Smart Agriculture monitoring and control system using IOT

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Abstract—**In olden days, Farmers used to figure the ripeness of soil and influenced suspicions to develop which to kind of yield. They didn't think about the humidity, level of water and especially climate condition which terrible a farmer increasingly The Internet of things (IOT) is remodeling the agribusiness empowering the agriculturists through the extensive range of strategies, for example, accuracy as well as practical farming to deal with challenges in the field. The problems based on agriculture have been always hindering the development of the country. The highlighting features of this project includes IOT to connect multiple sensors data and to display big-data to perform tasks like weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance. The development includes smart irrigation with smart control and intelligent decision making based on accurate real time field data. Which also includes temperature maintenance, humidity maintenance and weather reports. Controlling of all these operations will be through any smart mobile or computer connected to Internet and the operations will be performed by interfacing sensors. The data can be completely updated faster when compared to other wireless computing. IOT development can diminish the cost and update the productivity of standard developing.**

Keywords: Soil moisture sensor, Water level sensor, Humidity sensor, Temperature sensor, IOT.

I. INTRODUCTION

India has agriculture as its primary occupation. According to IBEF (India Brand Equity Foundation), 58% of the people living in rural areas in India are dependent on agriculture. As per the Central Statistics Office 2nd advised estimate, the contribution of agriculture to the Gross Value Addition (India) is estimated to be roughly around 8% which is very significant contribution. Under such a scenario, the usage of water especially the fresh water resource by agriculture will be enormous and according to the current market surveys it is estimated that agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant because of population growth and increased food demand. This calls for planning and strategies to use water sensibly by utilizing the advancements in science and technology. There are many systems to achieve water savings in various crops, from basic ones to more technologically advanced ones. One of the existing systems use thermal imaging to monitor the plant water status and irrigation scheduling. Automation of irrigation systems is also possible by measuring the water level in the soil and control actuators to irrigate as and when needed instead of predefining the irrigation schedule, thus saving and hence utilizing the water in a more sensible manner. An irrigation controller is used to open a solenoid valve and apply watering to bedding plants (impatiens, petunia, salvia, and vinca rosea) when the volumetric water content of the substrate drops below a set point.

The emerging global water crisis: In addition to managing scarcity and conflict between water users, the available fresh water is further contaminated by the human and animal population and the pollution levels have increased at an alarming rate. This if continues, will be leading to limitation of food production which in turn will affect the human productivity and thus the entire ecosystem will be affected in the years to come. The primary and the most important reason for this problem is the tremendous increase in the population which has increased at a rate which is faster than the food production rate. This population growth especially in water short countries will directly have an impact on its growth on the world map. The food production needs to be increased by at least 50% for the projected population growth. Agriculture accounts for 85% of freshwater consumption globally. This leads to the water availability problem and thus calls for a sincere effort in sustainable water usage. For a variety of reasons, feasible expansion of irrigated agriculture will be able to accommodate only a portion of this increased demand, and the rest must come from an increase in the productivity of rain fed agriculture. In the absence of coordinated planning and international cooperation at an unprecedented scale, the next half century will be plagued by a host of severe water related problems, threatening the wellbeing of many terrestrial ecosystems and drastically impairing human health, particularly in the poorest regions of the world. In this paper, a smart and intelligent agriculture system which can help the farmer to utilize the water level sensibly and also take care of other discrepancy factors like unrequired animal entry into the fields are discussed. The system consists of a microcontroller and sensors like moisture, temperature, humidity, motion etc. but not limited to only these. The system uses both wired and wireless connections for the communication between the sensors, microcontroller and the internet. The system also consists of an android application which allows the user to give his/her input based on which the watering will be controlled. Smart Agriculture System is proposed in this paper which will use concept of IOT, WSN and cloud computing to help farmer plan an irrigation schedule for his farm through a agriculture profile which can be edited as per his/her requirements. Based on the users input an automated irrigation system is developed to optimize water use for agricultural crops. The system has a distributed wireless network for soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a micro controller-based gateway to control water quantity. Proper scheduling of irrigation and fertilization is very important for proper development of crops. The several factors which affect the amount of water required by crops in various climatic conditions are:

- Temperature
- Humidity
- Sunshine
- Wind speed
- Passive infrared sensor
- Seed monitoring
- pesticide.

The collected and sensed climatic data from field along with weather data from web repositories can be used to take several effective decisions for increasing production of crops. If environmental condition is hot, dry, sunny, windy then there is need of high amount of water for crops and if these factors are like cold, humid, cloudy, little wind then the need of water is less for the crops. Previous study model abstracted a system that consist of six parts that are monitoring, management, planning, Information Distribution, decision support and control action. The above study model does data analysis for better decision support [1]. In [2], a GSM based smart agriculture system was proposed for doing automation of several agriculture tasks. Automation is proposed by smart irrigator that moves on mechanical bridge slider arrangement. The smart irrigator receives signal from smart farm sensing system through GSM module. The sensed data is transferred towards central database from which all crop details are analyzed and transferred to irrigator system to perform automatic actions. IOT based smart Agriculture [3] gives information about irrigation and has services like smart control and making intelligent decision depending upon real time data from fields. All these operations will be controlled through any smart device placed remotely and the interfacing sensors are used to perform operations along with Wi-Fi, actuators and other hardware devices. The entire system was established using infield sensors which collects data from farm and using GPS data is sent to the base station where necessary actions are determined to control irrigation according to database available with the system. Researcher's measure soil related parameters such as humidity and moisture as important factors for the growth of any crop. Auto mode and Manual mode are the two modes of operation of the system. System takes its own decisions and controls the installed devices and user can control the operations of system using android app or commands in auto and manual mode respectively. Internet of Things is proven to be a cost effective and reliable technology to implement smart systems [5]. In smart village system advance rural connectivity is enabled through web service and measuring different environmental factors in real time.

Automated agriculture system proposed in [7] finds the moisture values from the moisture sensor and turn the lights in the green house ON or OFF based on light sensors and actuators are used to control the motor. Automated system definitely helps farmer in increasing the yield of crops. Paper [8] produces an agricultural model in IOT environment which is human centric. It incorporates IOT and cloud computing universally to remove the inadequacy and lack of management, which are the root of problems in agriculture.

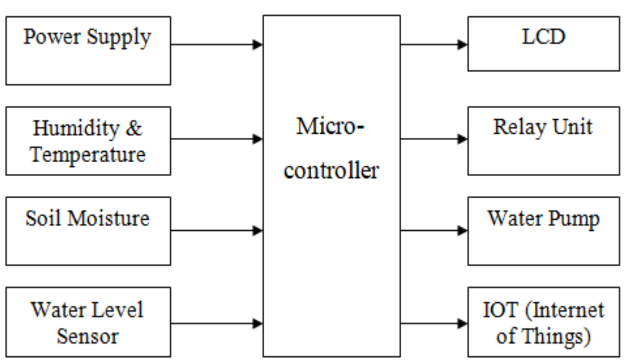

Fig. 1. Hardware block diagram.

II. IOT TECHNOLOGY & AGRICULTURE

2.1 Internet of Things- Concept & Definition

Internet of Things (IoT) (Atzori et al 2010) (Nayyar, 2016) consists of two words- Internet and Things. The term "Things" in IoT refers to various IoT devices having unique identities and have capabilities to perform remote sensing, actuating and live monitoring of certain sorts of data. IoT devices are also enabled to have live exchange of data with other connected devices and applications either directly or indirectly, or collect data from other devices and process the data and send the data to various servers. The other term "Internet" is defined as Global Communication network connecting trillions of computers across the planet enabling sharing of information. As forecasted by various researchers, 50 Billion devices based on IoT would be connected all across the planet by year 2020.

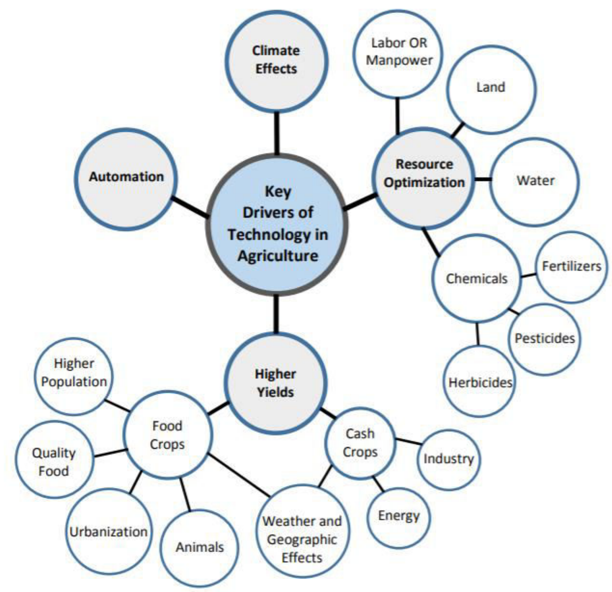

Figure 1: Key Drivers of Technology in Agriculture Industry

The Internet of Things (IoT) has been defined as (Smith, 2012): A Dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "Things" have identities, physical attributes, and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information network, often communicate data associated with users and their environments". An ideal IoT device consists of various interfaces for making connectivity to other devices which can either be wired or wireless. Any IoT based device consists of following components:

- I/O interface for Sensors.
- Interface for connecting to Internet.
- Interface for Memory and Storage.

- Interface for Audio/Video.

IoT devices can be of various forms like wearable sensors, smart watches, IoT smart home monitoring, IoT intelligent transport systems, IoT smart health devices etc.To summarize this discussion, figure 1 provides the main drivers of technology, while figure 2 highlights themajor hurdles of technology implementation in smart agriculture.

2.2 IoT Enabling Technologies

Internet of Things has a strong backbone of various enabling technologies- Wireless Sensor Networks, Cloud Computing, Big Data, Embedded Systems, Security Protocols and Architectures, Protocols enabling communication, web services, Internet and Search Engines. Wireless Sensor Network (WSN): It consists of various sensors/nodes which are integrated together to monitor various sorts of data. Cloud Computing: Cloud Computing also known as on-demand computing is a type of Internet based computing which provides shared processing resources and data to computers and other devices on demand. It can be in various forms like IaaS, PaaS, SaaS, DaaS etc. Big Data Analytics: Big data analytics is the process of examining large data sets containing various forms of data types—i.e. Big Data – to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information. Communication Protocols: They form the backbone of IoT systems to enable connectivity and coupling to applications and these protocols facilitate exchange of data over the network as these protocols enable data exchange formats, data encoding and addressing. Embedded Systems: It is a sort of computer system which consists of both hardware and software to perform specific tasks. It includes microprocessor/microcontroller, RAM/ROM, networking components, I/O units and storage devices.

2.3 IoT Applications in Agriculture

With the adoption of IoT in various areas like Industry, Homes and even Cities, huge potential is seen to make everything Intelligent and Smart. Even the Agricultural sector is also adopting IoT technology these days and this in turn has led to the development of "AGRICULTURAL Internet of Things (IoT)"

2.4 Benefits of IoT in Agriculture

The following are the benefits of IoT in Agriculture:

1. IoT enables easy collection and management of tons of data collected from sensors and with integration of cloud computing services like Agriculture fields maps, cloud storage etc., data can be accessed live from anywhere and everywhere enabling live monitoring and end to end connectivity among all the parties concerned.
2. IoT is regarded as key component for Smart Farming as with accurate sensors and smart equipment's, farmers can increase the food production by 70% till year 2050 as depicted by experts.
3. With IoT productions costs can be reduced to a remarkable level which will in turn increase profitability and sustainability.
4. With IoT, efficiency level would be increased in terms of usage of Soil, Water, Fertilizers, and Pesticides etc.
5. With IoT, various factors would also lead to the protection of environment.

2.5 IoT and Agriculture Current Scenario and Future Forecasts

Table 2. Shows the growth of IoT based adoption in Agriculture sector from Year 2000-2019 and Forecasts of year 2035-2050.

Year	Data Analysis
2000	525 Million Farms connected to IoT
2019	540 Million Farms till Date are connected to IoT
2035	780 Million Farms would be connected to IoT
2050	2 Billion Farms are likely to be connected to IoT

III. RELATED WORKS

Nikesh Gondchawar et al., [1] proposed work on IoT based smart agriculture. The aim of the paper is making agriculture smart using automation and IoT technologies. Smart GPS based remote controlled robot will perform the operations like weeding, spraying, moisture sensing etc. It includes smart irrigation with smart control and intelligent decision making based on accurate real time field data and smart warehouse management. It monitors temperature maintenance, humidity maintenance and theft detection in the warehouse. All the operations will be controlled by smart device and it will be performed by interfacing sensors, ZigBee modules, camera and actuators with microcontroller and raspberry pi. All the sensors and microcontrollers are successfully interfaced with three Nodes using raspberry pi and wireless communication. This paper gives information about field activities, irrigation problems, and storage problems using remote controlled robot for smart irrigation system and smart warehouse management system respectively.

Rajalakshmi P.et.al., [2] described to monitor the crop-field using soil moisture sensors, temperatureand humidity sensor, light sensor and automated the irrigation system. The data from sensors are sent to web server using wireless transmission and JSON format is used for data encoding to maintain server database. The moisture and temperature of the agriculture field falls below the brink, irrigation system will be automated. The notifications are sent to farmers mobile periodically and farmers can be able to monitor the field conditions from anywhere. The parameters used here are soil moisture sensor, temperature and humidity sensorDHT11, LDR used as light sensor and web server – NRF24L01 used for transmitter and receiver. This system will be more useful in areas where water is in scarcity and it is 92% more efficient than the conventional approach. Automation of irrigation system data was stored in MySQL database using PHP script. Total average power consumption is 2 Ah per day for a single motor pump and water requirement analysis.

Tanmay Baranwal et al., [3] this project concentrates security and protection of agricultural products from attacks of rodents or insects in the fields or grain stores. Security systems are used to provide real time notification after sensing the problem. Sensors and electronic devices are integrated using Python scripts. Algorithm is designed based on collecting information to provide accuracy in notifying user and activation of repeller. Testing is done in an area of 10 sq. m. and the device is placed at the corner. The PIR sensor identifies heat it starts URD sensor and webcam. Based on attempted test cases 84.8% success is achieved. It will be helpful to extend the security system to prevent rodents in grain stores.

Nelson Sales et al., [4] this paper describes Wireless sensor Networks. The network performs three nodes i.e. acquisition, collection and analysis of data such as temperature and soil moisture. The benefits of irrigation process in agriculture are decreasing water consumption and environmental aspects. Cloud Computing is an attractive solution for high storage and processing capabilities of large amount of data by the Wireless Sensor and Actuator Network. This work aims to agriculture, greenhouses, golf courses and landscapes. Architecture is divided in to three main components: a WSAN component, a cloud platform component and a user application component. It contains three different types of nodes such as sink node, a sensor node and an actuator node. SimplitiTI is a simple protocol for WSAN implementation in a cluster tree topology. The soil moisture monitors to assess the plants it need water for its proper development and optimization of natural resources.

Mohamed Rawidean Mohd Kassim et al., [5] this work describes a Precision Agriculture (PA). AWSN is the best way to solve the agricultural problems like farming resources optimization, decision making support, and land monitoring. Using this approach provides real-time information about the lands and crops that will help the farmers to make right decisions. Precision agriculture systems based on the IOT technology explains the hardware architecture, network architecture and software process control of the precision irrigation system. The software collects data from the sensors in a feedback loop depending on that activates the control devices based on threshold value. Implementation of WSN in PA optimizes the usage of water fertilizer through irrigation and also maximized the yield of the crops.

LIU Dan et al., [6] this paper describes greenhouse technology in agriculture represents the design and implementation based on ZigBee technology using CC2530 chip. It is mainly used for environment monitoring system. The wireless sensor and control nodes uses CC2530F256 core for data acquisition, data processing, data transmission and reception. Here computer provides all the real time data for the concerned person using wireless communication like temperature control, fans condition. In this system uses intelligent monitoring and control of green house. It is helpful to farms for scientific and balanced planting crops.

IV. PROPOSED METHODS

Components

The system utilized IoT and picture handling to locate the supplement and mineral insufficiencies that influence the yield development. M.K. Gayathri and at al advance the quick improvement of agrarian modernization and help to acknowledge brilliant answer for horticulture and productively explain the issues identified with ranchers. Zhou Zhongwei and at al have proposed a technique to picture and follow rural items in inventory network. Li Sanbo and at al centre around the equipment engineering, arrange design and programming process control of the exactness water system framework. Smash and atal have proposed an approach to direct water in rural fields. Bo Yifan and atal have concentrated on the investigation on the use of distributed computing and the web of things in horticulture and ranger service. M.V. Latte and at al have utilized shading and example investigation to recognize numerous insufficiencies in paddy leaf pictures

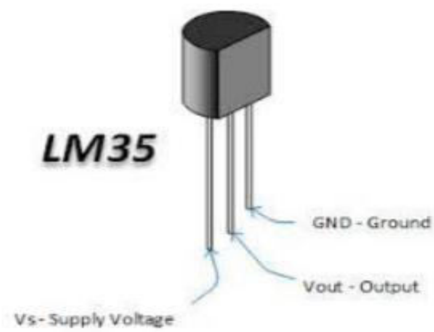

Figure.2.Temperature Sensor

Those LM35 may be an incorporated information preparing sensor that might a chance to be used to figure temperature for an electrical yield proportional of the temperature (in °C). It might quantify temperature additional faultlessly over a utilizing an indoor controller.

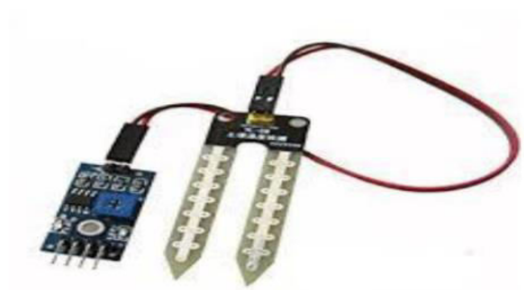

Figure.3. Moisture Sensor

Soil sensor may be a sensor which faculties those wetness material of the soil. That sensor need just as the plain and the propelled yield. The propelled yield will be created and the plain yield limit might a chance to be fluctuated. It takes a shot on the example about open Also short crazy. That yield may be secondary or low demonstrated toward the headed. During those side of the point when the mud may be dry, those current won't experience it Along these lines it will clear out for Concerning illustration open circuit. During those purpose the point when those dirt is wet, those present will take off from single terminal of the following and the circlet is gathered with make short and the yield will be nothing.

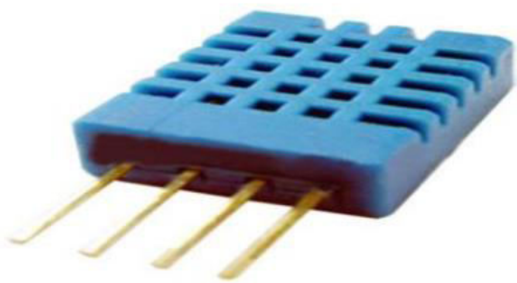

Figure.4. Humidity Sensor

HR 202 Humidity is coordinated circuit sensors that can be utilized to gauge the nearness of water in arrive. The HR202 is another sort of stickiness touchy resistor produced using natural macromolecule materials, it can be utilized as a part of events like: clinics, stockpiling, workshop, material industry and so on. The Stickiness sensor with its yield Relative to the temperature (in RH %). The operational temperature extend is from20-95%RH.

Figure.5. Water Level Sensor

Water level buoys sensor, otherwise called drift balls, are round, tube shaped, have a place or correspondingly melded items, produced using either unbending or adaptable material, that are light in water and different fluids. They are non-electrical equipment every now and again utilized as visual sight-markers for surface outline and level. They may likewise be joined into switch instruments or translucent liquid tubes as a segment in checking or controlling fluid level

Figure.6. ARM Processor

Node MCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added. NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).[8]. The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits.[citation needed. Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the

ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects).

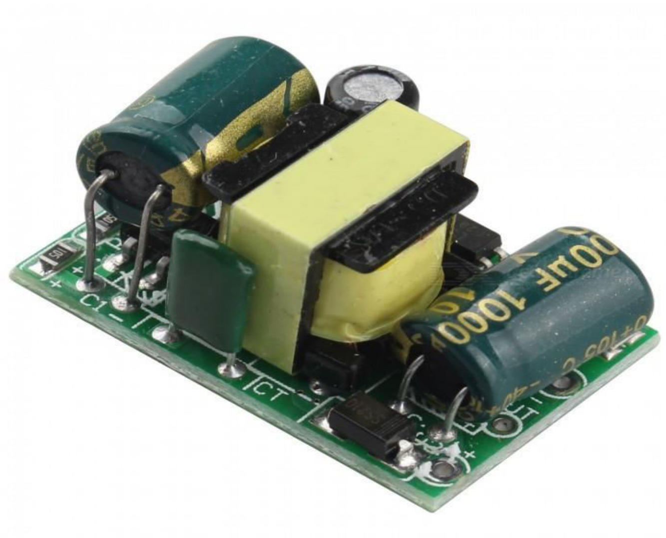

Figure.7. Power Supply

Here full bridge converter, phase shifted, 600-W high-efficiency power supply is used. It converts a 370 V to 410-V DC input in to a regulated 12-V output. To achieve high efficiency, the UCC28950 was used to drive synchronous rectifiers on the secondary side of the full bridge converter. The UCC28950 operates in burst mode. The DCM (Discontinues Current Mode) function is to improve no-load efficiency and to meet GreenMode Requirements. The DCM comparator was intended to turn off the synchronous rectifiers at critical conduction in lighter loads (< 20%).

Proposed Work

The reason for the Arduino controller is that it interfaces every one of the parts related with the Development pack. Number of pins in this controller is 28. The temperature limit esteem will be refreshed to server or framework, through IoT for each 1 minute from the incorporated advancement pack. LM35 temperature sensors utilize speaker at the accurate supporters outright temperature (estimated in Kelvin) into also Fahrenheit or Celsius rely leading it arrangements. The two resistors are adjusted in the production line to create an exceedingly exact temperature sensor. The coordinated START Read the information Deployment of Sensor Is Temperature/the Humidity esteems in go Is the water esteems in run Motor on STOP NO YES Data server (IoT passage) circuit has various transistors in it - two in the centre, a few in each intensifier, a few in the dependable flow source, and several in the bend give circuit. The edge esteem is achieved (1 RH%-100 RH%) this breaking points can be set in the microcontroller if its goes above past 10 RH% conditions will be unusual generally dampness level will be in ordinary conditions. The qualities can have refreshed to framework through IoT passage [6]. The highlights of stickiness sensor are excellent linearity, low power utilization, wide estimation extend, fast reaction, against contamination, high dependability, elite value proportion. Water level pointer is utilized to quantify the water level in water system arrive. In the water level sensor esteem measure by utilizing scale level and it's speak to in cm. On the off chance that the water level achieves the base of the metal bar it demonstrates unusual condition and the control will consequently turn ON, the motor. In the event that the water achieves the specific level the motor can be killing naturally. These statuses can be endlessly revived to the structure using IoT. The Internet of things (IOT) would be the internetworking [8] connected with brute machinery, transit, architecture and varying things embedded with equipment, programming, sensors, actuators, and framework organize that engage these articles to gather and exchange data. These contraptions hoard critical data with the help of various existing advances and after that uninhibitedly stream the data between various devices. The module can even be reconstructed to go about as an independent Wi-Fi. IOT is becoming 3.3v power– don't self-discipline magnetism accompanying 5 volts. data processing should put across by the use of following through 3.3v additionally doesn't feel 5v tolerant sources of info, so you require level change to speak with a 5V microcontroller.

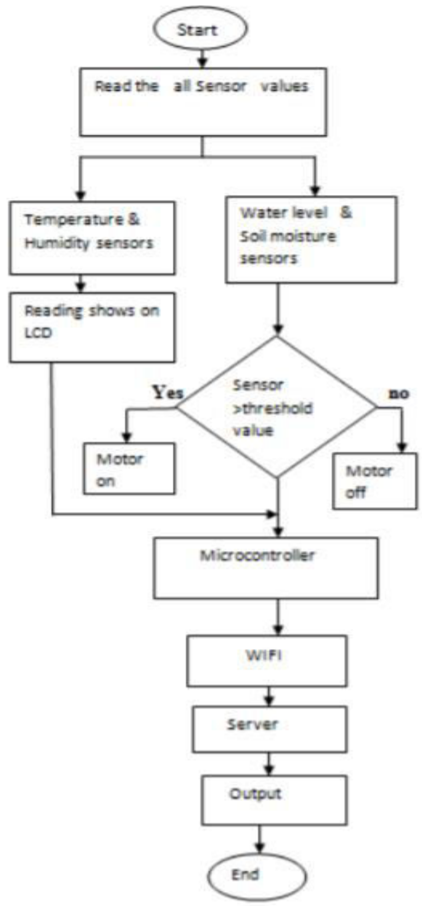

Figure.7. Flow Chart

V. RESULT

The yield appeared beneath signifies the temperature, soil dampness state and the gate crasher discovery. The next outcome is the yield as of the Android purpose that is produced in the cell phone. It decides the temperature, stickiness, dampness as well as the interloper discovery. The yield appeared beneath means the temperature, soil dampness state with the gate crasher identification. The second outcome is the yield from the Android purpose that is produced in the cell phone. It decides the temperature, dampness, dampness with the gate crasher location.

VI. CONCLUSION

Therefore, the paper proposes a thought of consolidating the most recent innovation into the agrarian field to turn the customary techniques for water system to current strategies in this way making simple profitable and temperate trimming. Some degree of mechanization is presented empowering the idea of observing the field and the product conditions inside some long-separate extents utilizing cloud administrations. The points of interest like water sparing and work sparing are started utilizing sensors that work consequently as they are modified. This idea of modernization of farming is straightforward, reasonable and operable. As relying upon these parameter esteems rancher can without much of a stretch choose which fungicides and pesticides are utilized for enhancing crop creation.

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