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ENGINEERING APPLICATION AND IMPLEMENTATION

INTERNET OF THINGS IMPLICATIONS FOR THE ADEQUATE DEVELOPMENT OF THE SMART AGRICULTURAL FARMING CONCEPTS

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ABSTRACT

It is essential to increase the productivity of agricultural and farming processes to improve yields and cost-effectiveness with innovated technologies such as the Internet of Things (IoT). In particular, IoT can make agricultural and farming industry processes more efficient through automation by reducing human intervention. The aim of this research paper is to prescribe recently developed IoT applications in the agriculture and farming industries to provide an overview of sensor data collections, technologies like embedded electronics, and sub-verticals such as water management and crop management. This article highlights the potential of wireless sensors and IoT in agriculture, as well as the challenges expected to be faced when integrating this technology with the traditional farming practices. This paper includes the description of systems with the electronic circuitry of the systems, used network protocols and smart distant monitoring systems for PCs and Smartphones, etc. Later it includes some propositions and finally, the paper concludes with describing the future scopes of relevant technologies in smart farming.

KEYWORDS

Internet of Things, agricultural, smart farming, business, sensor data, automation.

1. INTRODUCTION

Internet of Things (IoT) envisions everything in the physical world will be connected seamlessly and integrated securely through Internet infrastruc ture. When things react to environment or stimuli, data will be captured a nd transformed into valuable insights, which can be utilized in various ap plication domains, ranging from automated home appliances, smart grids and high-resolution assets, to product management. This newsletter port rays the need and strategy of enhancing the present stance of IoT by incor porating security and privacy into its design and implementation (Bacco, 2019).

2. STARTUPS OF INTERNET OF THINGS

"Internet of Things" was first coined by the co-founder and Executive Director of MIT's Auto-ID lab, Kevin Ashton in the mid-1990s1. Major vendors and technology leaders are announcing initiatives to leverage the Internet of Things' opportunities, and define IoT differently, according to each of their area of specialty. Nevertheless, there are salient attributes across array of definitions, such as sensors, things, people, process, automation, data, network, connectivity, convergence, and intelligence. Hence, Internet of Things can be defined as "Intelligent interactivity between human and things to exchange information & knowledge for new value creation" (Charania, 2019; Yoon, 2018; Baldovino, 2018).

2.1 Component of IoT

Characterizing IoT by referencing the number of connected devices or connection is oversimplifying the phenomenon. IoT is a complex eco-system encompassing all aspects of the Internet, including analytics, the cloud, application, security and much more. Technologically, connecting things to the Internet can be accomplished with the existence of three main technology components (Figure 1), namely physical devices and sensors (connected things), connection and infrastructure, and analytics and applications (Hu, 2019; Farooq, 2019; Adel, 2019).

1) Physical devices and sensors
2) Connection and infrastructure
3) Analytics and applications

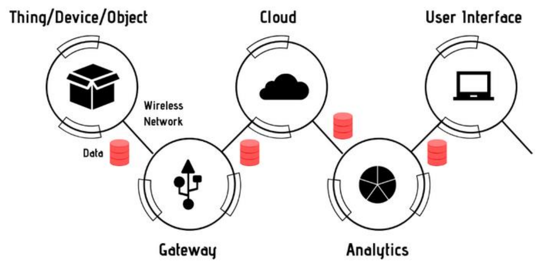

Figure 1: Components of the Internet of Things (Baldovino, 2018)

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The essential barrier that arises in traditional agribusiness is climate change. The number of effects of climate change includes heavy rainfall, most intense storm and heat waves, less rainfall etc. To boost the productivity and minimize the barrier in agriculture field there is need to use innovative technology and technique called Internet of things. The Internet of Things (IoT) refers to a network comprised of physical objects capable of gathering and sharing electronic information (Sulayman, 2018; Rosli, 2018). The leading desire of our project is to bring the convenient and effortless way to; in order to rescue the time of farmers manage any farming and any other crofting system we are constructing this type of project which will assist farmers to maintain their boisterous and extent gaining work. Our Project is beneficial for increase in agricultural production and for cost control and real time monitoring of farm.

3. Background of IoT Technology Trend in Agriculture

The Internet has evolved as in Figure 2 to become an ever more pervasive and critical infrastructure underpinning society and commerce around the globe. In 1990, with the creation of worldwide web (a method of publishing information on the Internet) by Tim Berners-Lee, Internet became the richest source of information, and since then the number of websites has exploded. Yesterday's Internet was a universe of interlinked human and creates new generations of interactive experiences. Internet usage had exploded since 2005 to reach the first billion users in 2015. The second billion was in 2010, and the third billion is expected to be reached by the end of 2020.

The next phase of the Internet will be IoT: a world of networked smart devices equipped with sensors, connected to the Internet, all sharing information.

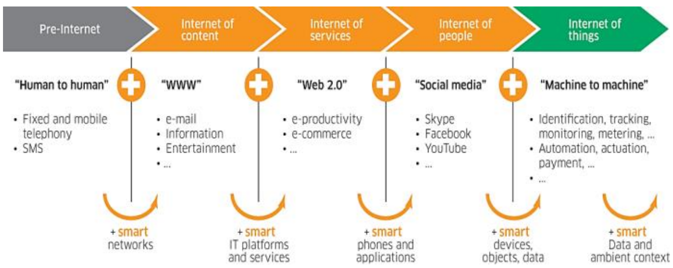

Figure 2: Internet of things evolution (Yuan, 2016)

Our project titled as IoT-Based Self-Operating Agronomics System. In other words, it is a Labor-saving system. The predominant quality of this product is that, it is based on application software. We easily instruct some gadget of our system through the smart phone application or also from software. And this application brings us many opportunities. We can also monitor the temperature, water level, presence of unknown source within the system can also be detected by sound sensor and humidity level from mobile and laptop screen via internet or some using Wi-Fi modules. Basically, this system also provides us many benefits like labor-saving, reduces the labor expense, less human mismanagement or errors, produce higher quality product at the end; in short, it is a well disciplined and managed system as compared to the manual system. At last, we reached and carried out all the policies that we were documented (Wang, 2018; Gabriel, 2018; Farooqui, 2018; Hakazawa, 2014; Shin, 2018).

3.1 Agriculture Transformed Automation

If you look backward over the history for the first indication of modernizing imported into the field of Agronomics, you will land at "A well-known machine introduced during this time was Eli Whitney's cotton gin", one of the first machines used in agriculture. Eli Whitney, born in Massachusetts, patented his cotton gin on March 14, 1794. This machine was able to quickly separate cottonseed from cotton fibers, creating up to fifty pounds of cleaned cotton a day, the equivalent of hundreds of man-hours. As the first major machine of the agricultural revolution, the cotton gin led the way to our modern agricultural machines (Navulur, 2017; Sarawi, 2017).

Figure 3: Smart farming (Sarawi, 2017)

3.1.1 Trends of IOT

Goals and Objective of this research is to bring the easy and effortless way to manage any farming and any other crofting system (Botta, 2016). These are the superiorities of our system;

- Boost efficiency in yields
- Minor individual mismanagement
- Lesser labor expense
- Turn up safety
- Regulatory compliance
- Monitor anywhere and anytime
- Availability of electricity through renewable energy resources

3.2 Functionalities of indigenous research

Analytics and applications transform sensor-generated information to a new and key source of knowledge for action-taking. They enable users to leverage the large amount of data gather, converge information for further analysis provides actionable insight for the enterprise for productivity enhancement, offer unique solutions, and enhance life experience (Papastergiou, 2017; Wan, 2019; Wang, 2019; Bettstetter, 1999; Zhen, 2009; Milella, 2019).

- Performing hazardous task
- Performing repetitive task
- Measuring temperature task
- Checking humidity task
- Wind power and solar energy
- Power house protection
- Water level sensor

3.3 Technological implementation

IoT-Based Self-Operating Agronomic System is the idea which is arrive from home automatization. In this project we are going to control small rural area through a simple smart phone application. By doing this we will able to limit the work of different farmers. By developing this software, we can lower the ratio of employs for work (Strobel, 2014; Zhu, 2019). We don't need hundreds of workers to do their work on time, we just need a computer expert who know what operation to be done or in what time and he will be able to do it by just app in his mobile (Kaewmard, 2015). There are also few automated features like when temperature and humidity exceed its limits then few operations should be done.

4. Data Collection

In this project we are using both software and hardware. Firstly, the user will enter any command on mobile application. This command will directly send to the Cayenne server, then Cayenne server send that specific command to the Wi-Fi module which is working within the rural area. Due to the use of Wi-Fi, we needed a fast and reliable wi-fi connection all the time. Because without this, this software will be useless, because it is a Wi-fi dependent software. This system also has some automated features in it. The first one is turning on the water pump automatically if the moisture level fell to lower limit and when the appropriate moisture attain then pump will automatically turn off. The appropriate working of sensors is also necessary because without it few commands will not run like wind fans and water pumps. After the delivery of command from server to Wi-Fi module, next the Wi-Fi module generate a specific command to relay, further next task will work when relay send message i.e. to start the water pumps.

5. Overall Architectural Design

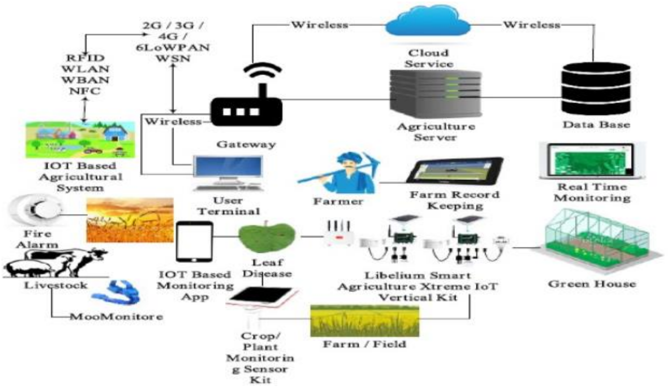

Figure 4: Smart farming trends (Li, 2019)

The policies adopted by different countries for the standardization of IoT based smart agriculture have been discussed. Also, some success stories of different countries in this area are presented. Lastly, the challenges and issues in IoT based agricultural technologies which can be improved have been discussed. shows smart farming trends. illustrates the major components of IoT based smart farming.

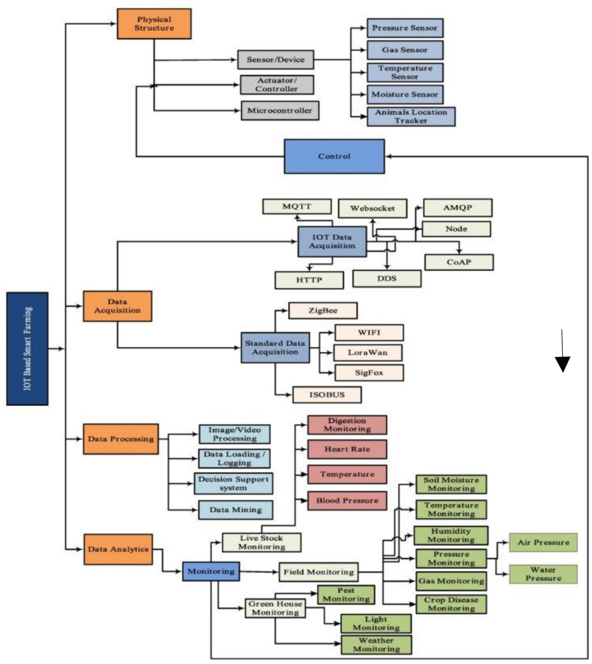

Figure 5: Major components for developing IoT based smart farming

5.1 *System Architecture, Software Architecture and Frameworks*

The detail is as under for software requirement:

- IoT-based Self-Operating Agronomic System App (Cayenne Application)
- Arduino ID

The detail is as under for hardware requirement:

- Four channel relay
- Jumper wires
- Soil moisture sensor
- Temperature sensor (DHT-11)
- WeMos (ESP8266)
- Sound sensor module
- Water level sensor
- Heating bulbs
- Cooling Fans

5.2 *Components involved*

5.2.1 *ESP8266 (WeMos D1 R1)*

Node MCU (Node Micro Controller Unit) and WeMos D1 are an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266.

Figure 6: WeMos D1 & R1

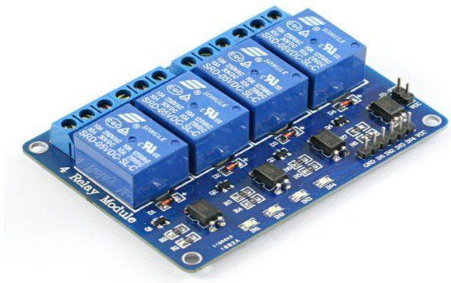

Figure 7: Channel Relay

5.3 Channel Relay

A relay is defined as an electrically operated switch; their main use is cont rolling circuits by a low-power signal or when several circuits must be co ntrolled by one signal. The Arduino relay module is designed for a wide ra nge for micro controllers such as the Arduino board or Node MCU.

5.4 Humidity Sensor

The sensor we are using here is DHT-11. This humidity sensor (or hygrometer) senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.

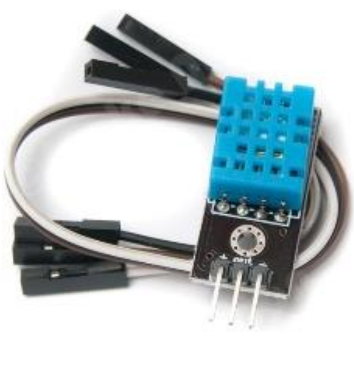

Figure 8: DHT-II

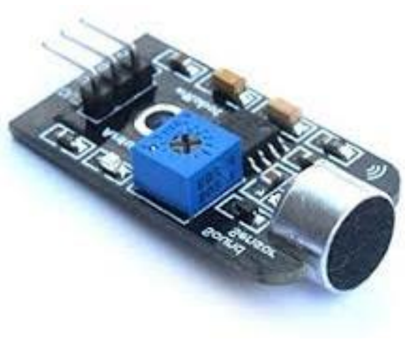

Figure 9: Sound Sensor

5.5 Arduino Compatible Mini Sound Sensor

This sensor will detect any sound nearby, On the top of the sound sensor is a little flathead screw you can turn to adjust the sensitivity and analog output of the sound sensor.

5.6 Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. In this system we are using soil-moisture sensor to determine the quality of the soil, whether it is good for crops or not etc. It also senses the water content of the soil.

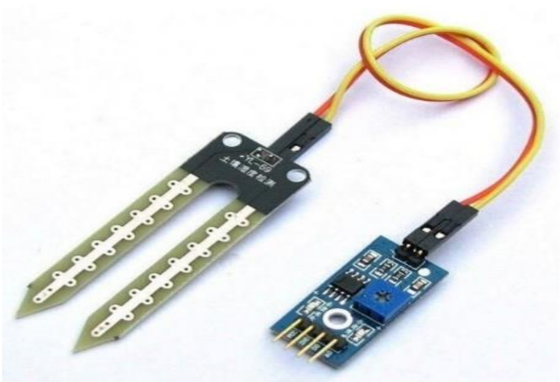

Figure 10: Moisture Sensor

Figure 11: Water level sensor

5.7 Water Level Sensor

Water level sensor used to detect the level of any liquid flow Level measurements can be done inside containers or it can be the level of a river or lake. Such measurements can be used to determine the amount of materials within a closed container or the flow of water in open channels.

5.8 Designing of System

Designing of project is not complicated, you can easily understand it. First the command will be sent from the application software, that command will send to the server, then server will that specific command back to wi-fi module which is being setup at the power house. In Node MCU, the temperature and humidity are also monitored, then further the command will move towards relay and, then relay will decide to on or off the happening operations. If temperature will exceed it limit, then fans will start automatically. And if humidity level declines below limit, then water pumps will start automatically.

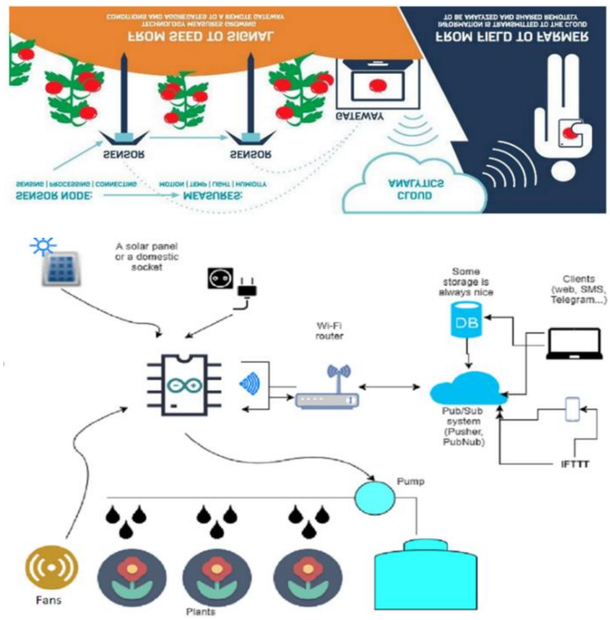

Figure 12: Overall Design of System

6. Implementation

After the construction or developing of all phase next phase is to attach all these phases. At first, connect the Arduino IDE to the smart phone application (Cayenne), and the next step is to connect the Wi-fi module to the soil moisture sensor, sound sensor, water level sensor, temperature sensor and relay, then further the relay will connect to the different parts of the smart village. Each node on relay will be specified for one command which can further divided into different commands like colling fans, lights, water pumps and housing society.

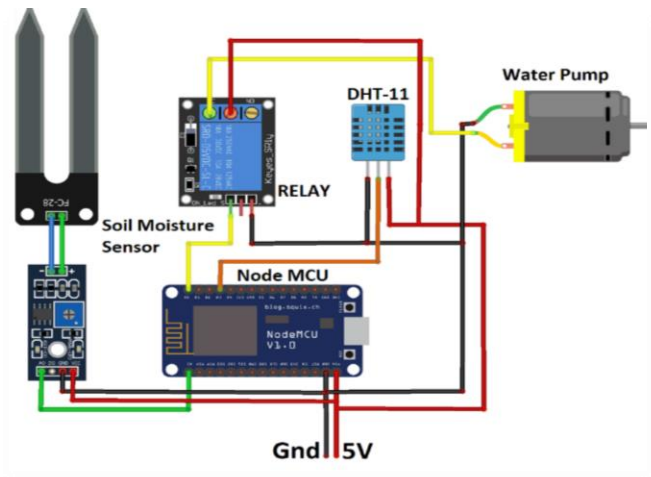

Figure 13: Circuit Diagram of System

7. Project Deliverables

1) Following are the achievements which are achieved:
2) User will be able to generate multiple commands at a time.
3) There is no specification any computer expert will be able to handle this soft ware from his PC.
4) Fast and accurate functioning is possible.
5) Whole area can be handled by application software.
6) By this software we will be control different portions of an area like green house and fields, from monetary room.
7) If any problem occurs in any part of area, we will be able to find it wi thin seconds, that where error happened.
8) A user-friendly environment will be possible for the user.
9) This system will help the farmers a lot.

8. Benefits, Challenges and Future Scopes

8.1 Benefits

The benefits of smart farming are given below (Nakazawa, 2014). Smart agriculture concept empowers cautious management of the demand forecast and release of products to the market without delay to diminish waste. Smart agriculture is centered on the correct developing parameters and for instance, fertilizer, moisture or material substance to ensure better production of the correct harvest that is in demand. The smart agriculture frameworks actually rely upon the utilization of a programmed system for the management of the business. Control framework manages sensor input, delivering remote data for supply and decision making, in addition to the mechanization of equipment and devices for responding to different issues and crop production support. Adequate management of cost and reduction of waste lead to expanded control over crop production. Having the option to perceive any oddities in crop growth, one will have the option to minimize the risks of losing yield. Increased business efficiency by incorporating automated system. By using smart devices, you can automate multiple processes across the production cycle, e.g. irrigation, fertilizing, or pest control. Benefitted countries and their success stories in agriculture by adopting smart farming:

8.2 USA

USA has invested millions of dollars to create new farming technologies to satisfy the requirements of food. National Institute of Food and Agriculture is engaged in a project on Internet-of-Ag-Things and development sensing technologies to facilitate smart agriculture concept. The significant motivation behind this task is to create accurate technologies to improve the productivity of agro-industrial (Shin, 2018). The USDA (U.S. Department of Agriculture) has initiated a venture to address water management difficulties and introduce a new solution for those issues which are influencing agriculture. Technical specialists are using USDA datasets to enhance agricultural services (Navulur, 2017).

8.3 China

China has declared its 13th five years plan in 2016 in which China integrated IoT in agri-sector to enhance agricultural productivity. The project regarding agricultural advancement has been initiated in eight provinces of the country, with multiple products, sophisticated technologies, and around 426 applications. Farming data was gathered from provincial and national level data centers. Moreover, NB-IoT technology designed by Huawei Corporation in China developing and enhancing agriculture in a more innovative way. The NB-IoT assists with cost-effective agricultural solutions as compared to the cellular networks where gateway implementation is not necessary. Huawei NB-IoT conceives a large pool of connections and a wide range of coverage due to which it can resolve the issue of scattered agricultural data (Sarawi, 2017).

8.4 Malaysia

Agricultural policies in Malaysia were built up in two-time frames, the policy before independence (1948- 1957) and after independence (1957-2020) (Botta, 2016). The reason for adopting the policies was to ensure the superior improvement of farming and diminishing poverty. Various solutions have been introduced by MIMOS (Malaysian Institute of Microelectronic System) which are highly suitable for the improvement of farming. A sensor named Mi-MSCANT PH has been designed by MIMOS to gather ecological information.

8.5 France

Ministry of Agriculture of Government of France has become a leading partner of the Agriculture Innovation Project' 2025. The core concept of this project is the superior enhancement of farming land, observing the atmospheric conditions and build up incubators to strengthen the agriculture of France. The MoA (Ministry of Agriculture) additionally share the gathered information with farmer's to introduce new solutions in the field of Agriculture (Papastergiou, 2019). French Agri-sector is administrated by the EU (European Union) supported through a framework known as CAP (Common Agriculture Policy). Another CAP policy was declared in 2015 at the European Union level for the next 5 years which is gainful for various agro-biology ventures for farming.

9. Challenges

There are few challenges that can be concerning for the IoT based smart Agri-system or farming system. The challenges are described below: Implementation –Implementation of this micro-electronics based smart farming system over a larger farming field can be a challenging issue. Maintenance –If the farming field is larger in area than the maintenance of the IoT based farming system can be challenging as they are based on micro-circuits. Environmental condition –Extremely sunny conditions or heavy rainfall can cause damage to the electronic circuits used in smart farming. Connectivity –As the system is wireless sensor network-based if a wireless sensor node failed to communicate with the central node than the sensor data of the corresponding node will not be available to the central node. Thus, the sensor data of the corresponding area covered by that sensor node will not be available to the user.

10. Conclusion

All over the globe researchers are exploring technological solutions to enhance agricultural productivity in a way that complements existing services by deploying IoT technology. To facilitate the growth of agricultural productivity, this article has introduced a smart agri-system or farming system based on embedded electronics, IoT and wireless sensor networks. This article earlier provided an overview of ongoing research on smart agriculture and discussed possibilities of smart farming through literature review. Afterward introduced the prescribed smart farming system by describing the system architecture including core components of the system, communication protocols used by the communication modules present at the system to utilize the features of IoT, also described the functional framework of the system architecture. Furthermore, the article provided the detailed framework of the prescribed IoT based smart farming system, included circuit diagrams of the embedded system, described the working principle and functionality of the prescribed system with the necessary description of all vital elements. Finally focused on the benefits that can be obtained by implementing the smart farming system, described some challenges that can emerge against the smart farming system and also introduced some notable points describing the further scope of development and enhancement of the system. The smart farming nowadays one of the prime R&D (Research and development) issues of the world as agriculture is one of the vital pillars of the human race.

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