"AN IOT-BASED SMART PLANT WATERING SYSTEM"

A Project Report Submitted in Partial Fulfillment of the Requirement for the Degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

A.KALYANI (16091A0138)
M.HARSHA VARDHAN REDDY (16091A0127)
C.NARENDRA (17095A0122)
K.BHUVAN CHANDRA (16091A0110)
B.PRATHYUSHA (15091A0184)

Under the Esteemed Guidance of

Dr.G.SREENIVASULU Ph.D IISc

Professor of Civil Engineering

Department of Civil Engineering

R. G. M College of Engineering and Technology

(Autonomous),

Nandyal 518 501, A. P., INDIA

(Affiliated to J. N. T. University Ananthapur, A. P., INDIA)

(Approved by AICTE, Accredited by N.B.A, NewDelhi, NAAC-A+ Grade)

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(ESTD-1995)

CERTIFICATE

This is to certify that the Project Report entitled "AN IOT-BASED SMART PLANT WATERING SYSTEM " that is being submitted by

A.KALYANI	(16091A0138)
M.HARSHAVARDHANREDDY	(16091A0127)
C.NARENDRA	(17095A0122)
K.BHUVAN CHANDRA	(16091A0110)
B.PRATHYUSHA	(15091A0184)

in partial fulfillment of the requirement for the award of B.Tech in Civil Engineering in the **RAJEEV GANDHI MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY,**Nandyal (Affiliated to J.N.T University, Anantapur) is a bonafide record of confide work carried out by her under our guidance and supervision. The results embodied in this technical report have not been submitted to any other university or institute for the award of any Degree.

Signature of the Project Guide
Dr. G. Sreenivasulu Ph.D (IISc),
Professor and HOD

Signature of Head of the Department
Dr. G. Sreenivasulu Ph.D (IISc),
Professor and HOD

Examiner:
Date:

Dedicated to my beloved parents, and teachers who have worked hard throughout my education.

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A.KALYANI

M.HARSHA VARDHAN REDDY

C.NARENDRA

K.BHUVAN CHANDRA

B.PRATHYUSHA

Abstract

Automation of farm activities can transform agricultural domain from being manual and static to intelligent and dynamic leading to higher production with lesser human supervision.Internet Of Things (IOT) is a shared network of objects or things which can interact with each other and provide the internet connectivity. IOT plays an important role in agriculture industry. Smart agriculture helps to reduce wastage, effective usage of fertilizer and thereby increase the crop yield. In this work, a system is developed to monitor crop-field using sensors (soil moisture) and automate the irrigation system. These sensors are connected to AurdinoUNO which can receive the sensor data and transmit it . The micro controller will analyse the sensor data and determine the amount of water needed for irrigation. The amount of water required for the field is based on the type of crop, duty and delta. It also sends control signal to the Relays. The micro controller can also transmit the data to web server. By using web application the data can be read from the web server and analysed and then control commands can be sent to the micro controller through internet.

Key words:Automation, Microcontroller, Arduino Uno, IOT, Wireless Sensor Network, Duty, Delta, Soil Moisture.

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Chapter 1

Introduction

1.1 GENERAL

Agriculture is the unquestionably the largest livelihood provider in India. With rising population, there is a need for increased agricultural production. In order to support greater production in farms, the requirement of the amount of fresh water used in irrigation also rises. Currently, agriculture accounts 83% of the total water consumption in India. Unplanned use of water inadvertently results in wastage of water. This suggests that there is an urgent need to develop systems that prevent water wastage without imposing pressure on the farmers.

Over the past 15 years, farmers started using computers and software systems to organize their financial data and keep track of their transactions with third parties and also monitor their crops more effectively .In the Internet era, where information plays a key role in people's lives, agriculture is rapidly becoming a very data intensive industry where farmers need to collect and evaluate a huge amount of information from a diverse number of devices (eg., sensors, faming machinery etc.) in order to become more efficient in production and communicating appropriate information With the advent of open source Arduino boards along with cheap moisture sensors, it is viable to create devices that can monitor the soil moisture content and accordingly irrigating the fields or the landscape as an when needed.

Figure 1.1: Agricultural Feild

1.2 INTRODUCTION TO IOT (INTERNET OF THINGS)

The Internet of things (IOT) is a system of interrelated computing devices, mechanical and digital machines that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.
The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks.
control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In the consumer market, IOT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers.

There are a number of serious concerns about dangers in the growth of IOT, especially in the areas of privacy and security, and consequently industry and governmental moves to begin to address these.

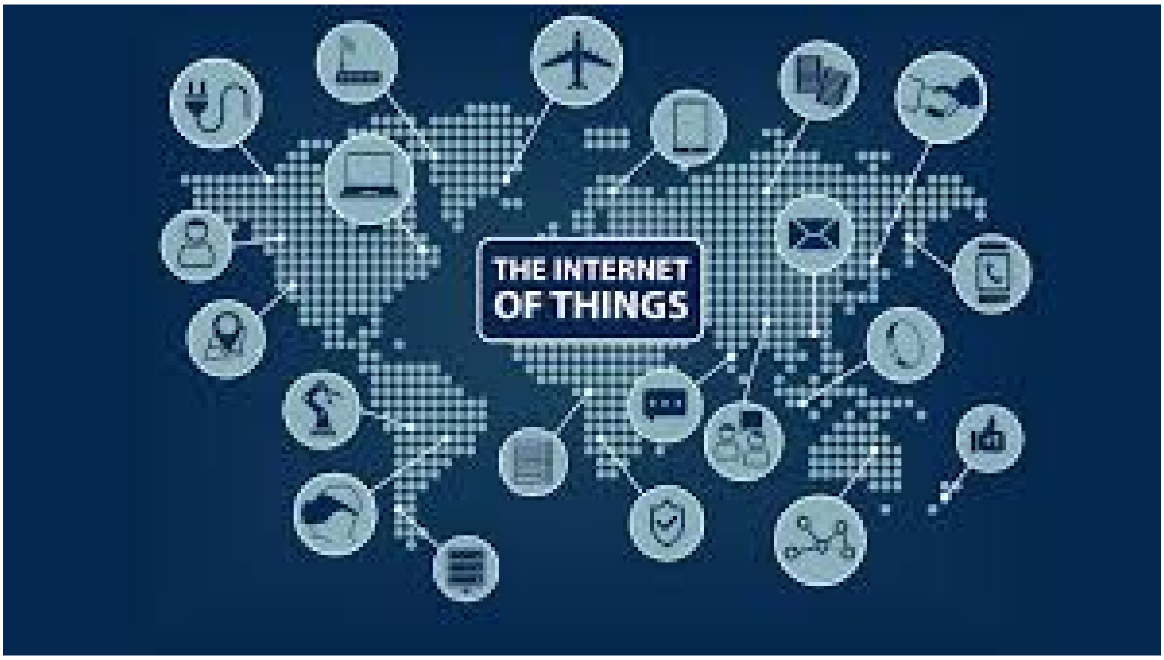

Figure 1.2: IOT

- **Today, Internet application development demand is very high.**
- **Basically,IOTis a network in which all physical objects are connected to the internet through network devices or routers and exchange data.**
- **IOT allows objects to be controlled remotely across existing network infrastructure.**
- **It refers to the billions of physical devices around the world that are now connected to the internet,all connecting and sharing data.**
- **The term IOT is mainly used for devices that wouldnt usuallybe generally expected to hacve an internet connection.**
- **The idea of adding sensors and intelligence to basic objects was discussed in the 1980s and 1990s.**
- **Processors were cheap and power-frugal enough to be all but disposal where needed became before cost effective.**

- **The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at Carnegie Mellon University becoming the first internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold. Kevin Ashton (born 1968)is a British technology pioneer who is known for inventing the term "the Internet of Things" to describe a system where the Internet is connected to the physical world viaubiquitous sensors.**

- **IoT is able to interact without human intervention. Some preliminary IoT applications have been already developed in healthcare, transportation, and automotive industries. IoT technologies are at their infant stages; however, many new developments have occurred in the integration of objects with sensors in the Internet.**

- **The development of IoT involves many issues such as infrastructure, communications, interfaces, protocols, and standards. The objective of this paper is to give general concept of IoT, the architecture and layers in IoT, some basic terms associated with it and the services provided.**

1.2.1 Concept of IOT

Kevin Ashton firstly proposed the concept of IoT in 1999, and he referred the IoT as uniquely identifiable connected objects withradio-frequency identification (RFID) technology. However, the exact definition of IoT is still in the forming process that is subject to the perspectives taken. IoT was generally defined as "dynamic global network infrastructure with self-configuring capabilities based on standards and communication protocols".

- **Physical and virtual things in an IoT have their own identities and attributes and are capable of using intelligent interfaces and being integrated as an information network. In easy terms IoT can be treated as a set of connected devices that are uniquely identifiable.**

- **The words "Internet" and "Things" mean an inter-connected world-wide network based on sensors, communication, networking, and information processing technologies, which might be the new version of information and commu-**

nications technology (ICT). To date, a number of technologies are involved in IoT, such as wireless sensor networks (WSNs), barcodes, intelligent sensing, RFID, NFCs, low energy wireless communications, cloud computing and so on.

- **The IoT describes the next generation of Internet, where the physical things could be accessed and identified through the Internet. Depending on various technologies for the implementation, the definition of the IoT varies. However, the fundamental of IoT implies that objects in an IoT can be identified uniquely in the virtual representations. Within an IoT, all things are able to exchange data and if needed, process data according to predefined schemes.**

1.2.2 Architecture of IOT

A critical requirement of an IoT is that the things in the network must be connected to each other. IoT system architecture must guarantee the operations of IoT, which connects the physical and the virtual worlds. Design of IoT architecture involves many factors such as networking, communication, processes etc. In designing the architecture of IoT, the extensibility, scalability, and operability among devices should be taken into consideration. Due to the fact that things may move and need to interact with others in real-time mode, IoT architecture should be adaptive to make devices interact with other dynamically and support communication amongst them. In addition, IoT should possess the decentralized and heterogeneous nature.

Service oriented architecture A critical requirement of an IoT is that the things in the network must be inter-connected. IoT system architecture must guarantee the operations of IoT, which bridges the gap between the physical and the virtual worlds. Design of IoT architecture involves many factors such as networking, communication, business models and processes, and security. In designing the architecture of IoT, the extensibility, scalability, and interoperability among heterogeneous devices and their models should be taken into consideration. Due to the fact that things may move physically and need to interact with each other in real-time mode, IoT architecture should be adaptive to make devices interact with other things dynamically and support unambiguous communication of events.

1.2.3 IOT Applications In Agriculture

There are numerous IOT applications in farming such as collecting data on temperature, rainfall, humidity, wind speed, pest infestation, and soil content. This data can be used to automate farming techniques, take informed decisions to improve quality and quantity, minimize risk and waste, and reduce effort required to manage crops. For example, farmers can now monitor soil temperature and moisture from afar, and even apply IoT-acquired data to precision fertilization programs.

The proposed system makes use of microcontroller ATMEGA328P on Arduino Uno platform and IOT which enable farmers to remotely monitor the status of moisture content installed on the farm by knowing the sensor values thereby, making the farmers' work much easier as they can concentrate on other farm activities.

Chapter 2

Irrigation In India

2.1 Soil moisture constants

1. Saturation Capacity

   This can also be called as maximum moisture holding capacity or total capacity and is the amount of water required of water required to fill all the pore spaces between soil particles by replacing all air held in pore spaces. It is the upper limit of possible moisture content. When the porosity of a soil is known, the saturation capacity can be expressed as equivalent cm of water per meter of soil depth. So, if the porosity is 50% by volume, the moisture in each meter of saturated soil is equivalent to depth of 50cm the field surface.

2. Field Capacity:

   The field capacity is the moisture content of the soil after free drainage has removed most of the gravity water. The concept of field capacity is extremely useful in arriving at the amount of water available in the soil for plant use. Most of the gravitational water drains through the soil before it can be used consumptively by plants.

3. Permanent Wilting Point :

   Permanent Wilting Point is defined as the minimum amount of water in the soil that the plant requires not to wilt. If the soil water content decreases to this or any lower point a plant wilts and can no longer recover its turgidity when placed in saturated atmosphere for 12 hours.

4. Temporary Wilting:

   Temporary wilting may sometimes take place during hot windy-day, but the plant will recover in the cooler portion, of the day. No addition of water is required. Thus temporary wilting may take place during the hot summer day, even when soil moisture is higher than the wilting coefficient, because of increased transpiration rates.

5. Ultimate Wilting:

   Ultimate wilting is slightly different from permanent wilting. When ultimate wilting occurs, the plant will not regain its turgidity even after the addition of sufficient water to the soil and the plant will die. The soil moisture tension at ultimate wilting point is as high as 60 atm. The ultimate wilting point occurs at the hygroscopic water content. Hence the ultimate wilting point is also known as hygroscopic coefficient. The ultimate wilting point or the hygroscopic coefficient is about 2/3 of the permanent wilting point.

6. Available Moisture :

   The difference in water content of the soil between field capacity and permanent wilting point is known as available moisture.

7. Readily Available Moisture :

   It is the portion of the available moisture that is most easily extracted by plants, and is approximately 75% of the available moisture.

8. Moisture Equivalent:

   This is an artificial moisture property of the soil and is used as an index of the natural properties. It is the percentage of moisture retained in a small sample of wet soil 1cm deep when subjected to a centrifugal force 1000 times as great as gravity, usually for a period of 30 minutes. Moisture equivalent is used as single factor to which equivalent roughly equals field capacity for a moisture textured soil.

   The relation between these are as follows :

   Moisture equivalent = Field capacity

   = 1.5 to 2 Permanent wilting point

= 2.7 Hygroscopic coefficient.

9. Soil Moisture Deficiency:

   Soil moisture deficiency or field moisture deficiency is the water required to bring the soil moisture content of the soil to its field capacity.

2.2 Crop Seasons in India

1. Kharif Crops:

   The word Kharif is Arabic for autumn since the season coincides with the beginning of autumn or winter. Kharif crops also are known as monsoon crops. These are the crops that are cultivated in the monsoon season. The Kharif season differs in every state of the country but is generally from June to September. These crops are usually sown at the beginning of the monsoon season around June and harvested by September or October. Rice, maize, bajra, ragi, soybean, groundnut, cotton are all Kharif types crops.

2. Rabi Crops:

   The Arabic translation of the wordRabi is spring. These crops harvesting happens in the springtime hence the name came. The Rabi season usually starts in November and lasts up to March or April. Rabi crops are mainly cultivated using irrigation since monsoons are already over by November. In fact, unseasonal showers in November or December can ruin the crops. The seeds are sown at the beginning of autumn, which results in a spring harvest. Wheat, barley, mustard and green peas are some of the major rabi types of crops that grow in India.

3. Zaid Crop:

   There is a short season between Kharif and Rabi season in the months of March to July. The crops that grow in this season are Zaid crops. These crops are grown on irrigated lands and do not have to wait for monsoons. Some examples of Zaid types of crops are pumpkin, cucumber, bitter groud.

2.3 Major Types of Crops in India

1. Rice:

   Rice is tropical crop that can be grown almost throughout the year.

   India is the second largest producer of rice in the world.

   It is a kharif,rabi type of crop.

   Rainfall required is 150 cm.

   Temperature required for this crop is 24℃.

   Major producers are West Bengal, Uttar Pradesh, Andhra Pradesh,Punjab,Bihar,Orissa,Assam,Tamil Nadu,Haryana.

2. Wheat:

   It is the 2nd most important food crop in India.

   Type of crop is Rabi.

   Temperature required is 17-20 ℃.

   Rainfall required for this crop is 20 - 100 cm.

   Soil type is Clay loam, Sandy loam.

   Major producers are Gujarat, Maharashtra, Haryana, Madhya Pradesh, Punjab, Rajasthan, Bihar, West Bengal, Uttarakhand.

3. Cotton:

   Cotton is a tropical and subtropical kharif crop.

   India ranks 3rd in the production of cotton worldwide.

   It is a dry crop but roots need timely supply of water at maturity.

   Temperature required for this crop is 21-30 ℃.

   Rainfall required for this crop is 50-100 cm.

   Soil type is Black soil(Highly water retentive soil).

   Major producer are Gujarat, Maharashtra, Andhra Pradesh, Haryana, Madhya Pradesh, Punjab, Rajasthan, Karnataka, Tamilnadu, Orissa .

4. Jute:

   Jute is a tropical plant that requires hot and humid climate.

   Almost 85% of the world's jute is cultivated in the Ganges Delta.

Type of soil is Zaid.

Temperature required for this crop is 24 - 35 ℃.

Rainfall required for this crop is 125 - 200 cm.

Soil type is Sandy and Clay loam.

Major Producers are West Bengal, Bihar, Assam, Andhra Pradesh, Orissa, Meghalaya, Nagaland, Tripura, Uttar Pradesh .

5. Tea:

   Tea is an evergreen plant that mainly grows in tropical and subtropical climates.

   India is the 2nd largest procedure and the largest consumer of tea in the world.

   Tea plants require high rainfall but its roots cannot tolerate water logging.

   Temperature required for this crop is 20 - 30 ℃.

   Rainfall required for this crop is 150 - 300 cm.

   Soil type is Loamy soil which is acidic in nature and rich in organic matter.

   Major Producers are Assam, Darjeeling(West Bengal), Meghalaya, Kerala, Himachal Pradesh, Tamilnadu, Karnataka.

Chapter 3

Literature Review and Study Objectives

3.1 Literature Review

- **IOT BASED SMART IRRIGATION SYSTEM** Srishti Rawal(2017)
  A system to monitor moisture levels in the soil was designed and the project provided an opportunity to study the existing systems, along with their features and drawbacks. The proposed system can be used to switch on/off the water sprinkler according to soil moisture levels thereby automating the process of irrigation.Information from the sensors is regularly updated on a webpage using GSM-GPRS SIM900A modem through which a farmer can check whether the water sprinklers are ON/OFF at any given time. Also, the sensor readings are transmitted to a Thing speak channel to generate graphs for analysis.
- **ARDUINO BASED SMART IRRIGATION SYSTEM USING IOT** R.Nandhini1, S.Poovizhi2, Priyanka Jose3, R.Ranjitha4, Dr.S.Anila(2017)
  The main objective of this smart irrigation system is to make it more innovative, user friendly, time saving and more efficient than the existing system. Measuring four parameters such as soil moisture, temperature, humidity and pH values and the system also includes intruder detecting system. Due to server updates farmer can know about crop field nature at anytime, anywhere.
- **SMART IRRIGATION SYSTEM** R.Suresh (2014).
  This paper mentioned about using automatic microcontroller based rain gun irrigation system in which the irrigation will take place only when there will be intense requirement of water that save a large quantity of water. These systems bring a change to management

of field resource where they developed a software stack called Android is used for devices that include an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language. Mobile phones have almost become an integral part of us serving multiple needs of humans. This application makes use of the GPRS feature of mobile phone as a solution for irrigation control system. These system covered lower range of agriculture land and not economically affordable.

- **A STUDY ON SMART IRRIGATION SYSTEM USING IOT** Bobby Singla,Satish Mishra,Abhishek Singh,Shashank Yadav(2019).
  The most highlighted feature of this paper is how smartly and automatically control the water supply to the agriculture fields according to the need. For this, sensors used are soil moisture sensor and DHT-11 temperature sensor. All the information is sent on the farmer mobile application using Wi-Fi Relay Module and Arduino UNO R3.

3.2 Study Objectives

- To save water and reduce human intervention in the agriculture field.

- Continuously Monitoring the status of sensors and provide signal for taking necessary action.

- To get the output of soil moisture sensor and provide required water to crop.

- To observe other parameters for better yield .

Chapter 4

Components For Smart Irrigation

The proposed system consists of different components, the brief introduction about components was given below.

- Soil moisture sensor.
- Arduino UNO.
- Jumpers.
- Pump.
- Relays.

4.1 Soil moisture sensor

- In this proposed system the soil moisture sensor is one part of the wireless sensor unit.

- Use: To measure the moisture content of the soil.

- Copper electrodes are used to sense the moisture content of soil.

- Soil Moisture Sensor. The Soil Moisture Sensor is used to measure the volumetric water content of soil. This makes it ideal for performing experiments in courses such as soil science, agricultural science, environmental science, horticulture, botany, and biology.

Working Principle of Moisture Sensor

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium In soil, dielectric permittivity is a function of the water content. The sensor averages the water content over the entire length of the sensor.

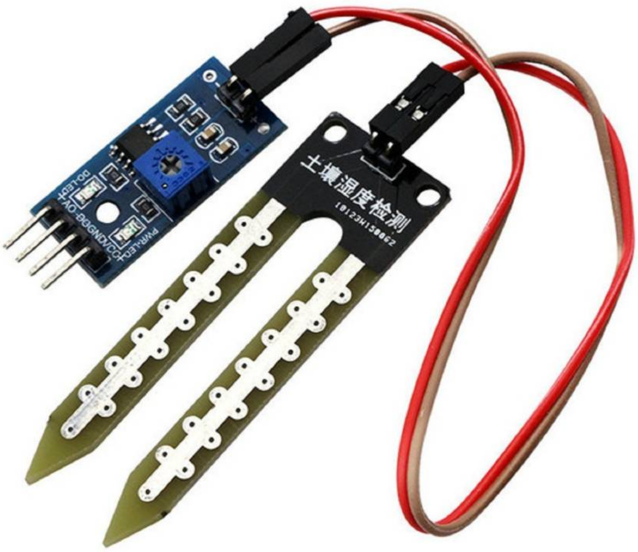

Figure 4.1: Soil Moisture Sensor

4.2 Arduino UNO:

- The Arduino Uno board is a micro controller based on the AT mega 328.

- It has 14 digital input and output pins (of which 6 can provide PWM output), 6 analog inputs, a USB connector, a power jack an reset bottom.

- The operating voltage is 5 volts.

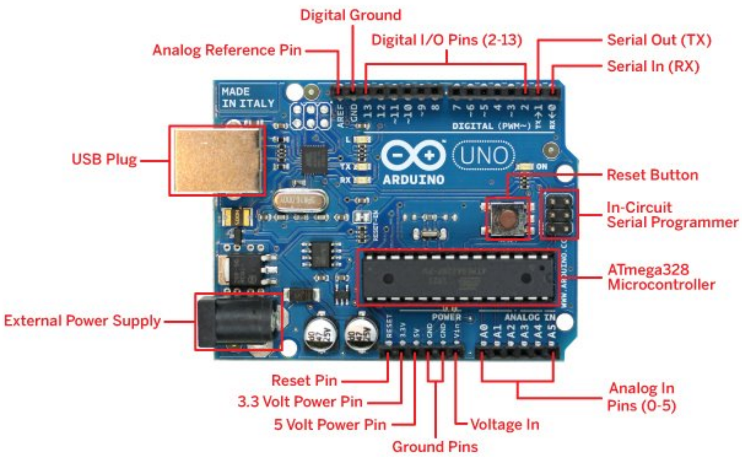

Figure 4.2: Arduino UNO

4.3 Jumpers

Jumper wirestypically come in three versions: male-to-male, male-to-female andfemale-to-female. The difference between each is in the end point of thewire. Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used withbread boardsand other prototyping tools in order to make it easy to change a circuit as needed.

Figure 4.3: Jumpers

4.4 Pump:

Pump is used for lifting water from the source and pumping those water to the field by using pipes.

The supplied voltage is 5 volts.

By using the pump or motor the water generation is to be done by conneting through pipes to the farm feild.

Figure 4.4: Pump

4.5 Relay

2-Channel 5V Relay Module is a relay interface board, it can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and so on. It uses a low level triggered control signal (3.3-5VDC) to control the relay. Triggering the relay operates the normally open or normally closed contacts.

The relay has two outputs-normally open and normally closed (NO and NC). When the IN1 or IN2 pin is connected to ground, NO will be open and NC will be closed, and when IN1 or IN2 is not connected to ground the opposite occurs. ... A microcontroller can also be used to control IN1 and or IN2 and cause the relay to trip.

Since the relay has 5V trigger voltage we have used a +5V DC supply to one end of the coil and the other end to ground through a switch. ... The purpose of the diode is to protect the switch from high voltage spike that can produced by the relay coil.

Figure 4.5: Relay

Chapter 5

METHODOLOGY

5.1 System Overview

In order to solve the water management to the irrigation system we proposed this " IOT-Based Smart Plant Watering System ".

This prototype monitors the amount of soil moisture . A predefined range of soil moisture is set, and can be varied with soil type or crop type.In case the moisture of the soil deviates from the specified range, the watering system is turned on/off.

The proposed system used to control the water irrigation system using Wireless Sensor Unit (WSU) and Wireless Control Unit (WCU) based on microcontroller.

The block diagram of smart plant watering system is represented below. It consists of a microcontroller which is the brain of the system.Both soil moisture sensors are connected to the input pins of the controller. The relay is connected to output pins. Relay and two motors are coupled with eachother. If the sensors depart from the predefined range, the controller turns on the pump. The relay is used to control the motor.

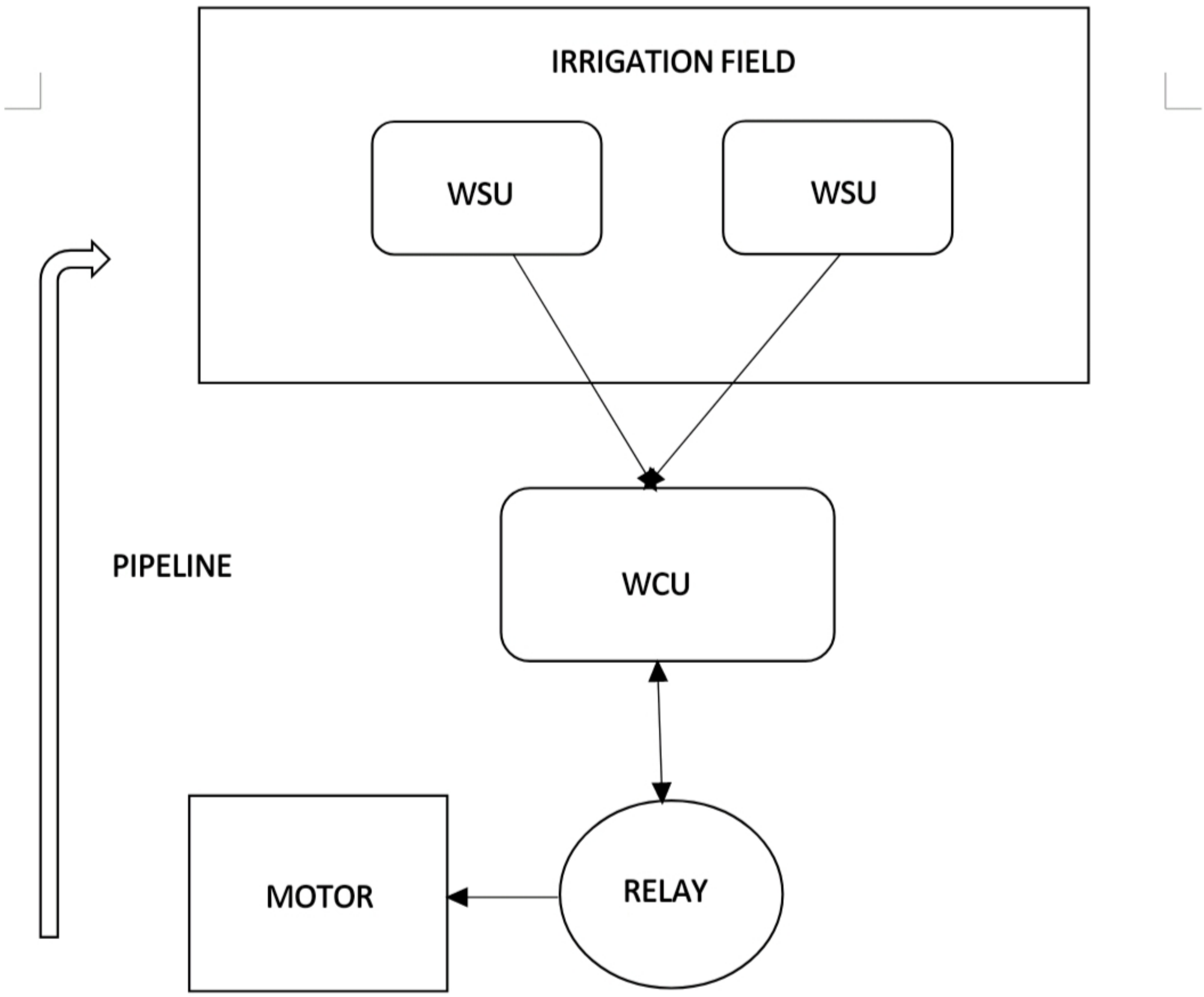

Figure 5.1: Block Diagram

5.2 Project Description

Hard Ware Design:

In our model,we are demonstrating watering of two feilds, so two soil moisture sensors are used.Depending on the number of feilds the number of moisture sensors will vary.When the soil moisture sensor is interfaced with the board the inbuilt ADC in Arduino is used to convert the data into digital form (0 to 1023),which represents resistance. Dry soil will have maximum resistance and wet soil will have least resistance.

The relay is connected with the output pins of the Arduino, the motor will turned on using relay when the value is less than the threshold value. The vice versa is applicable when value is greater than the threshold value.

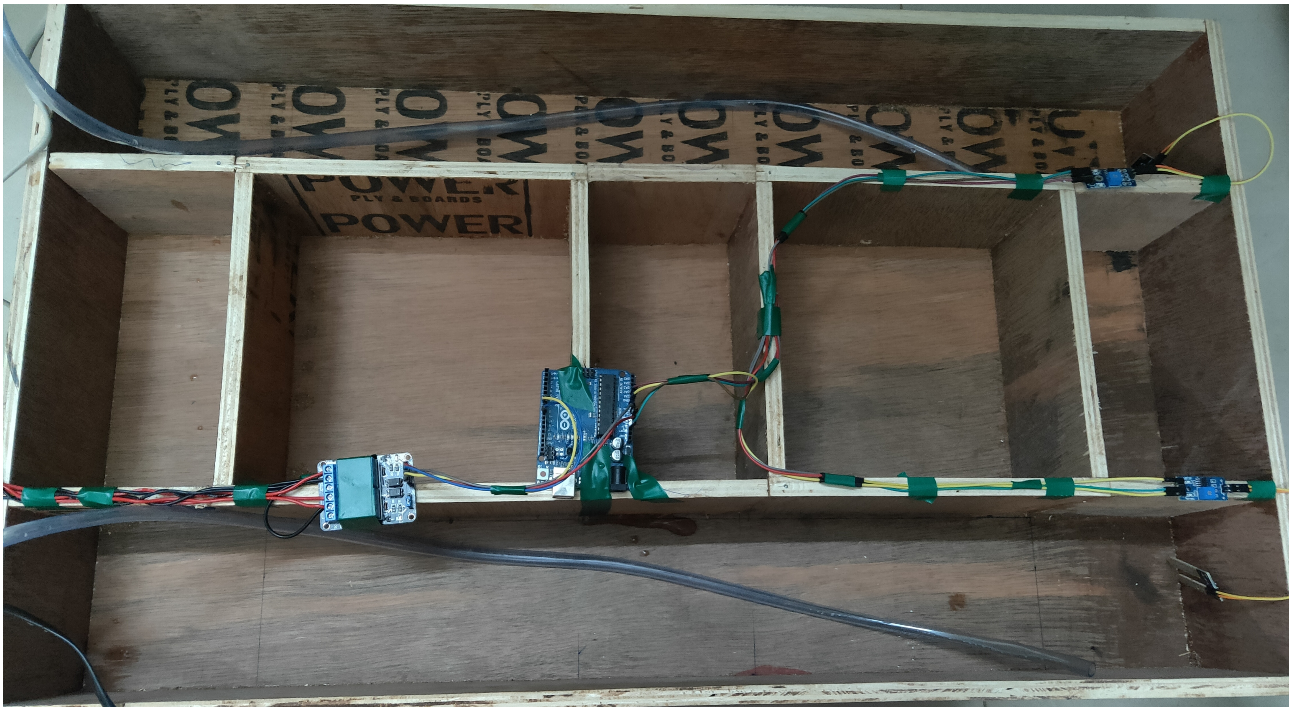

Figure 5.2: Prototype

Software Design

The software used in this project is Arduino. It provides a number of libraries to make programming simple. In our prototype, the controller AtMega328 is programmed in Arduino. The program is arduino designates a preset range of resistance value in digital format(ranging from 0 to 1023) for both the moisture sensor. Any aberration from the set range switches ON/Off the pump, to water the plants.

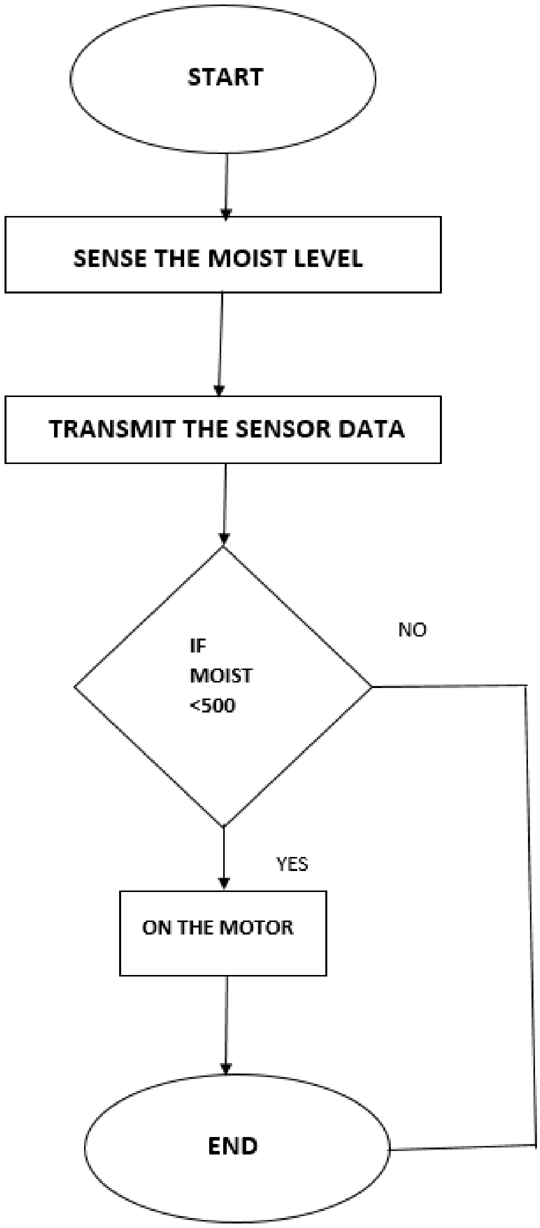

Figure 5.3: Flow Chart

moisture2 | Arduino 1.8.9

File Edit Sketch Tools Help

moisture2

```
int trig1 = 7;
int trig2 = 8;
void setup() {
  // put your setup code here, to run once:
pinMode(trig1,OUTPUT);
pinMode(trig2,OUTPUT);
Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
int moist1 = analogRead(A0);
int moist2 = analogRead(A1);
if (moist1 < 450)
{
  digitalWrite(trig1,HIGH);
  Serial.println(moist1);
}
else if(moist2 < 500)
{

   digitalWrite(trig2,HIGH);
   Serial.println(moist2);
}
else
{
  digitalWrite(trig2,LOW);
  digitalWrite(trig2,LOW);
}
}
```

Figure 5.4: Program for Arduino UNO

Chapter 6

RESULTS

6.1 Advantages

- Water Conservation.
- Lowered Operation Costs.
- Efficient and Saves Time.
- Increase in productivity.
- Reduce soil erosion and nutrient leaching.
- very accurate
- Ability to read soil volumetric water content directly.
- Continuous measurements at same location.

6.2 Disadvantages

- Difficult in maintaince
- Difficult in setup/repairs
- In the case of equipment like robots amd computer based intelligents for running the devices,it is highly unlikely that a normal farmer will be able to possess this knowledge or even develope them.
- The procces will cost huge amount.

Chapter 7

CONCLUSION

A system to monitor moisture levels in the soil was designed. The proposed system can be used to switch on/off the water supply (or) motor according to soil moisture levels thereby automating the process of irrigation which is one of the most time consuming activities in farming. The system uses information from soil moisture sensors to irrigate soil which helps to prevent over irrigation or under irrigation of soil thereby avoiding crop damage. Through this project it can be concluded that there can be considerable development in farming with the use of IOT and automation. Thus, the system is a potential solution to the problems faced in the existing manual process of irrigation by enabling efficient utilization of water resources.

Further Work

To improve the efficiency and effectiveness of the system, the following recommendations can be put into consideration. Option of controlling the water pump can be given to the farmer i.e. he can switch on/off the pump in order to start/stop the process of irrigation without being present at the farm. The farmer may choose to stop the growth of crops or the crops may get damaged due to adverse weather conditions. In such cases farmer may need to stop the system remotely. The idea of using IOT for irrigation can be extended further to other activities in farming such as cattle management, fire detection and climate control. This would minimalize human intervention in farming activities.

Chapter 8

REFERENCES

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