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AI Web Interaction Using Voice Agent in KRISHI-SHETRA

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Abstract*—Millets are resilient crops that are nutrient-rich and vital for sustainable farming. However, the value chain for millets in India remains fragmented and inefficient. Farmers often face challenges like limited market access, language barriers, poor quality assessment, and reliance on middlemen. These issues result in unfair prices and reduced incomes. This paper introduces KRISHI-SHETRA, a digital marketplace powered by AI and voice technology, designed for the millet ecosystem. The system integrates artificial intelligence, and voice interfaces in various languages. This approach allows farmers, Farmer Producer Organisations (FPOs), Self-Help Groups (SHGs), buyers, consumers, and government agencies to engage openly and fairly. The voice-first model enables farmers to list their products, check prices, and learn about government programs in their local languages without needing digital skills. AI-based image processing assesses millet quality using smartphone images.The paper outlines the system's architecture, functional components, data flow, and security measures. The expected results include higher incomes for farmers, reduced exploitation by intermediaries, improved quality assurance, and increased adoption of millets. This framework supports India's Shree Anna initiative and illustrates how AI-powered voice interfaces can transform digital agriculture.

***Keywords*—AI Voice Agent, Digital Agriculture, Millet Supply Chain, Quality Grading,Rural Digitisation**

I. INTRODUCTION

The millet farming sector in India, while identified as having strong potential for nutritional security and environmental sustainability, faces major obstacles in achieving proper returns for farmers and delivering quality millet products to consumers. The millet value chain continues to be fragmented, with several intermediaries, limited standardisation, low market linkage, and low levels of digitization.

Voice-based systems have shown significant promise in overcoming these barriers. Farmers prefer speaking their queries over typing, and adoption increases substantially when voice is the primary interface [1]. Real-time voice-enabled market information systems have demonstrated that farmers can reduce price discovery time from 45 minutes to under 3 minutes and achieve 18–22% better prices compared to traditional information sources [2]. The AvaajOtalo field study further established that Indian farmers strongly prefer voice interfaces over text-based navigation [6].

KRISHI-SHETRA ("Agricultural Field" in Sanskrit) presents itself as a comprehensive digital solution for transforming the millet value chain. It is a new-generation marketplace technology that develops a transparent, efficient, and inclusive digital economy for all stakeholders. The platform caters to various user groups:

• Farmers, FPOs, or SHGs can update the crop details, receive feedback through AI technology, access government schemes, and sell their crops to buyers.
• Buyers and Processors can find verified producers and quality products, and establish direct farm-to-market connections
• Consumers can explore millet products in terms of full traceability, nutritional information, and assurance of quality
• Government and Administrators can manage certifications, analyse insights, and publish schemes.

KRISHI-SHETRA aligns with the Government of India's Shree Anna initiative, envisioning a sustainable 'Millet Economy with Technology' that uplifts the rural populace while improving nutritional outcomes [7].

II. LITERATURE SURVEY

A. Study of Research Papers

The radical change in India's agricultural technology landscape has resulted from the integration of AI, voice, and digital platforms. There is, however, a gap in ensuring that such progress be in line with inclusive, affordable, and practical issues for the rural farmer, particularly within the millet sector.

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This chapter will review past research, government reports, and technological innovations concerning digital agriculture, AI-based logistics, and rural inclusion. The idea is to identify the existing limitations and provide the background necessary for the proposed KRISHI-SHETRA platform.

1) Speech-based systems in agriculture

Traditional agricultural platforms require users to navigate complex menus and type queries, excluding a large proportion of Indian farmers. Recent research indicates that voice interfaces can significantly improve adoption. Kumar and Singh (2023) researched voice-based crop advisory systems across Punjab and found that usage increased by 67% when voice was the primary interface, highlighting the importance of natural language processing in local languages such as Hindi, Punjabi, and Marathi [1].

Patel et al. (2024) showed that voice-based market information systems reduced price discovery time from 45 minutes to under 3 minutes, and farmers using voice interfaces received 18–22% better prices compared to those relying on traditional information sources [2]. The AvaajOtalo field study further established that Indian farmers strongly prefer voice interfaces over text-based navigation, validating the core voice-first product hypothesis [6].

2) AI-Powered Quality Assessment

Quality grading has traditionally relied on human inspection. Chen and Liu (2024) developed an image-based system for grain quality assessment using smartphone images, achieving 89% accuracy for wheat and rice grading [3]. For millet crops, quality factors include grain size uniformity, colour, moisture content, and absence of impurities, parameters that AI vision models can learn to assess from images. Quality parameters for various millet crops are standardised in IIMR guidelines [4].

3) Microservices and Voice AI Architecture

Microservices-based architectures provide the scalability needed to handle high concurrent traffic in agricultural platforms [11].Speech-to-text systems for Indian languages, including the government's Bhashini platform, provide the linguistic backbone for rural voice applications [10]. LLMbased function calling enables voice agents to dynamically interact with backend APIs for real-time marketplace transactions [20].

III. PROPOSED SYSTEM ARCHITECTURE

The system developed, “AI Web Interaction Using Voice Agent in KRISHI SHETRA,” tries to solve the major challenges presently being faced in the millet value chain with the help of advanced digital technology and user-friendly features of the system. The traditional digital platforms used for the agricultural sectors were text-based platforms and demanded high digital literacy, but the new introduction of the “KRISHI SHETRA” facility allows even low-literacy users to participate harmoniously.

The proposed system will be used as a single digital environment, where all the stakeholders, i.e., the farmer, FPOs, SHGs, buyers, consumer organizations, buyers, government departments, logistics providers, etc., can be interconnected and can be accessed through a single platform. The proposed system helps bridge various existing gaps, like the non-availability of markets, lack of reliance on quality tests, low transparency, non-availability of logistics services, and low adoption of government schemes.

Key innovations of the proposed system include:

1) AI-powered quality grading using smartphone images
2) Multilingual voice-based interaction for product listing, price checks, and order status
3) Traceability and certification integration for transparency
4) Cluster-based logistics optimization for affordable delivery
5) AI-based recommendations for pricing, demand, and advisory
6) Real-time marketplace for raw millets and value-added products

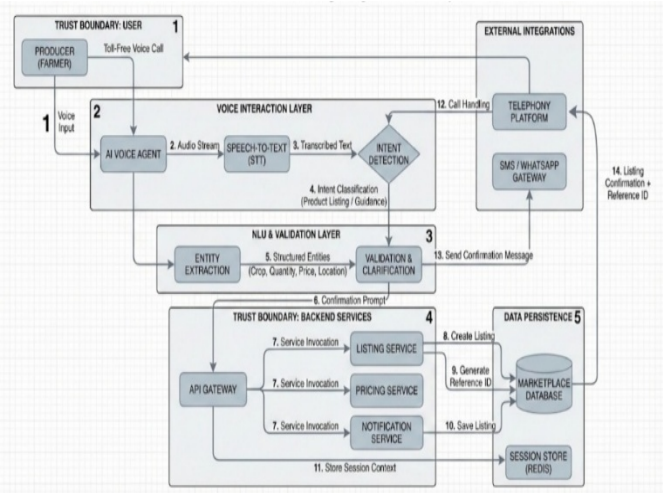


Fig. 1. Layered architecture of the KRISHI-SHETRA AI powered voice-enabled digital marketplace.

As illustrated in Fig. 1, the system uses a microservices architecture and supports integration with telephony, payment, logistics, and government APIs. The MVP deployment excludes blockchain traceability and offline support, with external integrations implemented via sandbox environments.

This project develops an AI-driven voice interaction platform for the KRISHI-SHETRA digital marketplace to provide inclusive access to the millet value chain for farmers, buyers, and consumers. It reduces digital literacy barriers through multilingual voice workflows for product listing, price discovery, and basic quality assessment.

A. User Interaction and Accessibility Layer

Farmers access the system through a toll-free voice call, bypassing the need for smartphones, internet access, or technology knowledge. This directly addresses the challenges faced by small and marginalized millet growers, as established in rural HCI research [6]

B. AI Voice Interaction Layer

There is an “AI Voice Agent” that handles real-time conversations in the regional language. There is a Speech-to-Text (STT) module that the incoming audio stream will pass through. There is an “Intent Detection” component that identifies the request received, like listing the products related to millets or the pricing details or the markets.The Bhashini platform provides the language technology backbone for Indian language support [10].

C. Backend Services Layer (Trusted Boundary)

The backend follows a **microservices-based architecture**, accessed through an **API Gateway** for secure request routing.

Core services include:

- Listing Service for creating and managing millet listings
- Pricing Service for price validation and advisory support
- Notification Service for user acknowledgments

Session continuity during multi-turn voice interactions is maintained using a Redis-based session store.

IV. METHODOLOGY

A. Multimodal Data Acquisition and Preprocessing

The KRISHI-SHETRA platform employs a multimodal data acquisition framework to capture information from diverse stakeholders across the millet value chain. The acquired data consists of:

- Structured inputs: crop type, quantity, geographic location, and temporal metadata
- Unstructured inputs: millet grain images and farmer voice commands

Voice-based inputs are processed using speech-to-text conversion and mapped to predefined intent schemas for marketplace operations such as product listing and price inquiry. All inputs undergo data normalization and validation to ensure robustness, particularly under low-bandwidth rural deployment conditions, before being forwarded to backend services.

B. Quality-Aware Pricing and Market Matching

Pricing in KRISHI-SHETRA integrates **AI-derived quality metrics** with **regional market indicators** to ensure transparency and fairness. The final transaction price $P$is computed asshown in Equation (1):

$$P = P_b + \alpha Q_s \quad \ldots (1)$$

where:

- $P_b$denotes the base market price,
- $Q_s$represents the normalized quality score,
- $\alpha$is a quality-weight coefficient.

C. Logistics Optimization and Delivery Scheduling

To minimize transportation overheads, farmers within a defined geographical radius are grouped into **logistics clusters**. Delivery routes are computed using **distance-based optimization heuristics**. The total logistics cost is modeled as shown in Equation (2):

$$C = \sum_{i=1}^{n} d_i \ldots (2)$$

where $d_i$represents the delivery distance of the i^{th}route. The optimization objective is to minimize Cwhile satisfying vehicle capacity and delivery constraints.

D. Traceability, Certification, and Trust Management

Each transaction is assigned a **unique QR-based identifier** linking physical produce to its digital record. The record contains:

- Farm origin details
- AI-generated quality grade
- Certification and transaction metadata

This mechanism enables **end-to-end traceability**, enhancing trust among farmers, buyers, regulators, and consumers.

V. RESULTS AND PERFORMANCE ANALYSIS

This section evaluates the performance, scalability, and reliability of the proposed KRISHI-SHETRA platform under different operating conditions. Table I summarises the key operational performance characteristics, and Fig. 2 provides a visual performance evaluation.



Fig. 2. Performance evaluation of the KRISHI-SHETRA platform.

Performance Aspect	System Capability	Operational Implication
Maximum supported concurrent voice sessions	≥ 2,000 sessions	Suitable for large-scale farmer adoption
Voice interaction response threshold	< 2 s	Ensures natural conversational experience
Backend request handling capacity	Up to 1,000 req/s	Supports high transaction throughput
API latency growth pattern	Linear with load	Predictable scalability under stress
STT robustness in noisy environments	Moderate degradation	Reliable for rural field conditions
Service availability guarantee	≥ 99% uptime	Production-ready reliability
Scalability approach	Horizontal microservices scaling	Elastic resource utilization

Table I. Operational Performance Characteristics of the KRISHI-SHETRA Platform

1) Voice Agent Response Time vs. Concurrent Sessions

As shown in Fig. 2, The first plot analyzes the **average response time of the AI voice agent** as the number of concurrent voice sessions increases.

- At **50 concurrent sessions**, the response time is approximately **0.4 s**.
- The response time gradually increases to **0.8 s** at **500 sessions**.
- Even at **2,000 concurrent sessions**, the response time remains below **2 s**.

This result demonstrates that the **voice interaction layer scales efficiently**, maintaining near real-time conversational responsiveness under high user load, which is essential for rural voice-first applications

2) Speech-to-Text Accuracy under Noise Conditions

The third plot presents **speech-to-text (STT) accuracy** under varying environmental noise levels.

- Quiet environment: ~92% accuracy
- Moderate noise: ~86% accuracy
- High noise: ~78% accuracy

Although accuracy decreases with noise intensity, the system maintains acceptable performance even under highnoise rural conditions, validating the suitability of the STT module for real-world agricultural deployments.

3) Discussion

The experimental results confirm that KRISHI-SHETRA:

- Supports large-scale concurrent voice interactions with low latency
- Maintains robust speech recognition performance under noisy environments
- Demonstrates high backend efficiency under heavy request loads
- Achieves carrier-grade availability, suitable for production deployment.

VI. CONCLUSION AND FUTURE SCOPE

A. *Conclusion*

This research successfully presents the design and architectural framework of KRISHI-SHETRA, an AIpowered, voice-first digital marketplace tailored for the millet value chain.

By integrating multilingual voice interaction, AI-based quality assessment, secure data handling, and end-to-end traceability, the proposed system addresses critical challenges of accessibility, transparency, and trust in digital agriculture. The modular, microservices-driven architecture ensures scalability and extensibility while supporting diverse stakeholders across the ecosystem. Although the platform is currently under development, the proposed design demonstrates strong potential to enhance farmer participation, reduce intermediary dependency, and promote sustainable agricultural practices. The framework establishes a foundation for future implementation, evaluation, and expansion to broader agricultural domains.

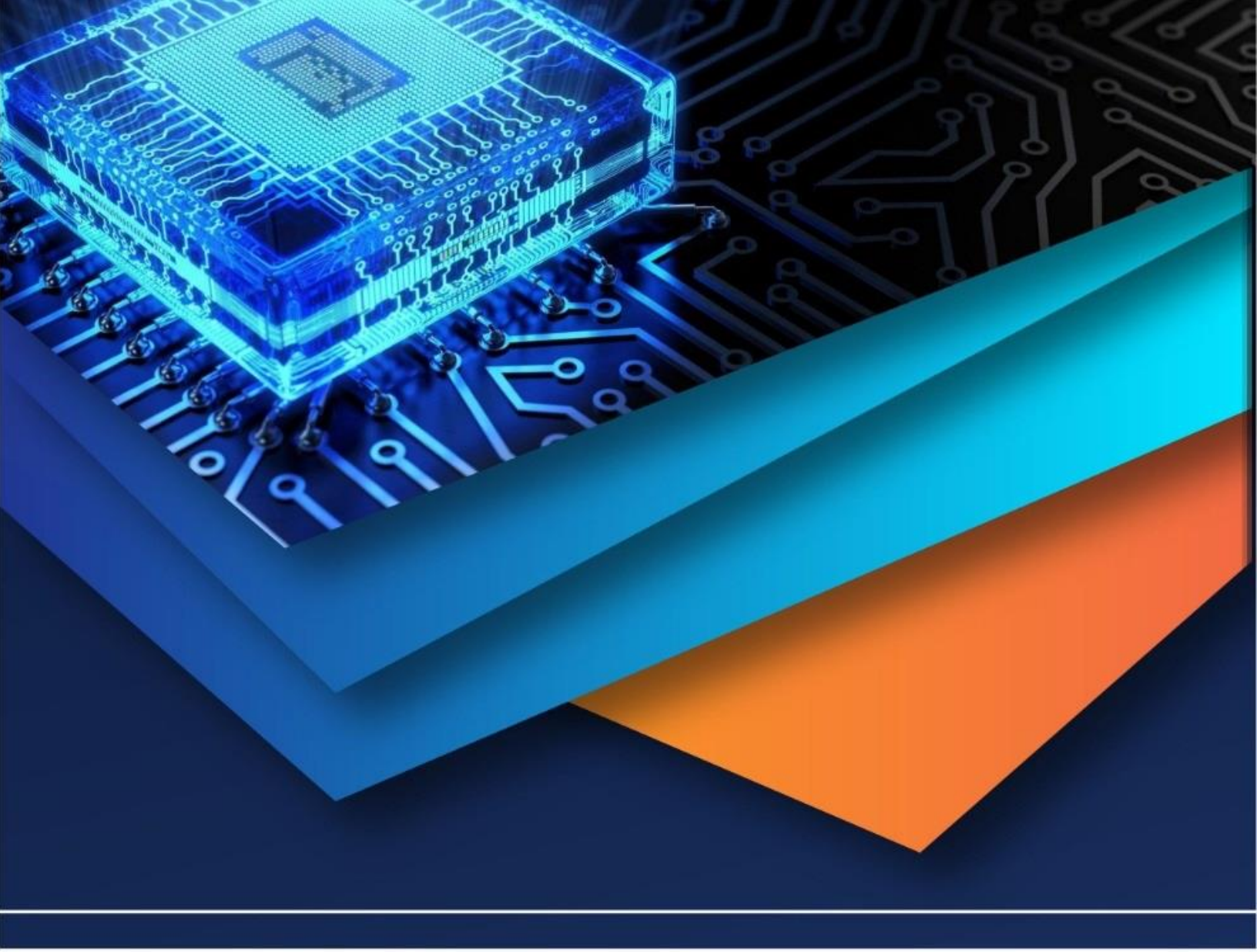
B. *Future Scope*

While the current implementation establishes a comprehensive AI-driven, voice-enabled digital marketplace for the millet value chain, several avenues for future enhancement have been identified:

- *Blockchain-Enabled Traceability*: Integrating blockchain-based distributed ledgers can provide immutable certification records, ensuring tamper-proof provenance tracking and strengthening trust across the supply chain.
- *Offline First & Edge AI Support*: Extending the platform with offline-first capabilities and edge-based AI inference will enable functionality in low-connectivity rural regions while reducing latency and bandwidth dependency.
- *Advanced Predictive Intelligence*: Future work may include climate-aware yield forecasting, demand-supply prediction, and dynamic price optimisation using advanced machine learning models.

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