Application of Sensors & IoT based technology in Drip Irrigation

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Abstract- Irrigation is a vital input in agricultural productivity and agricultural growth. More than 80% of accessible water resources worldwide as well as in India are being presently utilized for irrigation purposes. However, in India, the average efficiency of water used for Irrigation Projects is assessed to be only of the order of 30-35%, and also the scarcity of clean water resources around the globe has generated a necessity for optimum utilization of clean water resources. IoT plays an important role in many fields, one of that is Agriculture which can help to save water significantly by properly estimating the need for water in the soil for the crop to grow & cultivate properly. The whole system is microcontroller

based and can be operated from a remote location through wireless transmission so there is no need to be concerned about irrigation timing as per crop or soil condition. The sensor is used to take sensor readings of soil like soil moisture, temperature, and air moisture this data received from sensors is then sent to the server database using wireless transmission, and decision making is controlled by the user(farmer). The farmer is notified with the real-time information regarding field conditions through mobile periodically. This system will be more useful in areas where there is a scarcity of water and will be worth efficient in satisfying its requirements. We will not only use a new technic but also choose the proper type of irrigation to efficiently use the technic and also to save water like Drip Irrigation. Drip irrigation is one amongest the highly effective water-saving technology which is adopted for the potential usage of the available water. This technology will increase the productivity of the crops by efficiently using water resources. Despite many advantages of drip irrigation many farmers in the country have not adopted drip irrigation, so to find and also to analyze the reasons for the farmers for not adopting drip irrigation, including financial constraints, water scarcity, and no subsidy from the govt. authorities, damage by the animals, high maintenance cost, lack of technical skills, etc., the aim of this paper is to overcome this challenge. This paper discusses the need to increase the efficiency of water in existing Irrigation Projects and new projects by studying the successful case studies in detail.

Keywords – Internet of Things(IoT), soil moisture sensors, Drip Irrigation, modernization of irrigation system, wireless transmission, optimum utilization of clean water resources, efficient use of water resources, no subsidy from the govt. authorities.

I. INTRODUCTION

1.1 Introduction:-

Agriculture plays a crucial role in the development of a country. In India, over 72% of individuals depend on farming is one-third of the population invests in farming. A country like India has which has very good climatic conditions to grow different types of agricultural crops. But at the same time land and water are the more crucial resources in India. Among these two, inadequacy in water resources causes a sizably voluminous impact on the yield of agricultural crops. So, water scarcity has an astronomically immense impact on agriculture. The absence of water makes the farmers struggle to produce crops and this makes a downfall to feed every human in the growing population. according to International Water ManagementInstitute(IWMI) states that 70% of accumulated water usage from the ground level, is employed for domestic, industrial, and environmental uses increase the water scarcity problem. If such an amount of water is employed for other usages, then the main use of water for agriculture has been shirked, causing the population to think about the optimal way of water management.

One such method of water management is the irrigation system. Irrigation is a vital input in agricultural productivity and agricultural growth. More than 80% of accessible water resources worldwide as well as in India are being presently utilized for irrigation purposes. In India, agriculture plays an important role in the development of food production and it depends on monsoons that are not sufficient sources of water. So the irrigation process is adopted in the agriculture field. However, in India, the average efficiency of water used for Irrigation Projects is assessed to be only of the order of 30-35%, and also the scarcity of clean water resources around the globe has generated a necessity for optimum utilization of clean water resources. There is no doubt that modernization of irrigation systems like using the Internet of Things (IoT) which is a milestone in the evolution of technology is needed. IoT plays an important role in many fields, one of that is Agriculture which can help to save water significantly by properly estimating the need for water in the soil for the crop to grow & cultivate properly. The whole system is microcontroller based and can be operated from a remote location through wireless transmission so there is no need to be concerned about irrigation timing as per crop or soil condition. The sensor is used to take sensor readings of soil like soil moisture, temperature, and air moisture this data received from sensors is then sent to the server database using wireless transmission, and decision making is controlled by the user (farmer) by using a microcontroller. The irrigation is going to be automated when the moisture and temperature of the field area are reduced. The farmer is notified with the information regarding field conditions through mobile periodically. This system will be more useful in areas where there is a scarcity of water and will be worth efficient in satisfying its requirements. We will not only use a new technic but also choose the proper type of irrigation to efficiently use the technic and also to save water like Drip Irrigation. Drip irrigation is a highly effective water-saving technology that is adopted for the potential usage of the available water. The traditional form of irrigation is surface irrigation, where water will flow within the land to reach the destination of the crops, this repeatedly leads to wastage of water. But, Drip irrigation is a technology that will take the water directly to the root of the crops through the pipes. This technology will increase the productivity of the crops by efficiently using water resources. The findings are about

the factors that drive the adoption of drip irrigation in a separate part of the country, India. Despite many advantages of drip irrigation many farmers in the country have not adopted drip irrigation, so the findings also analyze the reasons for the farmers not adopting drip irrigation, including financial constraints, water scarcity, and no subsidy from the govt. authorities, damage by the animals, high maintenance cost, lack of technical skills, etc., the aim of this paper is to overcome this challenge and provide a sufficient solution for it. [2] [3] [1]

1.2 Background :- [6]

Irrigation is believed to have started in Egypt, in Mesopotamia. People directed an overflow of water in any one region to a place where water for agriculture was required. The automation of irrigation systems began in the 1800s, and there has been no turning back since then. The shift towards automatic irrigation systems occurred because the value of a house at that time was often based on the condition of its lawn. To ensure the right amount of water was provided to the plants, the sprinkler system was introduced in the 1950s. This was followed by several innovations that controlled the activity of these sprinklers and further more development have taken place in this ideology.

II. LITERATURE REVIEW

Sr. no	Title of paper	Important data from the paper
1.	**A Study on Understanding the Adoption of Water Saving Technology: A Case Study of Drip Irrigation [1]**	1. The traditional form of irrigation in the agriculture is the surface irrigation, where water will flow through the ways of the crops. There will be a huge loss of water in this type of irrigation, because the water has to flow in the sand where there is a chance of evaporation before the water reaches the destination. Drip irrigation is a type of the micro irrigation, which plays a major role in water conservation and increasing the productivity of the crops by utilizing every single drop of the water. Drip irrigation is an advanced system which will irrigate the water directly through the crop with the help of motor and PVC pipes. 2. Drip irrigation is one of the water saving technology which is used for the potential usage of the available water. The traditional form of irrigation is surface irrigation, where water will flow in the land to reach the destination of the crops, this will lead to wastage of water. But, Drip irrigation is a technology which will take the water directly to the root of the crops through the pipes. This technology will increase the productivity of the crops. The finding is about the factors that drives the adoption of drip irrigation in Erode district in Tamil Nadu, India. Despite many advantages in the drip irrigation many farmers in the district have not adopted to the drip irrigation, so the findings also analyses the reasons for the farmers to not adopt drip irrigation, including financial constraints, water scarcity, no subsidy from the government, damages by the animals, high maintenance cost, lack in technical skills, etc.,
2.	**A Study On Smart Irrigation Systems For Agriculture Using IoT [2]**	1. Agriculture plays an imperative role in the country's development. In our country, more than 72% of people depend upon farming which is one-third of the population invests in farming. Thus, the challenges and issues concerning agriculture need to be focused to hinder the country development. The only recommended solution to this issue is modernizing agriculture using smart technologies. IoT can construct agricultural and farming processes more efficient by tumbling human intervention through automation. In agriculture, irrigation is one of the processes which support crop production by supplying needed water to the soil. The irrigation methods involve lot of time and effort in farming. A Sensor-based automated irrigation system provides a promising solution to manage agricultural activity. This research article provides a vast study on the irrigation system in smart agriculture.
3.	**An IOT based Smart Irrigation System using Soil Moisture and Weather Prediction.[3]**	1. The scarcity of clean water resources around the globe has generated a need for their optimum utilization. Internet of Things (IoT) solutions, based on the application specific sensors' data acquisition and intelligent processing, are bridging the gaps between the cyber and physical worlds. IoT based smart irrigation systems can help in achieving optimum water-resource utilization in the precision farming landscape.

4.	**Smart Irrigation system using Internet of Things. [4]**	A smart irrigation system is configured with various Essential components as listed as follows. • ARDUINO Uno • DHTll Temperature and Humidity Sensor • Connecter wire • Bread Board, Laptop • Water level Sensor • Soil Moisture Sensor. Some of the software requirements are Thing Speak application, Arduino application, C Programming for Arduino
5.	**Smart Irrigation Technology: Controllers and Sensors. [5]**	Wind Sensors:- Watering during windy conditions reduces irrigation distribution uniformity across the landscape and decreases the amount of water infiltrating into the soil profile. Wind sensors interrupt the irrigation cycle if wind speed exceeds a specific threshold.

III. METHODOLOGY

3.1 Material and Components Used:-

A smart irrigation system is configured with various essential components as listed as follows.

• ARDUINO Uno

• DHTll Temperature and Humidity Sensor

• Connecter wire

• Water level Sensor

• Soil Moisture Sensor

• Rain and freeze Sensors

• Wind Sensors

• Wifi Module

• Bread Board & Jumper wire

Some of the software requirements are Thing Speak application, Arduino application, C Programming for

Arduino.

3.1.1 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a PC with a USB cable or power it with a AC-to-DC adapter or battery to begin.

It is a open source which is organizes the components by the programming language and integrates the enterprise with the client group to produce microcontroller packs. These microcontroller packs are used as an intelligent agent which was programmed to detect and to control working of the system in the real-life. Generally, Arduino boards are inexpensive and used in various operating systems. It is easy and flexible for the beginners. It is compatible with various languages such as C++ and JAVA. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. [4]

Figure 3.1: *Arduino Uno*

3.1.2 DTH11 Sensor:

DTH-11 sensor is a very popular sensor for measuringthe humidity and temperature with +0.5 degree accuracy. DTH-11 sensor consists of a moisture sensing sensor, atemperature sensor, and an IC on the backside of the sensor. It comes with 4 pins and 3 pins.

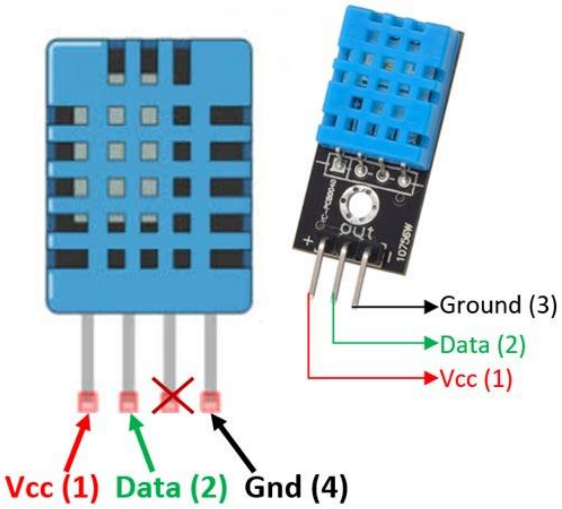

Figure 3.2:*DTH11 Sensor*

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermostat to measure the surrounding air and spits out a digital signal on the data pin. It measures relative humidity. The relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in the air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. It detects water vapor by measuring the electrical resistance between two electrodes. [4]

3.1.3 Soil moisture sensor

Soil moisture sensors measure the volumetric water content in soil .Since the direct gravimetric measurement of free soil moisture requires removing, drying and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the soil, then read the resistance of soil for reading moisture level. We

known that water make the soil more prone to electric conductivity resulting less resistance in soil where on other hand dry soil has poor electrical conductivity thus more resistance in soil. [4]

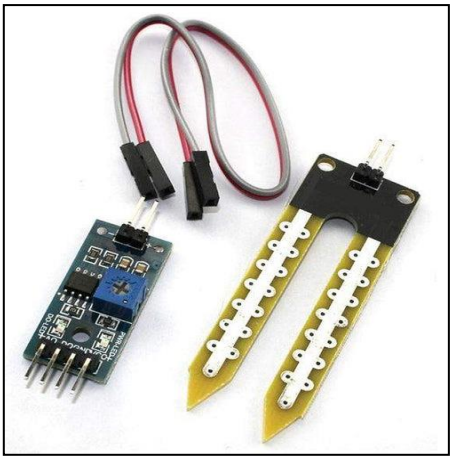

Figure 3.3: *SOIL MOISTURE SENSOR*

3.1.4 Rain and Freeze Sensors

Although these sensors are not considered smart technology, rain and freeze sensors interrupt the irrigation cycle during a rain or freeze event when irrigation is unnecessary. Watering during the rain wastes water, money and causes unnecessary runoff.

Potential water savings depends on the amount of rainfall in any given year. During years with average to above average rainfall, water savings are more significant than during dry years. Rain sensors have shown payback periods of less than a year, but should be monitored for optimum performance (Cardenas-Laihacar and Dukes, 2008).

Freeze sensors interrupt an irrigation cycle when air temperatures fall below 32 F. Eliminating irrigation during freezing temperatures can potentially extend irrigation system life and prevent sidewalks and streets from icing over, causing dangerous situations. There are many rain sensors including a freeze sensor therefore the homeowners should account for sensor capability when considering the worth .

3.1.5 Wind Sensors

Watering during windy conditions reduces irrigation distribution uniformity across the landscape and decreases the amount of water infiltrating into the soil profile. Wind sensors interrupt the irrigation cycle if wind speed exceeds a specific threshold.[5]

Figure 3.4: *Irrigating during windy conditions wastes water and reduces system efficiency.*

3.1.6 Wifi Module

ESP-8266 is a cheap Wi-Fi module. It has dualfunctionality; it can carry and drive the entire application andcan control other micro-controller units. Its working power range is 3.0 to 3.6 volts. It has a built-in TCP/IP stack.[4]

Figure 3.5: *Wifi module*

3.1.7 Bread Board and jumper wires

A breadboard is a solider less contrivance for ad interim template with test circuit designs. A bounce wire (generally called jumper, jumper wire, jumper interface, DuPont wire, or DuPont interface – named for one creator of them) is an electrical wire or social occasion of them in a connection with a connector or stick at each end (or from time to time without them– essentially "tinned"), which is commonly utilized to interconnect the sections of a breadboard or other model or test circuit, inside or with other hardware or parts, without soldering. Singular bob wires are attached by implanted their "end connectors" into the initial way gave in a breadboard, the header connector of a circuit board, or a touch of test outfit. [4]

Figure 3.7: *JUMPER WIRE*

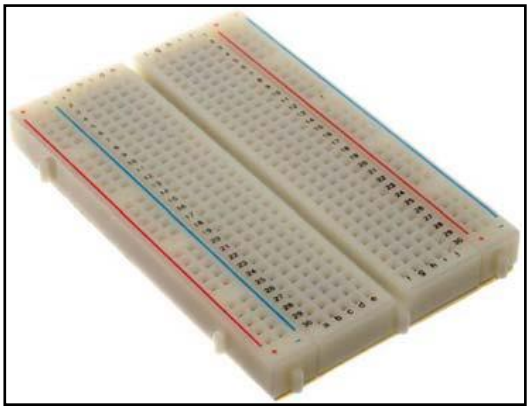

Figure 3.6: *FREE BOARD*

3.2 Proposed concept

The irrigation system will be automated by using sensors, microcontrollers, Wifi/Bluetooth, and Android applications. We will use sensors like soil moisture sensor, temperature and humidity (DTH11) sensor, rain and freeze sensor, wind sensor, Wifi module, and the breadboard, this sensor is connected to the Arduino board. This hardware communicates through wire-less wifi transmission so that the user can access the data through his mobile that has an android application that can get the sensor data from the Arduino via Wifi. As far as the cost of the device is considered Wifi technology is used which can be replaced by Bluetooth. The Arduino board is programmed using Embedded C in order to control the transmission of sensor data and the working of the motor according to the (farmer) decision-maker. The coordination of the motor and sensors are maintained by the program

fed into the Arduino. After preparing the sensors and programming them properly, the sensors are placed in every section of the field at a certain depth beneath the soil near the crop roots to get accurate results.

As we know that drip irrigation is a technique in which water flows through a filter into special drip pipes, with emitters located at different spacing. Water and nutrient are distributed through the emitters directly into the soil near the plant's roots zone through a special slow-release device, in the right amounts, at the right time, so each plant gets exactly what it needs, when it needs it, to grow optimally. This sensor will provide us with real-time data which is then transmitted through wireless transmission and is reached to the user on his mobile phone so that he can control the irrigation process as per his requirement.

A mobile application is to be designed in such a way to analyze the data received and provide information accordingly. The threshold values for both soil moisture and temperature and humidity are going to be set and stored within the Arduino and mobile application. The sensor value varies according to the climatic conditions as soil moisture will be different in the summer and winter seasons and so as the temperature and humidity values. The threshold value is fixed after considering all the environmental and weather conditions. The decision can be made either by the application automatically without user interruption like work if soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF or manually through the application with user interruption.

The sensors continuously send data regarding the moisture content of the soil. Whichever sensor indicates low moisture content, the valve gates are opened in that particular area automatically and the motor is switched on and then water is pumped, if it indicates high moisture content valve gates are closed and the pumping of water is stopped by switching off the motor. All of these are managed by the program that has been written into the Arduino Micro-controller. The farmer can even switch on the motor from mobile using the mobile application. The irrigation system is automated once the control is received from the mobile application.

An ultrasonic sensor is used to monitor the water level in the reservoir. The ultrasonic sensor work according to the piezoelectric method. It has a trigger pin and echo pin. The trigger pin act as a transmitter and therefore the echo pin act as a reflector. The trigger pin sends ultrasonic waves once it started functioning. The ultrasonic waves once started functioning. The ultrasonic waves hit the water and reflected towards the echo pin. The duration to receive the echo is calculated which indicates the water level. The duration is converted to the distance using the subsequent equation:

$$\text{Distance in cm} = \left(\frac{\text{duration}}{2}\right)/29.1$$

$$\text{Distance in inches} = \left(\frac{\text{duration}}{2}\right)/74$$

Before the motor is switched on, the water level is checked to ensure that the required amount of water is available for irrigation. If the required amount of water is not present, the motor will not be switched on or only less amount of water is supplied. The notification is sent to the farmer's mobile for further decisions to be made.

IV. Advantages, Disadvantages & Limitations

4.1 Advantage of Sensors & IOT based technology in Drip Irrigation:

1. Save water by efficiently using water as per the crop requirement.
2. Gives real-time analysis of the field for better decision-making.
3. Fewer labors are required as almost the whole system is automated and every step is controlled by the owner's mobile phone.

4.2 Disadvantage of Sensors & IOT based technology in Drip Irrigation:

1. Skilled labors are required as the whole system is automated by technology.
2. Maintenance cost is high.

4.3 Limitations

The main limitations are,

1. User should have a proper understanding of the whole system to completely utilized it.
2. Due to heavy rainfall soil erosion take place and result in the displacement of sensors.

V. CONCLUSION & FUTURE SCOPE

As scarcity of clean water increases with the decrease in soil quality we need a proper solution to tackle this type of problem for future generations. We carried out research on the application of IoT-based irrigation systems by using drip irrigation to efficiently and effectively use the water resources for agriculture. The IoT-based system helps in analyzing the requirement and need of water to grow a particular crop according to the climatic condition, type of soil, type of crop to grow, etc. This paper proposed an IoT-based smart irrigation system utilizing sensors to record the data and provide a real-time analysis through wireless transmission to the user on his mobile phone. The whole system is automated and controlled by the user through a mobile phone so it can also be time-saving and less effort is needed. Decision-making is done very efficiently and accurately due to the real-time analyzed report. In the future, these IoT-based sensors can be used for the calculation of different properties of soil by using recorded data. This type of system can be you for pre-analysis of soil for foundation, retaining walls, etc, and give a rough value of the soil properties required.

VI. ACKNOWLEDGMENT

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