IoT in Agriculture: A Smart Forming in Apartment Building at Sultanate of Oman

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The world strives to exploit the fourth revolution in technology, including the great developments such as the Internet of Things (IoT) to improve life. IoT technology is used in many areas of life from industry health and environment to personal life. Agriculture is, therefore, one of the key sectors of life that have benefited from modern technology such as the use of drones for crop assessment, irrigation, monitoring and mapping, big data in crop analysis for companies and countries. The Internet of Things was not far off as it was introduced to monitor plant irrigation. Increased awareness of the environment and the exploitation of small and semi-enclosed areas in agriculture and turning them into green areas. The IoT technology converts this process into intelligent and dynamic based on wireless sensing with the help of the device programmed by the Arduino. This data is collected in Power BI what to help in the future development of the device and analysis of the data. The device senses soil moisture and temperature and connects it to its cloud platform for optimal management of future planting. The device senses soil moisture and temperature and connects it to its cloud power BI platform for optimal management of future planting. This technology helps reduce agricultural costs and labor. Therefore, this paper proposes an intelligent system with the help of the Internet of Things in the management of smart farming in apartment building with the help of Arduino.

I. INTRODUCTION

The effects of climate change diminish the ability of natural resources with the huge demand for food for the world's population increasing, food security and climate change are a challenge that is a major problem and must be addressed. (FAO, 2019). As the population grew and lived in small places like apartments, dozens of primitive inventions were invented to use technology. Consequently, to cope with the increase in these populations, world food production has increased by 70%, yet the world suffers from a lack of food as shown in Figure 1 the world agriculture (learner.org, 2016).

Due to the lack of agricultural land, the world suffers from a shortage of food products. In the fact the numbers say, the decline in agricultural land in 2013 was over 10 million square miles. This is about 37% of the land area (WorldBank, 2016).

In order to exploit small spaces and residential areas such as apartments to the possibility of using smart technology to increase production and provide individuals the opportunity to invest small areas in apartments for the production of agricultural products. Smart agriculture is one of the solutions by applying ICT in wireless agriculture.

Smart agriculture relies on advanced technology such as computing, remote sensing, big data analytics and the Internet of Things (Zhang et al, 2002). Traditionally, crop and harvest operations are carried out following a predetermined schedule. But the process of measuring soil moisture and watering plants is done through the Internet of Things. The management system relies on monitoring, measuring and responding to agricultural changes in various aspects. The control of

small areas of agriculture is simple using the Internet of Things.

First of all, the Internet of Things provides the infrastructure for sensors to communicate with each other and to the Internet. This provides the simplest solution for collecting, collecting and sharing data with the IoT platform for management. Second, the second foundation, the Internet where data processing, decision-making and decision-making without human intervention. Together they represent a network of connected devices that recognize the environment in which they are placed. These devices continually transfer data to the database for analysis. Decision making by the IoT environment helps users access data and information stored and make decisions and perceptions based on the analyzed data. Farming in apartments is not only an aesthetic appearance but also changes the psychology of the human being and the exploitation of narrow spaces for the benefit of production.

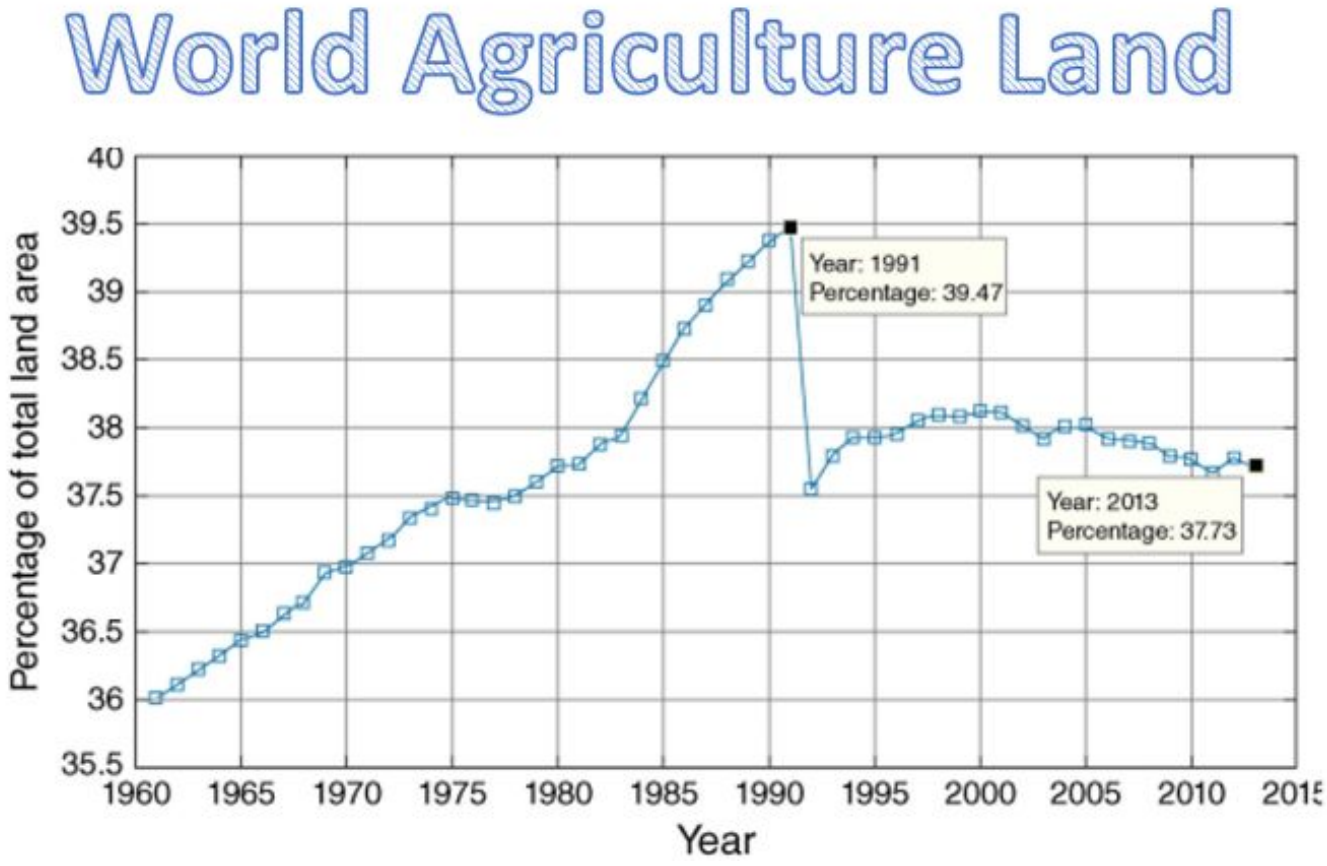

Figure 1. *World Agriculture from 1960 -2015*

II. LITRATURE REVIEW

Oman is trying to increase agricultural production despite water problems and lack of agricultural land because it represents the food basket for the GCC countries. In 2008 there was a marked reduction in crop consumption due to the global food crisis. The climate is dry to semi-tropical in the south where the climate in Dhofar is characterized by low temperatures in summer.

However, what is happening is putting additional pressure on the environment, agricultural land, water and other resources that are already affected. Many solutions in smart agriculture can be combined and expanded, and small-scale investment in housing, energy and water resources can be improved efficiently. Because the Sultanate resort to desalination of sea water to water scarcity in general.

Smart Farming Platform by authors Jayaraman and his group of authors present to him that the IoT platform can collect and correlate data such as the surrounding environment, fertilizers, soil and irrigation and evaluate its performance. Most importantly, IoT devices can be integrated into this platform as sensors, cameras and weather stations. And save data in the cloud for analysis of performance (Jayaraman et al, 2016).

Referring to several books of MDPI a leading company in the field of open scientific publishing Developed research on the agricultural application of IoT technology for real-time monitoring of moisture and citrus nutrients, as well as analysis of this mix of fertilizer and irrigation support systems (Zhang et al, 2017).

Another group of researchers looking for intelligent management of freshwater for planting irrigation to increase crops, reduce water costs and thus sustain the environment. IoT is the best choice management for smart water management. The SWAMP project is based on 4 pilots from Brazil and Europe. Weaknesses in the project is high cost (Kamienski et al, 2019).

Other researchers reported the possibility of using wireless sensor networks in agriculture and providing farmers with a huge amount of data and information. Precision agriculture is a term that uses an administrative strategy that uses information technology to improve production and quality and efficiency. Most wireless sensor networks suffer from high energy consumption (Jawad et al, 2017).

This microcontroller is integrated like Arduino UNO board. The receiver receives the data from the sensor connections, then sends it to the IoT platform and data store, and provides a user interface for monitoring it, where it is programmed by the user. With reference to this, Arduino Uno is an open source platform-independent hardware and software that is used as a small controller. In terms of collecting data from sensors, analyzing it and sending it to the database via Bluetooth (Sandeep et al, 2018).

Researchers focus on establishing an intelligent farm system using a low-power Bluetooth connection unit and a low-power LPWAN network including wired connections. In addition, monitoring and control system which is dedicated Telemetry Transport protocol for the Internet of things (Chiyurl et al, 2018).

III. IoT ARCHITECTURE FOR AGRICULTURE

The building blocks of the Internet of Things in agriculture in apartments are no different from the rest of the sectors as shown in figure 2. The basis is one but the difference in how classes are employed. It represents a vision of a set of technologies, systems and design principles linking things, based on the physical environment, all of which is done online. With the increasing communication between machines, a new class of applications has emerged modern technology requires a change in infrastructure to fit the Internet of Things. This architecture is not designed to support communication between sensors and devices via local or global Internet.

Perception layer: The perception layer is similar to the physical layer in the Open Systems Interconnection (OSI) model which consists of different types of sensors. It includes devices responsibility to collated data and acting accordingly, such as temperature, humidity, energy consumption and connectivity. The Arduino platform is an open-source platform that is easy to program. They are connected to sensors for analysis.

Network Layer: The second layer of infrastructure because its technologies transform traditional sensors in the perception layer into intelligent and connected devices. The network layer allows you to select nodes over the Internet or any local area with the help of the Arduino board. Many devices use many networking technologies. In addition, data transfer is an important and sensitive process

because hacking and accessing the site is something no one wants. The use of highly secure communications is therefore important.

WiFi: Particularly useful in case of future data collection and analysis. It is characterized by its high energy consumption. But it's not a problem for many users, especially in homes that are permanently connected to the network.

Bluetooth Low Energy: Wireless standard to share data over short distances and create personalized area networks. Bluetooth technology is one of the most affordable and available technologies that do not require high power consumption. They are widely used in agriculture because they do not require immediate human decisions.

Middleware Layers: The heart of the IoT environment is service management in technology management. The management is either through software or phone applications, but most of them resort to IoT platforms because they are easier, flexible management and efficient. This layer helps programmers as well as skilled users to identify and program services based on hardware settings, even if these devices differ. Both networks interact with sensors in a complex way. The link between these layers is the common platform between the sensors and the user.

Application Layer: A layer that provides help to IoT users via a programmed interface by adjusting the required settings such as humidity, temperature and also infrared. Works in any device, whether the smart watch down to the desktop computers. Also, through applications in the web or mobile. Applications provide a visual view of all the data that has been made via sensors. This layer represents the greatest threat to users in terms of being targeted by attackers, so security in this layer is very important. However, the proliferation of applications means the proliferation of IoT demand in all walks of life.

Business Layer: This layer is quite different from the application layer, can access the Internet of Things and data environment, for example, graphs, business models in addition to diagrams. This layer does not allow unauthorized users to access data. This access helps users to design, analyze, implement, evaluate, monitor, and develop IoT systems. The main reason is that they contain sensitive data that affects user privacy as well as user outputs as well as user location on maps if maps are enabled. This layer is divided into two categories based on its functions (Semantics and Big Data Analytics).

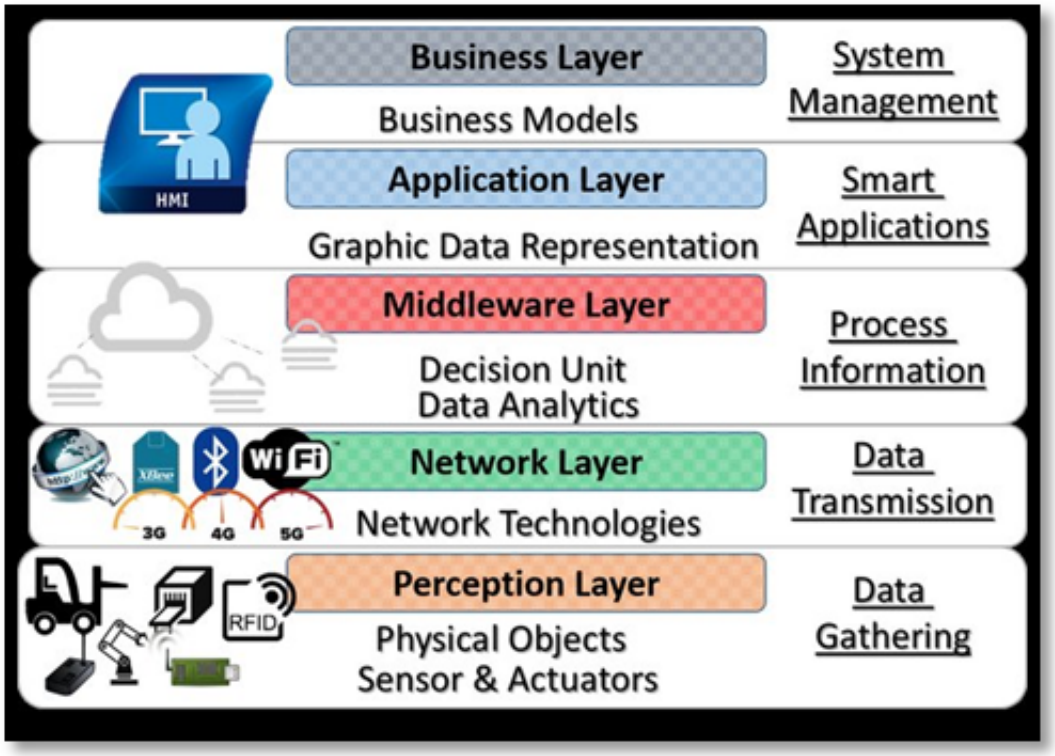

Figure 2. *IoT Architecture for Agriculture*

IV. INTERNET OF THINGS BASED AGRICULTURE

The huge development of the Internet of Things has contributed to its introduction in the agricultural sector because it is one of the vital sectors in life. The Internet of Things (IoT) works efficiently to rationalize and accelerate irrigation and agricultural production to suit the growing demand. This category of agricultural sector in the Internet of Things has been divided into three main divisions: data collection, decision-making through data analysis, and finally decision-making with the help of the Internet of Things.

Data Collection: The purpose of data collection is to obtain soil condition, irrigation, fertilization for subsequent operations and future plans and avoid errors. Through virtual multifunction devices equipped with remote sensing systems. Various sensors have been developed to measure humidity, temperature, etc. as needed. All data will be fed into the Geographic Information System (GIS) in order to create a crop index analysis.

Decision-Making by Data Analysis: IoT applications are designed to use data from connected devices, and the advanced tools available in the cloud allow you to see, explore, and build complex analytics. For complex IoT applications that use multiple devices, it is important to understand the status of the devices and frequently communicate with the application components that benefit from these devices. It is also necessary to ensure secure identity and access between devices and applications. As with any technology revolution, the IoT also faces challenges. With more devices connected to the Internet, the amount of data generated is huge. This puts great pressure on the Internet and creates a need for infrastructure that can transfer and store this data more efficiently. As the number of connected devices continues to grow, there is a drive to create "smart" devices smart enough to do some processing and send results to servers rather than sending huge amounts of data to central servers for processing.

IoT Application in Agriculture: IoT technologies can play key roles in the application of agriculture. IoT not only provides communications infrastructure to connect every smart object

from the sensor or mobile user device over the Internet, but also This data is obtained either remotely through IoT or local platforms. This data is analyzed in a smart way through algorithms. This leads to appropriate decisions. In addition, access to this information, user interface, and process automation Agricultural.

V. EXPERIMENTAL PROCEDURES

In the experimental section, it consists of two main sections: Hardware and Software. Various sensors are deployed in this area such as temperature and humidity sensor. Collected of data by these sensors are connected to Arduino UNO. In the Control section, will be received the data and verified using threshold values. If the humidity level is low, Arduino sends a message to the user via the IoT platform as shown in Figure 3 for block diagram for Arduino. Plant growth is monitored by the IoT platform and analysis is carried out by means of the Power BI.

In the Control section, after it received the data they will be verified using threshold values. If the data exceeds the threshold value, the bell is triggered and the lamp starts to blink. This alert is sent as a message to the user via the platform and the power is turned off automatically after sensing. Then, the values are created in the web- page and the user gets a detailed description of the values. In the Arduino board there are two categories either manual mode or automatic mode which is preferred in the case of apartments because the user is not always available.

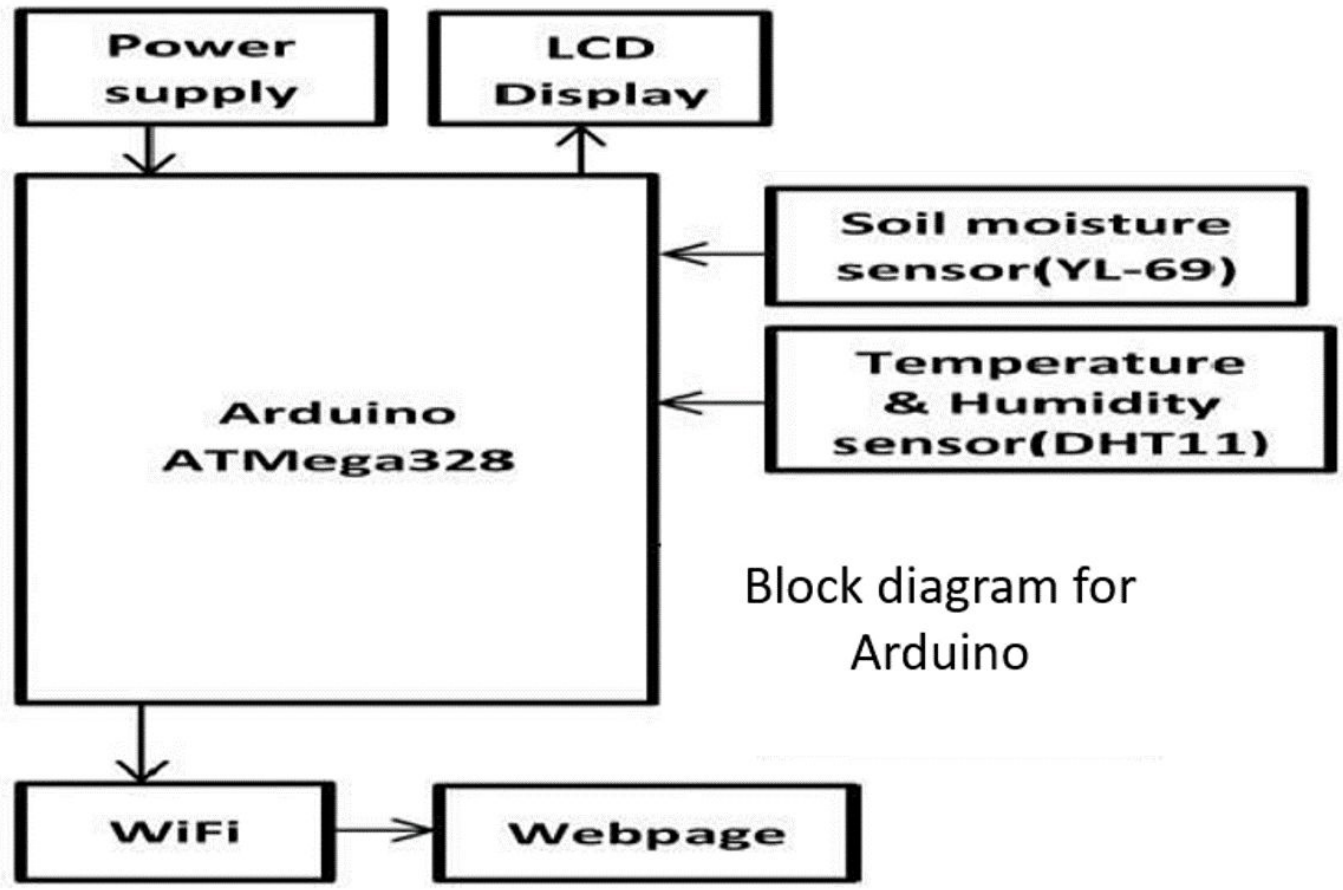

Figure 3. *Block diagram for Arduino.*

Hardware Section:

Arduino Uno

It is a device and software at the same time. Designed for interactive and easy-to-programmable environments because its programming is comparable to Java programming. The device is open source and easy to program The Arduino Uno panel is controlled by many components such as USB input, 16 MHz ceramic resonator and also a power socket and there is a button for resetting to the original position. UNO can be programmed using Arduino software.

Soil Moisture Sensor

One of the parameters of agriculture is soil moisture. We must measure soil moisture to ensure plant growth well. In fact, when we say the humidity sensor is not the humidity of the atmosphere, but in agriculture it is concerned with soil moisture. It consists of two heads of pins to read the value of moisture to see if it is above the threshold.

DHT22 Sensor

Maintaining temperature and humidity within certain values also maintains crop health. To monitor the temperature and humidity, we can use DHT22. The capacitive humidity sensor and thermistor are used to measure ambient air. Also, cost-effective and provides low power consumption.

PIR Sensor

All organisms whose temperature is higher than absolute zero emit heat energy in the form of radiation. It represents a device such as a human eye or a monitor as it detects infrared waves of different lengths. It detects heat-emitting objects such as animals or harmful insects

Software Section:

Power BI

Rapidly gaining popularity among data science professionals as a cloud-based service that helps them easily visualize and share ideas with other users. Power BI connects to a range of data sources, from basic Excel spreadsheets to databases, cloud-based and cloud applications. Power BI is built on the basis of Microsoft Excel, so the learning curve from Excel to Power BI is not that steep; anyone who can use Excel can use Power BI, but the latter is much stronger than its spreadsheet counterpart. Microsoft Power BI is used to run reports and superficial insights based on user data. Power BI can connect to a wide range of data sets, and "arrange" the information it feeds so that it can be better digested and understood. Reports and visual images resulting from this data can then be shared with other users. Power BI helps users see not only what happened in the past and what is happening today, but also what may happen in the future. Power BI is awash with machine learning capabilities, which means that patterns in data can be identified and used to make informed predictions and run “what-if” scenarios. These estimates allow users to create forecasts and prepare themselves to meet future demand and other key metrics.

ThingSpeak

IoT Cloud platform where you can send sensor data to the cloud. ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from objects using HTTP and MQTT over the Internet or over a local network. ThingSpeak allows all inexperienced users or engineers to perform prototypes and IoT systems without creating servers or developing web applications.

VI. RESULTS AND DISCUSSION

The proposed system consists as shown in Fig 4 IoT Agriculture Project. After the plants are watering and the sensor starts reading soil moisture level data to determine the level of soil dryness. This data is then sent to the ThingSpeak platform. In addition, temperature and infrared waves sensor. If there is live objects detected by infrared waves it will send a danger message directly to the user. Whenever the value changed from the value that has been programmed sends a message to the platform it programming was done to record soil moisture readings every two hours. The user is programming his own humidity setting based on the climate in which he lives and the type of agriculture he performs. This helps the user to change plants depending on the season and weather and follow the plant growth and irrigation.

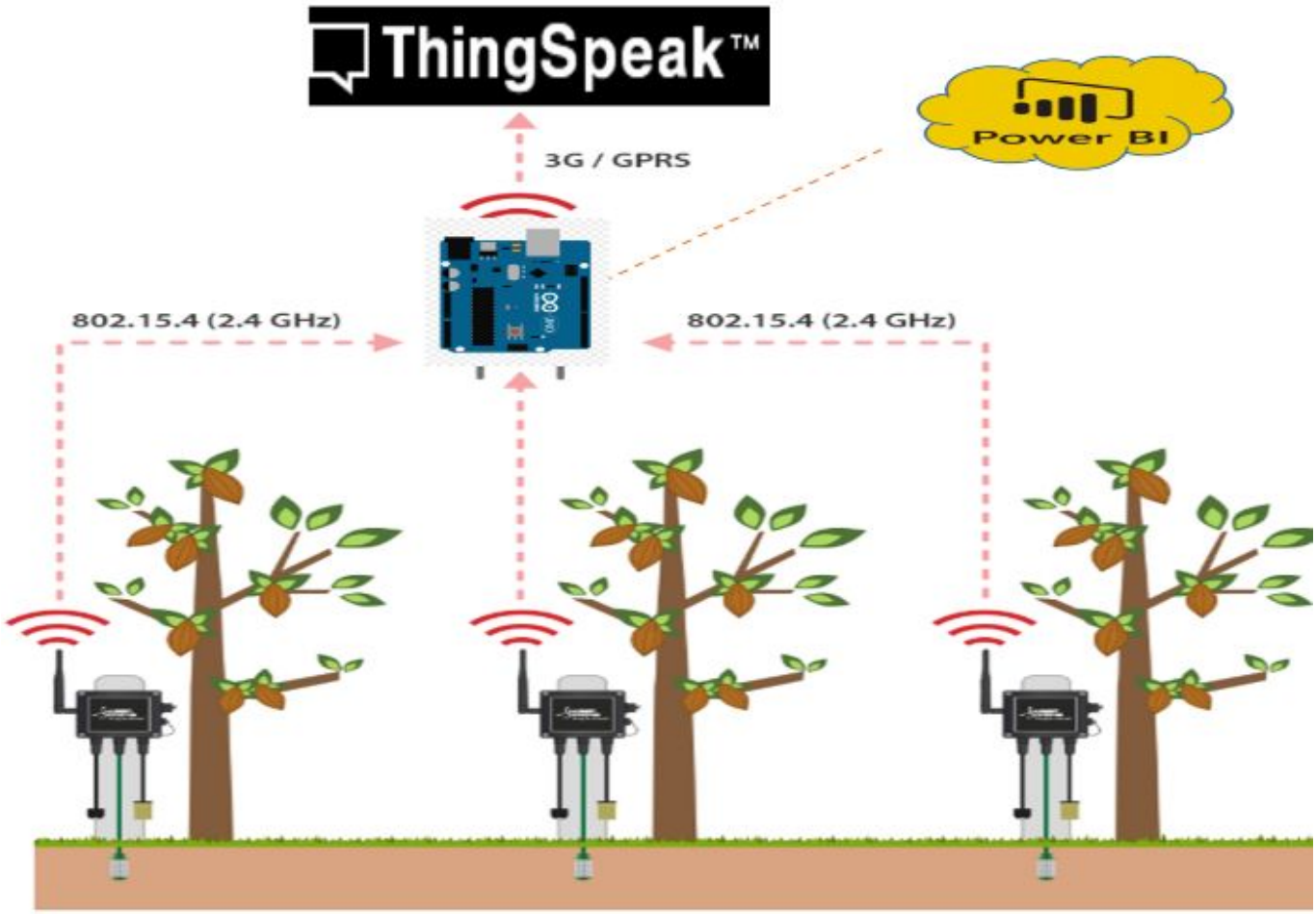

Figure 4. *IoT Agriculture Project.*

VII. CONCLUSION

Fortunately, the development of technologies, especially the IoT and agriculture mix, paves the way for reaching the goal. Man is now on the threshold of the Green Revolution and solving the world's food problems. The Internet of Things (IoT) is the future for decades to come and help develop the smart world where everything is connected to a single network. Since security is always a big problem in every system. The proposed research work provides an existing farming solution in the apartments via the Internet of Things. Due to the use of IoT devices, the system will provide an automatic solution for obtaining data from sensors. The proposed system is simple, cost-effective and measures different environmental conditions. It includes measuring the temperature and

humidity of the soil and infrared waves.

In the future a remote-operated water pump sensor can be added, thereby reducing human effort. Also, IoT with the cloud helps improve water consumption and work more efficiently. Data accuracy can also be improved through payment platforms and integrated with the cloud computing environment. Using this data, plants that do not grow in a hot and semi-desert environment can be grown and controlled in the way they grow. Using this data can be shared with experts who use big data and be part with many users, analyze it and make use of it.

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