Summary of the internet of things and its application in agro-industrial production

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Abstract. The internet of things, day by day accompanies the development of activities that are executed in any space, through remote access. Households and companies have included new technologies in different areas for the automatic development of activities or processes, real-time monitoring and control, which has become a pressing need for decision-making. For this reason, it is necessary to carry out a bibliographic review, by searching for scientific articles, in the most recognized digital databases, where the most important aspects of the internet of things, technologies and elements used in the last ones are mentioned years, in order to know a little more about these and their characteristics in common. For the investigation, the recommendations and analysis of the results obtained in case studies will be taken into account, seeking to leave a precedent that contributes to the improvement of the agro-industrial production processes, so that they are supported in new technologies that allow identifying, measure and control variables, that achieve the efficient operation of resources, maximizing the potential of their characteristics.

1. Introduction

The agricultural sector is undergoing profound changes due to transformations related to the rural, the increase in poverty, the consolidation of productive and commercial blocks, the environment, natural resources, biotechnological and computer development, which has led to modernization production processes. It can see how entrepreneurs, institutions and even the common people, implement and use systems more frequently that allow them to have control from large industries to everyday use; which has even led to a socio-cultural change due to the transformations in the relationship between man and his reality, which leads us to understand technology as a dynamic, multidirectional, interconnected and complex system [1,2].

Internet of things (IoT) is known as the connection of technological or electronic objects that connect to the internet [3].

In the field of agriculture, most processes are carried out in rural areas with little access to technology and depend on what is called family farming that produces 70% of food worldwide, being an influential economy, but that due globalization has made it difficult to be competitive and have the control that allows them to plan in the long term; which creates the need to generate benefits for farmers and lead them to modernization [4].

The objective of this article is to expose the research contributions that frame the internet of things and how it is applied in agribusiness; exposing the set of elements that comprise an IoT solution,
approached from the architecture that supports it, allowing other researchers to know the hardware, software and communication elements that are required for the capture and transmission of data, storage concepts, processing and management that demands the enormous amount of information generated by this type of technological system.

2. Methodology
To locate the bibliographic documents, a search was conducted in electronic databases such as Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE) Xplore, scielo, science direct, scopus and google scholar, using the descriptors: Scientific articles, reviews, concept maps, and critical readings. Searching include keywords such as: Sensors in agricultural production processes, agricultural technology, case studies of processes that implement IoT, among others, identifying publications made in the last five years; obtaining records that ranged between 500 and 560, is the result of the combination of different keywords. The selected documents present general characteristics of the IoT and projects carried out in the field of agriculture.

3. Internet of things overview
The IoT refers to the network interconnection of all everyday objects, which are often equipped with some kind of intelligence; it is a platform for teams that communicate electronically and share specific information and data with the world around them, combining physical and digital components to create new products and businesses, generate value in companies based on the monitoring and control categories, big data and business analysis and information exchange and collaboration, being a critical and integrated system, an infrastructure in which many applications and services can run; which will be personalized and others will be throughout the city [5-9].

3.1. Fields of application
The following application areas can be established: transport systems, logistics, smart cities, home automation, agriculture, smart farms, industry and business, parking applications, structural health, maps, traffic congestion, smart lighting, waste management, pollution of air, detection of forest fires, disaster prevention, use and quality of water and energy, leaks, smart meters, security and emergencies, entertainment (weather conditions, information inquiries, etc.) [10-12].

3.2. Architectures
In general, it involves the following components: connected objects, network technologies, communication protocols, IoT platforms for data processing and user applications, and hardware devices used in agricultural facilities, surveillance and monitoring, industrial processes, environments domestic and mineral exploitation [13,14], distributed in several layers, as shown in Table 1, the outermost layer is responsible for displaying and extracting knowledge that is based on the data that was captured in the layer more internal [15].

| Table 1. Proposed architecture. |
|---------------------------------|
| **Components**                  | **Description**                                      |
| Application                     | It is divided into web and through the browser processes the requests made by the user and a graphical user interface, designed for management |
| Middleware                      | It seeks to standardize the communications destined to obtain data related to the state of the system |
| Communications                  | Responsible for all communications between different devices |
| Dispositive                     | It is made up of all devices or hardware in charge of measuring and surveying the system |

3.3. Technologies used
These technologies can be in an intelligent environment, in an open field, and inside a home. Every day, applications are sought to focus on wireless networks, but currently, wired network applications are
generated and technologies should point to both types of networks. Table 2 generally shows some of the most used technologies in each layer according to the architecture proposed [15,16].

Table 2. Technologies used by IoT.

| Application          | Proposed technologies and equipment                                      | Features                                                                 |
|----------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Middleware           | Request and response adapter protocol (RRAP), Fi-Ware                   | Responsible for addressing actions such as registration services, service requests and failures [18]. |
| Communications       | IEEE 802.15.4, Xbee, TCP / IP Architecture RFID, IEEE 802.15.4, Z_Wave, LTE, LoRa, NFC, UWB, M2M, 6loWPAN, NGN, WSN, Zigbee, Wavenis, Wireless Mbus, Wifi, Wmaz, PLC, GSM, GPRS, SCADA systems, IP networks, PSTN, XDSL, PAN, LAN, MAN, CDMA, WCDMA, CDMA, HSPA, Bluetooth, RF, Microwave, Infrared, among others | They consume low energy, compatible with Arduino and other platforms, and are divided into two layers, one physical and one medium access control. Used for data transfer. Based on wireless and wired networks [19]. |
| Dispositive          | Oracle Sun SPOT, MEMSIC Iris, Arduino UNO, RFID Readers, M2M Terminals, SCALA Meters, NFIC, QR Codes, BIDI Codes, People Mobile, Environmental Devices, Furniture, Buildings, Piping and Piping Systems, Weather Stations, Microelectromechanical Systems (MEMS) and nanoelectromechanical (NEMS) | Devices capable of getting involved in HTTP communications, mote modules with various capabilities to improve the overall functionality of wireless sensor networks [20], low-cost boards used for detection and actuation |

4. Internet of things in agro-industrial production

The agricultural sector requires the use of new technologies that allow efficient use, resource monitoring, and decision making. The internet of things has been having a great impact in this area due to new alternatives and the low costs offered to meet this objective, offering efficiency and productivity in crops, and measuring variables related to soils, plants and improve production processes, optimizing resources and improving their performance level [21-23].

The IoT allows farmers to automate the activities of monitoring crops and animal production, in some cases allowing remote access to their farms [24], developed platforms use sensors that take values which must be managed and evaluated with high precision to allow for successful decision-making that generates benefits [25], mostly consisting of wireless sensor networks and actuators [26]; allow control of autonomous irrigation systems [27], monitoring system of environmental variables, powered by solar energy, a system based on DigiMesh and Wi-Fi that can be applied in both rural and urban scenarios and a transmission system with IoT platforms [28,29], and information systems focused on precision agriculture technologies [30].

5. Elements and technologies

Through the use of sensors and actuators, IoT systems can guarantee the quality of products of plant origin for human consumption and allow the producer to offer new services, have control of their data collection, monitoring and decision-making processes. Applications based on hardware and free software such as Arduino and Raspberry have been made, in addition to Linux, Java, wildfly, python, radio mobile that allow us to offer solutions to improve and optimize resources and crop quality [26,31,32]. Table 3 summarizes the elements and technologies that characterize the solutions that were developed in the field of agriculture [16,30]:

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Table 3. Technologies used by IoT.

| Components | Proposed technologies and equipment | Features and/or uses |
|------------|-------------------------------------|----------------------|
| Application | Positioning Systems GPS, GLONASS, Galileo, BeiDou, Linux, Java, Wildfly, Python, Mobile Radio | Traffic control that provide real-time data [30] |
| Middleware | Decision Support Systems (DSS, Decision Support Systems), Data Mining | They carry out comparisons between sampling processes, production, crop damage and costs, use of fertilizers, schedule operations during harvest for decision making, present crop yield and productivity maps, perform processes to explain the behavior of data [33-36] |
| Communications | Standard 802.15.2, Wifi, Bluetooth, ZigBee, mobile phones. GPRS, Xbee | They allow messages to be adapted to the specific needs of the application, such as Xbee, which allows low-power electronic devices to carry out their wireless communications [37,38] |
| Dispositive | Arduino, Raspberry and its complements, Wireless Networks of WSN Sensors, Variable Rate Technologies and (VRT) Remotely piloted aircraft, Drones | They are microcontrollers and system memories, modules such as Bluetooth, XBee, WSN sensors that communicate two or more sensors to monitor large environments [39-41] are commonly used |

6. Applications and platforms

For data management in the development and proper functioning of the proposed applications, some of the authors mention the use of the applications and platforms shown in Table 4.

Table 4. Applications and platforms.

| Application | Features |
|-------------|----------|
| Google Drive | Cloud storage tool, synchronous and asynchronous communication [42,43] |
| Dropbox | Supplier of cloud-based storage systems [44,45] |
| Microsoft Azure | It is a set of cloud services that allow you to create, manage and deploy applications on a huge global network with your favorite tools and frameworks [46] |
| Amazon | E-commerce platform and cloud computing services [47] |
| Web services | An application accessible to other applications through the web that requires the coordination of hardware and software resources [48,49] |
| IBM Watson | It is a cognitive technology that processes information similarly to a human by understanding natural language and analyzing unstructured data [50] |
| Ubidots | Data platform to create applications that capture information, connecting devices to the cloud [51] |
| Phant | SparkFun software whose IoT protocol is HTTP, custom software, graphics through open-source [52,53] |
| ThingSpeak | The definition of ThingSpeak is: It is a web-based open API IoT source [54,55] |

It is important to recognize that there is still more to be developed, and according to the authors, the lack of interoperability between platforms must be taken into account, so that it can always act or operate between systems and they are transversal with the technology, so that users you don't have to be changing system; It is also proven that there are solutions capable of supporting current agricultural applications that connect a small number of devices and low data generation rates, but future applications must perform a deployment of larger components, because they demand greater bandwidth, generation of data and number of connected networks, also the environmental impact that will be generated by electronic waste that is growing faster and faster due to the speed of IoT development should be taken into account [56,57].
7. Conclusions
One of the main features in the development of an IoT architecture is the use of a wireless network of sensors that allow data capture of system variables, which will then be analyzed for decision making within the production process.

There are a variety of technologies for the implementation of IoT applications, but their choice will depend on the environmental and geographical conditions where they will be used, as well as the resources available since there are also free hardware and software options that allow performing the functions mentioned in the article.

The IoT applications that currently exist generate satisfactory results, but with the passage of time and market demand they will require a greater number of applications that lead to the use of better technologies and equipment with greater reach, much larger networks and more complex information systems.

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