

EXPLORING THE POTENTIAL OF INTERNET OF THINGS (IOT) TECHNOLOGY IN REVOLUTIONIZING THE AGRICULTURAL SECTOR IN EDUCATION.

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Abstract

This study explored the potential of Internet of Things (IoT) Technology in revolutionizing the agricultural sector in education. This was prompted by the relatively depreciation in food supply over to meet the health needs of the ever growing population in the world and Nigeria in particular. The agriculture industry currently employs a wide range of technologies, techniques, and instruments. The implementation of the Internet of Things (IoT) is critical for optimizing operations, reducing expenses, time, and human involvement, and increasing productivity and performance. The automation of agricultural processes, including but not limited to water management, soil control, crop management, and animal monitoring, employs a variety of sensor types. Intelligent greenhouses protect plants from harsh weather conditions. A remote smart system utilizes an Internet-connected computer, sensor, camera, microcontroller, and other components to monitor these operations. The economic situation of Nigeria is affected by the growth in the agriculture sector. The focus of this article is the Internet of Things function of intelligent agriculture.

Keywords: Smart Farming, IOT in Agriculture, IoT Technology.

Introduction

Agriculture serves as the fundamental pillar of the nation and constitutes a significant component of Nigeria's economy. A significant population of the nation's population relies on agriculture, which also serves as a primary source of national income, like Nigeria and other countries. Farmers cultivate a wide range of crops, including fruits, vegetables, cotton for apparel, maize, and various other commodities. Currently, there exists a wide array of technologies and techniques utilized in the field of

agriculture. According to the United Nations Food and Agriculture Organization (Pawar et al., 2022), to sustain the growing global population, the earth will require a 70 percent increase in food production by the year 2050 compared to the levels observed in 2006. Considering the fact that the primary factor of labour (land) is fixed as fast reducing in sized due to human and technological factors, something needs be done urgently as the unprecedented surge in population growth in the world, especially, in developing countries, seems to threaten the quality of life and health. To address this demand, farmers are transitioning from conventional agriculture to intelligent agriculture. To enhance production, maximize profitability in a shorter timeframe, reduce expenses associated with worldwide marketing, and minimize human intervention in farming operations, numerous agricultural businesses have turned to the employment of IoT technology in the realm of smart farming. One prevalent and influential technology in contemporary society is the Internet of Things (IoT). The Internet of Things (IoT) comprises a diverse range of sensor types, electronic devices, network components, and software (Spandana & Pabboju, 2023). The Internet of Things (IoT) facilitates the autonomous interchange of information among individuals within networked systems, without the need for direct human interaction. The Internet of Things (IoT) is widely acknowledged as a crucial means of leveraging cutting-edge technology and methodologies to enhance agricultural productivity, improve product quality, and mitigate challenges encountered by farmers (Chitra & Muthulakshmi, 2022). Every day, farmers will acquire extensive knowledge regarding the latest advancements in agricultural technology and the Internet of Things (IoT). One area that the IoT is urgently required for application is agriculture.

Internet of Things (IOT)

The Internet of Things (IoT) represents a very efficient and important approach to problem-solving. The Internet of Things

(IoT) is constituted by a diverse range of component blocks, which comprise a variety of sensors, software, network components, and other electronic devices. The precision of the data has also increased. In the absence of human intervention, the Internet of Things (IoT) will autonomously exchange data inside the network. In this study, we will illustrate individuals in the technological world, such as sensors, automobile operators, and other entities, in a manner that closely resembles their real-life counterparts. In the case of data transmission via a network, an IP address is assigned. There is a projected increase of 30% in the number of interconnected devices by 2016 in comparison to the previous year. Furthermore, it is anticipated that in the future, this figure would further escalate to reach a total of 26 billion gadgets (Jash Doshi et al, 2017). There are several reasons that contribute to the increased efficiency of IoT technology.

1. The concept of global connectivity using various gadgets.
2. The concept of "minimum human effort" refers to the idea of reducing the amount of labour or work required by individuals to accomplish a task or achieve a goal.
3. The concept of "Faster Access", which is the ability to obtain information or resources in a more expedited manner.
4. The concept of "time efficiency" also the ability to complete tasks or achieve goals in the most optimal and effective manner within a certain time frame.
5. Efficient communication with Internet of Things.

The interaction of all the indices listed above could lead to something progressive in the field of agriculture using IoT. One of the outcomes of such interventions is the emergence of Smart Agriculture. Smart Agriculture entails systematic management of the elements of production such as Water, crop, soil, and insects using IOT as a control measure. This is diagrammatically presented as follows;

Smart Agriculture Using IOT

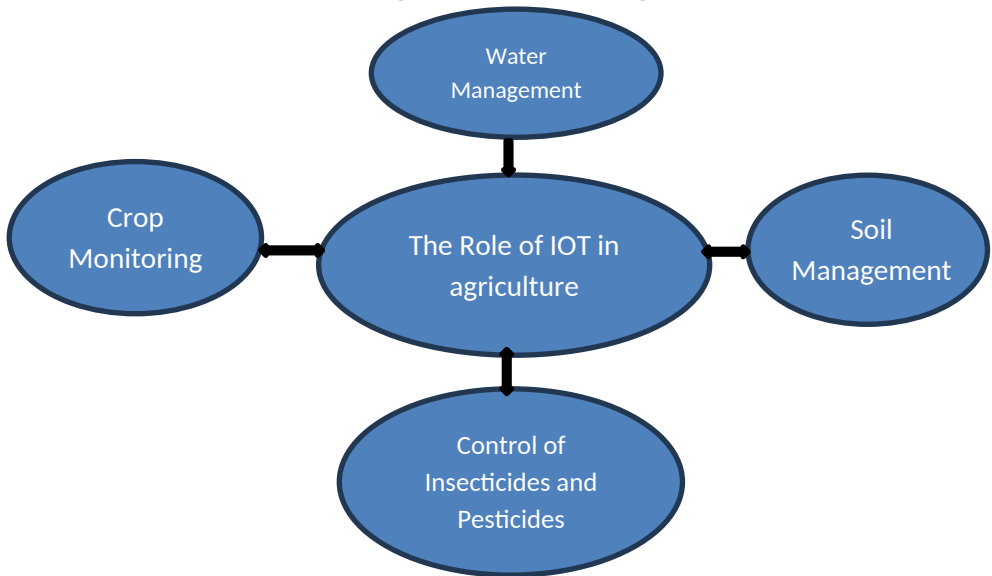


Figure 1: Role of IoT in Agriculture (Jash Doshi et al, 2017).

The primary driver of economic development in Nigeria is the production of agricultural goods. However, Nigeria is currently experiencing economic crises due to several factors including poor knowledge of farmers in the use of modern technologies, poor management of resources, misappropriation of resources and climate change among other factors.

Climate change creates a significant obstacle to current agricultural practices. The impacts of climate change include heightened occurrences of flooding, intensified storms, prolonged heatwaves, reduced precipitation, and other related phenomena. The observed phenomenon leads to a considerable decrease in production. The seasonal variation in plant life cycles also presents environmental consequences associated with climate change. The implementation of sophisticated technologies and methodologies, commonly referred to as the Internet of Things (IoT), is important to enhance productivity and mitigate obstacles within the agricultural sector (Muhammad, 2020). Currently, the Internet of Things (IoT) is undergoing significant advancements in the agriculture sector,

enabling farmers to effectively address the substantial issues they encounter. By leveraging the Internet of Things (IoT), farmers will get substantial amounts of data and knowledge related to current trends and advancements in technology. According to projections (Mohammed et al., 2020), the anticipated market value for intelligent agriculture is expected to reach \$18.45 billion as of the year 2022, with a compound annual growth rate (CAGR) of 13.8%. By estimations, it was anticipated that there would be a Compound Annual Growth Rate (CAGR) of 20% in the year 2020, resulting in the shipment of 75 million units of Internet of Things (IoT) equipment specifically designed for agricultural purposes. The utilization of Internet of Things (IoT) devices has demonstrated considerable potential in enhancing agricultural productivity and crop yield. This is primarily attributed to their ability to effectively monitor and assess crucial factors such as soil acidity, temperature, and other relevant variables (Chitra & Muthulakshmi, 2022).

Smart agriculture can also contribute to the enhancement of animal output and well being through effective supervision. The utilization of Internet of Things (IoT) sensors in agriculture can offer farmers vital data regarding crop yield, rainfall patterns, pesticide infestation, and soil nutrition. This information is crucial for the advancement and progress of agricultural practices. The information they provide is precise and can be utilized over an extended period to improve agricultural technologies.

The Internet of Things (IoT) has the potential to bring about substantial changes to the agricultural supply chain. By using its real-time capabilities, accuracy, and mutual qualities. The IoT offers crucial technologies that can enhance the efficiency of agricultural logistics.

The primary benefits of implementing IoT to improve agriculture are as follows:

- i. Water management can be accomplished efficiently using IoT and sensors to prevent water waste.

- ii. IoT enables continuous land monitoring, which enables early intervention precautions.
- iii. It increases efficiency in agriculture, decreases manual labour, and saves time.
- iv. The growth of a crop can be readily observed through crop monitoring.
- v. Soil management parameters, including PH level, moisture content, and others, are readily discernible, enabling farmers to sow seeds in accordance with the soil level.
- vi. RFID chips and sensors aid in the detection of crop and plant diseases." The RFID tags transmit the EPC (information) to the receiver via the internet. This information can be remotely accessed by the farmer or scientist, enabling them to implement the necessary actions. Plants will be proactively immunized against forthcoming diseases.
- vii. On a global scale, there will be a surge in crop sales. Farmers can effortlessly connect to the global market without geographic restrictions.

Livestock Monitoring

The Internet of Things enables producers to monitor animal health, food preferences, location, reproductive cycle, and other important information. By monitoring vital signs such as metabolism, temperature, blood pressure, heart rate, and respiration, connected wearable sensors have the capability to notify a farmer immediately in the event of any indication of illness. IoT may also assist farmers in monitoring a cow's reproductive cycle to determine when the animal is prepared to give birth. The farmer is notified of the condition of the bovine by IoT devices. Additionally, IoT-enabled wearable sensor systems monitor an animal's location, enabling producers to promptly detect and appropriately care for sick animals (Muhammed et al., 2019).

Implementing IoT technology in intelligent agriculture represents an innovative paradigm in agricultural management that effectively enhances field productivity. Smart farming enables farmers to optimize the utilization of fertilizers and other resources to augment the quality and yields of their crops (Acharya, 2022). A farmer is unable to maintain a constant physical presence on the field. Additionally, farmers might lack the capability to utilize a variety of instruments to determine the optimal environmental conditions for their crops. The Internet of Things equips you with an automated device that operates autonomously and notifies you of the most appropriate course of action to resolve a variety of agricultural issues. The farmer can communicate and receive notifications from a remote location, enabling him to manage a greater expanse of land and thereby increase his yield (Panigrahi, 2020). The benefits of this technology would include remote control for farmers, conservation of water and other natural resources, improved management, increased cattle production, precise evaluation by farmers and agriculture, and enhanced livestock production of superior quality. However, using smart farming IoT comes with its own challenges. Agriculture is mostly a natural occurrence, and nature is predicted or regulated by the people who allow rain drought to be available for sunlight, Regulation of pests, etc. Intelligent agriculture constantly requires Internet access. This requirement was not met by the rural portion of the developed countries. The internet is also slower. Again, fault sensors or data processing engines can lead to defective decisions that can lead to water, fertilities and other waste. Smart agricultural machinery requires farmers to understand the use of technology and to learn how to use it. This is the biggest obstacle in the broad adoption of smart agriculture (Acharya, 2022).

Management of Agricultural Water Using IoT

Agricultural water is a critical component in all agricultural processes. In recent times, farmers have encountered many obstacles because of changes in the environment, including the increasing severity of climate change, modifications in the demand and

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utilization patterns of domestic water supplies for agriculture, and rising costs associated with water supplies (Muhammad, 2020). The recognition of agricultural water as a commodity became more important. Moreover, the management of demand for agricultural water became more significant due to changes in internal as well as external factors affecting its use and administration. However, measuring and monitoring the practical application of agricultural water provides serious obstacles. Most socioeconomic characteristics were neglected in the study of the supply and demand of agricultural water with a focus of engineering aspects. Current agricultural water management practices predominantly focus on supply side strategies to augment water availability. Nevertheless, demand management is an absolute necessity due to factors such as shifting internal water use patterns caused by crop conversion, increasing water demand in sectors other than agriculture, and increasing expenses resulting from organic water management in agricultural supply facilities. Furthermore, the value of farm water to farmers and non-farmers cannot be estimated; accurate monitoring and measurement is the only means of determining its actual use. The examination of agricultural water supply and demand often encountered setbacks due to engineering considerations that were influenced by socioeconomic factors. To establish a dependable and effective agricultural water management policy, it will be essential to examine the economic characteristics of agricultural water supply and demand (Bjornlund, 2019).

The Need for Integration of Internet of Things (IoT) Technology in Agricultural Extension Services

The implementation of digital tools has had a significant impact on agricultural extension services, leading to a revolutionary transformation in the dissemination and accessibility of information for farmers. The utilization of customized digital extension services is strongly and fundamentally associated with the feedback process (Deji et al., 2023). This has resulted in worthwhile and

transformational effects on numerous aspects of the agricultural industry. Some analysis of how mobile apps, web platforms, and data analytics have transformed agricultural extension, empowering farmers and increasing productivity (Mehta et al., 2019). Digital tools have effectively reduced geographical limitations, enabling farmers to effortlessly access information irrespective of their physical location. Mobile applications and web platforms provide a variety of data including weather forecasts, market prices, effective strategies, pest control strategies, and governmental initiatives. The provision of up-to-date and pertinent information enables farmers to make well-informed decisions and enriches their entire knowledge library (Deji et al., 2023). The availability of data empowers farmers to make well-informed decisions, improve productivity, and minimize hazards. The utilization of mobile applications and web-based platforms has significantly contributed to the distribution of agricultural knowledge, hence empowering farmers with the latest practices (Suvedi, 2019). The reality is that about 80% of farmers in Nigeria are subsistent farmers with little or no adequate knowledge on IoT. This tends to compound the food crises in the nation already aggravated by insecurity. There is therefore an urgent need to improve on local farming using IoT. This can better be enhanced by integrating IoT into Agricultural extension schemes. The reason is that agricultural extension farmers interact and interrelate with the rural farmers who, if exposed to the knowledge and understanding of the use of IoT, could foster productivity in the sector and thus, economic development in the nation. This will also serve as a bridge between local farmers and technology-based farming.

Methodology

Smart Agriculture System using IoT Technology

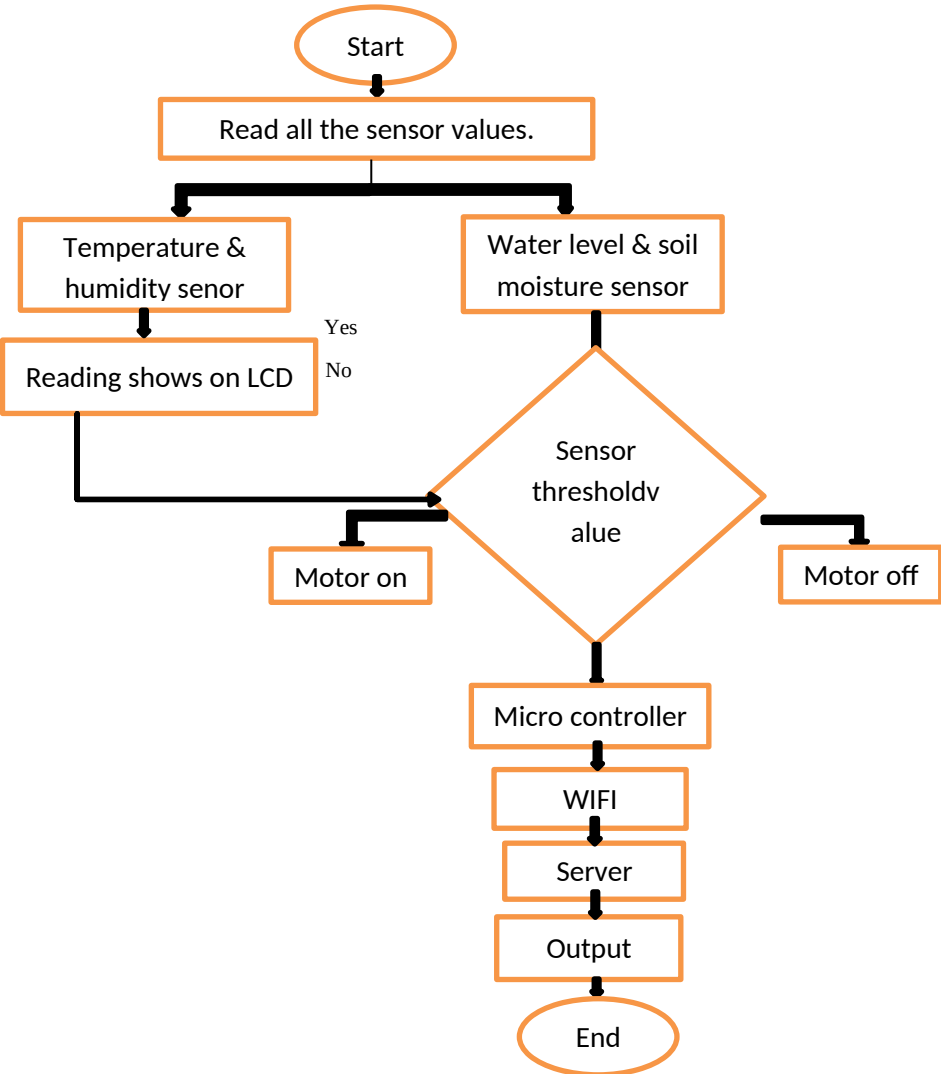


Figure: 2 Smart Agriculture System using IoT Technology (Jain, 2020).

Furthermore, the module can be reconstructed as an independent Wi-Fi link. IOT module uses 3.3v of electricity, hence, don't stick to the self-discipline magnetism of 5 volts. Additionally, when implementing follow-up 3.3v, data processing fails to identify 5V-tolerant

information sources, therefore, levels must be adjusted to communicate with a 5V microcontroller (Jain, 2020).

Security Challenges

When it comes to smart IoT-based farm security, there are three main requirements: authentication, access control, and stakeholder privacy. But threats from outside should be dealt with in the sensor network layer, and data collection in the network layer should be safe. Only authorized users should be able to view application layer data through certain entities. Most security problems on the perception layer are with physical security, which means making sure that tools and information are safe. Because all these tools are used in public, safety is very important. Being able to use an IoT gadget in different places doesn't mean that a single security protocol is enough. Information leakage is another important security problem (Patel & Patel, 2021).

Conclusion: Agriculture is expected to assume an important position in the coming years. As a result, intelligent farming is necessary. Enhancing agricultural production and the national economy demand adoption of technology-based farming for which IoT seems most appropriate. However, adoption of such technology without adequate consideration of the local farmer, who engage in majority of farm activities, would seemingly add no value to the system. The only way to engage them in technology-based farming is to integrate IoT in agricultural extension services/ schemes and use them as a link to the rural farmer. Therefore, intelligent agriculture utilizing the Internet of Things is necessary. It enables farmers to cultivate a wide variety of crops in their fields with little effort. Enhance competitiveness, the global economy, quality, and other characteristics.

Recommendations: In exploring the Potential of Internet of Things (IoT) Technology in Revolutionizing the Agricultural Sector in education, several factors should be put into consideration;

1. There is need for the integration of Internet of Things (IoT) technology into the agricultural extension services. This would make local farmers become abreast with current and modern farm technologies that boost farm produce.
2. Government should, through the instrumentality of the education

sector, expand the curriculum content of agricultural sciences to include Internet of Things (IoT) at all levels. This will help to expose students to current technologies that enhance agricultural activities.

3. There should be a compulsory course on IoT for all agricultural students as part of effort to enhancing the use of Internet of Thing (IoT) for the advancement of agricultural activities and services.

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