Effective Contribution of Internet of Things (IoT) in Smart Agriculture: State of Art

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Abstract. The popularization of the Internet of Things (IoT) (IoT) has made it possible to optimize and significantly improve the agricultural system. Thanks to this technology, farmers and ranchers are more confident in running their farms, which are now smart farms. By using New Information and Communication Technologies as a catalyst and essential facilitator for the development of this new style of agriculture. Several devices and mechanisms are used in intelligent systems related to agriculture. In this article, we review 30 scientific works produced and published by certain researchers and which sufficiently review the different dof management of smart farms without being exhaustive. This study aims to present a state of the art of integrating Internet of Things (IoT) into the agricultural environment to understand the improvements it brings and detect future smart agriculture issues. It turns out that smart agriculture is really at the heart of researchers, farmers, producers, and even states. The results of this state of the art show us that various devices and technologies are deployed in smart farms to ensure better performance. Depending on requirements and realities, each intelligent system should be adapted. This reflection helps to present directions for the development of intelligent farms that would be applicable and adaptable locally for the rest of our work.

Keywords: Internet of Things (IoT) (IoT) · Smart farm · ICT's · Review

1 Introduction

Several countries in the world have mainly based their economy on agriculture. Indeed, in addition to contributing greatly to the Gross Domestic Product, it also contributes to the fight against famine by meeting the food needs of the populations. Around the world, the economy of many countries depends on agriculture. It is also the focal point of industries regarding the supply of raw materials [8]. With the current expansion of New Information and Communication Technologies in all fields of activities, agriculture has suffered a generational shock and is now gradually migrating towards the integration of these technological tools in his activities. This is what the researchers called smart

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agriculture or agriculture 4.0 [18]. This new facet of agriculture facilitates agricultural work by reducing human physical action, it improves agricultural productivity, it reduces the consumption of resources (energy, water), and it allows better management of farms (monitoring, control, and decision-making [19]. Smart agriculture has been made possible thanks to the Internet of Things (IoT) (IoT) by making farming systems intelligent. These farming systems are now connected to various technologies such as Internet, and they can collect and analyze data from said systems while communicating with other connected devices [26]. The Internet of Things (IoT) (IoT) has therefore opened an exploitable breach for many countries and farmers to optimize and modernize the agricultural fabric. This work reviews specific articles published by researchers to present a state of art of applying the Internet of Things (IoT) in agriculture.

2 State of the Art

2.1 Development of Intelligent Systems for Smart Farms

The development of an optimal irrigation system for crops is proposed in this work [18]; this system is based on a network of wireless sensors. For the author, the aim was to design and set up a control system that uses knot sensors in crop fields with data management. That is to say, temperature management, moisture, and soil moisture through a smartphone and a web application. Three main elements made up this control system: the hardware, the web application, and the hardware, web application, and mobile application. The first piece of hardware was designed and built as a control box to control IoT devices and get data from crops. The second component used in the system is the web application, a database that will be used for decision-making for crop watering control. This component is to get real-time data that comes from IoT devices in each culture. The purpose of the Web application is to make it easier for an administrator to manipulate the water requirements of each crop. In addition, any administrator can consult and have detailed information on the temperature, humidity, and humidity of the soil resulting from IoT devices implanted on crops via the web application. These devices collect this data every 20 min, and it is analyzed daily. The final part of the system, the mobile app, was designed to control irrigation after data analysis. Based on the information from the IoT, two watering control modes are performed, namely manual watering or automatic watering. The proposed system architecture comprises 3 parts: the environmental data acquisition layer, the data and communication layer, the environmental data acquisition layer, the data and communication layer, and the application layer. The purpose of the first layer mentioned above is to collect data based on environmental factors from the sensors. The second layer transports the data collected using the sensors and stores it in a server. Finally, the last layer uses the collected and stored data to monitor and control the crop. Thanks to IoT, agricultural activity is optimized, and it is now possible to predict the water needs of crops in the future.

[5] This work presents an automated system of irrigation and power distribution. To set up this system, the author uses a wireless sensor network communication methodology for collecting environmental data and sending a control command to activate - deactivate the system. The objective of this reflection is the use of the wireless sensor

network and the creation of a communication methodology that is specific to it to overlook the effect of global warming in the agricultural industry. The different components of the smart farm highlighted in this research are monitoring, control, and independent power supply through solar panels. This automated irrigation and energy distribution system aim to optimize the production potential of the smart farm because good energy management is essential to the survival of livestock and agricultural products such as fruits and vegetables. The author used Zigbee, and the irrigation simulation was done via WSN. After this simulation, we conclude that the system that has been developed is precise, robust, and reliable.

Excessive use of water in crops seriously harms them; this is the reason why [29] proposes an automated system capable of efficiently managing crop irrigation in a 25 cent peanut field. The proposed system is a technological mixing, which is the improvement of agricultural products and the minimization of the consumption of electrical energy. This is a method of monitoring the flow of water to prevent water from being used excessively. Said system uses the Raspberry pi B model for an interaction between the sensors and the motor pump to reduce the use of water and electrical energy. The proposed system architecture consists of the Raspberry pi B model, a temperature sensor that will monitor soil moisture and soil temperature, and a humidity sensor. This is the humidity sensor (DHT22) which precisely exercises, the temperature sensor (DS18B20) to measure the heat of the soil, a water flow sensor connected to the Raspberry pi device for the monitoring of the water pump, a Python module for managing the extracted data and for notifying farmers. It should be noted that the temperature must be between 27 and 32 degrees Celcius for a good groundnut culture. The recommendations highlighted here show that this system must be applied in smallholder agriculture.

This article [24] presents the importance of integrating technologies related to the Internet of Things (IoT) in the development of the agricultural sector. Proposed herein is the design and deployment of a system using wireless sensor networks to control light, temperature, and humidity in a greenhouse. For this, a hardware configuration has been carried out taking into account devices such as the NodeMCU which is a Micro Controller, the DHT11 sensor to measure the temperature and humidity, the Soil humidity sensor (KG003), An Eight-channel relay (5V) for switching and sensor (HC-SR04). In addition, a software configuration is also set up via the Blynk platform, which is open source and serves as a digital dashboard. The data collected is stored in the Cloud, and this allows the farmer to save time and especially to have holy and traceable vegetables and fruits. The particularity of this system is that it is designed using very inexpensive equipment that is accessible to all.

Motivated by the desire to find solutions to the challenge of capturing and recognizing pigs' faces on a farm, [17] proposed a framework combining Artificial Intelligence and the Internet of Things. Indeed, this new framework includes algorithms for computer vision, machine learning. A few deep learning techniques are offered with the aim of providing a cheaper and scalable solution for pig recognition. This work involves applying a deep Convolutional Neural Networks (CNN) for pig face recognition through an adaptive approach to choose high quality training and test data automatically. With the aim of quality control and management of the welfare of farm animals. The data used here was extracted from 30 randomly selected pigs, and images from 10 videos were tested to perform a performance evaluation of the data extraction process. This data was taken from an industrial environment, and the pigs do not have artificial markings. The results obtained from this work will allow the real practice of animal identification based on Artificial Intelligence in the pig industry.

In order to have a productive corn crop in large-scale fields, [3] implements an intelligent system including some hardware and software of the Internet of Things. Maize being a plant that cannot stand the cold, its germination is adequate in soil where the temperature is above 10 °C. Therefore, the author's havrefore, the authors have set up this 4.0 system consisting of a variety of agricultural sensors, drones, and IoT hardware and software devices. Thanks to heterogeneous sensor nodes, said system can perceive the levels of temperature, wind, light, rain and PH in corn plantations. These sensors mentioned above send the collected data to the coordination node, which sends them to the drone used. The drone transmits this data to the various base stations so that farmers can constantly monitor the cornfields - large-scale cornfields that already have wireless sensor networks with tasks individuals who provide this relay on site. The simulation is performed here in the Riverbed Modeler wired and wireless network program, which has advanced capabilities. While flying over a cornfield at a speed of 5 km/h, the drone is in communication for five minutes with the cluster of sensors and each coordination node. In addition, the Node-RED development platform receives this data and stores it in the InfluxDB database with NoSQL. Finally, the Grafana software intervenes to provide visual interfaces and data graphs. This is the smart agriculture application offered to optimize the cultivation of corn.

To obtain more reliable intelligent farms, [25] propose an adaptive network device that uses the LoRaWAN and IEEE 802.11ac protocols. This mechanism aims to increase the performance of existing systems already in smart farms. This mechanism is deployed in the application layer of the system so that the latter adapts according to the state of the network. The LoRaWAN protocol is suitable when the system needs to send small data packets such as sensor readings. On the other hand, the IEEE 802.11ac protocol is suitable for a high data rate such as sending images and videos. This protocol combination will allow the system to be reliable in terms of averaging data collected by the sensors and to continue monitoring parameters. Each protocol has its precise tools, the IEEE 802.11ac uses video bridge devices, a Raspberry Pi and a webcam; while the LoRAWAN also uses a Raspberry Pi and the LoRa nodes and gateway. To experiment with this mechanism, it is implemented in the application layer of the OSI model (Operation System Interactions). The results from this experimental phase show that by combining these two protocols, the monitoring system is more reliable and the performance of the network is improved. It is therefore advisable to migrate to this mechanism to the detriment of one-protocol systems.

With the aim of controllingaims to control agricultural production towards a perspective of renewable energy consumption, this reflection by [16] was carried out. Indeed, the author proposes a framework serving as a connection between renewable energies and intelligent agricultural systems. This idea of interconnecting the smart farm and renewable energy uses the surplus renewable energy for the agricultural sector and the smart farm for renewable energy supplies. Reactive Energy Utilization Technology (REUT) has been used as an efficient energy consumption system for smart agriculture. This system allows the prediction of an optimal wind energy scenario in the smart farm while watching over the continuous control variables with the lowest voltage level reached in each scenario. Not to mention the minimization of actual total power losses. Overall, this model has improved the monitoring system of agricultural machinery engines by collecting data from the wind energy system. This data facilitated monitoring all output determinants such as greenhouse temperature, humidity, natural light, carbon dioxide concentration, greenhouse gases, and soil temperaturemonitoring all output determinants such as greenhouse temperature, humidity, natural light, carbon dioxide concentration, and greenhouse gases soil temperature, and humidity. Soil reliably with greater accuracy (96.7%) and efficiency (95.6%). Hence the modernization of agriculture.

This work [26] proposes an intelligent system that will monitor and control the climatic parameters of the greenhouse on a farm and take action automatically if necessary, without the human intervention of the farmer. It is a question for the system to make automatic management of these parameters, that is to say recorded the level of temperature, the level of humidity and the level of CO2 at various places of the farm. The architecture of the proposed system consists of a detection node, routers, coordinator or gateway, BeagleBone, an access point, a web service, a web application and a smartphone application. The technologies deployed are Internet, Zigbee, WIFI, LAN and the Wireless Sensor Network (WSN). The system can visualize the graphical image of all continuous greenhouse data. This intelligent system is powered by solar and storage batteries and will thus be able to predict preventive measures related to environmental conditions. The farmer will be able to manage the operation of the devices remotely via his smartphone.

[9] Provides here a device using a technology capable of producing messages in various platforms to inform farmers in real-time about farm or greenhouse data. For the author, it is essential to create a prototype of an intelligent device whose installation, deployment and use would be easy in the field because farmers do not always have the required technical knowledge. This product uses various equipments and technologies including Node MCU ESP32, DHT11 Temperature and Humidity Sensor, Soil Moisture Sensor, SI1145 Digital UV/IR/Visible Light Index Sensor, connecting wires, LEDs and the Blynk mobile app because not all farmers have a PC. Said device monitors the farm or greenhouse via sensors for temperature, humidity, UV, IR, soil nutrients. The data from these sensors are recorded and messages are sent to the farmer; this allows him to act quickly. To inform the farmer, 3 channels are used here: the visual alert LED, the Blynk mobile application, and the various alert sounds thanks to a small ringtone. This makes it an efficient, accurate and cost-effective IoT device that will enable small farmers to effectively monitor crops through this user-friendly app and other alert biases.

[14] presents here the new smart stick of agriculture which is employed in detecting the value of pH, temperature, light and content of water and nutrients (potassium, phosphorus, nitrogen) to the using a sensor to have live data. For the authors, it is therefore important to gradually migrate to smart agriculture. The latter uses many sensors and devices to measure and regulate the above-mentioned elements. The proposed system extends the notion of "Plug & Sense" in which smart agriculture can be implemented by positioning the smart stick in the field to obtain data in real time. The architecture of this

smart stick incorporates a pH sensor, PIC16F877 microcontroller board, PIC16F877A microcontroller and real-time data that can be obtained through 162A LCD display.

To successfully integrate the Internet of Objects in agriculture, [23] proposes an architecture based on big-data. This architecture is called Big Data oriented Smart Farming (SFOBA). In the management of a smart farm, big-data can intervene to overcome the limits of traditional systems in terms of decision-making and storage. New intelligent systems are capable of handling huge amounts of data from big data. In smart agriculture, big data makes it possible to deploy and analyze sensors, model data, provide predictive modeling in order to face the risk of terrible harvests and maintain crop efficiency. The SFOBA will enable data management and batch processing in the smart farm.

2.2 Smart Farm Management

In this article [19], a platform is developed. Indeed, it offers farmers an opportunity to efficiently and effectively manage their smart farms. Apart from this management and decision-making component, a collaborative tool has been developed to allow different farmers to interact. To better develop this platform, the authors have proposed a software architecture having a base two applications, particularly a front-end application and a back-end application. They are independent and communicate using REST (Representational State Transfer) services. In the further implementation of this platform, a data collection algorithm is presented in detail. The algorithm deals with sending notifications to users when there is a problem, it also deals with statistical services and performance testing about the time required for the collection and processing of a large amount of data. The authors present this algorithm as one of the most important features in the development of this platform. One of the major challenges of this platform is to analyze the data collected to provide useful and exploitable information on the current state of the farm. The aim is to provide farmers through this integrated platform with real-time information on the subjects of statistics, trends, unexpected problems on farms and correlations.

This article [4] presents an integrated web service platform to improve the quality of products grown on farms and support the emergence of businesses in fields related to agriculture. This platform is deployed in the Cloud and has many advantages of Cloud-computing including flexibility, availability and it can be accessed at any time through the use of an Internet connection. In addition to localization, it enables users to manage their farms efficiently by giving them access to various statistics and forecasts. In addition, the platform can also be used as a social network that allows users to exchange through private messages or through posts in the forum or blog. It is made up of two main applications including the front-end application and the back-end application which are distinct from each other. This platform is made up of the identity management service; the farm management or registration service which allows farmers to register their personal farms in the platform, the weather service which provides an in-depth 7-day forecast for each farm, the statistics service, which connects the user on his farm by presenting real-time statistics on all the parameters monitored and the notification service. It should be noted that anyone who has an active account has the right to access the platform.

To study and improve the quality and safety of agricultural products in e-commerce, [34] proposes a new e-commerce system focused on the Internet of Things (IoT) and

5G. This new information system aims to position, share information, and ensure secure management of the supply chain; all this in real-time. It will allow agricultural enterprises to improve their efficiency and exploit more profit points. This combination of Internet of Things (IoT) and 5G revolutionizes the electronic commerce of agricultural products on four points, in particular the monitoring of products thanks to RFID tags to trace the quality of products, inventory management in terms of improvement in the reading and recording of products. Goods and in updating inventory information. As another revolution, we also note a clear improvement in logistics distribution via the combination of Internet of Things (IoT) and GPS. Finally, a real evolution in the means of payment can now be mobile and be carried out at any time and in any place. The work methodology adopted by the authors is mixed and the system uses Windows for the software operating platform. Concerning the development of this system, the NET platform is used and for the development language it is Microsoft.NET 4.0 which is used. This system has revolutionized the management of electronic commerce in agricultural products.

This article, [21] exposes globally on models within the agricultural enterprise by presenting the state of the art on smart technologies. Indeed, these technologies will allow the development of new models specific to the company and allowing better support in decision-making. Despite its harnessing of new Information and Communication Technologies as a catalyst for the efficiency of agricultural societies, smart agriculture needs a combination of models to deliver expressive information in real time. Decision support tools should therefore be modeled more in depth by integrating various agricultural activity models.

Still in the management of the farms of the future, [15] proposes here an efficient intelligent farm system which takes into account the automation of different aspects of a farm. Through this intelligent system of efficient management of the farm, it is about setting up an automatic lighting system, an automatic watering system, an automatic internal temperature control mechanism, fire and smoke detection mechanism, automatic door locking and unlocking device, humidity control device, preset wash time mechanism and connectivity remote mobile. This proposed system saves energy and water, greatly reduces manual labor, and improves the livelihood of livestock. The connection of all these components of the smart farm was made thanks to the GSM module which was interfaced. Access and control of the farm have been facilitated through the possibility for the owner of the farm to connect remotely via his smartphone.

This study [33] examines the factors influencing smart farm adoption in Korea. A research model is set up using the diffusion of innovation and the models that exist on the adoption of information technologies in organizations; moreover, 11 research hypotheses have emerged from this model. Both online and offline surveys were used to collect data for this study. They took place on the "cloud-based social science research automation site" which brings together farmers from "Korea Venture Agricultural University" and members of online agricultural exchange communities. The data was collected using QR codes linked to the web and mobile phones of the participants. 232 questionnaires were used for data analysis. The majority age group of respondents was over 50, made up of 162 men and 70 women, 72% of whom depended on private farms. Reliability and validity tests of the constructs were carried out giving a cronbach alpla of 0.7. The results of this study have shown that "compatibility" linked to the technological dimension, "the financial cost" linked to the organizational aspect and "the change of the digital environment" linked to the environmental aspect influence the adoption of smart farms.

This study [22] is carried out with the aim of knowing the different impacts that the use of climate-related smart agriculture techniques has on the household portfolio of the inhabitants of the Nyando basin in Kenya. For this, a combination is made between statistics and econometric modeling. This assembly is done via simultaneous equations in order to examine how the methods of smart agriculture culture act on the increase of assets and household income. This analysis was carried out on a sample of 433 households. It emerges that crops tolerant to multiple stress actually increase household income by 83% and consequently the accumulation of household assets, which would further promote the fight against poverty. In addition, the modeling results indicate that households would invest their income in livestock assets if given the opportunity. Livestock is seen as a kind of savings that can be used at any time to bridge the income gap in households. It should be emphasized here that multiple stress-tolerant cultivation activities relate to crops, livestock, integrated soil and water conservation, and agroforestry.

2.3 Robotics for Smart Farms

In order to set up an autonomous system, that tries to solve the problem of navigation in an agricultural orchard and which must dock autonomously with vehicles in citrus farms, [10] has developed an agricultural robot. Thanks to the Robot Operating System (ROS) software platform, a network has been developed between the robot's computer and a remote computer on the basis of a WiFi router to ensure communication and sharing of data between these two computers. While the robot's computer receives and processes the data from the sensors, the remote station's computer stores, displays the data and sends commands to the robot when the need arises. It is therefore a question for said system to navigate and travel autonomously from one point to another in a farm with the ability to thwart obstacles, to collect and transmit in real time to a remote station the data coming from the sensors and to monitor and control the robot in real time. In case of emergency, the developed system allows the computer of the agricultural station to make an interruption and manual control of the robot. This robot, through autonomous navigation, therefore makes it possible to reduce the driving of vehicles in the plantations and to reduce manual work.

With the aim of contributing to the development of robotic weed control, [31] highlighted the advances and perspectives of research on the signaling of cultivated plants using different markers applied to these plants to differentiate automatically crops and weeds. For this, three types of signaling methods were used, in particular physical markers (plant labels), chemical markers (systemic signaling compound for crops and topical markers) and biological markers (PF). This systemic crop signaling technology used refers to the labeling of crop plants by affixing a signaling compound to the seeds or roots of crop plants. A detection subsystem capable of detecting and specifying cultivated weed plants is therefore important to better implement this automatic weed control system. Said technology has great potential in intelligent crop recognition as it lays the foundation for an interaction between crop plants and sensors. Furthermore, it has many advantages such as the fact that it does not require prior knowledge of the characteristics of weeds or crops. It is also attributed with drawbacks such as the fact that the differentiation of weeds or crops in the field contains variable lighting conditions because vigor, signal strength and visibility of fluorescent compounds are essential. Having presented a novice overview of this term of crop plant signaling, it should therefore be understood that the agricultural sector is gradually moving towards the disappearance of companies offering traditional pesticides for an outbreak of companies offering smart weed control technologies.

2.4 Prediction in Smart Farms

The support of breeders and producers in the dairy sector has caught the attention of [6] in this article. Indeed, the authors present an intelligent system that will now guide producers in managing cow's milk breeding. For this, the MooCare model is used. The latter is a model that combines IoT sensors and actuators, a prediction engine, and a two-level notification system to individualizeto individualize and automate, and a two-level notification system to individualize and automate animal nutrition while analyzing their milk production. MooCare leads the actors of the dairy industry in the management of dairy cattle to have improved productivity indices. For this system which uses the MooCare model, it is a question of having the production data of a cow, of ensuring the prediction of the animal's milk production, of giving the concentrate in a unique way for each cow according to its production. Dairy and send alert messages to the producer using threshold values. This model has been segmented into two modules, including MooField and MooServer to have data related to food production and supply and ensure centralized control of data in input and visualization. Several IoT technologies are used in the design of this system such as milk production sensors, feed actuators, a system board controller and an RFID tag for each animal for identification purposes. Then, evaluation experiments were carried out via series of lactation data collected in the Brazilian company EMBRAPA. At the end of this evaluation, a prediction accuracy of 94.3% in the tests is noted. These experiments are done on lactating cows only and generally over a period of 30 days to calculate milk production per animal.

Kerala is a region in India where Arecanut is widely cultivated. It is a commercial and very important tree crop for Kerala. As farmers are generally faced with the problem of price volatility, [27] through this research proposes a price prediction model of Arecanuts in Kerala. Many models have been used and compared here to make this prediction on the Kerala markets, in particular SARIMA, the Holt-Winter seasonal method and the LSTM neural network. Time series have also been incorporated. Subsequently, these models were evaluated in terms of performance to obtain the best and adapted model; and the LSTM neural network model was the most suitable model for the data. These data refer to the price of Arecanut on the Keralien market from 2007 to 2017. The choice of the LSTM model was made because it can detect and take the nonlinear dependence of the data points. This feature is very important in forecasting time series. Unlike the seasonal SARIMA and Holt-Winter methods, statistical methods are usually used for prediction with the trend and seasonality side only. Predicting time series therefore has an essential place in agricultural markets.

2.5 Security in Smart Farms

This study, [8] proposes ubiquitous wired network devices to ensure the protection of crops from the proximity of wild animals which are hostile to the development of these crops. This method is combined with the so-called traditional methods for more efficiency. Thanks to an on-board system, the author develops prohibitive fences in order to develop an intelligent security system. It is a surveillance program capable of providing an alert in the event of animal intrusions. This security system works from an underground fence wire used as a sensor, a microcontroller serving as a warning device and a GSM module to notify farmers of the presence of wild animals.

This article [7] discusses security issues and challenges in Agriculture 4.0 systems. The objective here is to highlight various essential solutions in this area and to discuss security threats. Indeed, intelligent agriculture has a great variety and a large amount of resources because it integrates various traditional components from the IoT, internet networks and even cellular and wireless networks. As much as these technologies present security vulnerabilities, smart agriculture is not left out because it is exposed to climatic variations, natural incidents, the transmission of power lines, stray animals, human action and agricultural machinery and devices. These above-mentioned security concerns can reach communications devices and systems used in smart agriculture and can usually be intentional or not. It is also worth highlighting some new complications related to the security of these intelligent systems such as data and device integrity, data accuracy and availability; which were also mentioned by the author. The concern for security must now be integrated into every intelligent agricultural system because agriculture 4.0 is exposed to a wide range of cyber attacks. The design of these systems should incorporate compatibility with distinct devices, protocols, subsystems and multiple access methods as they are machine-to-machine (M2M) communications using devices manufactured by various vendors.

The main focus of this article is to develop an intelligent farming system that combines Internet of Things (IoT) and Data Analytics to improve the safety of agricultural production. Through this research, [2] have shown how data analytics can effectively bring together insurance, estimation, transport, decision-making, agriculture and even precision agriculture. Data Analytics is oriented according to the use needs of the Internet of Objects in the agricultural sector, whether it is predictions, storage control, decision-making, integrated farm management, precise application or insurance. WSN's migration to the Internet of Things (IoT) took place in smart agriculture by highlighting the use of new modules such as cloud computing, middleware, RFID and end-user functionalities. Data analytics in IoT smart agriculture applications therefore allows farmers and pastoralists to have real-time data on the different aspects of running a smart farm.

2.6 New Challenges of Smart Farms

To understand the use of the Internet of Things (IoT) in vertical gardens [12] made a state of the art on this issue. More and more, the trend is migrating towards the adoption of vertical gardens or farms in order to sustainably maintain the environment. To carry out this study, the authors examined the delicate elements in the process of automating vertical and sustainable garden systems. These were the vertical gardens that use the Internet of Things (IoT) in smart cities. Data from 30 works published by researchers were examined on the basis of crop type, vertical garden architecture, sensing data, technological devices used, power supply, pace of data collection and their storage processes, communication technologies used, data analysis methods used, any other strategy employed and the different countries that have set up vertical gardens. The results of this evaluation showed that lettuce is the most popular crop in vertical gardens with 28.6%. In addition, 44.4% used sensors connected to the battery or directly to the power supply while 11.1% of vertical gardens were powered by solar energy. The IoT sensors deployed in the vertical gardens mostly measured ambient temperature, humidity, light intensity and soil supply. The technology used to transmit the data was Zigbee and WIFI in most of these vertical gardens and this data was collected with a speed of one to three minutes. To store this data, vertical gardens made much more use of the local database, the platform dedicated to remote data management and the Cloud. The most widely used soil cultivation technology was "hydroponics". The countries already engaged in this practice of integrating the Internet of Things (IoT) into vertical gardens are the United States with 41.2% and China with 23.5%. The other factors analyzed and which are integrated in the establishment of these gardens are solar energy, the use of recycled and reused water and a supervised interior space without sun or soil. This analysis made it possible to better understand the challenge of integrating the Internet of Things (IoT) into vertical gardens.

This reflection by [32] fully presents the importance of integrating blockchain and the Internet of Things (IoT) into intelligent precision farming systems. The incorporation of blockchain into the Internet of Things (IoT) is a serious contribution to the digital revolution of various industries. This can lead to original safety and performance solutions in smart farming systems. The article took an in-depth look at blockchain platforms commonly used in crops, livestock maintenance, and supply chains. This was driven by the desire to design intelligent P2P systems that can control and secure agricultural data in IoT systems. This is why the authors propose new blockchain models that can be deployed in precision agriculture. It should be noted that the security challenges that hamper the deployment of blockchain-IoT systems in smart agriculture have been addressed. The fact remains that the blockchain represents a gap in facing the challenges encountered by precision farming systems.

To improve the capacity of agricultural systems to cope with the different shocks and variations that they can undergo, [13] proposes a system based on technological tools such as remote sensing and Artificial Intelligence. Throughout this work, the benefits of such a combination for farming systems are explored. Among these different positive points, we have the precise quantification of phenotypic information in a field and the integration of big data in tools used for predictive and prescriptive management. This is therefore a godsend for meeting the challenges of the agricultural sector. This combination of remote sensing and artificial intelligence allows the emergence of crop simulation models that take into account and manage untested scenarios. Unlike current Machine Learning systems which only take into account the scenarios they find in the database. It is a precise and safe platform that combines an HTP system based on Unmanned Aerial System (UAS). This aforementioned combination is now gaining momentum both in the smart agriculture sector and in the space sector.

This work by [30] focuses on the challenge of sharing and controlling data for smart farms. Indeed, data is at the root of the sustainability of farms in the agricultural sector. This is an idea of a data sharing agreement and a data management model between various actors via artificial intelligence applications. The method used here is that of the principles of the science of design. This approach will develop access monitoring using artificial intelligence techniques. The purpose of such a challenge is to better guide decisions on role-based data management policies, hence the concept of "data sharing agreements". After this methodology, it was a question of implementing this new approach in a smart farm in the form of a scenario. This work has thus contributed to materialize, through artificial intelligence techniques, scenarios for sharing data and controlling access to this data in an intelligent farm.

3 Limits of IoT in Smart Farms

Internet of Things (IoT) refers to all the objects that collect data and transmit it to a computer network via adequate technologies such as WI-FI, Bluetooth, 4G, 5G and many others [12, 18]. Talking about the flaws of the Internet of Things (IoT) in general and in the smart farm in particular would bring to the fore reflections based on the security of IoT devices in smart farms including the problems of vulnerability, system intrusion, confidentiality, integrity and availability [1]. According to the Gartner firm, the number of security breaches in these devices has doubled since 2013 and 80% of connected objects in circulation are vulnerable [11]. In the field of IoT, a single system configuration error or poor security practices can become the entry point for sophisticated cyber attacks and data theft [7]. The compromise of a single device is capable of bringing down the entire network of the farm and crippling its internal organization because these devices are interconnected. We can have in a smart farm unauthorized access to stored or exchanged information, loss of confidential data, Data hijacking via installed cameras [30]. Other security issues are related to the use of default login credentials configured in factory mode and DDOS attacks [2]. Indeed, it is found that due to the cost, several IoT device manufacturers use the same standard connection data for all their devices, instead of setting a separate password for each [1, 2]. Every device in a smart system is a potential vector for ransomware attacks. Whatever object is connected, if it is not well secured, it opens a door for cybercriminals. Another limitation of integrating IoT into smart farms is psychological. When connected objects take control of an action performed only by humans, this can constitute a potential danger. The delegation of tasks to connected objects can make the individual dependent and constitute himself an insecurity for his system [20]. Because it will be easier for humans to easily disconnect from a computer but not from connected objects. More and more users are becoming real "addicts" to the IoT and can no longer escape this virtual life. Their excessive use can lead to a degradation of social ties [28].

4 Discussion

In general, all of the above-mentioned documents presented developments of various intelligent systems for connected farms. It should be noted here that many technological devices and supports are used in the implementation of these intelligent systems.

Temperature, humidity, light, PH and even potassium sensors are used such as DHT11, DHT22, DS18B20, KG003, HC-SR04, SI1145. And for better assembly of these sensors, micro-controllers such as Node MCU ESP32 PIC16F877, PIC16F877A, Raspberry pi B, Arduino, LoRAWAN are useful. They are deployed and tested on online platforms such as blyink, Node-RED, NET, Robot Operating System ROS. Various technologies are used because of their different advantages including WIFI, 5G, WSN, Zigbee, Bluetooth and LAN highlighting the use of new modules such as cloud computing, middleware, RFID, Data Analytics. For a poultry farm it is necessary to have a system that allows long range, minimal power consumption with long battery life; it is therefore appropriate in our local context to orient ourselves more WIFI and Zigbee. In addition, the data collected in the various cases mentioned above are stored in the cloud. This does not necessarily take into account the case of developing countries where the internet penetration rate is low. Hence the development of intelligent systems with the possibility of storing data in removable media in addition to cloud computing. This brings us back to the problem of Fog computing in connected farms; which is not yet very explored in this research.

5 Conclusion

All in a nut shell, this study consisted of reviewing some thirty scientific articles published on smart agriculture in order to gain an overview of the various achievements in this field of activity. This work was done in the form of a classification of articles according to whether it was about the technical development of intelligent systems in smart farm, according to the direction of the smart farm, according to the integration of robotics in the smart farm. The smart farm prediction and security challenges were also briefly introduced. Then, some new smart farm challenges were also highlighted, including the emergence of vertical gardens, the integration of blockchain into farming systems, and the deployment of the combination of machine learning and the airless system. Pilot in intelligent farming systems. Finally, the major limits of IoT in smart farms were highlighted.The security of connected objects is reflected and determined from the manufacturing process of connected objects. In light of these articles, it should be noted that the Internet of Things (IoT) (IoT) is now evolving at the pace of modernization of agriculture and archaic farming systems are gradually disappearing. In addition, the cybersecurity of connected objects is a major and current concern for the Internet of Things.

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