Internet of Things (IOT) in Agricultural Science, Propouse of a Standar Solution for Applications at Colombia

Internet de las Cosas (IOT) en las Ciencias Agrícolas, propósito de una solución estándar para aplicaciones en Colombia

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Fecha de recepción: julio de 2018 / **Fecha de aceptación:** septiembre de 2018

Abstract

The wireless sensor networks (WSN) are a technology that has been underway for several years with high potential in the Internet of Things (IoT) applied to agriculture. One of the main challenges is the construction of these systems. This article main objective is to show to design and implementation of full technological system that will aim to strengthen precision agriculture in Colombia, through the construction of a wireless sensor node with communication modules, capable of measuring the variability of the environment and the soil and how connect this devices to cloud computing, a system proposed motivated on the creation of an open source model of precision agriculture, based on the extraction and gathering of environmental data, from remote sensors. Furthermore, the paper explains the overall applications propose in the world and the current technological developments in the agricultural sector in Colombia, emphases on researching on the architecture and key technology of Internet of Things (IoT). Finally, the paper demonstrates the development of a technology-based project that offers an efficient solution and contributes to the welfare of a specific target population, the Agro of Colombia.

Keywords: Technological progress, data, environment, reliability.

Resumen

Las redes inalámbricas de sensores (WSN) son una tecnología que ha estado en marcha durante varios años con un gran potencial en el *Internet of Things* (IoT) aplicado a la agricultura. Uno de los principales desafíos es la construcción de estos sistemas. El objetivo principal de este artículo es mostrar el diseño e implementación de un sistema tecnológico completo que apunte a fortalecer la agricultura de precisión en Colombia, mediante la construcción de un nodo sensor inalámbrico con módulos de comunicación, capaz de medir la variabilidad del ambiente y del suelo y cómo conectar estos dispositivos a la computación en la nube. Un sistema propuesto y motivado en la creación de un modelo de fuente abierta de agricultura de precisión, basado en la extracción y recolección de datos ambientales, desde sensores remotos. Además, el documento explica las aplicaciones generales propuestas en el mundo y los desarrollos tecnológicos actuales en el sector agrícola en Colombia, con énfasis en la investigación sobre la arquitectura y la tecnología clave de *Internet of Things* (IoT). Finalmente, el documento demuestra el desarrollo de un proyecto basado en la tecnología que ofrece una solución eficiente y contribuye al bienestar de una población objetivo específica, el agro de Colombia.

Palabras clave: avance tecnológico, datos, medio ambiente, fiabilidad.

Introduction

The future of agriculture is attached to technology; thus, Precision agriculture emerges as a response to the integration between information and communications technologies with field work. There are even many solutions that have not yet been implemented, and agriculture has a vital role in manufacturing and sustenance. Therefore, in this Internet of things (IoT) applications in agriculture have the potential to transform the ways in which we live in the world, cheaper food, better exploitation of the land in terms of size and quality of the land, a driving force behind increased agricultural production at a lower cost is the Internet of Things (IoT), The proposal for this work is to show the assembly of a model for use in agriculture, in the future we will work with farmers to develop different sensors and applications. Furthermore, we plan to make the data available for researchers to do agricultural predictions.
Internet of Things (IoT) Description

The creation of the ubiquitous computing discipline, whose objective is to implant technology into the experience of everyday life. At present, we are in the post-PC era where smart phones and other handheld devices are changing our environment by making it more interactive as well as informative (Jayavardhana Gubbi, 2013). Furthermore, to the IoT concept, it integrates a huge amount of technological foundations that must be built for its operation as wireless sensor networks (WSN), middleware, cloud computing and, IoT application software.

Wireless sensor networks. Wireless sensor networks (WSN) are electronic sensor-equipped devices to monitor physical or environmental conditions and can cooperate with telecommunications systems to better track the status of things such as their location, temperature, and movements. WSN allows diverse network changing and moving topologies and communications. Recent technological advances in low-power integrated circuits and wireless communications have made available efficient, low-cost, low-power miniature devices for use in WSN applications (Gubbi, Buyya, Marusic, & Palaniswami, 2013).

Telecommunications systems. They provide way communications with the meter, allowing sending commands from the utility to the smart meter for multiple purposes, including monitor real-time values and change the frequency of readings among others. The network between the smart meters and the utility Centre allows collection and distribution of information to customers, suppliers, utility companies, and service providers (J. Lloret, 2016).

Middleware. IoT require a software platform defined as middleware, fundamentally providing abstraction to applications from the things, and offering multiple services. The common goal of all the middleware development initiatives is to develop a framework which can enable an adaptation layer in a plug-n-play mode. In recent past, many reviews have been made on different middleware, and on their basic features to support the important needs of the respective domains (Soma, 2011).

Cloud Computing. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be quickly provisioned and released with minimal management effort or service provider interaction (Mell, 2011). Parts of the IoT cloud system, such as networks and cloud services, can be properly well controlled, but IoT elements can't. Analogous to cloud services in datacenters, which we can easily select, combine, and deploy to provide a platform suitable for an application or domain, the software stack for IoT services should support virtualization and composition (Dustdar, 2015). Cloud services and IoT are created disjointedly by cloud providers and IoT providers.

IOT application software. IoT platform is a virtual parametric model for energy management and simulation is a challenging task. Indeed, such platform needs to transparently integrate hundreds of heterogeneous data sources and IoT devices that may be exploited to monitor and manage energy consumption. Furthermore, it must be scalable and reliable (F. G. Brundu, 2017).

Related Work. The use of equipment in agricultural around the world it is reasonable to say that there are plenty of technological developments associated to these topics, among the most prominent countries in Agriculture IoT are as a reference Israel, the Netherlands and the United States.

Data-driven Climate Smart Agriculture. The Ubidots Company Using real-time data as an extra helping hand, farmers and horticulturists merge the physical world with digital tools to combat everyday problems and Boost product yield, reduce per acre energy consumption and economize water consumption (Ubidot, 2018)

Precision farming. Precision agriculture is one of applications of IoT in the agricultural sector and several groups are leveraging this method from one place to another. Crop Metrics is a precision agriculture organization focused on ultra-modern agronomic solutions while specializing in the management of precision irrigation, IoT For All Company explain that can be thought of as anything that makes the farming practice more controlled and accurate when it comes to raising livestock and growing of crops. In this approach of farm management, a key component is the use of IT and various items like sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, and so on (Leverege, 2016).

Agricultural Drones. Provided farmer Inoculation of agricultural chemicals Injection Introduction High efficiency self-made agricultural inorganic, agricultural unmanned aerial agricultural machinery top uniformity, high efficiency etc. superiority, superior atomization startup permissible agricultural chemical spraying granule miniaturization use easier to absorb, Possible Effective Breadth Rate Low Farming Pharmaceutical Dosage. Measurement method of the method of redeposition Scheme method Measurement trial Minimum application volume for fertilizer, farmer 's crop cultivation model, transshipment construction standardization course, design unmanned aerial construction work method, low technology gate cage, increasing low - technology cage, model number replication. Drones can provide farmers with three types of detailed views. First, seeing a crop from the air can reveal patterns that expose everything from irrigation problems to soil variation and even pest and fungal infestations that aren't apparent at eye level. Second, airborne cameras can take multispectral images, capturing data from the infrared as well as the visual spectrum, which can be combined to create a view of the crop that highlights differences between healthy and distressed plants in a way that can't be seen with the naked eye. Finally, a drone can survey a crop every week, every day, or even every hour. Combined to create a time-series animation, that imagery can show changes in the crop, revealing trouble spots or opportunities for better crop management (Anderson, 2018).

Livestock Monitoring. Link labs says that thanks to livestock monitoring, ranchers can use wireless IoT applications to gather data regarding the health, well-being, and location of their cattle. This information saves them money in two ways: 1. It helps identify sick animals, so they can be pulled from the herd, preventing the spread of disease. 2. It lowers labor costs because ranchers can identify where their cattle are located (LinkLabs, 2014).

Smart Greenhouses. Greenhouse farming is a method that improves the yield of crops, vegetables, fruits etc. Greenhouses control environmental parameters in two ways; either through manual intervention or a proportional control mechanism. However, since manual intervention has disadvantages such as production loss, energy loss, and labor cost, these methods are less effective a smart greenhouse through IoT embedded systems not only monitors intelligently but also controls the climate. Thereby eliminating any need for human intervention (Data, 2017).

The Connected Tractor and Future of AgBots. Quora Company affirms that onboard telematics software that monitors farm machinery's hours of use and maintenance needs also helps improve farming productivity. Farmers can gather data that are analyzed by software and provide feedback that will suggest exactly what should be planted and where, how much fertilizer to add, and when harvesting should begin (Anon., s.f.).

Applications in Colombia Agriculture

Even in Colombia several distributors of technology proposal numerous equipment for Agriculture IOT, is not evident the creation of solutions, however, there are interesting developments, for example, Identidad company says than on farm of one of the largest coffee exporters in the country, ten sensors were installed in two lots of three and a half hectares, each one to measure in real time determining factors in agricultural production, this is a experiment, which will last four months, where it will be carried out in a Caturro quality coffee crop, with this data farmers can make better decisions to increase the yield of their harvests.

Other Company, Sioma, in Urabá use drones in banana yields to make measurements and collect soil and plant data which serve to control drains such as moisture information in yields, nutrition control, soil conductivity and monitoring of areas that are ready to receive fertilizer. In Universities are work in several solutions, the University of Cordoba proposes the development of an Internet of Things system for the monitoring of protected crops. The data is captured in real time using the MQTT protocol that is part of the M2M protocols, through a broker and using the infrastructure given by the platform Arduino free hardware as controller of different sensors (Gómez, 2017).

Propose Work

The Internet system of things for the Use in protected agriculture is currently developing to continue our prototype, the architecture is an open source and can function for any application and thus components are described below.

Wireless Sensor Node: The sensor nodes are responsible for communicating among themselves and for centralizing the information to those that have active mobile connectivity. Such node has the task of receiving measurements from multiple sensors. The structure of the data frame created, and the data sent correspond to the temperature, humidity, battery percentage, Beaufort number (it allows to identify the wind intensity by means of a classification made at the wind speed in km/h), speed of the wind, luminosity, ultraviolet radiation and other variables captured by the sensors (see figure 1).

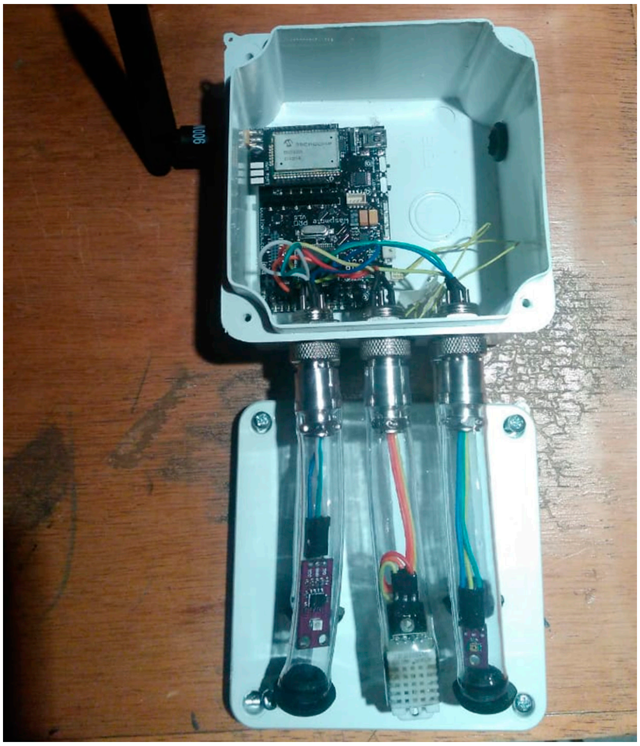

Figure 1. The sensors.

Telecommunication System. This is accountable for starting, controlling, maintaining communication to and from the devices, the commands defined by the users or applications to the Smart Agricultural Nodes can be sent through a console or can be retrieved from commands stored in a database, we use several systems at 900 MHz, Xbbee and for this LoRa one System, the public says that LORA is the best option for smart agriculture applications (Lukas, 2015). The system is provided by an IMST iC880A LoRa one "concentrator" board. This integrates two Semtech SX1257 transceiver ICs plus an SX1301 baseband processor. A Raspberry Pi 3 Model B was selected to run the gateway software and this interfaces with the concentrator via SPI and a very simple breakout/baseboard constructed from per board (see figure 2).

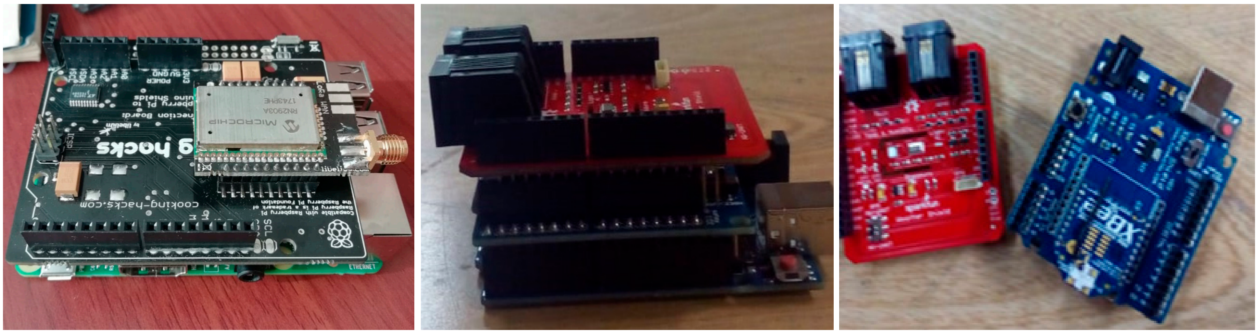

Figure 2. The board.

Application Software. Henceforth, an information system is presented which is integrated into the hardware development of the wireless sensor node, a LabVIEW Interfax (see figure. 3). was prepared the information system is responsible for storing the environmental information and sending by different electronic communication means Among the most important tasks that the system executes, is the synchronization of the information stored locally with the AWS public cloud, there a processing of the collected information is done, detailed reports are presented and a rain prediction process is carried out, from all the historical environmental data collected. For firmware the latest Raspbian Jessie Lite image was downloaded and written out to a Micro SD card. Upon then booting the Raspberry Pi, this was followed by the usual sequence. To enable communications via the SPI bus.

Figure 3. LabVIEW Interfax

System. A real case study was carried out on the greenhouse. The system processes requests and frames with measurements of weather conditions, in this scenario, the behavior of luminosity in shadows to which the greenhouse is subjected is evaluated. The frames with the information are sent through a hybrid network that combines the Raspberry Pi topology (LORA ONE network) (see figure. 4). This configuration was selected due to project constraints although the middleware has a sequence of TCP sockets.

Figure 4. LORA ONE network

Conclusions

Colombia is a country with prospective and is one of those with the greatest possibility of expanding its agricultural frontier and becoming the world's pantry, though, contrary to this, the implementation of new technologies is still incipient and disturbs this proposal. We have deployment this prototype it is a low-cost, highly available IoT platform for agriculture that it can used in environmental conditions as air monitoring, soil monitoring, water monitoring or precision agriculture as plant monitoring, animal monitoring, irrigation control, fertilizer and pesticide control.

References

Anderson, C. (2018). MIT Technology. Available at https://www.technologyreview.com/s/526491/agricultural-drones/

Anon., s.f. Available at https://www.quora.com/

Brundu, E. A. (2017). IoT Software Infrastructure for Energy Management and Simulation in Smart Cities. *IEEE Transactions on Industrial Informatics*, *13*(2), 832-840.

Data-flair (2017). Available at https://data-flair.training/blogs/iot-applications-in-agriculture/

Dustdar, H.T. (2015). Principles for Engineering IoT Cloud Systems. *IEEE Cloud Computing*, *2*(2), 68-76.

Gómez, J. (2017). Sistema de internet de las cosas (IoT) para el monitoreo de cultivos protegidos. *Revista Ingeniería e Innovación, 5*(1), 24-31.

Jayavardhana, G. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645-1660.

Lloret, J.T. (2016). An Integrated IoT Architecture for Smart Metering. IEEE *Communications Magazine, 54*(12), 50-57.

Leverege (2016). Available at https://www.iotforall.com/

LinkLabs (2014). Available at https://www.link-labs.com/

Lukas, E. A. (2015). On the application of IoT: monitoring of troughs water level using WSN. *Melaka, IEEE*, 58-62.

Mell, P. (2011). *The NIST Definition of Cloud Computing of Standards and Technology.* Gaithersburg: National Institute of Standards and Technology.

Soma, B. (2011). Role of Middleware for Internet of Things: A Study. *International Journal of Computer Science & Engineering Survey, 2*(3), 94-105.

Ubidot (2018). Available at https://ubidots.com