Monitoring and Implementation of SmartAgriculture Using IoT

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Abstract: Agriculture is the basis of human life. In the olden days, Farmers used to calculate the preparation of soil and had many questions to create which sort of yield. Theydidn't consider the mugginess, level of water, and particularly atmosphere condition, which is suitable to crop. They make their assumptions which may sometimes leads to losing of the crop. This research targets to make use of evolving technology i.e . IoT and the smart agriculture using automation. The monitoring of the environment aims to improve the yield of efficient crops also reduce the effort of humans. The feature of this project includes monitoring temperature and humidity and water level and soil moisture conditions in agriculture fields. These problems can be solved easily with the help of "IOT Technology". IoT devices and communication skills linked with wireless sensors occurred in agriculture applications are examined in detail. What are the sensors there for particular agriculture processes, like soil preparation, crop position, irrigation, insect and pest detection are listed. This technology servicing the growers throughout the crop levels, from sowing until harvesting is explained. The Internet of Things (IoT) explains the network of physical devices like things that are embedded with sensors, software, and other applied science to interlink and share data with other devices and systems by using the internet as medium from any place in the world.

Keywords: Internet of Things, smart agriculture, mugginess, embedded.

1. INTRODUCTION

To increase the farming profit with fewer reserves and labor efforts, significant creations have been earned throughout the out human past. However, the high community rate never let the pressure and supply match during all these times. According to the forecast for figures, in 2050, the world population is wanted to touch 9.8 billion, an increase of nearly 25% from the current figure [1]. Almost the entire mentioned rise of the population is forecasted to occur among the developing countries [2]. In addition, income levels will be multiples of what they are now, further driving food demand, mainly in developing nations. As a result, these countries will have to be more keen about their diet and food quality; so, consumer choices can shift from wheat and grains to legumes and, later, to meat. To feed this larger, more urban, and richer population, food production should double by 2050 [3], [4].

Further analysis showed that every crop field has different factors that can be assessed separately in terms of both integrity and quantity. Critical characteristics, like soil type, nutrient presence, the flow of irrigation, pest opposition, etc., define its suitability and capability for a specific crop. In most situations, the differentiation of characteristics can existwithin a single crop field, even if the same crop is being developed in an entire farm; hence, site-specific analyses are required for optimal yield production. Further, expanding the proportions of time, specific crops in the same field rotate season-to-season and biologically reach different stages of their cycle within a year in areas where location and secular discrepancies result in specific growth requirements to optimize the crop output. To respond to these demands with a range of problems, farmers need new technology-based procedures to generate more from less land and with fewer hands. By considering the efficient farming methods, farmers need to visit the farming sites frequently throughout the crop life to have a better understanding about the crop conditions. So that, the need for smart farming arises, as 70% of the farming time is needed in spending on monitoring and understanding the crop states rather than doing actual farm work [5]. Despite the awareness people may have regarding the farming procedure, the reality is that today's farming industry is data-centered, precise, and smarter than ever. Almost every sector, including the transition from statistical toquantitative approaches, has been redesigned by the rapid proliferation of Internet-of-Things (IoT)-based technologies. These technological developments are shaking the current methods of agriculture and generating new possibilities along with a number of challenges. This clausehighlights the strength of wireless sensors and IoT in farming, the challenges that are expected to be faced when consolidating this technology with the traditional agriculture methods. IoT devices and communication techniques correlated with wireless detectors experienced in agriculture applications are evaluated in detail. The category of sensors available for specific farming applications are listed, such as soil preparation, crop status, irrigation, detection of insects and pests. It explains how this technology supports growers during the crop stages, from sowing to harvesting, packaging and transport. Similarly, the use of unmanned aerial vehicles for crop surveillance and other positive applications such as optimizing crop yield is deemed in this article.IoT-based architecture and platforms used in farming are also highlighted wherever suited. Eventually, based on this thorough review, we identify recent and future trends of IoT in farming and highlight potential study challenges. Food quality and quantity, Internet of Things (IoT), urban farming, advanced agriculture practices, agriculture robots, automation, smart agriculture, further upcoming food expectations. To increase the agricultural yield with lesser resources and workers efforts significant innovative ideas have been made throughout mortal past. However, the high community ratio never let the need and stock match during all these times. According to the forecasted figures, in 2040, the world population s anticipated to touch 9.7 billion, an increaseof nearly 26%. Almost the entire mentioned rise of the population is figured to occur among the expanding countries. On the other side, the trend of urbanization is expected to continue at an accelerated pace, Furthermore, income levels will be multiples of what they are now, which will drive the food need further, particularly in developing countries IoT has been defined as a system of interrelated computing tools, mechanical and digital machines, objects, creatures, or people that are provided with unique identifier and the ability to transfer data over a network without requiring human-to-human or human-to-computer intercourse. A key area of interest in this paper is the application of IoT in farming. The world community isestimated to be about 9.7 billion in 2050; as such there will be a great demand for food. This coupled with the diminishing natural resources, arable land and uncertain weather situations make food security a major concern for most countries. The world is turning to the use of IoTcombined with data analytics (DA) to meet the world's food demands in the coming years [6]. Further examination showed that every crop field has different factors that can be measured separately in terms of both quality and quantity. Critical factors, like soil variety, nutrient dignity, the flow of irrigation, pest friction, etc., define its suitability and capability for a specific crop. In most situations, the differentiation of characteristics can exist within a single crop field, even if the same crop is being refined in the entire farm; hence, site-specific analyses are required for optimal yield production. In addition, incorporating the time dimension, unique crops in the same field rotate season-to-season and enter different stages of their cycle biologically within a year in areas where place and earthly disparities result in specific growth regulations to optimize the crop production. Farmers need new technology-based techniques to generate more from less land and with fewer hands in order to respond to these demands with a variety of problems. In order to have a better understanding of the crop circumstances, farmers need to visit the farming sites regularly during crop life, taking into account the regular farming procedures. For this, the need for smart agriculture arises, as 70%of the farming time is spent monitoring and understanding the crop states instead of doing actual fieldwork [7].

2. METHODOLOGY

It introduces the IoT agricultural system. It consists of four main parts: 1) IoT devices; 2) the Internet; 3) communication technology; and 4) data storage and processing. Figure 1 shows the natural state of IoT. In any IoT system, four major components are important. A description of the components of IoT as it affects agriculture is given as follows.

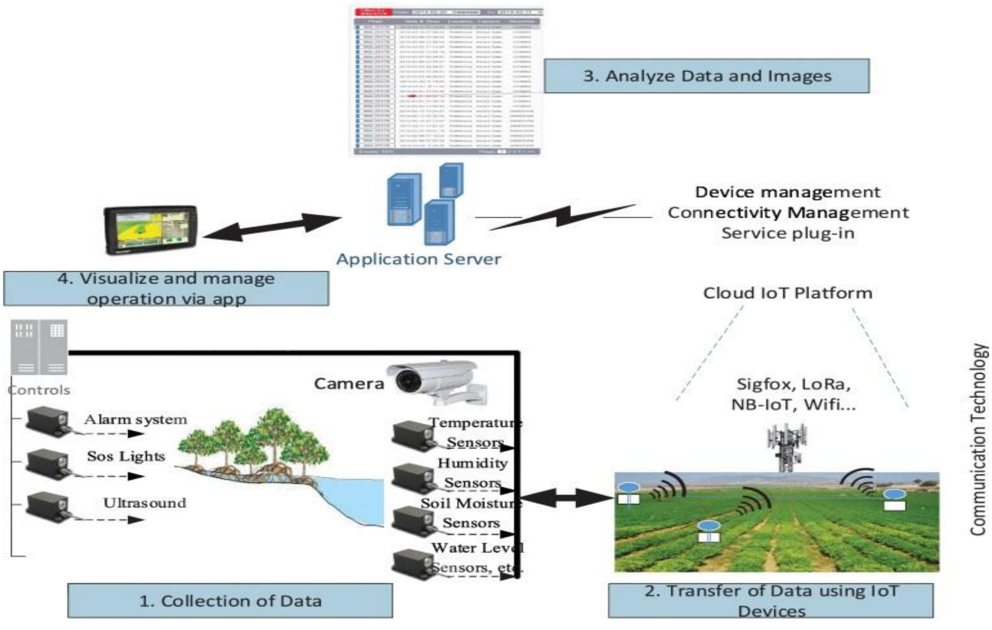

Fig. 1 Diagram of the IoT agricultural system

2.1 IoT Devices

Embedded systems that communicate with sensors and actuators and include wireless connections made with IoT devices. Typically, these IoT modules are called IoT sensors. It is referred to as the IoT system in this article. Fig.2 shows the construction of a standard IoT agricultural unit. Fig.2 shows the gate arrangements in the field of microprocessors, communication modules, memory, and output/output integration from the embedded system.

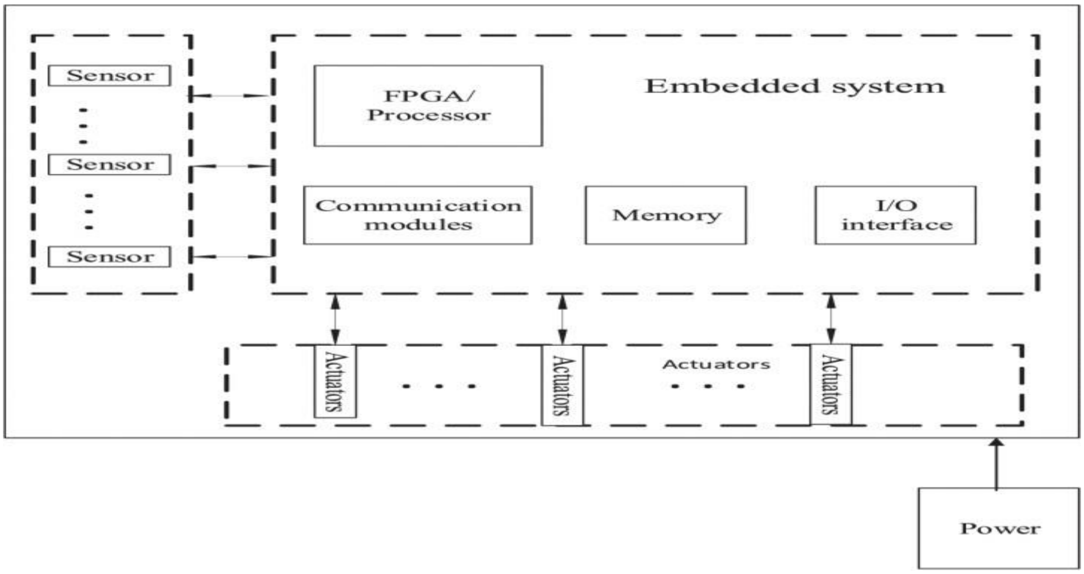

Fig. 2 IoT device design

Sensors are used to test and measure a variety of agricultural inputs (soil extensions, climaticdata) and materials that affect production. Sensors can be divided into local sensors, visual sensors, mechanical sensors, electrochemical sensors, and air-sensing [8].

2.1.1 Communication Technology

Communication technologies play a key role in the effective use of IoT systems. Existing communication technologies can be categorized according to application levels, conditions, and conditions. The level of communication can be grouped into short-term communication and long-distance communication. The communications spectrum can be divided into licensed and unlicensed spectrum. Application conditions for IoT devices can be based on sensors or in the backhaul network, as well as transmission conditions [9].

2.1.2 Spectrum

The unlicensed spectrum uses a commercial RF science and the medical band called the ISM band. Disadvantages of using unlicensed scope are security issues, infrastructure costs, and disruptions. Electromagnetic interference is caused by ISM IoT devices that interfere with radio communication using the same frequency. On the other hand, the licensed spectrum provided to the mobile network provides efficient traffic management, less disruption, better reliability, increased service (QoS), higher security level, wider coverage, and lower infrastructure costs for users. Disadvantages of licensed spectrum use arethe cost of data transfer registration and transfer power consumption on IoT devices.

2.1.3 General

There are several levels of wireless communication, the number of which is listed in Table II. they will be divided into short and long-term communication levels. short-range samples near devices allowed for network communication, Bluetooth, ZigBee, Z-Wave, frequency identification systems (RFID). Short-distance levels can cover distances of up to 110 m. Long-distance communication standards can cover distances of up to 10 s kilometers. Long-distance communication standards are categorized because of the low-power area (LPWA) (examples are LoRa, Sigfox, NB-IoT). LPWA uses low power and can cover a widearea [10], [11].

TABLE 1: Communication Technology [2]

Type	Spectrum	Transmission Distance	Type of Network	Frequency Bands	Bi-directional link	Data Rate
802.11a/b/g/n/ac	Unlicensed	6 - 50 m	WLAN	2.4/5 GHz	✓	2 Mbps - 7 Gbps
802.11ah	✓	1000 m	✓	various, sub -1 GHz	✓	78 Mbps
802.11p	Licensed	<1 km	✓	5.9 GHz	✓	
802.11af (white space)	✓	1 km	✓	54-790	✓	26.7 - 568.9 Mbit/s
SigFox	✓	Rural: 30-50 km Urban: 3-10 km	LPWA	868 or 902 MHz	✓	100 bps(UL), 600 bps(DL)
LoRaWAN	✓	<20 km	✓	various, sub-GHz	✓	0.3-37.5 kbps
Ingenu/OnRamp	✓	15	✓	2.4 GHz	x	78 kbps (UL), 19.5 kbps (DL)
Telensa	✓	1 km (Urban)	✓	60 MHz, 200 MHz, 433 Mhz, 470 MHz, 868 MHz, 915 MHz	✓	62.5 bps(UL), 500 bps(DL)
3GPP NB-IoT	Licensed (cellular)	<35 km	✓	450 MHz - 3.5 GHz	✓	250 kbps
3GPP LTE-MTC (Cat-M1)	✓	<5 km	WWAN	1.4 MHz	✓	200 kbps
EC-GPRS	✓	✓	✓	GSM licensed bands	✓	240 kbps
WiMAX	Licensed and Unlicensed	up to 50-80 km	✓	2 - 11 Ghz, 10 - 66 Ghz	✓	70 Mbps
Bluetooth	Unlicensed	< 100 m	WPAN	2.4 GHz	✓	2 Mbps - 26 Mbps
ANT+	✓	<30 m	✓	2.4 GHz	✓	
MiWi	✓	<50 m	✓	Sub-GHz, 2.4 GHz	✓	256
ZigBee	✓	< 1 km	WHAN	2.4 GHz	✓	250 kbps
Z-Wave	✓	< 100 m	✓	900 MHz	✓	100 kbps
Thread (6LoWPAN)	✓	< 30 m	✓	868/915/2450 MHz	✓	250 kbps
Enocean/ (ISO/IEC 14543-3-10)	✓	< 30 m	✓	900 MHz	✓	125 kbps
WirelessHART	✓	< 228 m	WFAN	2.4 GHz	✓	250 kbps
NFC	✓	< 20 cm	P2P	13.56 MHz	x	424 kbit/s

2.1.4 Working Status

The choice of communication technology also depends on the settings of the IoT device. Communication technology can be used for IoT devices that act as nodes or as backhaul networks. Nodes transmit low data and cover very short distances with minimal power consumption. The backhaul network supports high data rates and can be used over very long distances. Some communication technologies support bi-directional communication. The bi- directional link allows for advanced error correction, data handshake, data encryption, online firmware update, and communication between devices. In [12], the comparison of LoRa and NB-IoT shows that the same technology has its advantages and disadvantages which is why the most appropriate technology depends on the application.

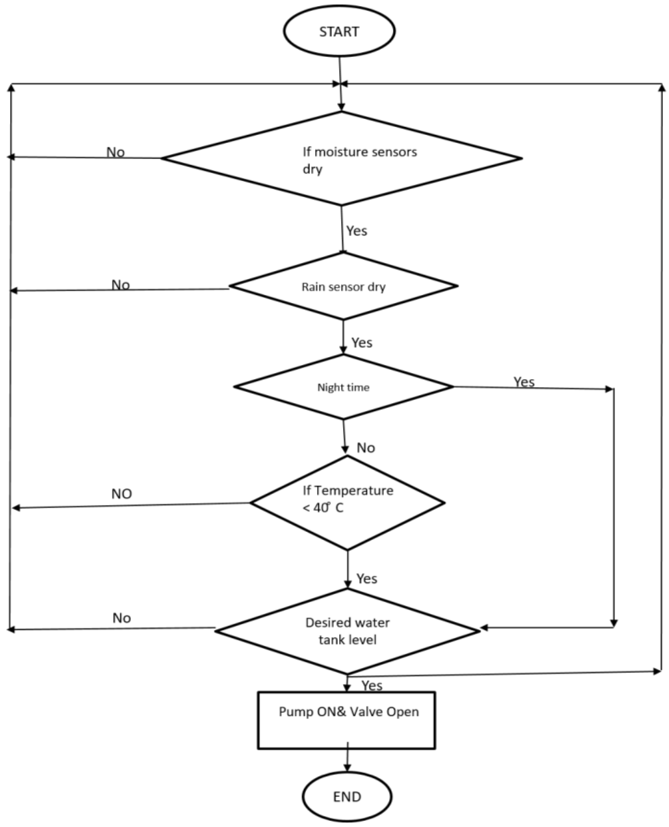

Fig. 3 Flowchart of the design

The choice of communication technology also depends on the settings of the IoT device. T nodes transmit low data and bed distances are very short with low power consumption. The backhaul network supports high data rates and can be used for very long distances. most communication technologies support a dual-directed link. The bi-directional link allows for advanced error correction, data handshake, data encryption, online firmware update, and communication between devices. In [12], the comparison of LoRa and NB-IoT shows that all technologies have their advantages and disadvantages which is why the best-advanced technology depends on what is used. Besides, the choice of communication technology for IoT devices also depends on the type of technology to be used. There are different types of topology, such as peer-to-peer (P2P) or line, star, mesh, ring, tree, and bus. In one of the above, the IoT device plays a variety of roles and functions.1 The role can be a private network (PAN) coordinator or as a terminal device. Tasks are usually fully functional devices(FFD) or a reduced operating device (RFD). Figure 3 shows two types of topologies and roles played. Within the P2P topology, PAN acts as FFD and initiates communication while high- end devices can act as FFD or RFD. a high-end device that works as an FFD can have multiple connections while a high-end device that works as an RFD can interact with one FFD and cannot interact with another RFD. Star contains a PAN that initiates communicationand receives communication from other devices. High-end devices can only create connections with the PAN connector.

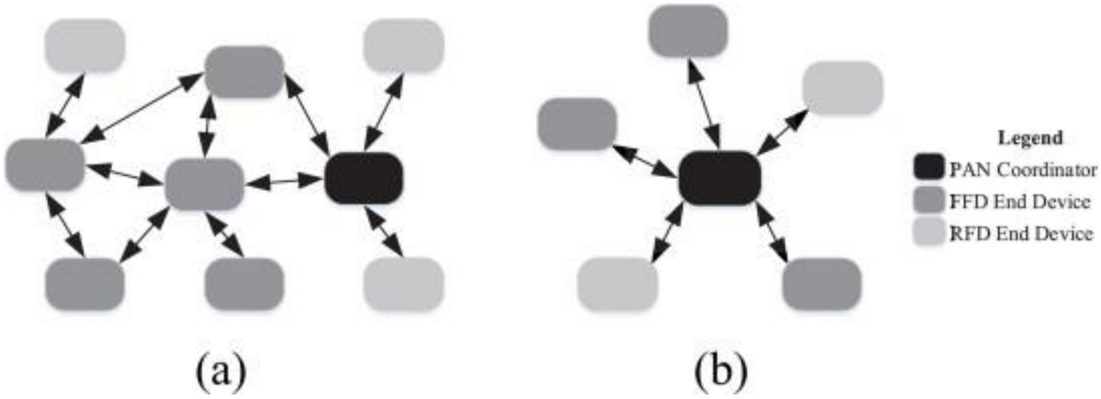

Fig. 4 Topology (a) Studying with peers (b) A star

Advances in the field of wireless communication, mobile devices, and ubiquitous services have opened the way for greater Internet connectivity. According to astudy report, the number of agricultural implements in the country is expected to grow from 13 million by the end of 2014 to 225 million by 2024.. The Internet forms the basis of a basic network layer, in which the means of transporting and exchanging information and network information between multiple sub networks are provided. The connection of IoT devices to the Internet makes data available anywhere and anytime. However, data transfer over the Internet requires adequate security, real-time data support and easy access. The Internet has opened the way for cloud computing, in which large amounts of data are stored and processed. Cloud computing includes user interface management, services, configuration and network nodes, computer, and processing data [13]. To achieve the connection o f complex applications and devices to the Internet, IoT middleware and connection processes are performed. Examples of IoT middleware are service-based properties (SOA), cloud-based IoT middleware and character-based IoT middleware used to support IoT [14], [15]. IoT SOA consists of multilayer architecture. One of the proposed IoT structures has the following layers: hearing, access, communication, middleware, and application layers. We refer students to [14], [16], and [17] and their references for more information on IoT design and technology.

2.1.5 Units for Data Storage and Processing

Data-driven agriculture involves the collection of large, dynamic, complex and spatial data, which need to be stored and processed [20]. Data complexity can range from formal data to informal [18], which can be in the form of text, images, audio, and video. Data may vary from historical data, sensor data, live streaming data, business data, and market-related data. The use of IoT cloud platforms allows large amounts of data collected from sensors to be stored in the cloud. This includes hosting a program that is critical to service delivery and managing end-to-end IoT infrastructure. More recently, edge or fog computing is being promoted, where IoT devices and gateways perform calculations and analyzes to reduce delays in critical applications, reduce costs and improve QoS.

There are many data management systems designed to manage different types of data [20]. Examples of other available platforms for sale are Onfarm, Farmobile, Silent Shepherd platform, Cropx , Farmx , Easyfarm, KAA, and Farmlogs . These forums offer data storage, data management.

3. RESULTS and DISCUSSION:

After finishing the arrangement and the assortment of the parts of the savvy Irrigation framework, it's been met the objective. Likewise, the entirety of the necessities was actualized to complete this brilliant Irrigation framework, so it turns out to be full creation and settle. From that point onward, the framework got tried, and the final product became as required. The framework will now not work until a few of dampness sensors from any line of the 3 fields send a sign to the Arduino that the dirt is dry and yield needs water. After the signarrives at the Arduino, it will send an order to the hand-off of that particular line field valve to be invigorated to open the valve and order to the hand-off of the siphon to trade it straight forwardly to water that field. Additionally, every one of the 3 fields can be inundated at an equivalent of time, if a few of each of the 3 plants dampness sensor are enacted. Along these lines, all solenoid valve transfers might be invigorated to open all valves and the siphon will rush to flood every one of the 3 plants. There has been an issue toward the starting to pick a reasonable siphon to compositions to inundate all blossoms at a similar second. The program of the framework has been designed and the framework will not, at this point work except if (or three dampness sensors) are initiated. However, on the off chance that one sensor is enacted of any lines, the framework will at this point don't perform, because that sensor can likewise it be imperfect. If the water tank level is low the framework won't work in any regard, even all plant sensors are enacted to secure the water siphon. Moreover, this savvy Irrigation framework has been designed that if there is pouring, it's going to not work, because the coming down sensor will actuate, and it will send a sign to Arduino to stop the water siphon and to close all valves as well. Further, on the daytime the framework will presently don't work, because of the mellow sensor will enact at the daytime and that will motivation to close the plant's an incentive just as to turn OFF the siphon. For the framework programming, it has been decisively picked as expressed in past parts to apply UNO Arduino, the wires associations from the regulators to the Arduino have been troublesome, because of a solitary error can harm any electric component. It was difficult to program the keen Irrigation framework and transfer it in Arduino to run the water siphon and beginning valves with eighteen sensors, however with the help of Arduino library, this framework transformedinto finished with best outcomes.

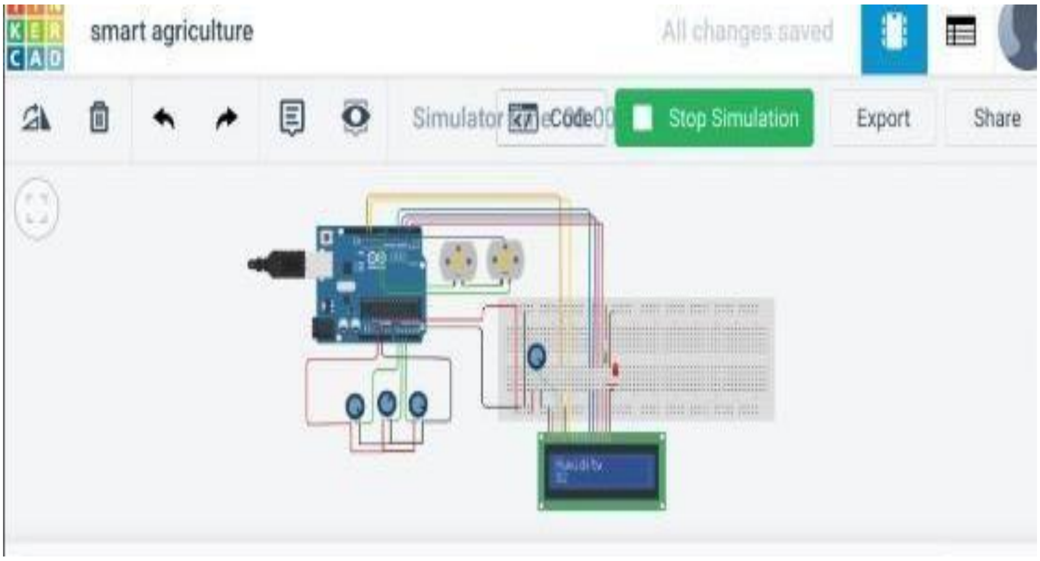

Fig. 5 Software Simulation in Thinker CAD

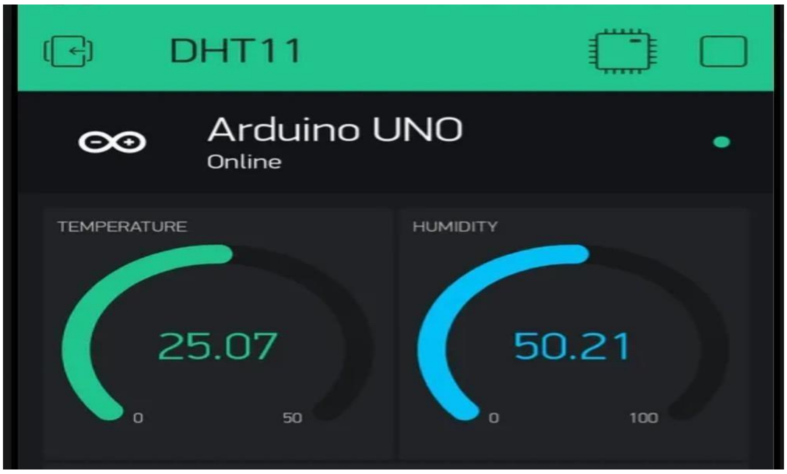

Fig. 6 By using blynk app storing data into the cloud for further analysis

4. CONCLUSION

As we can see the output of this project is a web interface where all the data from the sensor is collected and projected at a particular place. In this interface, we can display the data of temperature, humidity and Moisture. This is used for the optimization use ofwater in the agricultural field without the intervention of farmer by using soil moisture sensor that senses the moisture content of the Soil using Microcontroller that turns ON/OFF the pump automatically according to the need of water for irrigation and hencehelpful in saving water. This system is quite affordable and feasible. This sy stem of irrigation is also helpful in the region where water is scarce and improves its sustainability. And can also be adjusted according to the need of varieties of the crop tobe irrigated.

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