A Survey on Smart Agricultural System using IoT

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***Abstract*—In this paper, introduction on Internet of Things (IoT), application of IoT in agricultural field to improve the yield and quality by reducing the cost is provided. The sensors which are used in the architecture are discussed briefly and the process of transmission of data from the agriculture field to the central system is explained. The proposed system advantages are included. In addition, open research issues, challenges, and future of IoT in agricultural field are highlighted.**

Keywords—Agriculture; IoT; Cloud Computing; Arduino;

I. INTRODUCTION

The food and agricultural arm of the United Nations predicted that the worldwide food production should see a 70% increase by 2050 to feed the growing population. And the experts believe that IoT plays a crucial role in fulfilling this need [1].

The concept is basically developed on an idea, where there are numerous things or objects - such as Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile phones, etc., that are connected with the Internet. Each of the objects has a different address and is able to interact with other items. The things or objects co-operate with each other to reach a common goal [2].

IoT and Image processing are used to obtain the quality production by controlling the factors such as soil pH, Soil moisture, temperature, humidity and greenhouse in the field of agriculture. IoT can be used to provide the best irrigation facility to the field. While harvesting, IoT can be used to provide automatic packing system for better tracking system of the goods delivered. IoT technology is used to observe the temperature and pressure of the package while transporting from one place to another, also can be used to get the updates from retail and wholesale stores about the consumption of product to farmer. The analytics of the product can guide the farmer that which crop can give the optimal price at what time of the year [3-5].

The architecture of IOT is normally divided into three parts: sensors interfacing layer, transmission layer and application layer [6]. The sensor layer is mainly composed of all kinds of sensors or sensor entry such as temperature sensors, humidity sensors and Carbon Dioxide density sensors. The sensor layer functions just like nerve endings in human bodies, recognizing and collecting information [7]. Continuous monitoring and data collection by the devices demands large amount of power. Fulfilling the above demand is a serious challenge for the low energy battery powered nodes [6]. The transmission layer consists of different building structures of networks or platforms, including private networks, the Internet and cloud computing platforms [7]. Among these issues the most important one is security and privacy which needs serious attention. Public will keep ignoring the benefits of IoT till there is a public consensus on the protection of privacy of information collected by the smart devices constituting the IoT framework [6].

The application layer presents flexible interfaces between users and the system at the level of miscellaneous industry requirements [7]. Use of android in IoT framework naturally carries forward all anomalies and security flaws like viruses, malwares etc. associated with Android into the IoT domain [6].

The remaining part of this paper describes as follows. Session II discuss few applications of IoT. Session III presents the typical block diagram of system. The major challenges of IoT are discussed in Session IV. Finally, the paper concludes with a summary of work and a statement of future work is presented in Session V.

II APPLICATIONS OF IoT IN DAY TO DAY LIFE

A. Smart Homes

Smart home involves the monitoring and control of lights, temperature, fire, and security through controlling CCTV, stove, ovens, refrigerators, freezers etc.

B. Smart Parking System

Smart parking system tracks the arrival and departure of various vehicles in the city. It can be used to estimate the number of cars in the city. It can also be used to increase or to reduce the parking places by monitoring the parking availability for the vehicles [8].

C. Smart Traffic

Smart traffic system helps greatly to citizens and the government in choosing the less traffic route to reach the destination with in time conveniently.

D. Smart Environmental Pollution System

Smart environmental pollution system monitors the pollution status of the desired places and updates into cloud. This alerts the citizen suffering from health problems from entering into the polluted places.

E. Intelligent Health Management (Mhealth Or Ehealth)

Now days, the cliche of global aging and chronic diseases is becoming a regular phenomenon. To deal with the situation, many developed countries are focusing on reducing hospital beds and in contrast, they are building up intelligent home health-care systems. These kinds of systems are the combination of Hospital-centric services and Home-centric environments. Implementation of the systems by developing practical and advanced health related technologies by exploiting IoT is becoming a burning research issue [2].

F. Workplace Safety Enhancement

In developing countries like Bangladesh, Vietnam, India, etc., work safety is often ignored to save capital and more investment in production. Although the governments impose strict laws to prohibit disasters and accidents in workplaces, it is a very common practice of the industry authorities to bypass the restrictions with the help of corrupted officials. So, the situation asks for a solution that should be cost effective, easy to use and well-integrated. A well organized workplace monitoring system can ensure reliable and corruption mitigation procedures for meeting the safety standards in industry [2].

G. Smart Banking

Payments as an area have a huge scope for implementing IoT applications for banks. For instance, imagine a scenario where all household devices are connected with Internet of things. So a customer's cold storage box can sense how much milk is there inside and if any shortage of milk would order a packet of milk from nearby milk booth. Banks can utilize his contingency to help in the payment process. A bank app can be made available to the customer for his payments and they can imbibe loyalty programs in the app to collect data which can be utilized for marketing and customer service purpose.

H. Smart Irrigation and Agriculture

By implementing smart irrigation system water facility for the fields can be improved. So that loss of water can be reduced. With smart agriculture the yield of the crop can be made higher.

III. ARCHITECTURAL DETAILS

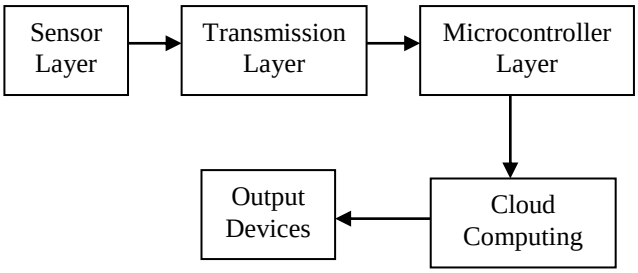

Fig. 1. Block Diagram of IoT based System.

The figure 1 shows the block diagram of the IoT based system where the required data of agricultural field like soil moisture, temperature, humidity, light, pH is collected by the sensors and is transmitted wirelessly to a microcontroller or any decision making device then the data stored into cloud for further computing and even for the analytics, and as the data is stored on cloud it can be accessed anytime, anywhere from cloud the data being transmitted to output devices like mobile phone, motors for required operation.

A. The Sensor Layer

1. Radio Frequency Identification (Rfid)

Fig. 2. RFID Tag.

RFID systems are composed of one or more RFID reader(s) and several RFID tags. Figure 2 shows the RFID Tag that is characterized by unique identifiers and is attached with objects/things. Readers generate transmission to the tags by generating a proper signal, which represents a doubt meant for the possible presence of tags in the surrounding and for the reception of their IDs. There are two types of RFID tags, the active RFID tags and the passive tags. Active RFID tags are battery powered while the passive ones derive power from the query signal sent to them by the RFID reader [6].

2. Temperature Sensor

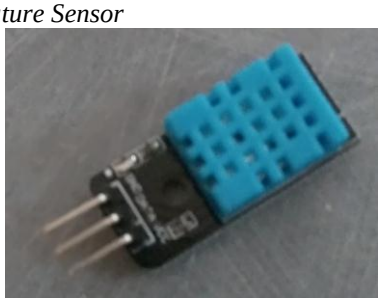

Fig. 3. DHT 11 Sensor

Figure 3 shows DHT11 digital sensor, which reads the temperature of the field connecting to a microcontroller. Sends this temperature to central unit, where processing of all the sensors data can be done.

Table 1. Temperature Sensors

Manufacturer	Sensor number	Output	Range
Texas Instruments	LM35	Analog	-55 to +150°C
Texas Instruments	LM73	Digital	-40 to +150 °C
Texas Instruments	LMT85	Analog	-50 to +150 °C
Texas Instruments	TMP101	Digital	-55 to +125 °C
D-Robotics	DHT11	Digital	0-50 °C

3. Humidity Sensor

The figure 3 shows the humidity sensor which senses humidity of the field and sends the digital data to microcontroller. This data will get transmits to the central unit for the further processing.

Table 2. Humidity Sensors

Manufacturer	Sensor number	Output	Range
Texas Instruments	HDC1080	Digital	0 - 100%RH
Texas Instruments	HDC1010	Digital	0 - 100%RH
D-Robotics	DHT11	Digital	20-90%RH

4. Moisture Sensor

Measuring soil moisture is important for agricultural applications to help farmers in managing their irrigation systems more efficiently. Generally, farmers are not only able to use less water to grow crops but also able to increase yields if they knows the exact soil moisture conditions. By this quality of the crop can also be improved.

5. Ph Level Sensor

The pH level of the water is an important parameter in the production of the crop. A sensor can be used to get the pH level, so that the farmer can be alerted when there is an abnormal pH level occurs.

6. Light Sensor

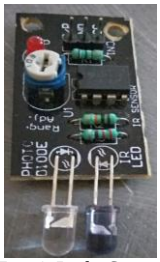

Fig. 4. Light Sensor

Figure 4 shows the IR sensor used to detect the light intensity. This helps the farmer to give appropriate decision when there is an abnormal light intensity occurs.

7. Water Level Sensor

Fig. 5. Ultrasonic Sensor

Figure 5 shows the Ultrasonic Sensor can be used to obtain the water level of the tank, sump or well.

8. Digital Camera

Condition of crop can be observed and detected by Digital camera, so that required pesticides can be used for the field. Digital image processing makes use of various computer algorithms to perform image processing on digital images. It is widely used for classification, pattern recognition, feature extraction, multi-scale signal analysis and projection [3].

B TRANSMISSION LAYER

Figure 6 shows ZigBee wireless sensor nodes can collect soil moisture, nitrogen concentration, pH value, precipitation, temperature, air humidity and CO_2 concentration. After collecting, it is delivered to the central device by wireless sensor network for the user to make decision and reference. By this user will be well advanced informed about the problems and can take effective measures to improve the survival rate of crops per unit of production [5].

Fig. 6. Zigbee Module

Figure 7 shows RF Wireless transmitter collects the information from the sensors and transmits wirelessly to the receiver module where a microcontroller can take decision on the data.

Fig. 7. RF Transmitter Module

Figure 8 shows the Bluetooth wireless transreceiver module collects the data from the sensors and communicates with the decision making module.

Fig. 8. Bluetooth Module

C Decision Making Module

The decision making module receives the data from the sensors connected in the agricultural field, this unit process it and transmits to cloud, where, further analytics can be taken place.

1. Arduino

Figure 9 shows the arduino microcontroller with GSM module, wifi shield, and receiver can be used for designing the system. The disadvantage of this is the complexity increases and cost also is little bit high.

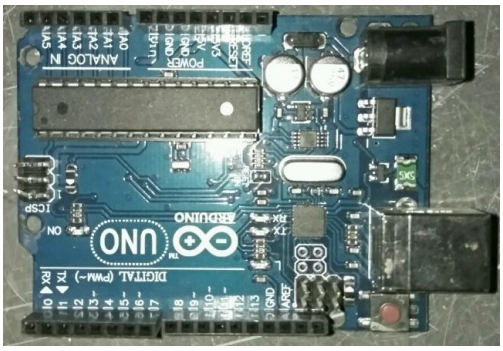

Fig. 9. Arduino

2. Raspberry Pi

A better decision making system can be designed by using a raspberry pi module as shown in figure 10 which has an in build wifi and bluetooth modules so that the complexity of the system reduces, but the system cost gets increases.

Fig. 10. Raspberry Pi

3. Cc3200

The decision making system can be designed by using CC3200 module as shown in figure 11 which has on chip wifi board which consumes less power with least complexity in the circuitry, but the system cost gets increases.

Fig. 11. CC3200 Module

4. ESP 8266

By designing the decision making system using ESP 8266 module as shown in figure 12 has the cost gets reduces as there is on chip wifi module but the GPIO pins are less in number. So the data from the sensor need to be receive serially.

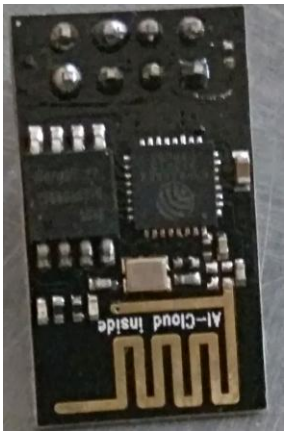

Fig. 12. ESP8266 Module

5. Node Mcu

The decision making system becomes better by using node mcU in the designing. The figure 13 shows the node mcU has on chip wifi module so the cost of the system reduces as well as the number of GPIO pins are more in number.

Fig. 13. Node MCu Module

6. MATLAB

The changes taken place in a plant is captured and analyzed on the MATLAB software using the algorithms to arrive at the result. The whole process of capturing the image along with the requisite environmental factors are done at once using the IoT sensing network and the data is fed onto the SD Card for further analysis. Once the test image is taken by the camera module, it tested and run against set of pre-defined database of images already taken. This is to be done by keeping the environmental constraints as well as general artificial catalyst namely N, P and K in mind. The algorithm thus analyses the given image and arrives at the conclusion which refers to the specific problem that affected the given plant [3].

D Cloud Computing

The services of cloud can be used at any time, any where the user needed it. The cost of the service is very low with less man power with least maintenance risk. The cloud service providers take care of maintenance, updating the software etc.

There are few free cloud services available which provide data analytics using matlab. Figure 14 shows the ThingSpeak cloud service is the one which provide fields with API Keys to send data to cloud using any controller.

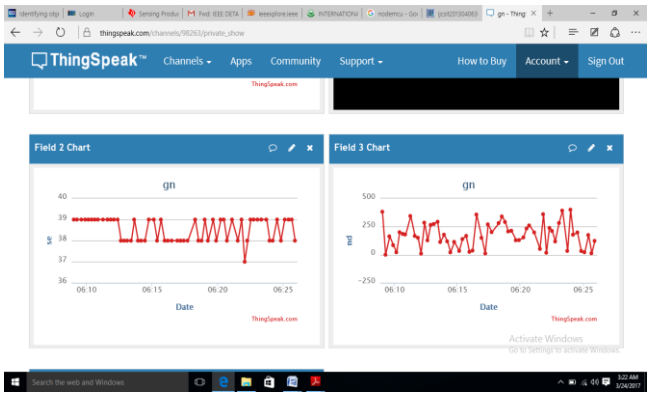

Fig. 14. Thingspeak Cloud Service

Figure 15 shows the Exosite is a cloud service provided by Texas, here the user need to pair the devices like CC3200 with the cloud and every time any where the data of sensors get updated into cloud.

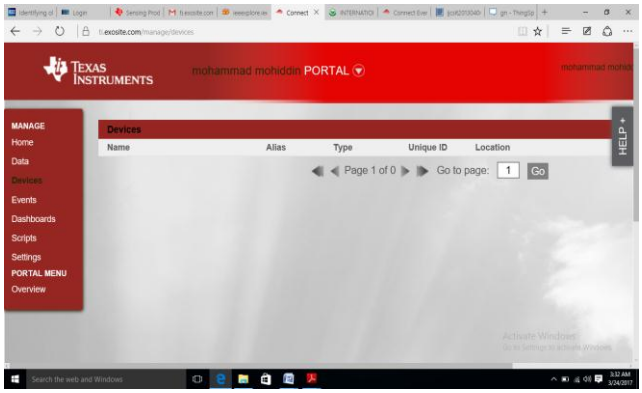

Fig. 15. Exosite Cloud Service

IV MAJOR CHALLENGES IN IoT

A *Unique Identification*

Since IoT includes a huge number of devices in its framework that will be connected to the internet, an efficient identification mechanism needs to be in place that can uniquely identify each and every object in the framework. Fast depleting IPv4 addresses can no longer be a viable option in addressing the objects, however the 128 bit IPv6 can mitigate the problem by granting unique addresses to each of the huge number of objects to be included in the global IoT framework [6].

B *Security of the Data Gathered*

Applications of IoT like home automation systems, healthcare automation systems etc. deal with huge amount of private data that should be kept confidential. But due to the use of wireless communication media that is prone to inherent security problems this data is vulnerable to snooping attacks, man-in-the-middle attack etc. So appropriate security and authentication, authorization, access control measures need to be in place. One solution to the various attacks is the use of cryptographic techniques. But the various techniques available are very computation intensive, reason why they cannot be adopted straight away by IoT where nodes are battery powered mostly. Hence lightweight yet powerful cryptographic schemes need to be developed to ensure confidentiality and integrity of the data received at the information processing centers [6].

C *Energy Consumption*

Continuous monitoring and data collection by the devices demands large amount of power. Fulfilling the above demand is a serious challenge for the low energy battery powered nodes. Moreover the transmission of collected data by these devices to the controlling point through wireless medium requires more power as compared to wired transmission. So energy efficient solutions and green technology are required to be adopted for making the nodes work on low power, and harvest energy from sun, wind etc. through the use of suitable techniques so that the lifetime of the devices can be prolonged without the need for frequent recharge [6].

D *Iot MALWARE*

Symantec confirmed the detection of the first IoT malware referred as ‘Linux.Darlloz’ in November 2013 which marked the invasion of malwares into the IoT domain. The interconnectivity of devices in the IoT can enable attackers to quickly propagate their carefully crafted malwares among the ‘things’ which can lead to threats like sensitive information disclosure, network throughput degradation etc. A single infected device can spread the malware all over the network. Malwares can also be planted in peripheral devices of a network that are often devoid of security for long term control of the IoT devices like security cameras. To deal with malwares in IoT energy efficient anti-malware technologies need to be designed [6].

V CONCLUSION and FUTURE SCOPE

This paper focused on the survey of application on IoT in agriculture field. The sensors used in the architecture are discussed. The transmission of data from the agriculture field to the central system is explained. The proposed system switches advantages are discussed briefly.

In future, this system can be implemented with good accuracy with low cost for various applications which will be helpful for society and country for better development.

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