SUMMER INTERNSHIP REPORT

On

Smart Irrigation System

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Certificate

This is to certify that the internship project entitled **"Smart Irrigation System"** was successfully completely the following students from various colleges in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology (B. Tech.)** under the internship program at **AICTE IDEA Lab - Guru Gobind Singh Indraprastha University** New Delhi - 110078.

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Declaration

We hereby declare that the project work presented in this internship report, entitled **"Smart Irrigation System"** is entirely our own work and has not been submitted for any degree or diploma from this or any other institute for partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology (B.Tech)**

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Abstract

In the face of increasing global water scarcity and the need for sustainable agricultural practices, smart irrigation systems present a promising solution. The main objective of this project is to provide a system leading to an automatic irrigation thereby saving time, money and power of the farmers, gardeners in greenhouses etc. The system is designed to automate the irrigation process by monitoring soil moisture levels and controlling the flow of water accordingly.

Soil moisture sensors are strategically placed within the agricultural field to provide real-time data on the moisture content of the soil. This data is then processed to determine the precise irrigation needs, ensuring that plants receive the optimal amount of water. Additionally, ESP microcontrollers are employed to monitor environmental parameters such as temperature and humidity. The collected data is transmitted wirelessly to a central server, allowing for remote monitoring and control.

Our system aims to reduce water wastage and enhance crop yield by providing accurate and timely irrigation based on the specific needs of the soil and environmental conditions. The integration of IoT technology in agriculture through this smart irrigation system highlights the potential for significant improvements in resource efficiency and agricultural productivity.

The system is designed to adapt to varying climate conditions and crop needs, thus promoting sustainable agricultural practices. Initial tests demonstrate the system's effectiveness in conserving water and maintaining soil moisture levels, proving its potential for broader application in agriculture.The results of our study indicate that the implementation of such systems can lead to sustainable water management practices, making them an essential component of modern agriculture.

Keywords: ESP 8266, Soil moisture Detector, Arduino UNO R3, Smart Irrigation, Internet of Things, Technology,DHT-11,Solenoid Valve, 4 Channel Relay

Table of Contents

Certificate **ii**

Declaration **iii**

Acknowledgement **iv**

Abstract **v**

List of Figures **vii**

1 Introduction **1**
- 1.1 Project Overview 2
  - 1.1.1 Efficient Irrigation System 2
  - 1.1.2 Key Features 2
- 1.2 Benefits 3
- 1.3 Potential Impact 3

2 Literature Survey **4**

3 Architectural Overview **6**
- 3.1 Programming Boards 6
  - 3.1.1 Arduino Uno R3: 6
  - 3.1.2 Esp8266 8
- 3.2 Application of Sensors and Solenoid Valve 11
  - 3.2.1 Soil Moisture Sensor 11
  - 3.2.2 4 channel Relay 12
  - 3.2.3 Solenoid Valve 14
  - 3.2.4 DHT 11 15

4 Methodology **17**
- 4.1 Agriculture Field Simulation 17
- 4.2 Usage of solenoid valves 18
- 4.3 IOT system for humidity calculation 19

5 Result **20**
- 5.1 Outcomes from the Project 20
- 5.2 Future Improvements: 21

6 Conclusion **23**

7 Bibliography **24**

List of Figures

3.1 Arduino [1] 6
3.2 Pin Mode Layout 8
3.3 Pin Layout of Esp8266 11
3.4 Pin layout of soil moisture sensor 12
3.5 Working of soil moisture sensor 12
3.6 Pin layout of Relay 13
3.7 Circuit Diagram of 4 channel relay 14
3.8 Working of solenoid valve 15
3.9 dht11 callibrated with esp8266 16

4.1 Set up of agriculture field in a box 17
4.2 Circuit Diagram of Soil Moisture sensor along with Uno 18
4.3 Circuit Diagram of Solenoid Valve 18
4.4 Realtime Monitoring using Dht11 19

1. Introduction

Agriculture is the backbone of many economies, and efficient water management is crucial for sustainable crop production. Traditional irrigation methods often lead to water wastage and do not meet the precise needs of crops. The Internet of Things (IoT) has been at the forefront of technological advancements over the past decade, transforming various aspects of everyday life through enhanced safety, ease, and efficiency. IoT technology has enabled seamless inter-device communication, facilitating automation and smarter decision-making processes across numerous applications.

Our project, the "Smart Irrigation System," leverages IoT to develop an advanced solution for optimizing water usage in agriculture. This system utilizes soil moisture sensors to measure soil moisture levels accurately. These sensors communicate with an Arduino microcontroller, which acts as the system's brain, comparing the received moisture levels with predefined thresholds. Based on this comparison, the Arduino controls the irrigation system, automatically turning it on or off to ensure crops receive the optimal amount of water.

To further enhance the system's efficiency, we have integrated ESP devices to monitor environmental parameters such as temperature and humidity. This data is transmitted wirelessly to a central server, enabling remote monitoring and real-time adjustments to the irrigation schedule based on current weather conditions. This integration of IoT technology ensures that water is used efficiently and effectively, reducing wastage and promoting sustainable agricultural practices.

1.1 Project Overview

1.1.1 Efficient Irrigation System

In an era where water conservation and sustainable agricultural practices are paramount, our project focuses on developing an advanced irrigation system that leverages modern technology to optimize water usage for crop irrigation. This system is designed to be both intelligent and automated, ensuring that crops receive the precise amount of water they need for optimal growth while minimizing waste.

1.1.2 Key Features

- **Real-Time Monitoring:**
  - **Moisture Sensor:** These sensors are strategically placed in the soil to continuously monitor the moisture levels. They provide real-time data on soil humidity, enabling the system to determine when watering is necessary.
  - **DHT11 Sensor:** DHT11 sensor is used to monitor environmental conditions such as temperature and humidity. This data helps optimize irrigation schedules by adjusting water flow based on current weather conditions, ensuring efficient water usage and enhancing crop health.
- **Automated Watering System:**
  - Based on the data collected from the sensors, the system automatically activates the irrigation process when soil moisture falls below a predefined threshold. This automation reduces the need for manual intervention and ensures that crops are watered consistently and accurately. The system is equipped with a microcontroller or a similar processing unit that collects data from the sensors. Using pre-set algorithms, it processes this data to make informed decisions about when and how much water to dispense.
- **Efficient Water Usage:**
  - By precisely controlling the amount of water delivered to the crops, the system prevents overwatering and under-watering, thereby conserving water and promoting healthy crop growth.

1.2 Benefits

- **Water Conservation:** The system's precision in water delivery ensures that water is used efficiently, reducing waste and conserving this vital resource.
- **Improved Crop Health:** Maintaining optimal soil moisture levels helps in preventing crop stress and diseases, leading to healthier plants and better yields.
- **Labor Savings:** Automation reduces the need for constant monitoring and manual watering, saving time and effort for farmers.

1.3 Potential Impact

The adoption of this Efficient Irrigation System can lead to significant advancements in agricultural practices. By promoting sustainable water management and enhancing crop productivity, it supports the goals of environmental conservation and food security. This project represents a step towards modernizing agriculture through technology, ensuring that farming practices are both sustainable and productive.

2. Literature Survey

Darshna et al. [1] suggested
In the work by Authors A. N. Arvindan and D. Keerthika [1], the Android smartphone was used as a remote control to make Arduino-based automated irrigation system easy-to-use and an economical one. The design of this system includes a soil moisture sensor that provides a voltage signal proportional to the moisture content in the soil, which is compared with a predetermined threshold value. On the basis of this comparison result, the appropriate data are fed to the Arduino Uno processor, which is linked by the HC-05 module to an Android phone. Android smartphone allows the user easy remote control for the irrigation system to switch on, to the drive motor. The system has the potential to be used in the real-time precision agriculture application.

In the research by the Chandan Kumar Sahu and Pramitee Behra [2], the authors present a prototype for full automation accessing of irrigation motor where Prototype includes numbers of sensor placed in different directions of the farm field. Each sensor is integrated with a wireless networking device and the data received by the "ATMEGA-328" microcontroller, which is an ARDUINO-UNO development board. The RASPBERRY-Pi is used to send messages through internet correspondence to the microcontroller process. The objectives of this paper were to control the water motor automatically and select the direction of the flow of water in a pipe with the help of soil moisture sensor. The information, which is considered as the operation of the motor and direction of water of the farm field, is finally sent to the user using mobile message and e-mail account.

In the paper by D. Baghyalakshmi et al. [3] the implementation details of WSN based temperature monitoring application. The main feature for the authors' proposed network is to continuously monitor the temperature in the 128 nodes High-Performance Computing Cluster for its smooth functioning. The wireless sensor node sense and transmit the current value of temperature to the base station. This paper explains about performance analysis of the network and the various steps involved in the experimental implementation and maintenance of the temperature monitoring network for High Performance Computing cluster.

In the paper by R. M. Aileni [4] , the author presents a mobile application for healthcare, which process data from humidity and temperature sensors. The mobile app is based on cloud computing SaaS (software as a service) cloud computing model. The cloud-computing infrastructure based on sensors is used in this paper for deploying an application, which provides patients monitoring (moisture, temperature or blood pressure). The data is sent and stored in a dedicated server for being analyzed later by doctors or caregivers. The advantages of sensor-cloud also come from using PaaS (platform as a service) and IaaS (infrastructure as a service) models.

In another research by P. Archana and R. Priya[5], the authors proposed a technique in which the humidity and soil moisture sensors are placed in the root zone of the plant. Based on the sensed values, the microcontroller is used to control the supply of water to the field. However, their system does not intimate the farmer about the field status.

In the paper by Sonali D. Gainwar and Dinesh V. Rojatkar[6] , the authors proposed a fully automated system in which soil parameters such as pH, humidity, moisture and temperature are measured for getting a high yield from the soil. In this system, the motor pump switches ON/OFF as per the level of moisture in the soil. However, the current field status is not intimated to the farmer. In another paper V. R. Balaji and M. Sudha [8], the authors proposed a paper in which the system derives power from sunlight through photo-voltaic cells. This system doesn't depend on electricity. The soil moisture sensor has been used and based on the sensed values PIC microcontroller is used to ON/OFF the motor pump. Weather forecasting is not included in this system.

In the research by C. H. Chavan and P. V. Karnade [7], the authors proposed a smart wireless sensor network for monitoring environmental parameters using Zigbee. These nodes send data wirelessly to a central server, which collects data, stores it, and allows it to be analyzed then displayed as needed and also be sent to the client mobile. Weather forecasting and nutrient content is not determined in this system.

3. Architectural Overview

The Smart Irrigation System uses a variety of Sensors,Programming boards and Valve.Their architecture and pin diagram is as follows:

3.1 Programming Boards

3.1.1 Arduino Uno R3:

The Arduino UNO R3 is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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 computer with a USB cable or power it with a AC-to-DC adapter or battery to get started

Architecture

Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories-Program memory and the data memory.The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.

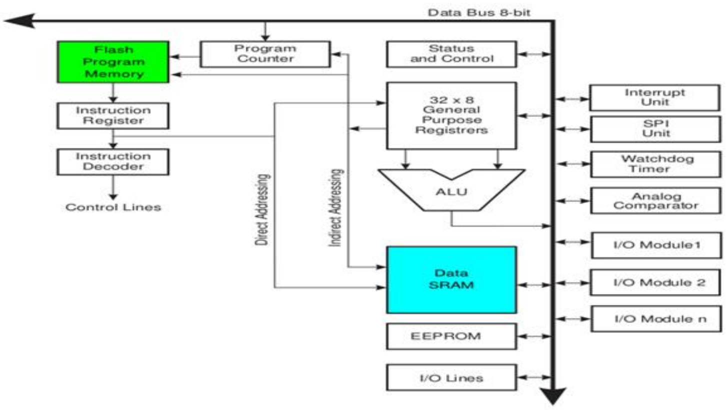


Figure 3.1: Arduino [1]

Pin Description

Pin description of Arduino Uno:

- **1.Power Pins** Vin: This is the input voltage to the Arduino board when it's using an external power source .

  5V: The regulated power supply used to power the microcontroller and other components on the board.
  3.3V: A 3.3V supply generated by the on-board regulator. Maximum current draw is 50 mA.
  GND: Ground pins.
  IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates.

- **2.Analog Pins** A0-A5: These pins can be used as analog inputs. They can also be used as digital inputs or outputs. Additionally, some of these pins have specialized functions:
  A4 (SDA): Used for I2C communication.
  A5 (SCL): Used for I2C communication.

- **3.Digital Pins** D0-D13: These pins can be used as digital input or output using the functions pinMode(), digitalWrite(), and digitalRead(). Each pin can provide or receive 20 mA as recommended operating conditions and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. Some of these pins have specialized functions:
  D0 (RX): Used to receive TTL serial data.
  D1 (TX): Used to transmit TTL serial data.
  D2: Interrupt 0 (interrupt service routine).
  D3: Interrupt 1, PWM (Pulse Width Modulation).
  D4: PWM.
  D5: PWM.
  D6: PWM.
  D7: PWM.
  D8: - D9: PWM.
  D10: PWM, SS (Slave Select for SPI).
  D11: PWM, MOSI (Master Out Slave In for SPI).
  D12: MISO (Master In Slave Out for SPI).
  D13: SCK (Serial Clock for SPI), also connected to the built-in LED. Communication Pins
  RX (D0) and TX (D1): Used for serial communication.
  SDA (A4) and SCL (A5): Used for I2C communication. SS (D10), MOSI (D11), MISO (D12), SCK (D13): Used for SPI
  communication.
  PWM Pins
  D3, D5, D6, D9, D10, D11: These pins provide 8-bit PWM output with the analogWrite() function.
  Built-in LED

D13: There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, and when the pin is LOW, it's off.
Reset Pin
RESET: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

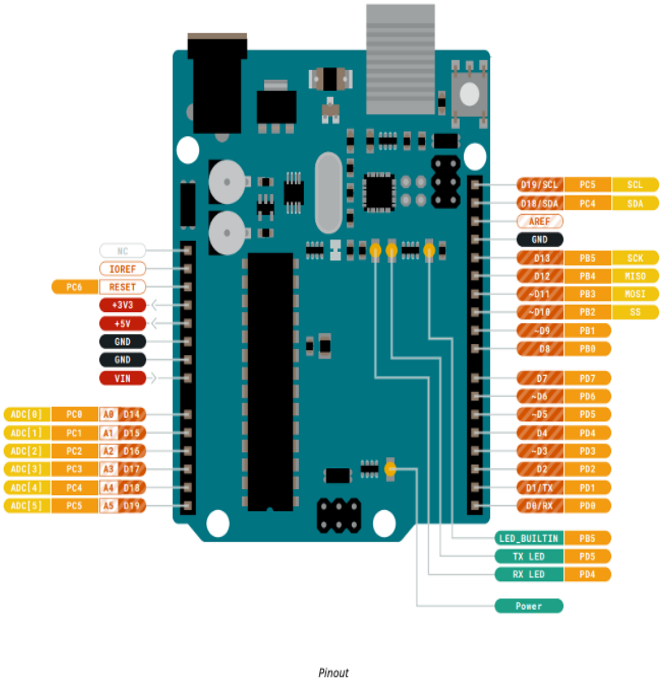


Figure 3.2: Pin Mode Layout
[8]

3.1.2 Esp8266

NodeMCU is an open-source Lua based firmware and development board. The NodeMCU ESP8266 development board comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

Pin Layout

- **Power Pins:**

- **Micro-USB:**

  The Micro-USB port stands as a vital gateway for powering the NodeMCU Development Board. Through this port, the board can draw power from an external source, typically a computer or a USB power adapter. This feature enhances the board's versatility, making it conveniently accessible for a wide array of applications.

- **3.3V :** This pin is designated for the regulated 3.3 volts power supply to the NodeMCU. The regulated nature of the power ensures a stable and consistent energy flow to the board. Users can connect an appropriate power source to this pin, reinforcing the reliability of the board's performance in diverse electronic projects.

- **GND:** Ground pins are fundamental components in any electronic setup, providing a reference potential for the circuit. The Ground pin on the NodeMCU Development Board serves this essential function, completing the electrical circuit and stabilizing the voltage levels.

- **Vin:** The Vin pin, short for Voltage In, serves as a port for an external power supply. This allows users to provide power to the NodeMCU Development Board from an independent source, offering flexibility in choosing the most suitable power input based on the specific requirements of the project. It is particularly useful in scenarios where the Micro-USB port might not be the preferred or available power source.

• **Control Pins:**

- **(Enable) Pin:** The Enable pin, denoted as EN, is a crucial element in the NodeMCU's control infrastructure. This pin acts as a switch, allowing or restricting the flow of power to the microcontroller. By manipulating the state of the EN pin, users gain the ability to turn the entire microcontroller unit on or off.

- **RST (Reset) Pin:** The Reset pin, abbreviated as RST, plays a fundamental role in restoring the microcontroller to its default state. When triggered, either through external intervention or by utilizing an integrated button, the RST pin initiates a reset mechanism.

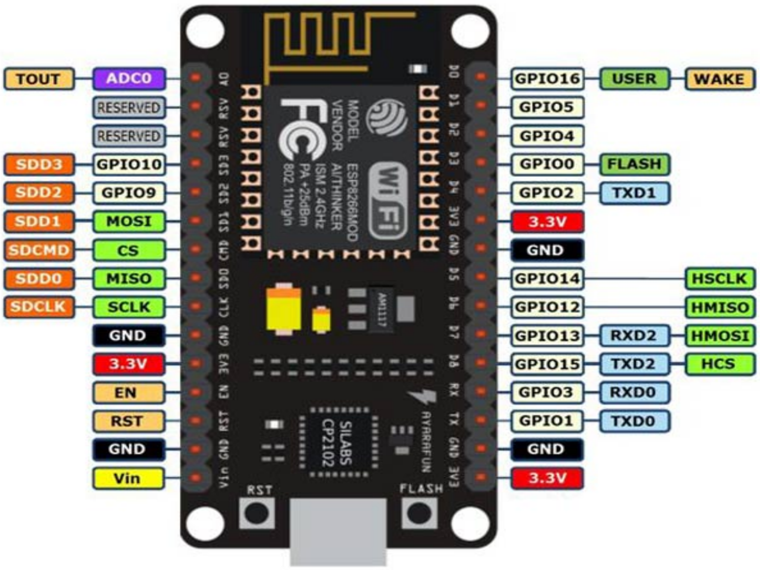
- **Analog Pin** A0, representing Analog Pin 0, is designated for the meticulous task of gauging analog voltage levels within the board's operational spectrum. This pin operates within the voltage range of 0 to 3.3V, offering a window into the subtle nuances of analog signals.

- **Vin:** The Vin pin, short for Voltage In, serves as a port for an external power supply. This allows users to provide power to the NodeMCU Development Board from an independent source, offering flexibility in choosing the most suitable power input based on the specific requirements of the project.

- **GPIO Pins** GPIO1 to GPIO16: The GPIO Pins, ranging from GPIO1 to GPIO16, collectively represent a dynamic ensemble of 16 General Purpose Input-Output pins embedded within the NodeMCU architecture. These pins are instrumental in facilitating bidirectional communication, enabling users to configure them either as inputs to receive external signals or as outputs to convey data to external components.

- **SPI Pins** SD1 (Slave Data Input/Output 1):
  SD1, or Slave Data 1, is a pivotal SPI pin that plays a crucial role in bidirectional data transfer. This pin serves as a conduit for transmitting data from the NodeMCU to a connected peripheral or receiving data from an external device.
- **CMD (Command)** The CMD pin assumes the role of signalling and control in the SPI communication process. It is responsible for conveying command signals from the NodeMCU to external devices, dictating the nature of the data transfer.
- **SD0 (Slave Data Input/Output 0)** SD0, akin to SD1, operates as a bidirectional channel for data exchange. It facilitates the reception of data from external peripherals or transmits data from the NodeMCU to the connected devices.
- **CLK (Clock)** The CLK pin, often referred to as the Clock pin, serves as the heartbeat of SPI communication. It generates a clock signal that synchronizes the timing of data transmission between the NodeMCU and connected peripherals.
- **TXD0 (Transmit Data 0)** TXD0 stands as the Transmit Data pin for UART0, the primary UART interface on the NodeMCU. This pin is responsible for transmitting serial data from the NodeMCU to external devices or peripherals.
- **RXD0 (Receive Data 0)** The RXD0 pin, denoting Receive Data for UART0, operates as the entry point for incoming serial data. It captures and relays data received from external devices to the NodeMCU.
- **TXD2 (Transmit Data 2)** TXD2, part of UART1, serves as the Transmit Data pin for the secondary UART interface. This pin is instrumental in transmitting data during communication sessions involving UART1.
- **RXD2 (Receive Data 2):** RXD2, corresponding to Receive Data for UART1, functions as the entry point for serial data received during UART1 communication. This pin complements TXD2, enabling the NodeMCU to receive data from external sources using the secondary UART interface..
- **UART1 and Firmware Upload** It's noteworthy that UART1, specifically involving RXD2 and TXD2, assumes a crucial role in the firmware upload process. During firmware upload, data is transmitted from an external source to the NodeMCU through UART1.
- **I2C Pins** The NodeMCU accommodates I2C functionality through specific pins, yet a distinctive aspect of their internal versatility necessitates a closer examination to pinpoint the dedicated I2C connections. I2C, a widely adopted serial communication protocol, facilitates the seamless exchange of data between the NodeMCU and various peripherals, such as sensors, displays, or other microcontrollers.
- **ESP8266 On-board LED** The on-board LED is linked to GPIO2.

- **Reset Pin** You can reset the board in two ways: either by pressing the reset button or by pulling the reset pin LOW.



[9]

Figure 3.3: Pin Layout of Esp8266

3.2 Application of Sensors and Solenoid Valve

3.2.1 Soil Moisture Sensor

The Soil Moisture Sensor is used to measure the volumetric water content of soil. It is used to tell whether the soil moisture content is sufficient enough for our crop or not.

Specification Sheet

- **Operating Voltage:**
  The voltage range is 3.3V to 5V DC.
- **Operating Current:**
  15mA
- **Output Type:**
  The type of output that the sensor generates, such as analog voltage or digital signals.
- **Connectivity:**
  The type of connector or interface that the sensor uses to connect to the controller or computer.
- **IC Used:**
  LM393 IC is used as a comparator.
- **Indicator:**
  Two LED Indicators are used one for Power and one for Output

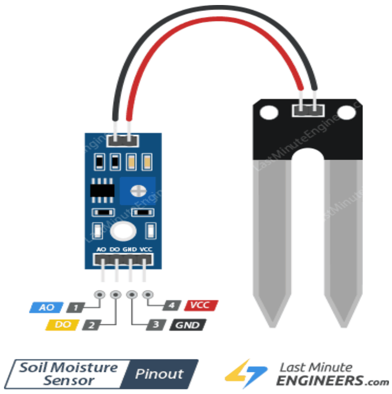


Figure 3.4: Pin layout of soil moisture sensor
[10]

Working of Soil Moisture Sensor

Soil moisture sensor has two conducting plates. First plate is connected to the +5Volt supply through series resistance of 10K ohm and second plate is connected directly to the ground. It simply acts as a voltage divider bias network, and output is taken directly from the first terminal of the sensor pin, which is shown in figure below

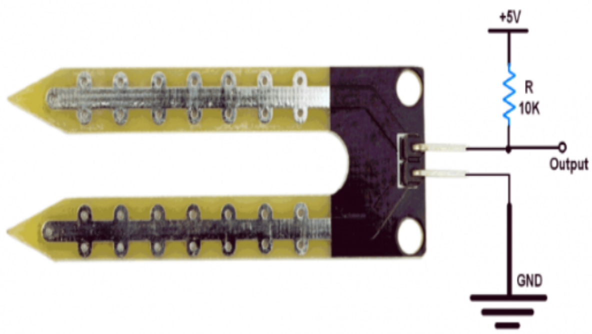


Figure 3.5: Working of soil moisture sensor
[10]

The output will change in the range of $0-5$ Volt, in proportion with change in content of water in the soil. Ideally, when there is zero moisture in soil, the sensor acts as open circuit i.e. infinite resistance. For this condition, we get 5V at the output.

3.2.2 4 channel Relay

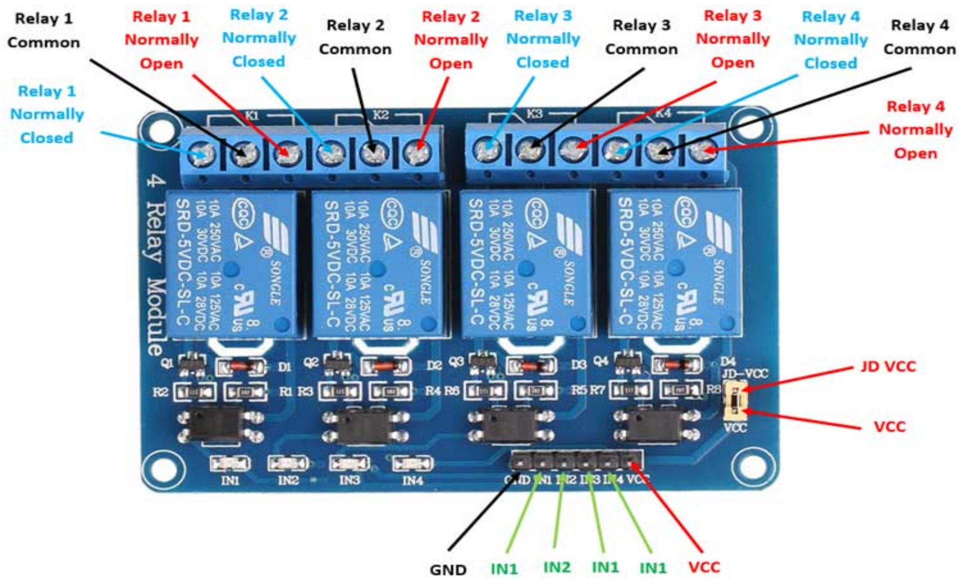
A 4 channel relay is an electronic device that allows you to control multiple high-power devices using a single low-power control signal.
Each channel corresponds to an individual relay, enabling the switching of different circuits independently.

Specification Sheet

Relay Maximum output: DC 30V/10A, AC 250V/10A.
• 4 Channel Relay Module with Opto-coupler:
LOW Level Trigger expansion board, which is compatible with Arduino control board.
• Standard interface that can be controlled directly by microcontroller (8051, AVR, *PIC, DSP, ARM, ARM, MSP430, TTL logic).
• Relay of high quality low noise relays SPDT. A common terminal, a normally open, one normally closed terminal.
• Opto-Coupler isolation, for high voltage safety and prevent ground loop with microcontroller

Pin Layout

- **Gnd:**
  Ground reference for the module
- **IN1**
  Input to activate relay 1
- **IN2**
  Input to activate relay 2
- **IN3**
  Input to activate relay 3
- **IN4**
  Input to activate relay4
- **VCC**
  Power supply for the relay module



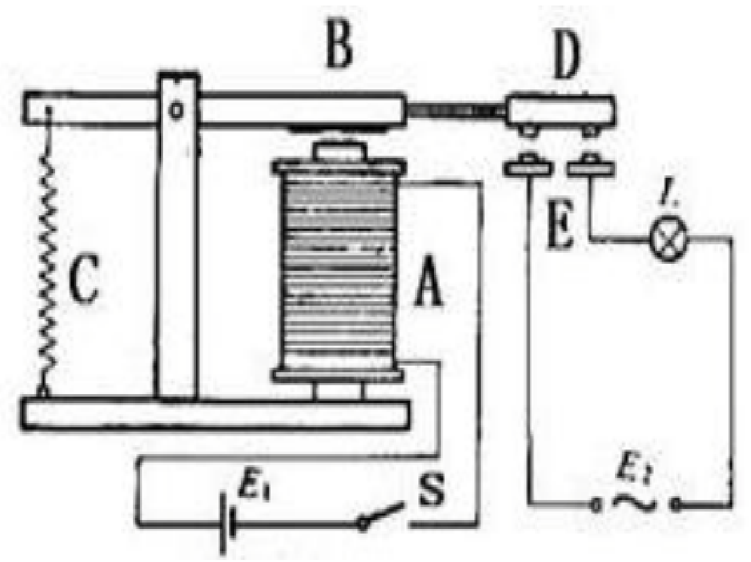
[11]

Figure 3.6: Pin layout of Relay

- **VCC**
  Power supply selection jumper
- **jVCC**
  Alternate Power Pin for Relay Module

Working OF 4 Channel Relay

See the picture below: A is an electromagnet, B armature, C spring, D moving contact, and E fixed contacts. There are two fixed contacts, a normally closed one and a normally open one. When the coil is not energized, the normally open contact is the one that is off, while the normally closed one is the other that is on.



[12]

Figure 3.7: Circuit Diagram of 4 channel relay

Supply voltage to the coil and some currents will pass through the coil thus generating the electromagnetic effect. So the armature overcomes the tension of the spring and is attracted to the core, thus closing the moving contact of the armature and the normally open (NO) contact or you may say releasing the former and the normally closed (NC) contact. After the coil is de-energized, the electromagnetic force disappears and the armature moves back to the original position, releasing the moving contact and normally closed contact. The closing and releasing of the contacts results in power on and off of the circuit.

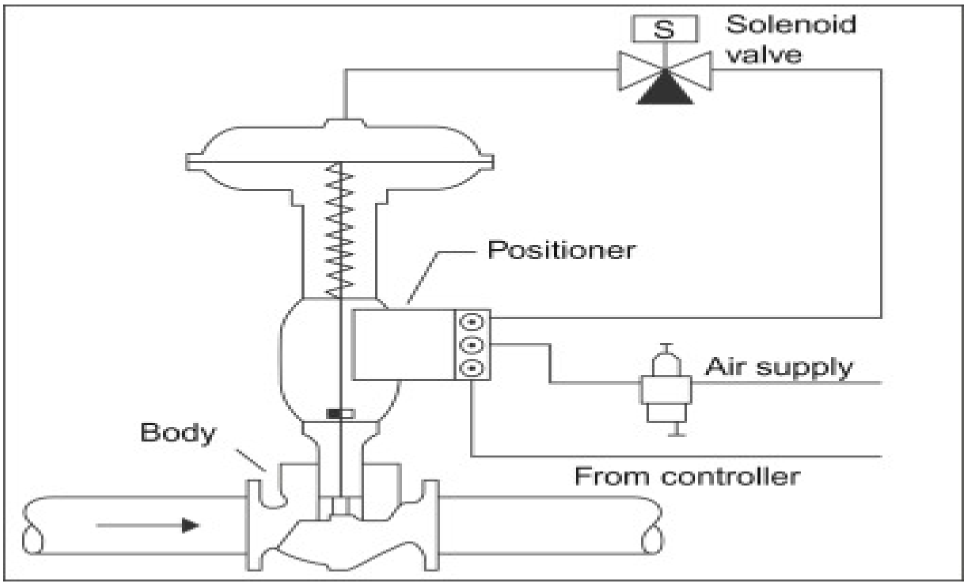
3.2.3 Solenoid Valve

A solenoid Valve is an electro-mechanical valve that is used to commonly employed to control the flow of liquid or gas

Working Of Solenoid Valve

A solenoid valve is a combination of two basic functional units: 1. A solenoid (electromagnet) with its core. 2. A valve body containing one or more orifices.

Flow through an orifice is shut off or allowed by the movement of the core when the solenoid is energized or deener-gized.



[13]

Figure 3.8: Working of solenoid valve

A common application of a solenoid valve to a diaphragm control valve is illustrated in Fig. 16.27. In an emergency the solenoid valve can be switched, causing the control valve to go to the preselected position.

3.2.4 DHT 11

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc... to measure humidity and temperature instantaneously.

Specification Sheet

Technical Details Low cost 3 to 5V power and I/O 2.5mA max current use during conversion (while requesting data) Good for 20-80 Good for 0-50°C temperature readings ±2°C accuracy No more than 1 Hz sampling rate (once every second) Body size 15.5mm x 12mm x 5.5mm 4 pins with 0.1” spacing

Working Of DHT11

DHT sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels.

For measuring temperature this sensor uses a NTC thermistor, The term “NTC” means “Negative Temperature Coefficient”, which means that the resistance decreases with increase of the temperature as shown in the graph below. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

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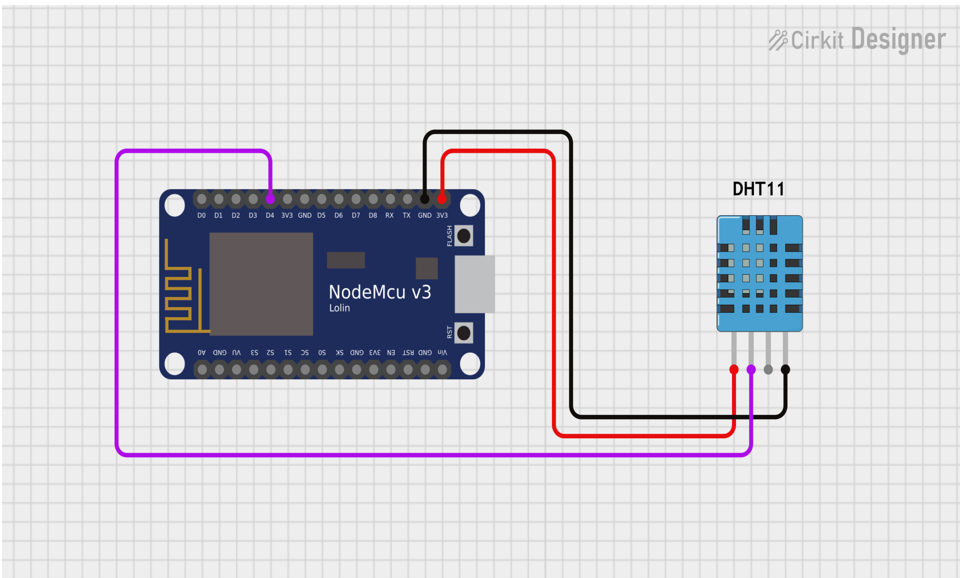

Figure 3.9: dht11 callibrated with esp8266

4. Methodology

The Smart Irrigation System is a Sensor Based IOT and Arduino based Project for automating the irrigation process in agriculture depending on the water requirement of the crops chosen by us along with the type of soil taken in consideration.

4.1 Agriculture Field Simulation

A 50 x 50 x 15 was designed to stimulate an agriculture field.
A soil moisture sensor uses volumetric analysis to calculate the moisture level present in the soil. It can show values from 0-1024 where 1024 meaning the moisture level is 0.

Wheat is the crop taken in consideration by us for the specific project.It consumes medium amount of water for loamy soil which was calculated out to be 800 litres of water in 10,000 of land. Optimizing the same values for 2500 of area

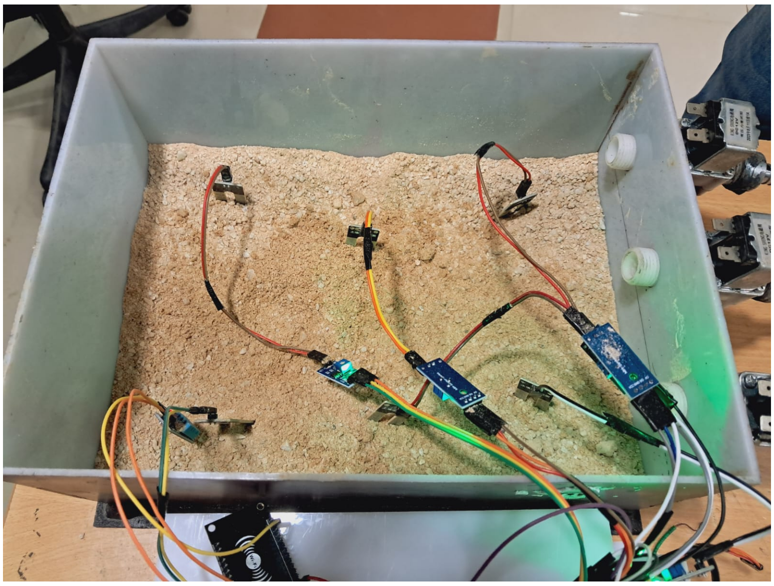

Figure 4.1: Set up of agriculture field in a box

at a depth of 5cm:

800 litres = 10,000 meter
1 Litre = 1000/8 meter
(8/1000)liter =1 meter

(8/1000)*1/100*1/100*2500 * 1000 ml =2500 cm
200ml for 2500 cm square area

The box is further divided into three regions and total 6 sensors are used to calculate the moisture level in the soil. Two sensors are in each of the three specific regions and their analog value is callibrate to point at a figure of 67ml. irrigation.

The soil is sandy in nature so it does not have good water holding quality,thus it would require constant irrigation from the motor

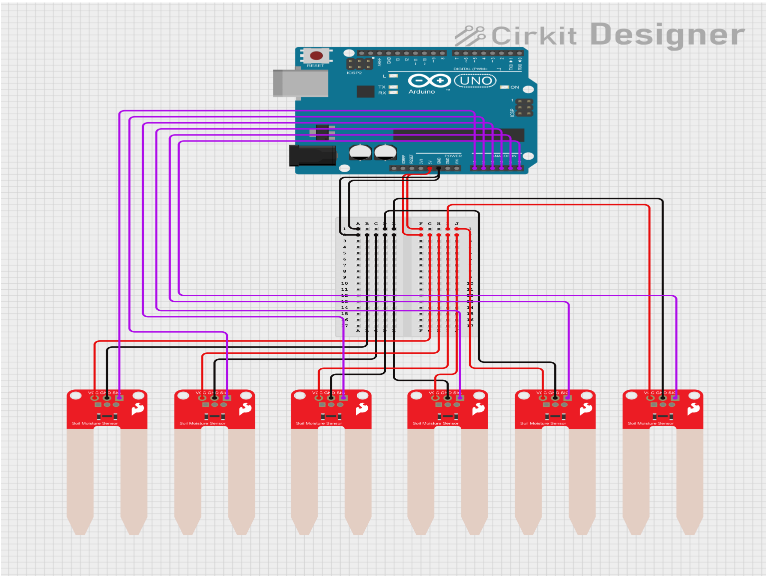

Figure 4.2: Circuit Diagram of Soil Moisture sensor along with Uno

4.2 Usage of solenoid valves

Each of the divided section has one solenoid valve attached to it,once the sensors direct that they are reaching their threshold value.

The solenoid valve stops the passage of water until the analog value for the sensor further increases.The three valves are controlled by a single four channel relay that decides which valve has to be closed according to the analog value

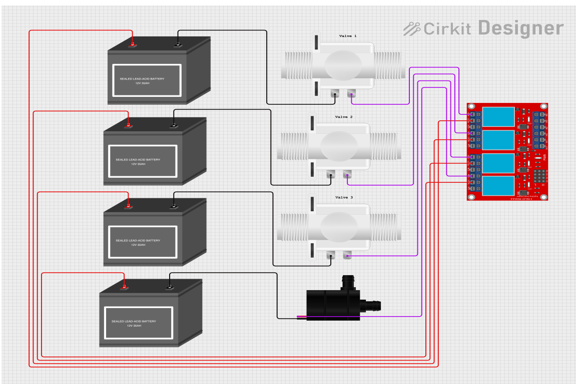

Figure 4.3: Circuit Diagram of Solenoid Valve

given by our sensor.

4.3 IOT system for humidity calculation

A DHT-11 Sensor is used to calcualte the humidity level in the environment built by us. The same data is then transmitted through blynk application to tell about the humidity and temperature in the set-up .

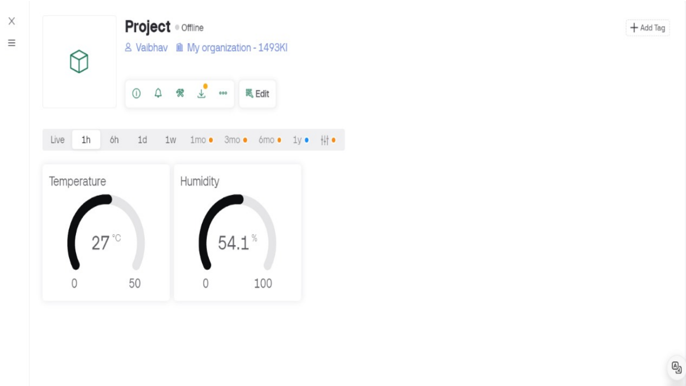

Figure 4.4: Realtime Monitoring using Dht11

5. Result

The smart irrigation system was tested over a period of a month in a controlled agricultural setting. The primary objectives were to evaluate the system's effectiveness in conserving water, maintaining optimal soil moisture levels, and providing timely notifications to the farmer. The following results were observed:

5.1 Outcomes from the Project

- **Water Conservation:**
  - The adaptive algorithm efficiently adjusted watering schedules to prevent overwatering, especially during periods of unexpected rainfall or high humidity
  - Mixed form of share cropping where one crop is more water intesive comapared to the other can be easily done in this automated smart irrigation set-up due to the nature of the soil moisture sensors and how they were callibrated.
- **Soil Moisture Maintenance:**
  - Soil moisture levels were consistently maintained within the optimal range for the specific crop tested, with deviations of less than 5% from the target moisture levels.
  - The system responded promptly to changes in soil moisture, ensuring that crops received adequate water even during peak evapotranspiration periods.
- **Real-Time Data Monitoring:**
  - The ESP module successfully uploaded live data to the remote server, enabling continuous monitoring and analysis of environmental conditions. This data was accessible through a web-based interface, providing real-time insights into field conditions.
  - Data logs showed accurate and consistent readings from all sensors, which were used to adjust watering schedules in real-time. The integration of temperature and water level sensors further enhanced the system's decision-making capabilities.
  - Historical data analysis indicated trends and patterns that could inform future irrigation strategies and crop management practices.

  - **Reducing the Burden on a Farmer**

- Automated process reduces the risk of human error and ensures correct amount of water is given to the crop in the specific period of time
- It reduces the burden off the farmer of the variable nature of irrigation that is highly dependent on the atmoshpheric and weather conditions.

- **Farmer Notifications:**
  - Farmers reported increased awareness and control over the irrigation process, reducing concerns over potential crop damage due to overwatering. The timely alerts allowed for quick intervention when necessary.
  -

- **System Reliability and Durability:**
  - The system operated smoothly without significant downtime or technical issues during the testing period. Regular maintenance checks confirmed the reliability of the components.
  - Sensors, the ESP module, and the Solenoid Valbve demonstrated durability and resistance to environmental factors such as dust, moisture, and temperature fluctuations.
  - Backup power solutions ensured continuous operation during power outages, further enhancing system reliability.

- **Overall Impact:**
  - The implementation of the smart irrigation system demonstrated a significant positive impact on water conservation and automation of the irrigation process. The system's ability to adapt to varying environmental conditions ensured optimal resource utilization.
  - The project's success underscored the potential for scalable deployment, suggesting that similar systems could be implemented in diverse agricultural settings to promote sustainable farming practices.

5.2 Future Improvements:

The current project was done on a very small scale and with very limited resources.It has the complete potential for large scale deployment on the groud level

- Based on the initial testing phase, potential improvements include expanding the system's capabilities to monitor additional environmental factors such as nutrient levels and pest presence.
- Enhancing the notification system with more detailed alerts and predictive analytics could provide farmers with even more actionable insights.

- Integration with other smart farming technologies, such as drone surveillance and automated weather stations, could further enhance the system's efficiency and effectiveness.
- Machine Learning algoritihms can further improve the efficiency of data analysis of how water is being conserved by using advanced algorithms
- Usage of other sensors to measure other data about soil such as its nitrogen,pottassium and phosphorous levels,pH level which could help in understanding the health of the soil.
- Estabilishing sprinkler system and drip irrigation to further improve on water conservation methods

6. Conclusion

The implementation of a smart irrigation system utilizing solenoid valves, soil moisture sensors, and DHT11 sensors has proven to be an efficient and sustainable approach to managing agricultural water use. The integration of these components ensures that irrigation is carried out precisely based on real-time soil moisture and environmental conditions, significantly reducing water wastage and optimizing crop yield.

The soil moisture sensors play a crucial role in determining the exact water requirements of the soil, while the DHT11 sensors provide valuable data on temperature and humidity, further refining the irrigation schedule. The solenoid valves, controlled by a central microcontroller, automate the water distribution process, ensuring timely and adequate water delivery to the plants.

Overall, this smart irrigation system offers a cost-effective and scalable solution for modern agriculture, addressing the challenges of water scarcity and inefficient irrigation practices. The project demonstrates the potential of technology to enhance agricultural productivity and sustainability, paving the way for future advancements in precision farming.

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