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A LITERATURE SURVEY:AGRICULTURE AREAS ANALYSIS USING IOT TECHNOLOGY

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Abstract— **The IoT (Internet of Things) based agricultural convergence technology is a technology to create a high value such as improvement of production efficiency, quality increase of agricultural products in the whole process of agricultural production. The growing demand for food in terms of quality and quantity has increased the need for industrialization and intensification in the agriculture field. Internet of Things (IoT) is a highly promising technology that is offering many innovative solutions to modernize the agriculture sector. Research institutions and scientific groups are continuously working to deliver solutions and products using IoT to address different domains of agriculture. This paper presents a systematic literature review (SLR) by conducting a survey of IoT technologies and their current utilization in different application domains of the agriculture sector.**

Keywords - **IOT, agriculture; agricultural applications; devices/sensors; communication protocols, IOT Platform**

I. INTRODUCTION

Internet of Things (IoT) is promising to provide the same benefit through its innovative technologies and giving a way to enhance the user's perception and ability by modifying the working environment. IoT offers multiple solutions in different domains such as healthcare, retail, traffic, security, smart homes, smart cities, and agriculture. IoT deployment in agriculture is considered the ideal solution because in this area there is a need for continuous monitoring and controlling. In the field of agriculture, IoT is used at different levels in the agriculture industrial production chain[1]. The main applications of IoT in agriculture are Precision Farming, Livestock, and Greenhouses, which are grouped into different monitoring domains. All these applications are monitored with the help of different IoT-based sensors/devices by using wireless devices that helps the farmers collect relevant data through sensing devices. Some IoT-based setups analyze and process the remote data by applying cloud services, which helps the researchers and agriculturists make better decisions[2]. Moreover, IoT-based agricultural monitoring solutions have been identified based on the sub-domains to which they belong. The identified sub-domains are soil monitoring, air monitoring, temperature monitoring, water monitoring, disease monitoring, location monitoring, environmental conditions monitoring, pest monitoring, and fertilization monitoring [3]. data collected about different agriculture parameters is transmitted to the user by trigger alerts or sending recommendations to authorities via messages.

Therefore, it is important to collect, summarize, analyze, and classify the state-of-the-art research in this area. The purpose of this research is to present a comprehensive systematic literature review in the field of IoT agriculture

II. BACK GROUND

Researchers have proposed different IoT-based technologies in the agriculture field that are increasing the production with less workforce effort. Researchers have also worked on different IoT-based agriculture projects to improve the quality and increase agricultural productivity. IoT-based agricultural techniques have been identified from the literature, which have been summarized in this section.

A real-time rice crop monitoring system has been designed to increase the productivity [4]. The crop monitoring system has been presented in [5], which collects the information of rainfall and temperature and analyzes it to mitigate the risk of crop loss and enhance crop productivity. A low-cost Bluetooth-based system has been proposed in [6] for monitoring various agricultural variables such as temperature by using a microcontroller that works as a weather station. The proposed system is best for monitoring real-time field data. A smart sensing platform based on ZigBee has developed by [7] for monitoring different environmental conditions such as humidity, temperature, sunlight, and pressure.

III. AGRICULTURE APPLICATIONS

IOT agriculture solution consist of multiple monitoring ,controlling, and tracking applications that measure several type of variables such as air monitoring, soil monitoring, water monitoring, Disease Monitoring, Environmental Condition Monitoring, Crop and Plant Growth Monitoring, Temperature Monitoring, Humidity Monitoring, Monitoring Gases in Greenhouse, Fertilization and Pest Control, Greenhouse Illumination Control, Location Tracking

Air Monitoring

The aim of this sub-domain is to evaluate and determine the air condition in order to prevent from damaging effects. In [8]an IoT-based agricultural air, humidity, and temperature monitoring system has been proposed. This system offers a real-time microclimate monitoring solution that is based on WSNs. The system consists of a temperature and humidity sensor that is supported by a communication technology called ZigBee and powered by solar panels.

Soil Monitoring

In this sub-domain [9] proposed solutions for soil moisture and temperature monitoring in the fields using WSN. Soil monitoring sensors allow farmers to collect data about moisture, temperature, and other metrics over time to track trends and predict irrigation needs.

Water Monitoring

The studies that have been categorized in this sub-domain intend to monitor water quality or water pollution by sensing PH, temperature, and chemicals, which can change the normal conditions of water. In [10], an IoT-based solution has been presented to monitor the water quality by measuring temperature, conductivity, and turbidity. This solution based on WSN combines sensing devices and monitors the multiple parameters of water in urban areas. A web-based decision support system has been proposed in [11] that use sensors to measure temperature, solar radiations, humidity, and rainfall for irrigation monitoring in olive fields

Disease Monitoring

The LOFAR-agro Project is the best example for crop or plant monitoring [12]. This project protects the potato crop by monitoring different climate conditions such as temperature and humidity through WSN. The proposed system protects the crop by analyzing the collected data from fungal diseases.

Environmental Condition Monitoring

An environmental condition monitoring system is proposed in [13] that measure the spatial sampling of humidity sensors using WSN. To determine the behavior of 2D correlation, a historical database is being used in the proposed system.

Crop and Plant Growth Monitoring

In this sub-domain, farmlands have been analyzed by using the mobile sensors presented in [14].The essential purpose of this proposed system is to monitor the growth of grapes and control plans for viticulture activities.

Temperature Monitoring

Soil temperature plays a vital role in crop productivity. In [15], a system has been proposed to monitor the amount of nutrients between surface and ground water. To measure the quantity of nutrients in soil, electrochemical impedance was applied. Soil test results are monitored through an inductance (L), capacitance (C), and resistance (R) (LCR) meter, and the results are calculated via standard library measurements.

Humidity Monitoring

The humidity level is measured in air by using multiple humidity sensors. An inappropriate amount of humidity leaves a negative impact on plants regarding cell growth [16].

Monitoring Gases in Greenhouse

Agriculture and greenhouse gases are related to each other. The excessive amount of gases in a greenhouse increases the temperature, which directly impacts the agriculture productivity. To monitor the greenhouse gases and CH_4, a WSN and solar powered Unmanned Aerial Vehicle (UAV) system has been presented [17].

Fertilization and Pest Control

In this domain, an IoT solution provides conservation approaches to improve the quality of the crops and amount of nutrients usage. An online climate monitoring system has been presented for greenhouses to monitor pests, irrigation, fertilization, and climate [18]..

Greenhouse Illumination Control

An automated agriculture system is developed to monitor the growth of cabbages and melons in greenhouses [19]. The designed system monitors the crop growing process and controls the greenhouse environmental conditions such as temperature, ambient light, and humidity

Location Tracking

This sub-domain referred to the tracking and tracing of animal locations and any unwanted movement all over the field. Different monitoring devices and sensors have been deployed in the field to save the crop from theft and wild attacks. For agriculture, an intrusion detection solution is presented in [20] that generates an alarm and sends a text message to the farmer’s mobile when an unwanted movement happens in the crop field.

IV. SENSOR ANDS ITS OPERATIONS

Infirmity Sensor	Devices Operations
PH Sensor	To monitor the exact amount of nutrients in soil, PH sensors are used, which is efficient for the healthy growth of plants and crops .
Gas Sensor	Through the observation of infrared radiations this sensor measures the exact amount of toxic gases in livestock and greenhouses
Motion Detector Sensor	The sensor is used to track/trace the location of animals and field, moreover it also detect the motion of an unwanted object in the field or farm and generate alerts to farmer for timely action and preventing crop loss
Ultra Violet Sensor & Passive Infrared (PIR) Sensors	An ultra violet sensor monitors the UV rays for the effective growth of crops. PIR sensor, a motion detector is fixed that traces the range of a person's movement in the field. The sensor also has a light detection property: while tracking an object, it changes the rising temperature into voltage for analyzing crop growth
Soil Moisture Sensor	The soil sensor measures the quantity of water and level of moisture all over the field
Temperature Sensor	Changes in the soil temperature affect the absorption soil nutrients & moisture .it's also monitor the temperature
Humidity Sensor	To sense the level of humidity in air, this sensor directly measures the temperature and moisture content in the air

V. IOT COMMUNICATIONS PROTOCOLS

A large number of IoT communication technologies are being utilized within IoT applications due to their low cost, wide coverage range, and low energy requirements as compared to other long-range communication technologies.

Message Queue Telemetry Transport protocol (MQTT)

MQTT used to send and receive sensor information. In [21], a MQTT protocol has been used to solve the irrigation problem that controls the water pump action and transmits the status of water pump and soil moisture conditions to a user's mobile application and web page.

Radio Frequency Identification (RFID)

RFID records information by assigning a unique number to each object individually and tracking their location. This protocol identifies environmental conditions such as moisture level and temperature conditions. To track crop information and identify the object location, an RFID tag has been used [22].

Zig Bee

One of the top IEEE 802 standards developed by the ZigBee alliance has a long-range battery life. This technology fulfills the demand for quick throughput by offering high-speed data transfer for applications such as agriculture [23].

WiFi

WiFi is a standard part of a wireless local area network (WLAN) that is used to exchange information over the internet wirelessly The communication range of WiFi is 20–100 m and the data transmission range is 2–54 mbs. In the field of agriculture over an ad hoc network, WiFi broadens the utilization of heterogeneous architectures connecting different types of devices [24].

Bluetooth

Bluetooth is a low-cost, low-power technology that is based on IEEE 802.15.1 standard and used for communication over short ranges i.e., 8–10 m. This technology is suitable for multi-tier agricultural applications due to its ubiquitous nature [25].

Worldwide Interoperability for Microwave Access (Wi MAX)

It is a wireless communication that is based on an IEEE 802.16 standard whose transmission range is 50 km and the data rate is 0.4–1 Gbps (IEEE Standard for Local and metropolitan area networks, 2011). WiMAX is suitable for monitoring and controlling different agricultural applications such as monitoring farming systems, crop area border monitoring, and controlling gates, lights, water pumps, and the remote diagnosis of the farming systems. The Ministry of Food and Agriculture, Ghana (MOFA) has utilized WiMAX and WiFi technologies so that user has choice of selecting WiFi or WiMAx to establish network connections [26].

VI. IOT PLATFORMS

IOT Platforms	Real time data capture	Data Visualization	Cloud service type	Data analytics	Developer cost
Ubodots (http://ubidos .com/)	Yes	Yes	Public	Yes	Free
Thing Speak (https://things peak.com/)	Yes	Yes (MatLab)	Public	Yes	Free
ThingWorx (www:thingwo rx.com/)	Yes	Yes	Private (IaaS)	Yes	Pay per Use
Plotly (https://plot.ly /)	Yes	Yes (MatLab)	Public	Yes	Free
Adafruit IO (https://io.adafruit.com)	Yes	Yes	Public	Yes	Free
Nimbits (www.nimbits. com/)	Yes	Yes (MatLab)	Hybride	Yes	Free
Connecterra (www.Connect erra.io/)	Yes	Yes	Private (IaaS)	Yes	Pay per Use
Axeda (www.axeda.c om)	Yes	Yes	Private (IaaS)	Yes	Pay per Use
Xively (https://xive	Yes	Yes	Public (IoTaa	No	Free

ly. com/)			s)		
Phytech (http://www.phytech.com/)	Yes	Yes	Private (IaaS)	Yes	Pay per Use

VII. CONCLUSIONS

This article has presented a systematic literature review that presents a discussion on selective high-quality research articles published in the domain of IoT-based agriculture. Thereafter, an analysis of different IoT agriculture applications, sensors/devices, and communication protocols has been presented and promising future directions have been given in the domain of IoT-based agriculture.

VIII. REFERENCES

[1] Medela, A.; Cendón, B.; González, L.; Crespo, R.; Nevares, I. IoT multiplatform networking to monitor and control wineries and vineyards. In Proceedings of the 2013 Future Network Mobile Summit, Lisboa, Portugal, 3–5 July 2013; pp. 1–10.

[2] Giorgetti, A.; Lucchi, M.; Tavelli, E.; Barla, M.; Gigli, G.; Casagli, N.; Dardari, D. A robust wireless sensor network for landslide risk analysis: System design, deployment, and field testing. IEEE Sens. J. 2016, 16, 6374–6386. [CrossRef]

[3] Torres-Ruiz, M.; Juárez-Hipólito, J.H.; Lytras, M.D.; Moreno-Ibarra, M. Environmental noise sensing approach based on volunteered geographic information and spatio-temporal analysis with machine learning. In Proceedings of the International Conference on Computational Science and Its Applications, Beijing, China, 4–7 July 2016; pp. 95–110.

[4] Rajesh, D. Application of spatial data mining for agriculture. Int. J. Comput. Appl. 2011, 15, 7–9. [CrossRef]

[5] Shaobo, Y.; Zhenjianng, C.; Xuesong, S.; Qingjia, M.; Jiejing, L.; Tingjiao, L.; Kezheng, W. The appliacation of bluetooth module on the agriculture expert System. In Proceedings of the 2010 2nd International Conference on Industrial and Information Systems, Dalian, China, 10–11 July 2010; Volume 1, pp. 109–112.

[6] Haefke, M.; Mukhopadhyay, S.C.; Ewald, H. A Zigbee based smart sensing platform for monitoring environmental parameters. In Proceedings of the 2011 IEEE International Instrumentation and Measurement Technology Conference, Binjiang, China, 10–12 May 2011; pp. 1–8.

[7] Pavithra, D.S.; Srinath, M.S. GSM based automatic irrigation control system for efficient use of resources and crop planning by using an Android mobile. IOSR J. Mech. Civ. Eng. 2014, 11, 49–55.

[8] Watthanawisuth, N.; Tuantranont, A.; Kerdcharoen, T. Microclimate real-time monitoring based on ZigBee sensor network. In Proceedings of the SENSORS, 2009 IEEE, Christchurch, New Zealand, 25–28 October 2009; pp. 1814–1818.

[9] Chen, K.T.; Zhang, H.H.; Wu, T.T.; Hu, J.; Zhai, C.Y.; Wang, D. Design of monitoring system for multilayer soil temperature and moisture based on WSN. In Proceedings of the 2014 International Conference on Wireless Communication and Sensor Network, Wuhan, China, 13–14 December 2014; pp. 425–430.

[10] Postolache, O.; Pereira, J.D.; Girão, P.S. Wireless sensor network-based solution for environmental monitoring: Water quality assessment case study. IET Sci. Meas. Technol. 2014, 8, 610–616. [CrossRef]

[11] Fourati, M.A.; Chebbi, W.; Kamoun, A. Development of a web-based weather station for irrigation scheduling. In Proceedings of the 2014 Third IEEE International Colloquium in Information Science and Technology (CIST), Tetouan, Morocco, 20–22 October 2014; pp. 37–42.

[12] Langendoen, K.; Baggio, A.; Visser, O. Murphy loves potatoes: Experiences from a pilot sensor network deployment in precision agriculture. In Proceedings of the 20th IEEE international parallel distributed processing symposium, Rhodes Island, Greece, 25–29 April2006

[13] Khandani, S.K.; Kalantari, M. Using field data to design a sensor network. In Proceedings of the 2009 43rd Annual Conference on Information Sciences and Systems, Baltimore, MD, USA, 18–20 March 2009; pp. 219–223.

[14] Lee, J.; Kang, H.; Bang, H.; Kang, S. Dynamic crop field analysis using mobile sensor node. In Proceedings of the 2012 International Conference on ICT Convergence (ICTC), Jeju Island, Korea, 15–17 October 2012; pp. 7–11.

[15] Alahi, M.E.E.; Xie, L.; Mukhopadhyay, S.; Burkitt, L. A temperature compensated smart nitrate-sensor for agricultural industry. IEEE Trans. Ind. Electron. 2017, 64, 7333–7341. [CrossRef]

[16] Krishna, K.L.; Silver, O.; Malende, W.F.; Anuradha, K. Internet of Things application for implementation

of smart agriculture system. In Proceedings of the 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Palladam, India, 10–11 February 2017; pp. 54–59.

[17] Malaver Rojas, J.A.; Gonzalez, L.F.; Motta, N.; Villa, T.F.; Etse, V.K.; Puig, E. Design and flight testing of an integrated solar powered UAV and WSN for greenhouse gas monitoring emissions in agricultural farms. In Proceedings of the 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems, Hamburg, Germany, 28 September–2 October 2015; Volume 1, No. 1. pp. 1–6.

[18] Pahuja, R.; Verma, H.K.; Uddin, M. A wireless sensor network for greenhouse climate control. IEEE Pervasive Comput. 2013, 12, 49–58. [CrossRef]

[19] Yoo, S.E.; Kim, J.E.; Kim, T.; Ahn, S.; Sung, J.; Kim, D. A 2 S: Automated agriculture system based on WSN. In Proceedings of the 2007 IEEE International Symposium on Consumer Electronics, Irving, TX, USA, 20–23 June 2007; pp. 1–5.

[20] Roy, S.K.; Roy, A.; Misra, S.; Raghuwanshi, N.S.; Obaidat, M.S. AID: A prototype for agricultural intrusion detection using wireless sensor network. In Proceedings of the 2015 IEEE International Conference on Communications (ICC), London, UK, 8–12 June 2015; pp. 7059–7064

[21] Kodali, R.K.; Sarjerao, B.S. A low cost smart irrigation system using MQTT protocol. In Proceedings of the 2017 IEEE Region 10 Symposium (TENSYMP), Cochin, India, 14–16 July 2017; pp. 1–5

[22] Wasson, T.; Choudhury, T.; Sharma, S.; Kumar, P. Integration of RFID and sensor in agriculture using IOT. In Proceedings of the 2017 International Conference on Smart Technologies for Smart Nation (SmartTechCon), Bangalore, India, 17–19 August 2017; pp. 217–222.

[23] Xiaojing, Z.; Yuanguai, L. Zigbee implementation in intelligent agriculture based on internet of things. In Proceedings of the 2nd International Conference on Electronic Mechanical Engineering and Information Technology, Shenyang, China, 7 September 2012.

[24] Li, L.; Xiaoguang, H.; Ke, C.; Ketai, H. The applications of wifi-based wireless sensor network in internet of things and smart grid. In Proceedings of the 2011 6th IEEE Conference on Industrial Electronics and Applications, Beijing, China, 21–23 June 2011; pp. 789–793.

[25] Ruiz-Garcia, L.; Lunadei, L.; Barreiro, P.; Robla, I. A review of wireless sensor technologies and applications in agriculture and food industry: State of the art and current trends. Sensors 2009, 9, 4728–4750. [CrossRef]

[26] Ofori-Dwumfuo, G.O.; Salakpi, S.V. WiFi and WiMAX deployment at the Ghana Ministry of Food and Agriculture. Res. J. Appl. Sci. Eng. Technol. 2011, 3, 1374–1383.