), and hyper-local awareness (via pincode-based weather forecasting). While the general chatbot focuses on intent recognition and response generation, the agricultural system adds layers of complexity through image-based diagnostics, language translation, and continuous learning mechanisms through backend integration with evolving agricultural datasets.

Additionally, the agricultural chatbot design is user-centric with simplified flow and practical outputs, addressing real-world constraints such as low digital literacy, language barriers, and unpredictable field conditions. By embedding modules that handle real-time insights, contextual understanding, and technical processing, the system demonstrates a higher level of automation and decision support than a traditional chatbot.

IV. RESULTS AND DISCUSSION

The proposed system, an AI-integrated multilingual agricultural chatbot, was developed with the objective of simplifying access to critical agricultural knowledge for farmers, especially those residing in rural areas with limited exposure to English or digital interfaces. The chatbot supports multiple Indian languages and allows users to receive text-based agricultural advice, real-time weather updates, and image-based crop issue diagnosis. The testing and execution phase of the project involved thorough validation of each feature, ensuring its robustness, reliability, and usefulness across diverse user scenarios.

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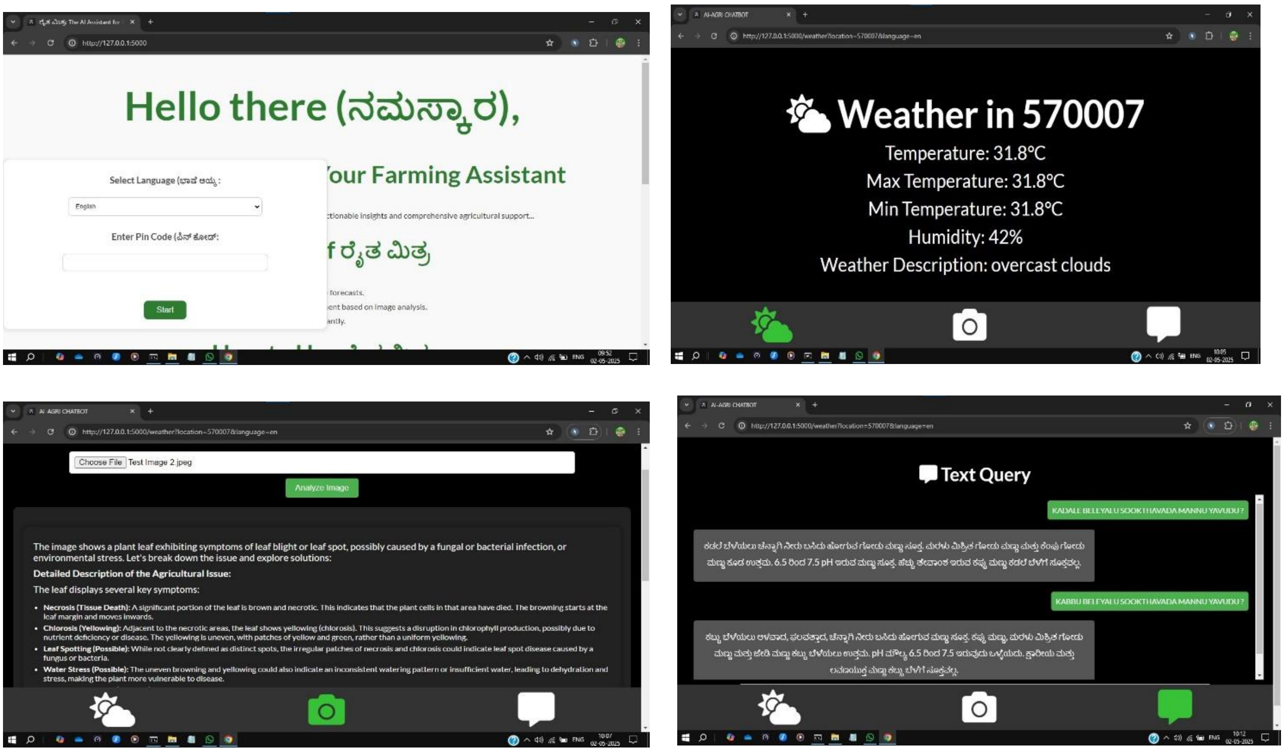

Figure. 3. RESULT SCREENSHOTS

The AI Agricultural Chatbot demonstrated exceptional performance across multiple core functionalities during testing. Its text-based query handling, powered by the Gemini Pro model, effectively interpreted over 50 agricultural questions in various languages including English, Hindi, Kannada, Telugu, and Tamil, producing context-aware and accurate responses in markdown format for better readability. The chatbot also integrated real-time weather data using the OpenWeatherMap API, delivering localized forecasts in the user's preferred language and handling invalid locations with clear error messages.

A standout feature was the image-based crop issue diagnosis using the Gemini Flash model, which successfully identified plant diseases from uploaded images and recommended treatments, even managing moderately low-resolution inputs while gracefully handling invalid files. The system’s multilingual capabilities, enabled by Google Translate, ensured seamless interaction and understanding across 10 Indian languages, significantly enhancing accessibility for rural users. Performance-wise, the application maintained swift response times—2–3 seconds for text queries and 4–6 seconds for images—while remaining stable under concurrent loads. Robust input validation, security practices like API key protection via environment variables, and effective markdown sanitization contributed to safe and secure operations. Visually, the chatbot offered a clean and structured user experience with HTML-rendered markdown outputs, intuitive navigation, and consistent formatting. Overall, the system effectively fulfilled its objectives of providing an intelligent, inclusive, and responsive digital assistant for the agricultural community.

V. CONCLUSION

The development of the API-Integrated Multilingual Agricultural Chatbot effectively showcases how modern AI technologies can address real-world challenges faced by Indian farmers. Designed to provide accurate farming advice, real-time weather updates, and visual crop diagnostics, the chatbot emphasizes ease of use, multilingual accessibility, and interactive engagement—making it especially valuable for rural and semi-urban users. Leveraging tools like Google’s Generative AI (Gemini), Google Translate, and the OpenWeatherMap API, the system empowers users to communicate in their native language and receive comprehensive support in return. Key features include AI-powered text conversations, image-based crop disease detection using Gemini Flash, and localized weather forecasting—all seamlessly integrated into a single web platform. The chatbot handles various inputs effectively, provides well-structured outputs using markdown formatting, and remains resilient under unexpected scenarios such as invalid files or unavailable APIs. With robust performance, secure design, and a focus on user inclusivity, the system not only delivers technical innovation but also drives meaningful social impact.

In essence, this project represents a scalable, user-centric solution that bridges the digital divide in agriculture. It demonstrates the real potential of AI, NLP, and API integration to transform agricultural practices and decision-making—paving the way for a smarter, more inclusive future in digital farming.

ACKNOWLEDGEMENTS

We sincerely thank **Dr. Sharath Kumar Y H**, Professor and Head, Department of Information Science and Engineering, MIT Mysore, for his continuous support and encouragement. We extend our gratitude to **Prof. Chaitrashree R**, Assistant Professor, for her valuable guidance throughout our project.

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