



Design and Development of an Intuitive Android Application for Smart Farming

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Abstract

Farmers face challenges in adapting to environmental changes, yet with decreasing implementation costs and a growing accessibility to technical expertise, progress is evident. This research introduces KisanVishwa, an Android app designed for smart farming. KisanVishwa optimizes precision agriculture systems, enabling farmers to monitor their fields in real time and address agricultural constraints. Tailored to meet the specific needs of today's farmers, the app provides user-friendly tools and the latest information on farm equipment, fertilizers, chemicals, technological advancements, and local distributors and retailers. By integrating KisanVishwa into their operations, farmers can overcome challenges associated with the adoption and maintenance of precision agriculture. KisanVishwa adopts a user-centric design for compatibility across diverse Android devices, integrating monitoring tools and collaborating with agricultural research institutions. Empowering farmers, the app addresses contemporary challenges, fostering informed decisions and efficiency. With its user-friendly interface, KisanVishwa promotes the adoption of precision agriculture, essential resources, and sustainable practices in the agricultural sector. Convincing traditional farmers to adopt advanced technologies may pose challenges. Functionality may depend on reliable internet, posing challenges in areas with limited connectivity.



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Introduction


The integration of Android applications into smart farming has revolutionized the agricultural landscape, empowering farmers and agricultural experts with

advanced software tools to refine farming techniques and amplify overall efficiency. Designed to deliver real-time information on critical factors like soil quality, weather patterns, and crop development,

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these applications enable informed decision-making and optimization of agricultural activities. The increasing popularity of smart farming apps is evident in the projected market size, with the global intelligent farming market anticipated to reach USD 13.5 billion by 2023, exhibiting a noteworthy CAGR of 13.8%.¹

Utilizing sensors and devices, smart farming apps gather crucial data on crop growth, weather conditions, and soil quality, leading to significant improvements in farming methodologies. The integration of Android applications into smart farming has transformed agriculture, equipping farmers and experts with advanced tools to refine techniques and boost efficiency. For instance, in grapevine irrigation, the implementation of smart farming practices resulted in a remarkable 28% increase in grape yield compared to conventional methods.³ This tangible example showcases the practical benefits of smart farming apps in enhancing crop yields.

Moreover, research indicates that adopting smart farming technology has the potential to increase crop yields by up to 30%, while concurrently reducing water and fertilizer consumption.² These statistics highlight the real-world impact of technology on agricultural productivity.

Beyond enhancing crop yields, these apps empower farmers with tools to analyse market trends intelligently, contributing to increased profit margins.⁴ Key functionalities of smart farming Android apps include data collection through sensors, weather monitoring, crop management, and market analysis. By delivering real-time data and automated recommendations, these applications enable farmers to enhance productivity, reduce costs, and achieve higher yields.

As environmental concerns grow, the significance of smart farming technology in agriculture is expected to rise, shaping the future of sustainable farming practices. Numerous studies underscore the positive impact of smart farming Android apps on agriculture and crop yields, making them indispensable tools for modern farmers seeking to navigate the dynamic landscape of the agricultural sector.

Literature Review

Numerous studies have delved into the development of informative and guideline-oriented mobile applications tailored for farmers, incorporating sensor monitoring and control functionalities. These applications serve as comprehensive tools, offering insights into cultivation practices, farming tools, equipment, and valuable search advice. The potential of smartphones in agriculture has been scrutinized, as highlighted in,⁵ which explores various agricultural applications, presenting a case study of a transformative agricultural system mobile app leveraging interactive sensor technology. The study meticulously examines app design and technology to provide farmers with a promising solution for accessing government information and fostering community engagement.

One noteworthy example is the "Cotton App," discussed in,⁶ which stands out as a trustworthy resource for real-time, site-specific information. Operating on both iOS and Android platforms, this app significantly streamlines user interactions by reducing feedback when accessing databases via a server. Another technological advancement, the smartphone-based LoRa Wizard, as outlined in,⁷ specializes in measuring soil propagation. The study rigorously tests LoRa technology for soil dissemination and its potential in providing agricultural support.

The focus on water conservation and irrigation is evident in,⁸ introducing the "EVAPO" Android app. This innovative application estimates evapotranspiration in real time, utilizing weather data and the Penman–Monteith process. Validation involves comparing the app's estimated evapotranspiration with meteorological station data to determine its effectiveness. Furthermore,⁹ introduces an Android app designed to accurately and swiftly count rice and wheat grains, boasting a mere 2% error rate and one-second counting time.

Apps like those discussed in^{10,12} play a pivotal role in assisting farmers in crop selection based on factors such as water supply, temperature, soil pH, location, and crop duration. These applications, designed to be simple, affordable, and customized, include

notable examples like the "Cotton Smart Irrigation" App and "Smart Sensor" developed by the University of Georgia, as compared in.¹¹

The realm of smartphone-based agricultural monitoring is explored in,¹³ where 3G/LTE connectivity and microcontroller-connected sensors are deployed to monitor water, fertilizers, and various farm parameters. The data collected is then analyzed through internet-connected microcontrollers. Additionally,¹⁴ introduces an offline Android app aimed at aiding maize farmers in "Malaybalay City, Bukidnon," with a focus on increasing crop yields and grain production. The app's development follows the modified waterfall model.

Research projects like¹⁵ delve into remote monitoring and field spray control mobile apps, developed for both Android and iOS platforms. The "Padi2U" app, detailed in,¹⁶ offers a wealth of information ranging from paddy variety and planting timetables to drone pictures, diseases, pests, weeds, weather forecasts, and farmers' reports. In a bid to empower farmers with direct access to agricultural information,¹⁷ introduces an informative Android app, eliminating the need for intermediaries or SMS responses from web portals. "Agro-Sense," explored in,¹⁸ utilizes Android and Arduino-based systems to monitor farm parameters such as light, temperature, humidity, and moisture. The app efficiently displays remote monitoring data for enhanced decision-making. Additionally,¹⁹ presents an Android app linking farmers to the food industry and retailers.

The innovative integration of an Android app and Arduino-based system for controlling cultivation water supply is presented in.²⁰ This system incorporates sensors to measure soil moisture and temperature, with the app receiving SMS notifications. Noteworthy is the app's capability to capture soil images for soil type detection. A suite of mobile apps, as outlined in,²¹ forecasts and prevents pesticide use for various crops. These applications offer farm control and monitoring functionalities without requiring additional hardware.

In conclusion, the collective impact of these smart farming Android apps is poised to significantly enhance crop yields, refine farming practices, and contribute to sustainability in the agricultural sector.

The widespread adoption of these technological solutions is anticipated to propel the agricultural industry forward, embracing the transformative potential of smart farming technologies.

Materials and Methodology

The KisanVishwa mobile application stands as a comprehensive solution meticulously tailored to meet the distinctive requirements of the Indian agricultural landscape. With a paramount focus on user-friendliness, the application is crafted to be effortlessly navigated, catering to individuals with limited technical proficiency commonly found in the agricultural community. Compatibility-wise, the application is optimized for Android devices boasting API level 23, ensuring seamless functionality across a wide range of devices, including those with lower memory capacities and slower network speeds. This deliberate optimization strategy enhances accessibility, making the app inclusive for farmers with varying technological resources.

The core features of KisanVishwa extend beyond basic functionalities, delving into critical monitoring and management tools for crop variables. An intelligent notification system has been integrated to alert farmers about potential threats, including the risk of animal encroachment. This proactive approach empowers farmers with timely information to mitigate risks and safeguard their crops effectively. A distinctive attribute of KisanVishwa is its role as a comprehensive agricultural ecosystem. The application serves as a central hub for identifying vendors, intermediaries, and suppliers of essential agricultural resources. This encompasses a wide array of offerings, including agricultural machinery, implements, and agrochemicals. Moreover, KisanVishwa doesn't stop at being a marketplace, it goes the extra mile by providing valuable farming recommendations tailored to diverse cultivars. This multifaceted functionality positions the application as an indispensable tool for farmers, offering not just a marketplace but a knowledge center to enhance agricultural practices.

The user-centric design of KisanVishwa caters to two distinct user groups within the agricultural spectrum. On one front, it accommodates individuals who have embraced precision agriculture infrastructure and IoT-enabled hardware. For this tech-savvy group,

the application seamlessly integrates with existing technologies, enhancing their precision farming practices. On the other end, KisanVishwa recognizes the diverse landscape of Indian agriculture, acknowledging those who have not yet adopted advanced technologies. The application serves as a bridge, providing a user-friendly entry point for those looking to step into precision agriculture, making it an inclusive platform for all farmers.

In addition to its existing features, KisanVishwa envisions expansion and continuous improvement. Future updates could include advanced analytics for crop management, real-time weather integration for more precise decision-making, and collaborative features to foster knowledge-sharing within the farming community. The scalability and adaptability of KisanVishwa position it as a dynamic tool that evolves in tandem with the changing needs and technological advancements in Indian agriculture. A simplified design and development flow for the KisanVishwa Android app is presented below.

Requirement Analysis

Understand and document the requirements for the app, focusing on both IoT and non-IoT functionalities.

User Stories and use Cases

Create user stories and use cases to capture different scenarios for users with and without IoT hardware.

Design Wireframes

Develop wireframes to visualize the app's user interface, ensuring it is user-friendly and optimized for Android devices.

Compatibility Planning

Plan for compatibility across a range of Android devices, specifically targeting API level 23 and optimizing for lower memory capacities and slower network speeds.

Cloud Service Selection

Choose a suitable cloud service for data storage and visualization, ensuring reliability and scalability.

Frontend Development

Develop the frontend of the app, including UI components for features accessible without IoT hardware

Backend Development

Implement the backend functionality, focusing on cloud integration and storage for data visualization. Develop features that require IoT hardware.

Security Implementation

Implement security measures for user data, especially for features involving data storage and remote control.

Testing

Conduct thorough testing, including unit testing, integration testing, and device testing for compatibility. Test both without and with IoT hardware functionalities.

User Feedback and Iteration

Collect feedback from users during testing phases and iterate on the design based on their input.

Documentation

Create comprehensive documentation for the development team, including architecture, data flow diagrams, and APIs.

Deployment

Deploy the app to the Google Play Store, ensuring it meets the necessary guidelines and requirements.

Post-Deployment Support

Provide ongoing support, addressing user feedback, fixing bugs, and planning for future updates.

Scalability and Future Updates

Plan for scalability and outline a strategy for future updates, considering advanced analytics, real-time weather integration, and collaborative features.

This flow provides a general guideline for the Android app design and development process. Additional steps or modifications may be necessary based on project-specific requirements and complexities.

Results and Findings

Features Accessible without IoT Hardware

The KisanVishwa application serves as an invaluable repository of information, offering users access to a diverse range of agricultural technologies and insights into the challenges tied to crop growth, as illustrated in Figure 1. This universal accessibility

ensures that every user of the system is equipped with the essential knowledge required for informed decision-making in agricultural practices.



Fig. 1: Page for Guideline Information of Cultivating different corps

The main page of the KisanVishwa application, showcased in Figure 2, is thoughtfully designed in Marathi, the regional language of Maharashtra. This strategic localization enhances comprehension and usability for users who prefer or are more comfortable communicating in Marathi.

The app incorporates valuable advice on agricultural practices sourced from Krishi Vigyan Kendra (KVK) – agricultural research and knowledge canter. This feature not only provides technical assistance but also establishes links for users to access government policies and initiatives in agrarian economies.

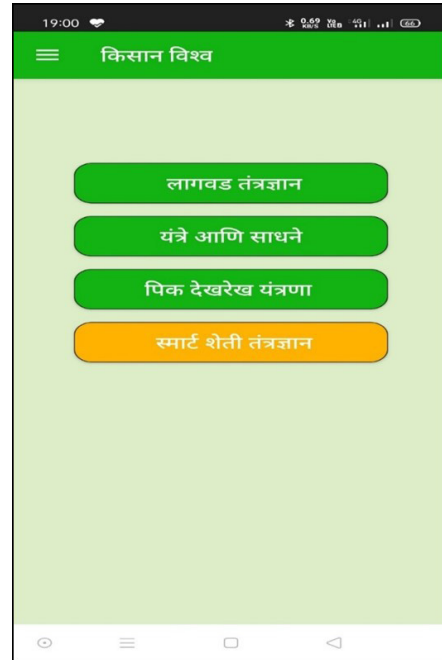


Fig. 2: Kisan Vishwa main Page



Fig. 3: Sub-menu centralised page

Figure 3 encapsulate all discussed solutions, providing users with a centralized page for easy reference. This ensures a seamless experience for users seeking information on agricultural practices, dealers, and other pertinent solutions. To ensure farmers have access to top-tier inputs, the app includes a dedicated section featuring names, addresses, and phone numbers of retailers specializing in crop-specific seeds, fertilizers, pesticides, and other agricultural supplies. This function assists users in pinpointing suitable dealers based on their current geographic location.

can remotely control actuators and collect field data through the app. The smart control page let farmers control actuators via the cloud. Data Visualization of Farm Field Parameters: The app displays real-time data and its fluctuations for different constraints. The results page that was developed within the app and is displayed in Figure 4 provides information about the cultivation of crops as well as the essential conditions that are specific to each crop. which would be of great assistance to farmers if they knew the precise constraints that are required for a particular crop.

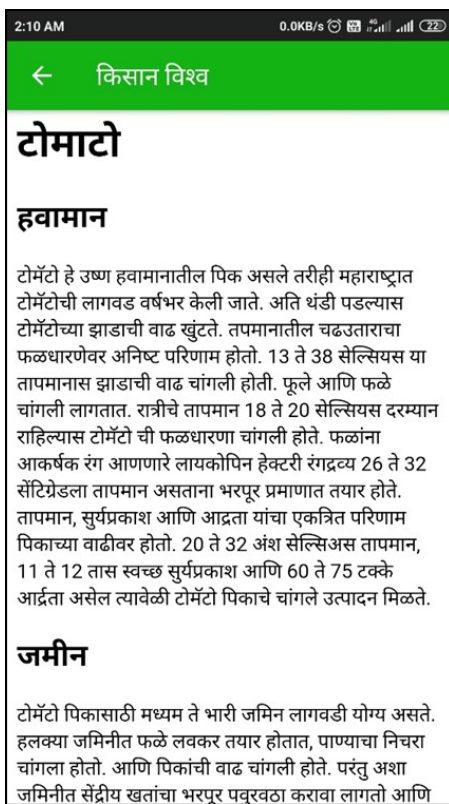


Fig. 4: Information about crop

To configure app in Real-time required sensor based hardware to be in synchronisation and configuration, visualization, and Control: KisanVishwa's integrated cloud infrastructure gives hardware users real-time control over farm parameters. The AWS EC2 cloud architecture is scalable and portable. Apps features are shown in Figure 5. Real-time Farm Control: With precision agriculture hardware in the field, users

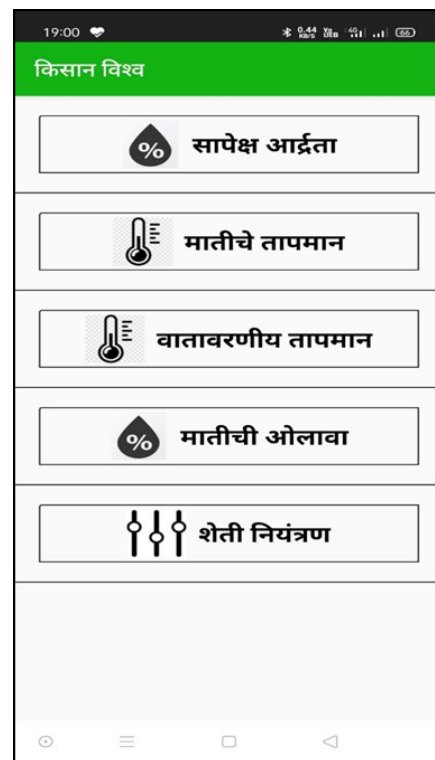


Fig. 5: Control view of Precision farming with hardware

Figure 6 illustrates the functionality of the "KisanVishwa" Android app that allows users to search for farming tools and equipment based on their location. This results page, which was developed within the app, enables users to search for and explore a variety of farming tools and equipment that is tailored to their particular location in a convenient and hassle-free manner.

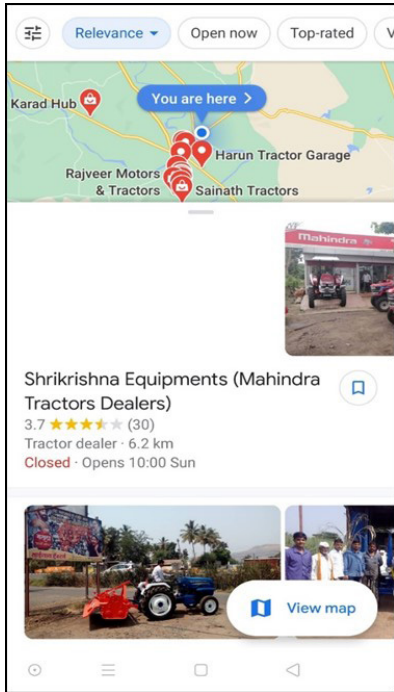


Fig. 6: Results of search of farming tools and equipment based on users location

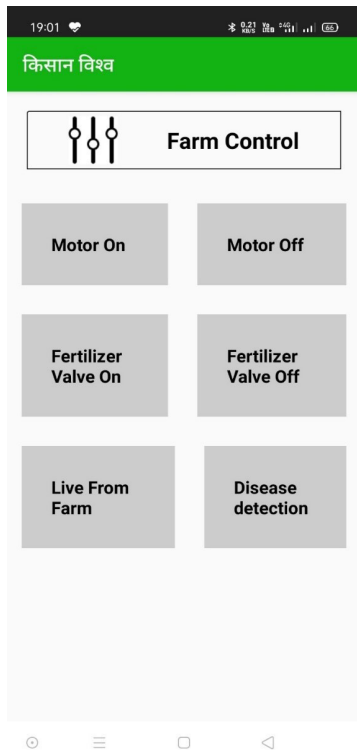


Fig. 7: Farm Control View of Kisan Vishwa

By implementing precision agriculture hardware in the field, farmers can remotely control various actuators and collect data from the field through the app. Figure 7 illustrates the page that enables the control of various farm parameters. Through the app, farmers can send controlling commands via the cloud to effectively manage and control the actuators.

The application displays data in real time and visualizes how it varies over time in response to a variety of constraints. Figure 8 (a) and (b) provide users with a graphical representation of the on-field temperature and humidity in the app, allowing users to monitor and analyse these extremely important parameters.

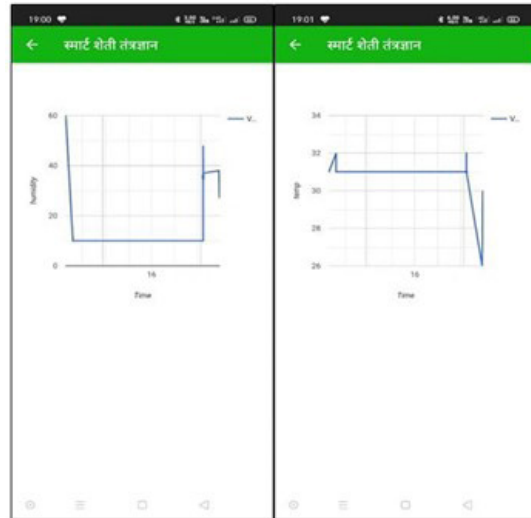


Fig. 8: (a) on field Humidity monitoring (b) on field temp Monitoring

Conclusion

the "KishanVishwa" Android app stands as a versatile solution, catering to both precision agriculture hardware users and traditional farming practices. Through its integration with Krishi Vignyan Kendra (KVK), the app ensures universal access to crucial information and expert guidance, fostering unity among farmers.

For precision agriculture users, real-time control and data visualization capabilities enhance operational efficiency. The app's user-friendly design in Marathi promotes inclusivity, reflecting a commitment to

accessibility. In the future, the app can be enriched by integrating an AI-enabled chatbot to provide advanced technical assistance and address inquiries from farmers. An option for feedback and suggestions can be incorporated into the application, allowing users to share their experiences and provide valuable input.

In essence, "KishanVishwa" empowers farmers with tools and technology, facilitating informed decisions and contributing to agricultural progress. Its diverse functionalities make it a transformative force, driving positive change in the farming landscape.

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Conflict of Interest

The author(s) has(have) no conflict of interest to declare.

Data Availability Statement

Not applicable

Ethics Approval Statement

This research study does not involve experiments on humans or animals. Therefore, ethics approval from a relevant authorizing body is not applicable.

Authors' Contribution

Arun Patokar Conceived and designed the research study as part of his Ph.D. work, Conducted all the development and implementation efforts. Generated and analyzed the experimental data. Drafted the initial manuscript, Dr. Vinaya Gohokar Served as the supervisor throughout the research process. Provided guidance and expertise in formulating the research objectives. Contributed to the critical review and refinement of the manuscript. Offered insights and suggestions for improving the methodology and analysis.

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