Automated farming as a service with Internet of Things support

[1]Anusha Kudithikunta, [2]Korri Raju, [3]Ramala Ashok, [4]Neeraja Balla

[1,2,3,4] Assistant Professor, Department of CSE, Narsimha Reddy Engineering College, Secunderabad, Telangana

Abstract:

This paper presents a comprehensive overview of the tasks that need attention within the agriculture industry. The task is executed by an automated device based on the Android platform, which operates in response to the farmer's instructions sent in a language unique to their local tongue. This communication is facilitated by an Android application loaded on the farmer's mobile device. Our organization facilitates effective communication among farmers, data centres, and automated equipment inside the agricultural field, enabling the development of an Android-based automated system. Regarding the use of GCM or JSON for communication purposes, our objective is to enable the Android automated device to operate and afterwards transmit the acknowledgment message. Furthermore, we provide an automated mode referred to as auto mode, facilitating the seamless integration of automated devices and the data centre, allowing for the exchange of data between them. The data centre provides assistance for the artificial intelligence system. The received data is subjected to analysis, after which instructions are generated in accordance with the outcomes of the analysis. Furthermore, it records data pertaining to individual processes, which is then stored and may be accessed for future use. The platform under development has a farmer-centric approach, including the option to pose questions or submit requests. Consequently, there is a pressing need to consolidate the many uses of agriculture into a unified system, a feat that has hitherto remained unattainable with preceding technology and research endeavours.

1. Introduction:

The agricultural sector in India has a rich and esteemed legacy that dates back to the era of the Indus Valley Civilization, and in some parts of southern India, its roots may be traced even farther into the past. India's agricultural output has now positioned it as the second-largest contributor on a worldwide scale. In the year 2013, the agricultural sector, together with its associated businesses like forestry and fisheries, contributed around 13.7% to the overall gross domestic product (GDP). This percentage is almost comparable to half of the total workforce. The share of India's gross domestic product (GDP) derived from the agricultural sector is declining in direct correlation with the overall growth of the nation's economy. Nevertheless, agriculture has the distinction of being the most prevalent economic sector in India from a demographic standpoint, and it assumes a crucial role in shaping the nation's socio-economic landscape.

One of the key advantages of automation is the eradication of the need for human labour. The pace of progress in industrial automation has shown remarkable significance during the last two decades. Nevertheless, the concept of automation is not as firmly entrenched within the agricultural industry. The primary rationale for the indispensability of automation in agriculture is in the projection that the world population would reach 9 billion people by the year 2042. Ensuring the adequate supply of food that meets high standards of quality, safety, healthfulness, and nutritional value is a significant challenge. Furthermore, conventional agricultural practices exhibit several drawbacks, including seed wastage and improper pesticide application, resulting in soil degradation and the potential toxicity of food consumed by individuals [1].

The use of automation has the potential to address India's aspiration of attaining industrial prowess comparable to global leaders. The agricultural sector in India is now in the first stages of seeing the impacts of the recent stimulus package aimed at the instrumentation, control, and automation industry. The domain of automation in India is experiencing significant advancements, yet it remains an area that cannot be deemed flawless or esteemed due to its inherent need for ongoing innovation and the recognition of emerging technological trends, alongside the innovations that propel the adoption of automation in other nations.

The emergence of precision agriculture technology in the 1990s allowed a novel viewpoint towards the significance of mechanization in the realm of agricultural crop care. The presentation of many conceptions, some of which were not new, resulted in a shift in the comprehension and handling of variability. The efficient evaluation and management of geographic variability has only been possible after the development of automation, with the advent of yield mapping and VRT (Variable Rate Treatments). Building upon previous research in the field of agriculture, a novel concept using the Android platform has emerged, offering enhanced efficiency and productivity in agricultural practices. This notion builds upon the existing research conducted by previous scholars in the respective discipline

In light of the aforementioned factors, there arises a need for the adoption of an information-driven agricultural approach sometimes referred to as "precision agriculture." The integration of precision agriculture methods with the internet of things yields optimal results within the agricultural domain [2]. By using this approach, we can effectively implement rigorous management of all available resources, leading to enhanced production while minimizing costs.

Agriculture has been a prominent occupation for humans since the emergence of early civilizations. Even in contemporary times, the need for human labour in agricultural activities remains essential and cannot be circumvented. The ubiquity of smart phones and rapid advancement of information technology have led to significant advancements in several domains, resulting in substantial development of smart phone apps. The main objective of this initiative is to enhance the use of Android technology within the agriculture industry.

India, although possessing one of the globe's most rapidly expanding economies with a predominant emphasis on agriculture and farming, has not shown a commensurate pace of technological adoption. It is essential for the government to proactively disseminate information on the automated system to the general public, enabling them to acquire familiarity with the system and actively engage in its operation.

2. Related work

Wireless Sensor Networks (WSNs) were used in the development of previous automation systems. Numerous proposals have been put out to develop protocols that include considerations of energy efficiency in the routing duties performed by sensors. In hierarchical networks, it is common for nodes to be organized into clusters, with one node inside each cluster designated as the head node of the hierarchy. The individual responsible for overseeing a cluster has the responsibility of coordinating internal operations within the cluster and facilitating the exchange of information with other clusters. Clustering demonstrates the potential to achieve a substantial delivery ratio in a scalable manner, hence reducing energy consumption and prolonging the network's lifetime [3]. The network used in agriculture may be rather broad due to its need to include all cultivated areas.

The wireless sensor network (WSN) technology is now seen as outdated due to the widespread adoption of the Internet of Things (IoT) and the global dominance of the Android mobile operating system. Hence, the integration of Internet of Things (IoT) and Android technology within the agricultural domain has the potential to bring about substantial transformations, leading to enhanced production while minimizing expenses.

The Android Automated device engages in communication with the internet and processes data in either GCM or JSON forms, both of which are characterized by their lightweight nature. In October 2003, the open-source platform known as Android was founded by Andy Rubin. From its creation, Android has received backing from prominent hardware and software developers such as Google, Intel, HTC, ARM, Motorola, and Samsung, all of which are members of the Open Handset Alliance. During the month of October in the year 2008, The preloaded software package on the device facilitates user interaction with Google's own applications like as Maps, Calendar, and Gmail. Additionally, it incorporates a web browser that provides support for the whole HTML standard. The Android operating system provides users with the capability to execute both native programs and third-party apps, which may be obtained via the Google Play platform. The first launch of Android Market occurred in October 2008, afterwards undergoing a rebranding to Google Play. The Android operating system has seen significant development and has emerged as the dominant platform in the mobile industry. Subsequently, we will proceed to provide a comprehensive outline of the Android Platform, alongside an examination of the distinct components that constitute an Android program. Figure 2 illustrates the composition of the Android platform, which comprises four distinct layers. At the topmost layer, applications are situated, while the subsequent layer consists of an Application Framework that provides diverse services to applications, including activity control and data access. Below the Application Framework layer lies the Library/VM layer, and at the lowest level resides the Linux kernel.

The code used for constructing JavaScript objects and the JSON format exhibit complete structural equivalence. Due to this proximity, a JavaScript program has the capability to leverage conventional JavaScript techniques for converting JSON data into native JavaScript objects, as opposed to relying on a parser, which is necessary for the conversion of XML data into native JavaScript objects [5].

There is already a significant proliferation of innovative concepts aimed at facilitating the advancement of agricultural automation and fully harnessing its capabilities. This scenario presents an opportunity for a paradigm shift, whereby we transition from traditional approaches used in previous instances to alternative methods including the utilization of SSM (small smart machines) [6]. The prevailing trend in equipment development is sometimes referred to as incremental development, when each subsequent machine exhibits incremental improvements over its predecessor. This technique has shown efficacy; nonetheless, it exhibits a notable disrespect for other revolutionary opportunities and prospects.

3. Idea

The main goal of the A2S initiative is to enhance agricultural practices by developing an automated farming system based on android technology. This system aims to efficiently manage numerous electrical devices in irrigation or field settings through an android platform and mobile handset. The transmission of data is facilitated wirelessly via an Internet service provider [7]. It is acknowledged that farmers get electricity supply at unconventional hours. As a result of this, we use an Automated Android Device to enable the farmer to activate the motor by a single action and deactivate it through a tactile input, even in our absence at the physical location. When configured in automated mode, the AAD establishes communication with the data centre in order to transmit the outcomes of its statistical computations pertaining to temperature, humidity, water level, and soil water content. If deemed required, it is possible to establish a connection with the automated agricultural machinery using Bluetooth technology in order to activate their operations [8]. The farmer maintains and operates a data centre, which serves as the repository for all of the farmer's operations. The artificial intelligence (AI) is housed inside the data centre, where it assumes the task of interpreting the statistical data acquired from the device. The subsequent course of action is selected based on the results. If the farmer is not present at the station, they may use the video buffering feature to remotely monitor the progress of activities during their absence. Furthermore, farmers are provided with the opportunity to submit their inquiries using the Android application, afterwards receiving responses to their queries.

4. Working Prototype

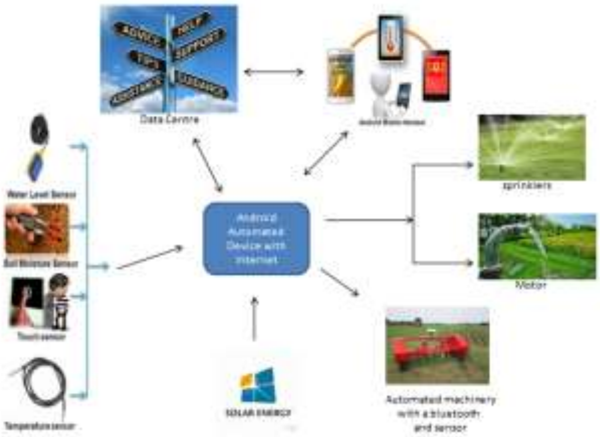

FIG 1: Architecture of A^{2}S

4,1Devices used in A^{2}S

SL.NO	Device	Usage
1	**Automated Android Device**	It is the main part of the A^{2}S and it communicates with all the other parts of the system and transfers the data
2	**Application**	Rests on the android phone and is used to control the operation of the device
3	**Solar Panel**	It is used to supply the power to AAD (Automated Android Device).
4	**Data Centre**	Data center rests the AI which is used to analyze the data and send the commands back. It also stores the every single user operations.
5	**Sensors**	These are used to sense the humidity, water level, water content and temperature in the soil and the sends the data to AAD.

The primary component of the system is the Automated Artificial Device, which operates on the Android Operating System. The system collects data from the sensors at specified intervals and transmits it to the farmer. The system accepts user instructions in the form of GCM or JSON, both of which are lightweight and efficient in terms of data delivery. The system engages in communication with motors, automated machines, and performs activities in accordance with given commands [9]. The communication is established between the device and automated equipment via the use of Bluetooth technology. The Automatic Agriculture Device (AAD) operates in auto mode, where it transmits the computed statistical information pertaining to temperature, humidity, water level, and soil water content to the central data centre. In the standard operational state, the data is sent to the Android application that is used by the agriculturalist. In the absence of an Internet Service Provider (ISP), the Global System for Mobile Communications (GSM) is used as an alternative medium for data transmission.

The application has been created specifically for Android smartphones. The system has two distinct modes. There are two modes of operation for the Authenticate Access Device (AAD). The first option is referred to as "normal mode." In this mode, the AAD sends an access notice to the user's phone. The user is then able to authenticate themselves in order to proceed with the desired action. In the automated mode, the data is sent to the central data centre for analysis, after which the processed data is returned to execute a certain action. Additionally, this platform offers the functionality to submit inquiries on agricultural matters and get responses from the data centre within a few hours, providing detailed solutions to the posed queries. By using the program, users have the ability to remotely activate and deactivate the motor with a simple touch. The system collects data pertaining to temperature, humidity, water content, and water level inside the field.

A solar panel has been erected in close proximity to the AAD (Antarctic Automatic Weather Station) with the purpose of providing electrical power to the AAD [10]. This solution effectively addresses the issue of electrical supply problems associated with the AAD.

The AI is housed inside the Data Centre, where it processes the data received from the AAD. Subsequently, the Data Centre sends a response back to the AAD in order to execute the necessary operation. It provides responses to the inquiries posed by agricultural practitioners. Additionally, it records every operation performed by the farmer.

Sensors are strategically positioned in the field, and the collected data is periodically sent to the Acquired Data (AAD) system.

4. Implementation

Working of the above system is explained in the form challenge faced and the solution provided by this system

Challenge-1: Need of monitoring the crop for statistics like humidity, water content in soil, temperature etc.

Solution: It solves the above challenge as sensors are deployed in the field and the statistics are collected in AAD and the normalized results are sent to both user and the Data Center. Farmer can regulate the time interval before receiving another notification about the statistics i.e. we can set the time interval for receiving the data about this [11]. The data sent to the Data Center is stored for analyzing. When the AAD is in auto mode the data is sent to both but the next action to do is taken care by the AI which is present in the Data Center

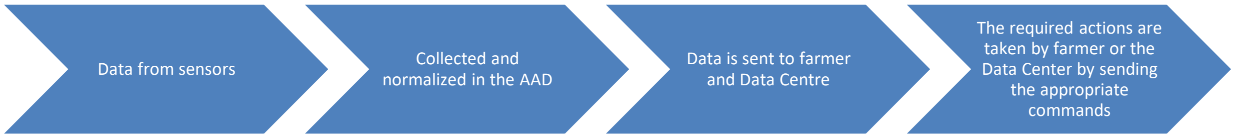

FIG 2: Field or land monitoring

Scenario 1:

Let us assume there a crop is in the initial stages and there a requirement that some environmental conditions to be maintained for the growth of crop. With the title we can get data about conditions like humidity, water level and content of water in the soil. And if we think that there is need of water then motor can be switched on immediately.

Challenge-2: Controlling the motor/sprinkler remotely

Solution: If farmer is far away from the field and the above is needed to be controlled then with a click of a button in the application it is turned on and off using GCM or JSON [12]. In auto mode the average time between two turning on off motors is calculated by the AI and the motor is switched on or off accordingly.

FIG 3: Motor Control

Scenario 2:

Let us assume that the electricity is being supplied at late hours and the farmer has to go all the way to the field and switch the motor on and have to be present to turn off the motor at those late hours. So this product gives the solution as they can switch the motor on or off very easily using the Application being present at home.

Challenge-3: Controlling the level of water in the field.

Solution: Let us assume there is a heavy rain with which the field is completely filled with water. So if these persist then there may be a chance of losing the crop. So as a solution a small gate as dam is prepared near the field and whenever there is large amount of water they can be taken off the field automatically. The water being drained out can be used for storing purpose for future use.

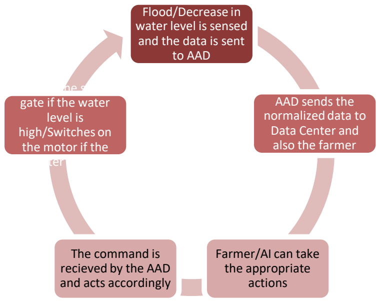

FIG 4: Water Management`

Scenario 3:

Let us assume the crop is at the final stage and is ready to harvest. Assume it rained very heavily that the complete field is filled with water which destroys the crop. The AAD sends the alert to the farmer and also the data center. If the farmer opts to open the gate then the AAD opens the gate until the water is drained off.

Challenge-4: Control of Farming Machinery

Solution: Let us think that in future we will be using automated machines like automated tractors in our Indian Fields which are used to plough the field. So we can access them by turning it on or off using Bluetooth or any other communication devices. AAD receives the command and communicates with the device to turn it on or off.

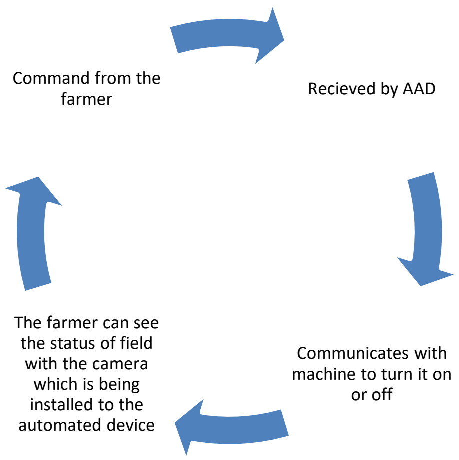

FIG 5: Online Monitoring

Challenege-5: If there is query about farm and agriculture.

Solution: So as to clear the queries and doubts of the farmer. We add a forum to it where farmers can ask their questions and get the answers. To our assumption if they are illiterate they can capture the diseased leaf and they can send that to Data Center. Data Center analyzes it and gives the remedial solution to farmer.

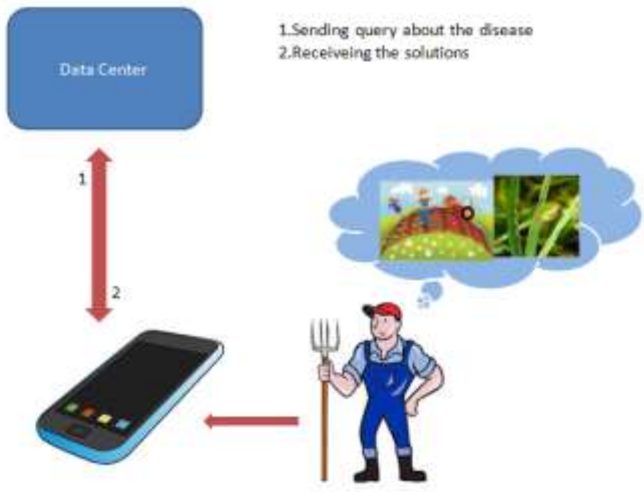

FIG 6: Mobile Query

Scenario: Assume the crop is infected with a disease. The farmer don't know the solution for it. He can just capture the photo graph of the diseased plant and can send that to the Data Center. They provide farmers with the solution.

Challenge-6: Notifying the farmer about spraying the pesticides.

Solution: This system also solves the problem of forgetting about spraying the insecticides and pesticides. If farmer give the date of the first sprayer and later how many days the next course is to be implemented then it alerts the farmer before 3 to 4 days so that he can make ready of what he actually need like pesticides etc.

Challenge-7: The tension to the farmer about what is happening in the field if he/she is out of station.

Solution: The solution that is being given here is using the video buffering facility provided. Though the each part of the field is not covered if AAD is placed such that all there will be a overall view it would be helpful for the farmer. It is still in the idea development phase. If it is developed better then it would be very much useful to the farmer.

Drawbacks and their solutions:

SL.NO	Drawback	Solution
1	24*7 supply of electricity to the Automated Device	Solved the problem of electricity by using Solar Plant in the system. And as the solar Plant is subsidized by govt. of AP the projects gets cost efficient.
2	24*7 ISP	As a new project on Internet provision is being implemented in AP makes the project cost efficient.
3	Theft	1. Touch sensors are placed which raises an alarm and sends notification to android application when

		it is touched. 2. When the ISP is disconnected or the connecting cable is damaged it sends a message to the farmer.
4	ISP Connectivity Issues	If ISP is not available then it uses GSM module to communicate with the farmers in the form of messages.
5	Illiteracy	Though the farmer is uneducated they can work with android applications as they are developed on their native languages.

5. Future Enhancement:

In future it may be possible to control all the machinery present in the agriculture land with just one application by using this System. As IoT is building a lot of craze there may be extensions possible and android has been used that this can used for future projects also.

6. Conclusion:

The practice of irrigation has played a pivotal role in the development and sustenance of human civilisation ever since the inception of agricultural activities by mankind. As the progression of generations unfolded, humanity has devised several techniques for using automation within the realm of agriculture. In the current context, the reduction of human resources has significant relevance. The current research endeavours to preserve the Earth's natural resources for the sake of humanity, while also developing more efficient agricultural practices. Through the implementation of continuous farm monitoring, it becomes feasible to optimize agricultural output to its fullest potential. The ability to monitor moisture, temperature, and water level sensors through ISP and GSM networks, coupled with the use of moisture and temperature sensors, enables the regulation of water flow by the simple act of pressing a button or sending a message from a mobile device. Highly sensitive sensors may be used in extensive agricultural settings to cover vast regions of land.The preservation of water resources and the optimization of labour efficiency: Given their automated nature, these systems do not need ongoing supervision by human labour. The system has the capability to operate in both manual and automatic modes, allowing for flexibility in its functioning. In manual mode, the land management is carried out based on orders provided by farmers, while in automatic mode, artificial intelligence (AI) takes charge of the land management process. The design exhibits a great degree of robustness and versatility.

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