A Review on Internet of Things (IoT) in Agriculture: Benefits, Challenges and Way Forward.

Adache Paul[1], Mohammed Auwal Ahmed[2], Dr. Naseer Sani Ajoge[3], Nahuru Ado Sabongari[4], Abubakar Balarabe[5]

[1]Student Department of Computer Science, UniAbuja, Nigeria
[2]Student Department of Mathematics, ATBU Bauchi, Nigeria
[3]Department of Computer Science, Kaduna Polytechnic, Kaduna Nigeria
[4]Student Department of Mathematics, ATBU Bauchi, Nigeria
[5]Department of Computer Science, Kaduna Polytechnic, Kaduna, Nigeria

---***---

Abstract - *Internet of things has been used to create changes in different areas of national life worldwide. These sectors includes: Homes, Cities, traffic, Security, financial industry, communication and the Energy sector etc. Agriculture is one of the units of these applications. This is because the world population is growing very fast and the traditional method of farming may not be able to produce enough food for the citizens. The condition of unsuitable weather, land use for social economic activities have made things complex. Insecurity, particularly in Nigeria such as: kidnapping, Animal rustling, Boko haram, Gun men attacks to lack of relevant agricultural technology and information by stake holders have affected productivity. Soil infertility, and crops that get contaminated by certain chemicals underground could be harmful to consumers. In the light of all these, the use of Internet of things can be deployed to handle input activities and increase productivity in the agricultural sector. Internet of Things is the marriage of several technologies, such as wireless sensor network, radio frequency identification, cloud computing, data analytics, miniaturization, computing and communication technology. These elements can connect and communicate over the internet. In this review paper, focus is on internet of things system, benefits of internet things to the agricultural sector, the challenges and way forward.*

Key Words: **Internet of things, Technology, Miniaturization and Boko haram**

1 INTRODUCTION

[3] Stated that, Internet of Things is a new technology that is gaining acceptance in several fields due to its usefulness in everyday life. It has found its utility in transportation, environmental monitoring and forecasting, home and office appliances, agriculture, health, security and energy conservation. According to [5], Internet of Things is the linking of physical objects, devices, vehicles, buildings and other items which are embedded with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data. The world population continue to increase annually and it is likely that it will hit 9.7 billion in 2050. Which means that, the demand for food will increase significantly. This is why the world is embracing the use of internet of things in the agricultural domain to beat the world's food demands in the years ahead. It is predicted that internet of things device installations in the agriculture sector will increase from 30 million in 2015 to 75 million by 2020 [1]. Wireless sensor network has been used for smart agriculture especially for environmental monitoring, and automation. The wireless sensor network can regulate and maintain itself and that is why it is a good choice for smart agriculture. It is a system that comprise of radio frequency (RF) transceivers, sensors, microcontrollers and power sources [2]. In the recent time, attention has shifted from the use of wireless sensor network to internet of things in smart agriculture. This review article is done under the following parts: Part I: Introduction, Part II: Internet of things system in agriculture, Part III: Application of Internet of things in agriculture, Part IV: Benefits, Part V: Challenges, Part VI: Way forward

2 Internet of Things System

To setup an Internet of things system in agriculture, there is a need to have the following: Hardware, Software, Communication Technology, Data Storage and Analysis domains.

2.1 Hardware

The hardware is the microcontroller which is an integrated circuit having all essential parts of a computer system. These includes Processor, Memories Peripherals Inputs and outputs

The processor is the power house and the brain of the system. Here all decisions and calculations takes place.

Memory is a domains where programs and instructions are kept before and after processing. It is divided into two namely: Read Only Memory (ROM) and Random Access Memory (RAM)).

Peripheral devices are deices which can attached to a system and can be detached from a system at will. Examples are Sensors and actuators

Inputs and outputs are the channels of communication between the world and the microcontroller itself. The sensors are used to monitor and measure parameters that affects crops production. By implication data are collected through short-range and long–range communication standard while the microcontroller acts as the manager of the entire system. There are different type of sensors such as: location sensors, optical sensors, mechanical sensors, electrochemical sensors, and airflow sensors. The data they collect is about air temperature, soil temperature, water temperature, light condition, relative humidity, potential hydrogen and electrical conductivity.

2.2   Software

Software are programs written using a particular computer language containing the behavior that processor needs to acquire and execute. Internet of things programs are usually written on the integrated development Environment (IDE) such as an Arduino UNO or Mega boards. High level languages like C, C++, and Python etc. are very good at it.

2.3   Communication Technology

The role communication technology (CT) plays in internet of things systems cannot be overemphasized. It can be looked at from the angles of standards, spectrum, and application scenarios. There are several standards for wireless communications. We have short-range and long-range communication standards. Spectrum defines the various colors that are produced when a signal (light) passes through an object, water for example. It is divided into licensed and unlicensed spectrum.

2.4   Data Storage and Processing.

Nowadays agriculture goes with the collection of big data in the form of text, images, audio, and video, which requires storage and processing. The use of cloud internet of things platforms allows for big data collected from sensors to be stored in the cloud and can be analyzed, visualized using math lab.

2.5   Layers of Internet of Things Technology

[4] stated that, there are three-Layer of an IoT-System.

Physical Layer
Network Layer
Application Layer

Physical Layer

This level involves the use of sensor devices for collect data from the environment or object under consideration. In the field of agriculture, there are different types of sensors that can be used. We have temperature and humidity sensors, water temperature and level sensor, light sensor, potential hydrogen and electrical conductivity sensors, soil moisture sensor, security sensor etc. These devices can collects data and communicate it to the controller for possible actions using actuators. The diagram below demonstrate this concept.

Network Layer

The network layer is consisted of communication technology such as WI-FI linking the cloud server. So from the control center, the controller transmits the data to the internet of things platform such as Thing Speak for storage analysis and visualization. Data from this platform can be exported to an application like Excel for further analysis. Thing Speak domain contains channel to accommodate all of these transactions.

Application Layer

This layer delivers application specific services to the user. Once data has been aggregated, cleaned, and processed, the information can be fed to the server to be analyzed and applied to new products and services. Farmers will be able to make informed decisions with availability of reliable outcome of processed data (information).

2.6 Application Areas of Internet of Things in Agriculture

Monitoring
Livestock Farming:
Aquaponics:
Crop Farming:
Agricultural Machinery
Data monitoring
Storage Management

2.7   Benefits of Internet Things to the Agricultural Sector

[6] Internet of things makes agriculture smart, precise available and enhance them with enough artificial intelligence of things.

Internet of things technology has collapsed distance in agriculture as farms can be monitored from remote centers

It has made farming indoors and outdoors easier for farmers in the urban domains.

It has brought in optimization in the use of resources in agriculture

It completely transform agriculture from traditional method to automated method.

With internet of things technology, agricultural data can be collected real time for processing.

Farming can take place all year round

It makes farmers to look clean as it does not involve grass wedding and making of ridges before cultivation can take place. Farming does not involve the use of soil but with water and nutrients forming nutrient solution.

Internet of things solutions in agriculture has introduced the concept of automation, for example, demand-based irrigation, fertilizing and robot harvesting.

2.8 Challenges of Internet Things to Agricultural Sector in Nigeria

Sourcing of components for the innovation of automation devices is very difficult, as they are not readily available in Nigeria except through importation.

Lack of collaboration between relevant stakeholders is a serious case as successful innovations do not get across to others.

Skilled manpower for the innovation is scarce.

Non-availability of internet services is a very big challenge in the application of this technology

Lack of functional electricity is hampering the progress of internet of thing expansion in Nigeria

Awareness among farmers is also a critical factor as level of awareness is still very poor.

Startup capital is a very big problem for some people that wants to go into electronic farming.

Corporate organization that are in the position to offer sponsorship prefers to do that for the entertainment industries instead of the agricultural sector

Generally, input components for the progress of internet of things are lacking in this part of the world (Nigeria)

2.9 Way Forward

Corporate organization should pick interest in sponsoring stakeholders in the agricultural fields to enhance productivity.

Government should reduce the rate of tax on importation to encourage importers to bring in internet of things (IoT) hardware and software elements.

Skilled manpower should be made available to render services to customers that might need them even if it means sourcing from other nations.

Functional electricity should be made available.

Uninterrupted internet services should be made available

There should be collaboration among relevant stakeholders so innovations can be shared.

Incentives should be introduced for interested parties to boost agricultural productivity.

3. Conclusion

In this paper, internet of things in agriculture has been reviewed. We presented internet of things system as the ecosystem, taking into consideration full analysis of various domains. Issues of layers of internet of things were brought to bear. Based on all of these, we looked at its application, benefits, challenges and way forward in the agricultural sector comprehensively.

References

[1]   Olakunle E, Tharek A. R, Igbafe O. Chee Y. L & MHD N.H (2018) An Overview of Internet of Things (IoT) and Data Analytics in Agriculture, Benefits and Challenges; IEEE internet of things journal Vol.5. No 5. October 2018, DOI: 10.1109/jiot.20182844296

[2]   N. Wang, N. Zhang, and M. Wang, "Wireless sensors in agriculture and food industry-recent development and future perspective," Computers and electronics in agriculture, vol. 50, no. 1, pp. 1–14, 2006.

[3]   Bamigboye, F.O., Ademola, O.: Internet of Things (Iot): It's application for sustainable agricultural productivity in Nigeria. In: 6th Proceedings of the iSTEAMS Multidisciplinary Cross-Border Conference, Held at University of Professional Studies, Accra Ghana, 2016, pp. 309–312 (2016)

[4]   IoT Devices, Sensors, and Actuators Explained - LeanIX*https://www.leanix.net* › blog ›4 Jan 2018.

[5]   GSI (Global Standard Initiatives): Internet of things global standards initiative (2015). http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx

[6]   Ume, A., Haruna, U.: Smart Agriculture in Nigeria with IoT; a reality. Am. J. Eng. Res. **7**(1), 277–282 (2018)