PRESIDENCY UNIVERSITY
Private University Estd. in Karnataka State by Act No. 41 of 2013
Itgalpura, Rajankunte, Yelahanka, Bengaluru – 560064

Smart Irrigation System for Precision Farming

A PROJECT REPORT

Submitted by

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PRESIDENCY SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

Certified that this report "Smart Irrigation System for Precision Farming" is a bonafide work of "Mekala Prakash- 20221CSE0433, Bana Tejeswar Reddy- 20221CSE0439, Bella Vishnu Vardhan- 20221CSE0447", who have successfully carried out the project work and submitted the report for partial fulfilment of the requirements for the award of the degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING during 2025-26.

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DECLARATION

We the students of final year B.Tech in COMPUTER SCIENCE AND ENGINEERING at Presidency University, Bengaluru, named Mekala Prakash,Bana Tejeswar Reddy and Bella Vishnu Vardhan, hereby declare that the project work titled **“** Smart Irrigation System for Precision Farming**”** has been independently carried out by us and submitted in partial fulfillment for the award of the degree of B.Tech in COMPUTER SCIENCE AND ENGINEERING during the academic year of 2025-26. Further, the matter embodied in the project has not been submitted previously by anybody for the award of any Degree or Diploma to any other institution.

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ABSTRACT

Agriculture accounts for a significant portion of global water consumption, and effective water management is now imperative due to the water crisis and the unpredictable weather patterns. Over-reliance on traditional irrigation systems, which are predominantly manually controlled and operated on a fixed schedule, often leads to over-irrigation or under-irrigation, causing water to be wasted, crop yields to decrease, and the soil to lose its fertility. Hence, this project proposes a Smart Irrigation System for Precision Farming to address such issues, which is meant to be an automated irrigation system that utilizes the Internet of Things technology and environmental monitoring sensors.

The system to be built will have a micro controller Node MCU (ESP8266) as the brain of the operations, which will be accompanied by several sensors Soil Moisture Sensor, DHT11 sensor, Rain Sensor, and Float Switch. Not only that these sensors will be continuously measuring the parameters of soil moisture content, temperature, and humidity but also rain, and water level in the tank. With the aid of 2-channel relay module, the Node MCU controls the water pump automatically to make sure the water is used for irrigation only if the soil requires it. As soon as the soil moisture level is under the predetermined threshold and there is no rain, the system will turn on the water pump. The pump operation is stopped when the soil moisture content is restored to the target level. The Float Switch prevents the water pump from using up the last of the water in the tank or water source, whereas a buzzer alerts the user with an audible signal. 16×2 I2C LCD serves the purpose of displaying the live data like moisture percentage, temperature, humidity, and system status. The Buck Converter guarantees a steady 5V power supply to all the modules, and a Logic Level Shifter safe voltage interfaces between the components.

The system works on its own without the need for human intervention; therefore, it saves water and it is also energy-efficient as it does not allow the pump to operate unnecessarily. Several tests were run on the system, and it compared well with the manual approach to irrigation in terms of the capacity for continuous moisture monitoring, the quick system response, and water savings. By using affordable electronic components and open-source software, the project becomes an affordable and scalable solution quite likely to be of interest to small and medium-scale farmers.

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Abbreviations:

Abbreviation	Full-form
IoT	Internet of Things
AI	Artificial Intelligence
LCD	Liquid Crystall Display
MCU	Micro Controller Unit
ESP	ESP8266 Microcontroller
DHT	Digital Humidity and Temperature Sensor
API	Application Programming Interface
Wi-Fi	Wireless Fidelity
SDG	Sustainable Development Goals
LED	Light Emitting Diode
PSU	Power Supply Unit
DC	Direct Current
UI	User Interface
WSN	Wireless Sensor Network

Chapter 1

Introduction

1.1 Background

Agriculture remains one of the main contributors to the overall economic growth and one of the major providers of livelihood to the majority of the global population. With the increasing population and the consequent demand for food, new food production methods have to be efficient and environmentally friendly. Farmers are facing many challenges and one of them is water management, which affects not only the crop yield but also the farmers' income. Besides, relying on the fixed schedule of irrigation methods or judging by eye, in which cases both over-watering and under-watering occur, moisture left in the ground leads to the enlargement of bacteria and other pathogens which deteriorate crops and soil quality.

And smart watering devices can end these problems by the using of the technology for example sensors, the automation of the scenario and the machine learning decision support systems. The precision farming (PF) is actually a good example where one can easily see how such technologies as the Internet of Things (IoT), integrated electronics, wireless communication, and cloud-based data analytics together can change the farming scenario by providing real-time field conditions. Monitoring the parameters such as soil moisture, temperature, humidity, and even rainfall allows farmers to find out the best irrigation rates for the crop based on these results.

Home gardeners and fields can simply program their watering timers to turn the water on and off in accordance with the environmental data but on a vast scale of commercial farms, smart watering systems are saving gallons of fresh water while keeping quality consistent and on portfolio. This co-operation between the nature and the technology turns not only this precious gift of water into an energy source of the future but also ushers in the era of more efficient food production and labor-saving as well as sustainable farming practices leading finally to improved food security in the world.

1.2 Statistics of project

India is the second-largest country in the world in terms of irrigated area, yet it suffers from a serious shortage of water because of inefficient irrigation. According to NITI Aayog's Composite Water Management Index, approximately 600 million Indians confront high to extreme levels of water stress. In particular, Karnataka is one of the most water-stressed states, with groundwater resources depleting at an alarming pace.

Statistics indicate the need for creating a smart irrigation system:

- Nearly 52% of India's total sown area relies on monsoon rainfall and makes farmers vulnerable to the unpredictability of the monsoons.
- India's irrigation efficiency is merely 38% while developed countries have irrigation efficiencies between 50-60%.
- Karnataka experiences a shortage of 40% regarding irrigation water during peak seasons, resulting in heavy losses for farmers every year.
- According to research, IoT-based irrigation will potentially result in cutting irrigation water consumption by as much as 30% and increasing crop yields by 15-20%.

Based on this information, there is a critical need for a low-cost, scalable, and dependable IoT-enabled irrigation system to achieve water sustainability and agricultural adaptability in India and similar places around the world.

1.3 Prior existing technologies

1. **Manual Irrigation:**1.Manual irrigation is fully reliant on the farmer's decision as to when and how much water to give the crops. This frequently leads to irregular watering, a high labor requirement, and a large amount of water being wasted.

2. **Sprinkler Irrigation:**Sprinkler systems distribute water over the crop area by simulating rainfall through pressurized nozzles. However, their efficiency drops in hot or windy climates, leading to high evaporation losses

3. **Drip Irrigation:**Drip irrigation delivers water directly to the plant root zone using emitters and pipes, ensuring targeted use. Despite its efficiency, it is costly to install and prone to clogging without proper filtration.

4. **Timer-Based Irrigation Systems:**Timer-based systems automate irrigation using preset schedules, reducing manual involvement. Still, they cannot respond to real-time soil or weather changes, often causing over-irrigation or under-irrigation.

5. **Early Sensor-Based Irrigation:**Early sensor systems use basic soil-moisture or water-level data to control pumps automatically. Their lack of wireless connectivity and cloud integration limits accuracy, coverage, and decision-making.

1.4 Proposed approach

The Project Smart Irrigation System intends to make the irrigation process automatic by using up-to-date environmental data gathered from various sensors. In contrast to the traditional irrigation methods that depend on a fixed schedule or an estimation, this system goes after a data-driven decision mechanism to make sure that water is given only if it is necessary. The new proposal embraces cutting-edge technologies such as IoT, sensor fusion, and automated control logic to achieve water efficiency, crop health, and monitoring convenience.

The system relies on a Node MCU (ESP8266) micro controller as the main control unit. Sensor data are kept updated by the system from a soil moisture sensor, temperature and humidity sensor (DHT11), rain sensor, and water level indicator. The controller decides automatically on the pump operation via the relay module if the decision thresholds are exceeded. The pump is turned on if the soil moisture is less than a predetermined value, no rain is detected, and if there is enough water in the tank. The pump is automatically switched off when the soil is at the optimum moisture level.

Besides automation, the system is also IoT -enabled for remote monitoring. Sensor readings, pump status, and system messages are sent to the cloud at regular intervals from where farmers can access the system via a mobile or web dashboard. The manual override feature allows operational flexibility when it is necessary to overrule the automatic decisions.

The Advantages for this method:

- Accurate irrigation from real-time environmental data
- Considerable decrease of water waste and over-irrigation
- Control and observation from a distance
- Cheap installation with a scalable system
- Enhanced crop health through regulated watering cycles

1.5 Objectives

Precision agriculture is going to be the world of agriculture. Among the main objectives of precision agriculture is the employment of available resources up to their maximum with minimum resources wastage. The main objectives for this system:

- Using IoT technologies to automate the irrigation process and save farmers time and money spent on this process.
- Cut the farmers spending on water and electricity by managing the available re-sources with maximum efficiency.
- Managing The water resource by addressing water scarcity without impacting the crops health.
- Maintain the farmers up to date with fields and crops real time status

1.6 SDGs

The Smart Irrigation System for Precision Farming aligns with several United Nations Sustainable Development Goals (SDGs) by promoting efficient water usage, technological innovation, environmental sustainability, and improved agricultural productivity. The project following SDGs:

- **SDG 2 – Zero Hunger**: The improvement of crop yields through optimal irrigation practices supports food security.
- **SDG 6 – Clean Water and Sanitation**: Up to 30% reduction in water waste (sustainable use of water) through reductions in the time required to irrigate.
- **SDG 12 – Responsible Consumption and Production**: Encouraging more efficient resource use through smart technology (to use economic, social, and environmental resources effectively).
- **SDG 13 – Climate Action**: Offering the adaptability of farmers to current and future climate variability by providing predictions of weather-based irrigation decisions.

Fig 1.1 Sustainable development goals

1.7 Overview of project report

The Smart Irrigation System for Precision Farming automates the irrigation process by incorporating sensors, micro controllers, and IoT technology to attain efficient and data-driven water management for agricultural applications. The system monitors the environment regularly for soil moisture, temperature, humidity, rainfall, and water availability from the storage tank. Based on the gathered information and set thresholds, the system activates the irrigation pump via a controller to use water at the optimum level, thereby growing the crop at a higher rate while saving water.

This report has been segregated into chapters to facilitate the understanding of system design and implementation. Chapter 2 presents the literature review and discusses the current smart irrigation technologies and the advantages they have over the previous ones. Chapter 3 gives an overview of the Methodology employed, including system architecture, workflow design, and component selection. Chapter 4 illustrates the project management approach with the help of planning, scheduling, and resource allocation techniques. Chapter 5 depicts the system design through block diagrams, circuit diagrams, and flowchart of logic.

Chapter 6 presents the implementation section covering hardware setup, software installation, and main program logic, which is followed by chapter 7 containing testing results, data analysis, system performance, and comparative analysis with traditional irrigation. Chapter 8 talks about the social, environmental, legal, ethical, and safety issues of using the system in the agricultural sector in the real world. The last chapter 9 summarizes the achievements of the project as well as suggests changes and future research directions.

Chapter 2

Literature review

A variety of researchers have tried out a multitude of different methods for figuring out how to automate irrigation through micro controllers, environmental sensors, and wireless communications technologies. These papers taken together emphasize that the main problems to be solved by such an automated irrigation system are, first, to make water use more efficient, second, to save water, and third, to reduce the human labor needed in the agricultural sector. This review discusses the main ideas, the ways they work, the pros and cons of the systems, and how they lay the groundwork for the proposal of the Smart Irrigation System, which is a step ahead of all the other solutions.

One of the pioneer conceptions was that of "GSM-Based Automated Irrigation Using Sensors" by Subalakshmi, Anu Amal, and Arthireena, in which they brought out an irrigation pattern that relied on a PIC16F877A micro controller along with soil moisture and temperature sensors. By way of the integration of sensor readings, their arrangement regulates the pump of the water automatically so gardening irrigation is conducted accurately. It should be noted that even if the farmer is not there, the crops will not suffer for lack of water thus it is a great solution for farmers. One more feature of this setup is the SMS notification system which is made possible by a GSM unit, and on the other side of the field, the status of the system as well as the values of the sensors are obtained thanks to the LCD that is fetched. Consequently, water is saved, eco-friendly agriculture is implemented, and the manual work load is decreased. On the other hand, the effectiveness of the method is confined by its requirement for GSM communication and the absence of advanced data analytics or remote dashboard visualization that are required for IoT scalability and integration.

In another landmark study, Jawad Awawda and Isam Ishaq proposed an Internet of Things-based smart irrigation system that connects sensors for soil moisture, temperature, and water level to the cloud. Users can view the actual state of the fields through an online dashboard and give the system the authority to carry out irrigation works automatically. The main goal of the work is to lessen the water consumption and at the same time to increase the crop yield by using real-time data for making the right decisions. Being cloud-based, their structure offers more advantages in terms of accessibility, data records, and performance monitoring over longer periods than the GSM-dependent solution. However, the system needs a reliable internet connection to work properly which in turn means that it is not very suitable for sparsely populated or off-grid areas.

Another research by Sharmin Akter and Pinkirani Mahanta researchers directed their attention towards an Arduino UNO-based irrigation system that was simple and efficient enough to be used in small settings like gardens or nurseries. They came up with a design that included a soil moisture sensor, a relay module, and a DC pump to mechanize the irrigation process of the plants when the soil was dry. Thus, the system not only saves water but also does away with the need for human intervention. The model might have done wonders for the money and be implementation-friendly, however, it still only monitors one parameter and is hardly adaptive enough for large-scale or open-field agriculture. Furthermore, the absence of features for connectivity or data analysis in the system disables it from being used in the future of the farming industry such as predictive or precision farming.

An even farther-ranging vision has been put forward by Marco Del-Coco and Marco Leo in their investigation on the employment of machine learning in the improvement of intelligent irrigation systems. They explain that their system has multiple layers architecture with layers responsible for sensors, data sources, and AI units for making decisions. Some of the issues are: lack of sufficient annotated data, the huge difference in the environmental conditions, and the difficulty in going from the lab to the real-world farms while the machine learning models are concerned. Nevertheless, the authors say, in the long run, such problems can be overcome and future irrigation systems powered by ML will be able to provide highly accurate irrigation, use less water, and, eventually, increase farming output by enabling the making of predictions ahead of time rather than reactive decision-making based on simple thresholds.

The “SMART IRRIGATION SYSTEM USING IOT” by C.K. Gomathy et al. elaborates the use of an automated irrigation system using the soil's moisture, temperature, and humidity sensors for controlling water flow in an efficient manner. To carry out the environmental monitoring in real-time, the authors have employed an IoT-enabled micro controller which is also responsible for starting the pump only when it is needed thus saving water and lowering the manual labor. Moreover, their system is equipped with the internet facility through which monitoring can be done from a remote location that means the users can know the condition of the field from anywhere.

2.2 Summary Table

Table 2.1 Summary of Literature reviews

Authors	Technology / Components Used	Main Features	Strengths	Limitations
Subalakshmi, Anu Amal, Arthireena	PIC16F877A microcontroller, Soil Moisture Sensor, Temperature Sensor, GSM Module, LCD	Automated pump based on sensor readings; SMS alerts; On-site LCD display	Reduces manual work; Saves water	No IoT dashboard; GSM-dependent
Jawad Awawda, Isam Ishaq	IoT-based system, Soil Moisture, Temperature, Water Level Sensors, Cloud Platform	Real-time monitoring through web dashboard; Automated irrigation via cloud	Remote access; Data logging	Internet dependency; Higher cost
Sharmin Akter, Pinkirani Mahanta	Arduino UNO, Soil Moisture Sensor, Relay, DC Pump	Automatically waters plants when soil is dry	Low cost; Simple setup	Not scalable; No multi-sensor support
Marco Del-Coco, Marco Leo	Machine Learning Models, Multilayer Sensor & Processing Architecture	AI-based decision-making; Predictive irrigation insights	Highly efficient; Smart predictions	Needs datasets; Hard to deploy on farms
C. K. Gomathy, A. Vamsikumar, B. Karthik, and A. Purushothamreddy	IoT-based sensors, NodeMCU/ESP8266, Soil Moisture Sensor, DHT11 Sensor, Cloud connectivity, Automated motor control	Automated irrigation based on moisture levels, environmental monitoring, IoT-based remote control	Reduces manual effort, improves water efficiency, real-time monitoring, simple architecture	Dependent on Wi-Fi connectivity, limited sensor accuracy, not scalable for large fields

Chapter 3

Methodology

The methodology adopted for this project focuses on designing, developing, and testing an automated irrigation system using IoT technology and real-time environmental sensing. The system is developed through a structured approach consisting of requirement analysis, hardware and software design, integration, implementation, and evaluation.

The steps are:

1. **Requirement Analysis:**This phase identifies the major problems in traditional irrigation, such as water wastage and lack of automation. The system requirements—soil moisture sensing, rain detection, environmental monitoring, and autonomous control—are defined. This ensures the solution directly targets real agricultural needs.

2. **System Architecture Design:**A complete block diagram is created to show how sensors, the ESP8266 controller, relay module, and pump interact. The architecture defines signal flow, power distribution, and connection mapping. This provides a clear structural foundation for the system.

3. **Hardware Integration:**Sensors like soil moisture, DHT11, and rain sensor are connected to the ESP8266 using appropriate analog and digital pins. The relay module is interfaced to safely control the water pump. All components are assembled to ensure proper communication and stable operation.

4. **Firmware Development:**The ESP8266 is programmed with non-blocking logic using millis() for continuous responsiveness. The automation algorithm includes rain override, moisture thresholds, and hysteresis control. This firmware enables intelligent and reliable pump decision-making.

5. **Automation and Output Control:**The microcontroller processes real-time sensor data and activates the pump through the relay module. A 16×2 I2C LCD displays moisture levels, temperature, humidity, and pump status. This provides autonomous control along with user-visible system feedback.

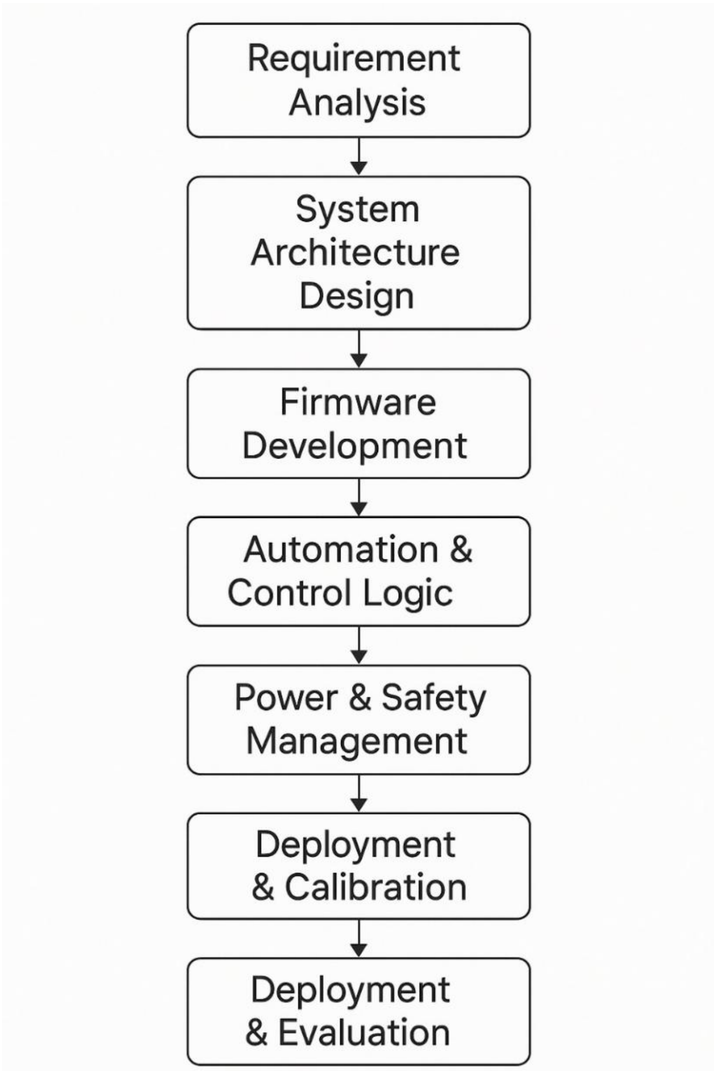
6. **Power Supply and Safety Management:**A 12V DC input is stepped down to 5V and 3.3V for system components. A logic-level shifter ensures safe interfacing between 5V

modules and the 3.3V ESP8266. This phase ensures stable power delivery and protects hardware from voltage damage

7. **Testing and Calibration:** The system is tested under different soil moisture conditions, rain scenarios, and temperature variations. Thresholds are calibrated for accurate moisture detection. Sensor accuracy, relay response, and algorithm performance are validated.

8. **Deployment and Performance Evaluation:** The system is installed in a real field to evaluate water savings and irrigation efficiency. Soil stability, pump behavior, and environmental responses are recorded. Results are compared with traditional irrigation methods to verify improvements.

Fig 3.1- Block Diagram of Methodology



Chapter 4

Project Management

4.1 Project timeline

The creation of a Smart Irrigation System for Precision Farming followed a series of planned stages throughout the project duration. Every single stage had defined deliverable and checkpoints to guarantee a methodical progress, on-time completion, and conformity with the project goals. The timeline below summarizes the main activities that were carried out in each phase.

Table 4.1 Project planning timeline

The project's planning timeline spanned in 10 phases.

Sl. No.	Project Phase	Duration
1	Project Initiation & Requirement Analysis	10 days
2	Literature Review	8 days
3	System Architecture & Design Planning	13 days
4	Hardware analysis & Setup	15 days
5	Firmware & IoT Development	16 days
6	Hardware–Software Integration	9 days
7	Testing & Calibration	11 days
8	System Optimization	5 days
9	Evaluation & Data Analysis	8 days
10	Final Documentation & Submission	6 days

4.2 Risk analysis

The development and deployment of the Smart Irrigation System involve several potential risks that could affect performance, reliability, and sustainability. These risks are categorized and analyzed below, along with mitigation strategies.

1.Sensor-Related Risks:

One of the largest problems associated with sensors is their long-term reliability. Soil moisture sensors, for example, may suffer from calibration drift, corrosion, or be affected by the soil in such a way that their readings become misleading. Rain sensors that are exposed to an extreme and continuous humidity as well as environmental noise may also give wrong reports and thus the irrigation system will be incorrectly controlled.

Mitigation: Some of the methods to deal with the problem are capacitive sensors, regular calibration, use of protective covers and installation of redundant sensors.

2.Software and Firmware Risks:

Firmware bugs, system freezes, or unexpected code behavior can interrupt irrigation control. Without safeguards, such failures may leave pumps running or inactive at critical times.
Mitigation: Code testing, debugging cycles, watchdog timers, and regular firmware updates.

3. Power Supply and Hardware risks:

Voltage fluctuations, relay malfunctions, and pump overloads may jeopardize system stability. Unregulated power can damage the ESP8266, sensors, and relay components.
Mitigation: Use of regulated power supplies, surge protection, insulation, and robust wiring practices.

4. **Connectivity and Communication risks:**

Since the system depends on Wi-Fi for cloud updates and remote monitoring, network instability poses a risk. Temporary down times can affect remote access, although the system continues functioning autonomously using threshold logic.
Mitigation: Offline fallback logic, local automation, and reconnect routines in firmware.

4.3 Project budget

Table 4.2 Project Budget Table

Item / Component	**Qunatity**	**Cost**
ESP8266 NodeMCU	1	350
Capacitive Soil Moisture Sensor	1	200
DHT11 Sensor	1	150
Rain Sensor	1	250
Float Switch	1	150
2-Channel Relay Module	1	200
16×2 I2C LCD	1	400
Buzzer, wires and connectors	__	300
Buck Converter	1	200
Water Pump	1	300
Bread Board	1	100
Total Cost	__	2600Rs/-

Chapter 5

Analysis and Design

5.1 Requirements

System Hardware Requirements:

The hardware components of this project are:

1. **Node MCU(ESP8266)**:Acts as the main micro controller unit with a built-in Wi-Fi module for data processing and wireless communication.
2. **Soil Moisture Sensor**: Provides the soil moisture content in real-time to figure out the water needs.
3. **DHT11 Sensor**: Helps temperature and humidity measurement in the environment for analysis.
4. **Rain Sensor**: Confirms the presence of rain to stop irrigation automatically during wet conditions.
5. **Float Switch**: Shows the situation of the water tank, thus stopping the pump from operating when the tank is empty.
6. **Relay Module**: Facilitates the turning on/off of the 220V AC water pump controlled by the user through electrical isolation in a safe manner.
7. **16×2 I2C LCD Display**: Shows the live sensor readings along with the system status locally.
8. **Buzzer**: Gives real audible alerts like in the case of water shortage or rain detection, etc.
9. **Logic Level Shifter**: Transforms the 5V output of the sensor into 3.3V logic that is compatible with Node MCU.
10. **Buck Converter**: Changes the 12V DC input into 5V to be used for the system components.

Behavioural Requirements

- **Real-time monitoring** – Capability to monitor soil and environmental conditions continuously.
- **Automatic irrigation** – Irrigation pump will automatically turn on or off according to soil moisture threshold limits.
- **Rain-based override** – When rainfall is detected, the irrigation system will automatically stop irrigation.
- **Tank protection** – Irrigation pump will remain off when water level is too low in the holding tank.
- **Local status display** – Display LCD will show the current status of the sensor data and whether or not the pump is currently operating.
- **Alert mechanism** – Buzzer will be used to notify the user when a fault and/or low tank level is detected.

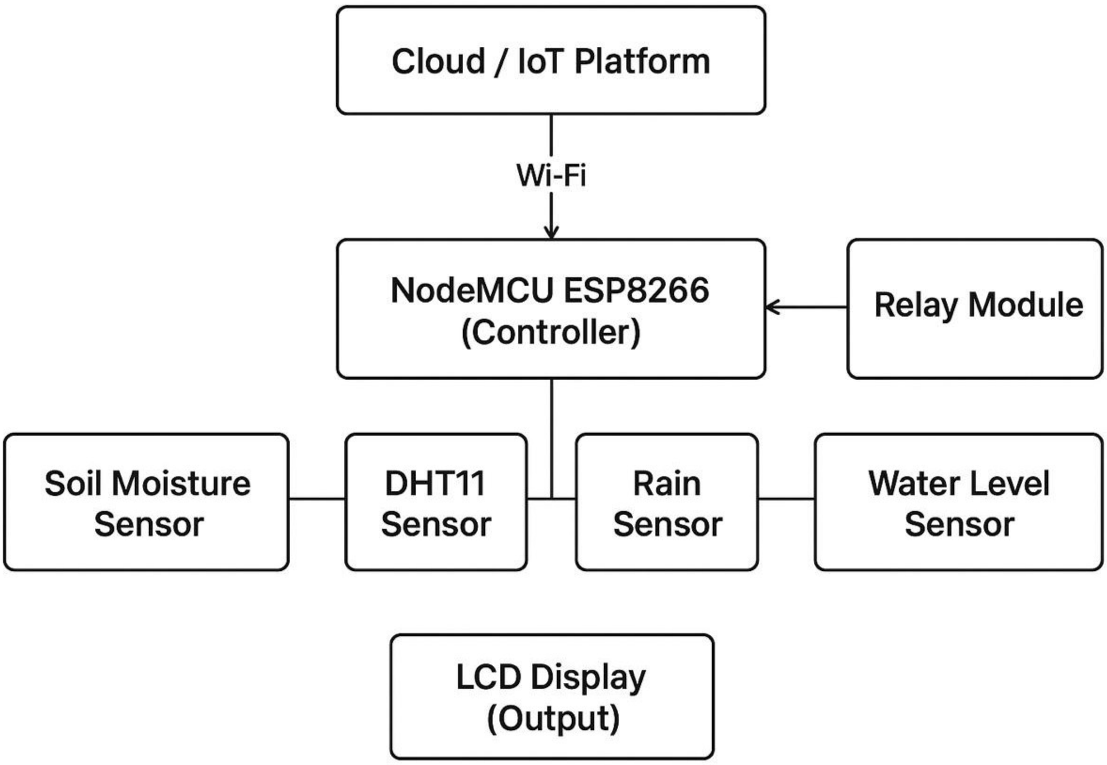
Data Requirements

- **Soil moisture (%)** – Primary data variable used to activate the irrigation process.
- **Temperature (°C)** – Provides additional information to better understand environmental conditions.
- **Humidity (%)** – Provides additional data for environmental monitoring and analysis.
- **Rain status** – Provides information to the computer on whether or not to stop irrigation.
- **Pump status** – Provides information on whether the pump is on or off for logging purposes.
- **Tank level** – Provides information on whether or not there is enough water in the holding tank to irrigate.

5.2 Block Diagram

Figure 5.1 depicts the functional block diagram of the Smart Irrigation System.The block diagram presents the system layout of the smart irrigation system where the Node MCU ESP8266 is the main controller. It is wired to 4 sensors that provide it with real-time data. The sensors are soil moisture sensor, DHT11 temperature–humidity sensor, rain sensor and water level sensor .With environment and soil as inputs, the controller evaluates the conditions. The Node MCU, thus, switches the relay module ON/OFF which is connected to the water pump to control the pump. The controller also sends output to the LCD display, which is basically the real-time system status and sensor readings available to the user. Moreover, the Node MCU is connected to the Cloud/IoT platform via Wi-Fi for remote monitoring and data logging.

Fig 5.1 -The functional block diagram of the Smart Irrigation System.

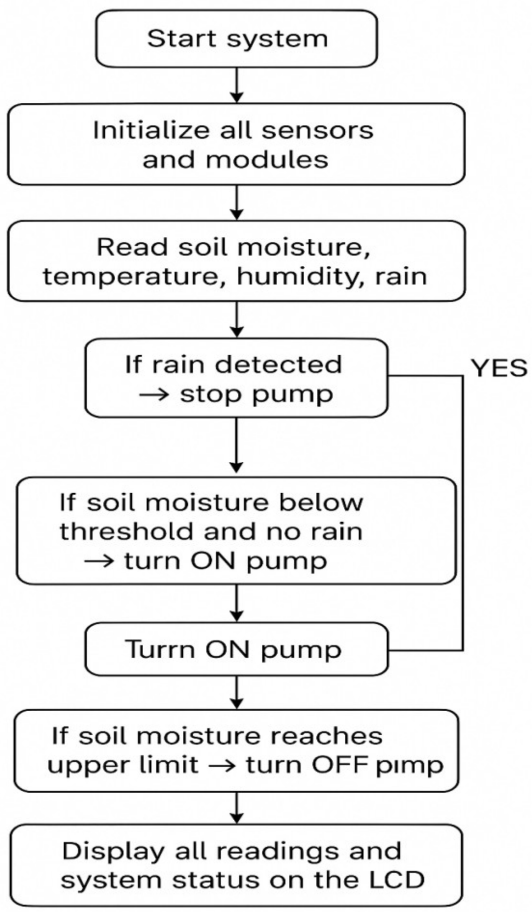


5.3 System Flow Chart

The flowchart depicts how the smart irrigation system functions. Once the system is up and running, it performs an initialization of all sensors and proceeds to fetch the real-time values for soil moisture, temperature, humidity, and rain. In case rain is detected, the pump is stopped at once to prevent irrigation that is not required.

If there is no rain and the soil moisture is less than the threshold, the controller will turn on the water pump. The pump is kept on for the period during which the soil moisture is at the lower limit and is turned off when the moisture reaches the upper limit by the system. To finish with, the readings of all sensors as well as the status of the pump are shown on the LCD for the user to read the data of sensors and status of water pump.

Fig 5.2 -The flowchart diagram of the Smart Irrigation System.



5.4 Choosing devices

This section shows why each component was selected for the Smart Irrigation System.

Table 5.1 Choosing devices Table

Component	Selected Device	Reason for Choosing

Microcontroller	NodeMCU ESP8266	Built-in Wi-Fi, lower cost, compact size, IoT-ready
Soil Moisture Sensor	Capacitive Soil Moisture Sensor	Non-corrosive, longer lifespan, higher accuracy
Environmental Sensor	DHT11 Temperature & Humidity	Sufficient accuracy, low cost, easy interface
Rain Detector	Rain Sensor Module	Real-time detection, independent of internet
Switching Unit	2-Channel Relay Module	Electrically isolates pump and controller safely
Irrigation Output	AC Water Pump	Readily available, compatible with existing systems
Display Module	16×2 LCD with I2C	Low power, low cost, easy integration

5.5 Designing Units

The design of the Smart Irrigation System is segmented into various functional units, each of which is accountable for a particular aspect of the system's working. The sensor unit is equipped with soil moisture, DHT11 temperature-humidity, rain, and water-level sensors that are always recording environmental and soil data. The controller unit which is centered on Node MCU ESP8266, changes the data gathered with the help of the programmed irrigation algorithm and it is the one that sends the message to the pump to start or stop. The actuator unit composed of the relay module and water pump is the one that carries out the controller's instructions by changing the pump status from OFF to ON or vice versa in a safe way. The power supply unit takes a 12V source which is regulated through a buck converter and logic-level shifter to ensure that the voltages remain stable for all the components. Finally, the display and alert unit is made up of the I2C LCD and buzzer which give the user the real-time system status, sensor readings, and warning alerts. These units which are well planned, dependable, modular, and efficient, constitute together a smart irrigation system.

Chapter 6

Hardware, Software and Simulation

6.1 Hardware Components

The Smart Irrigation System consists of various hardware components that were chosen with consideration to their functionality, compatibility, durability, power efficiency, and appropriateness for real agricultural environments. Every single component is gearing up the system for sensing, processing, automation, and control operations that are needed for precision irrigation. The system was realized through the use of the following hardware components:

- **Node MCU ESP8266 Micro controller**:This device is the central control unit handling the entire operation of data acquisition from sensors, making decisions, and communicating with the IoT platform by using its built-in Wi-Fi.
- **Capacitive Soil Moisture Sensor:** This sensor is employed to measure soil moisture and to furnish precise readings. The sensor's resistance to corrosion makes it ideal for a long-term deployment in wet soil.
- **DHT11 Temperature and Humidity Sensor:** It helps in monitoring the environment by measuring the temperature and humidity of the air, thus facilitating irrigation decisions based on climatic factors.
- **Rain Sensor Module:** It determines the occurrence of rain to stop watering automatically if weather conditions are wet. Thus, it helps in saving water and makes the system smarter.
- **Relay Module (2-Channel):** It acts as the module which connects the low power micro controller to the high power irrigation pump therefore, switching is done automatically with the relay along with electrical isolation for safety.
- **Water Pump:** If the relay is activated based on the system logic and sensor feedback, the water pump will be the one to physically irrigate the crop area.

- **16×2 LCD Display:** This device can display the live data from the sensors as well as the status of the system locally, thereby, operating and monitoring can be done even if there is no internet or mobile access.

6.2 Software development tools

1. Arduino IDE:

The Arduino IDE is where the firmware for the ESP8266 is written, compiled, and uploaded. It also includes libraries for sensors and LCD.

2. Embedded C++:

A simplified version of C++ programming language was used to develop the automation logic. It supports sensor interfacing, conditional control, delay optimization, and device communication.

6.3 Software code

The firmware listed below was written and loaded into the Node MCU ESP8266 micro controller via Arduino IDE. This program makes the whole thing automatic as it reads sensor values, decides the pump control, updates the LCD display, handles manual override control, and manages buzzer alerts.

The control implemented in the firmware can be simplified to the following detailed structured representation:

6.3.1 Sensor Reading Block

```
// Read DHT11 sensor
humidity = dht.readHumidity();
temperature = dht.readTemperature();

// Read soil moisture and convert to %
int raw = analogRead(A0);
moisture = map(raw, DRY, WET, 0, 100);
moisture = constrain(moisture, 0, 100);

// Read rain and tank level (active LOW)
isRaining = (digitalRead(RAIN_SENSOR_PIN) == LOW);
isTankFull = (digitalRead(FLOAT_SWITCH_PIN) == LOW);
```

This section reads environmental data from sensors, including temperature, humidity, soil moisture, rain status, and tank level. The soil moisture value is calibrated, converted into a percentage, and constraints are applied to ensure valid sensor output.

6.3.2 Automatic Irrigation Logic

```
if (isRaining || !isTankFull) {
    pumpState = false;          // Safety overrides
}
else if (moisture < DRY_THRESHOLD) {
    pumpState = true;           // Soil dry → pump ON
}
else if (moisture >= WET_THRESHOLD) {
    pumpState = false;          // Soil wet → pump OFF
}
else {
    pumpState = autoLastState;  // Hysteresis zone
}
autoLastState = pumpState;
```

This is the logic for Automatic Irrigation it checks all the sensor levels and performs the above logic to turn on or off pump.

6.3.3 LCD Display Output and Update

```
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("M:" + String((int)moisture) + "% ");
lcd.print(pumpState ? "P:ON" : "P:OFF");

lcd.setCursor(0, 1);
if (!isTankFull)
        lcd.print("TANK LOW");
else if (isRaining)
        lcd.print("RAINING");
else
        lcd.print("T:" + String(temperature) + "C H:" + String(humidity) + "%");
```

This code updates the LCD screen to display soil moisture percentage and pump status on the first line. The second line shows system warnings like "RAINING", otherwise it displays temperature and humidity readings.

6.4 Simulation

To confirm the embedded logic and hardware interactions, the Smart Irrigation System was initially simulated using the TinkerCAD / Proteus / Wokwi Simulator before the physical implementation. The environment was capable of supporting all the components that were required, such as the ESP8266 controller, DHT11 sensor, rain and water-level inputs, relay module, buzzer, LCD display, and a virtual soil-moisture input, thus allowing the testing to be done accurately without the hardware. The simulation was designed to validate sensor acquisition in real-time, pump switching behavior, rain-based override, tank-level protection, manual override functionality, and LCD output responses, at the same time, non-blocking execution of the algorithm was ensured.

The simulated system behaved exactly as expected, the pump was turned on when soil moisture was below the threshold and turned off when adequate moisture was reached, rain detection stopped irrigation at once, and low tank conditions turned off the pump and caused warnings to be displayed on the LCD. The relay switching remained stable and the manual override button enabled the user to control the pump independently without the system logic being affected.

Chapter 7

Evaluation and Results

7.1 Test points

In order to keep the Smart Irrigation System working as it should, being reliable, and logically correct, the developers have pinpointed and assessed a number of very important test points during the process. The test points are basically control points in the system where the expected values, responses, or events have to correspond to the defined operational behavior. Tests performed at these points serve to confirm the efficiency of the system components (hardware and software) and thus, the whole system is capable of functioning properly under any weather condition.

The following are the some list of test points:

1. DHT11 Sensor Reading

This test verifies whether the DHT11 sensor correctly measures ambient temperature and humidity. The expected output is stable, accurate readings displayed on both the Serial Monitor and the LCD without fluctuations or errors.

2. Soil Moisture Sensing

The soil moisture test ensures that the analog sensor correctly reads raw values and maps them to a 0–100% moisture scale. The value should update in real-time and reflect changes accurately when the soil condition varies.

3. Rain Sensor Input

This test checks the digital rain sensor’s ability to detect rainfall conditions. When rain is detected (LOW signal), the pump must immediately stop, demonstrating proper override functionality.

4. Float Switch Input

The float switch test confirms tank-level monitoring by checking whether the system prevents pump activation when the tank is empty. A buzzer alert should activate to warn the user of insufficient water.

5. Relay Output

This test validates the relay's ability to switch the pump ON and OFF correctly using active LOW control logic. The relay must respond accurately to the controller's decisions without delay or unintended triggering.

6. LCD Status Display

The LCD test checks whether real-time sensor readings, alerts, and pump status are correctly displayed. The display should remain clear, responsive, and free of incorrect or outdated data.

7.2 Test plan

Table 4.2 Test Plan Table

Test Case	Input Condition	Expected Output	Pass Criteria
Soil moisture sensing	Vary soil moisture	Accurate % displayed	Reading error < ±5%
Moisture threshold	Moisture < 35%	Pump ON	Pump activates within 1s
Rain override	Rain = HIGH	Pump OFF	Pump shuts off regardless of moisture
Tank low	Float switch LOW	Pump OFF + Buzzer ON	Irrigation prevented
LCD display	Normal operation	Moisture + Pump Status	All fields visible
Temperature/Humidity	Ambient conditions	Correct temp/humidity	Stable readings

Relay actuation	Logic HIGH/LOW	Pump ON/OFF	Correct switching

The table outlines the major test cases performed on the Smart Irrigation System to validate sensor accuracy, control logic, and actuator behavior.

7.3 Test Result

Table 4.2 Test result Table

Test Case Description	**Expected Output**	**Actual Result**	**Status**
Temperature & Humidity	Accurate temperature and humidity displayed on LCD & Serial Monitor	Values displayed correctly without errors	pass
Soil Moisture Percentage	Moisture percentage updates between 0–100%	Moisture values changed accurately based on input	**pass**
Rain Detection	Pump must stop immediately when rain detected	Pump stopped instantly when rain signal triggered	**pass**
Water Tank Level	Pump should not run if tank is empty; buzzer ON	Pump remained OFF and buzzer activated when tank low	**pass**
Relay Operation	Relay must turn ON/OFF according to logic	Relay switched reliably with no false triggering	**pass**
LCD Display	Real-time values and alerts displayed	LCD showed all readings and alerts properly	**pass**
Buzzer Alerts	Buzzer ON during rain or tank low; OFF otherwise	Alert triggered correctly during warning conditions	**pass**
Threshold logic & hysteresis	Pump ON below dry threshold, OFF above wet	Pump responded smoothly with no rapid toggling	**pass**

	threshold without oscillation		
System power stability	No resets, no false readings, stable operation	System remained stable throughout testing	**pass**

7.4 Insights

The design and testing of the Smart Irrigation System for Precision Farming have revealed a number of substantial insights, which significantly aided in enhancing the system's reliability, efficiency, and overall practicality. One of the major lessons learned was the indispensability of correct sensor calibration. It was necessary for the soil moisture sensor to be frequently returned since its readings were different depending on the soil texture, temperature, and the environment. As a result, this pointed to the necessity of having adaptive threshold values instead of fixed ones when implemented in the real world. Additionally, there was another insight about the advantage of having several safety mechanisms integrated. The features like rain detection and water tank level monitoring were instrumental in avoiding irrigation that was not needed and in saving the hardware from conditions in which it is difficult to run. In essence, this proved that the combination of different environmental factors leads to the making of more intelligent irrigation decisions and efficient use of resources. From the user's side, the manual override control and the LCD display were very important parts of user interaction. The feature that allowed the user to change from automatic to manual mode was the main point of interaction that gave the users freedom while real-time feedback helped them to understand system status quickly without the need to use other devices. This insight revealed that the level of simplicity in use is just as important as technical precision in the field of agriculture. Moreover, the system's ability to connect to the internet brought in some insightful lessons as well. Despite the fact that cloud integration and monitoring were Wi-Fi enabled, the system's self-sufficiency during connectivity interruptions made it very suitable for deployment in rural areas where network stability is likely to be inconsistent.

Chapter 8

Social, Legal, Ethical, Sustainability and Safety Aspects

8.1 Social Aspects

This section discusses how the Smart Irrigation System impacts society, farming communities, human interactions, and agricultural practices.

Positive Impacts:

The most important social advantage for the farmers from the project is that it fosters a new environment of less dependency on manual irrigation through the advanced system of automated irrigation boosting agricultural productivity. Most of the rural farmers suffer from the lack of proper water- management technology causing water wastage and crop losses and most of the time the laborious work is added to their burden. Thus the system that offered a solution to irrigation at the cheapest of prices and in the most convenient way turned out to be a powerful tool for farmers that gave them access to data logging and accurate water delivery in real-time resulting in good crop health and increased yields. The initiative is also a major step forward in the realization of digital inclusion as it provides the solution to smart farming technology even to the farming community which accounts for some 80% of the world's small-scale farmers who are the most underprivileged in the agricultural industry and are least likely to benefit from expensive agricultural automation systems.

- **Real-Life Example:**

  A farmer with a small landholding often irrigates crops based on guesswork or irregular schedules due to time constraints, weather unpredictability, or labor shortage. Through this intelligent irrigation method, the water pump is maneuvered to switch ON only when soil moisture content is at low levels and is turned off when the soil is adequately moist. In this way, the daily efforts are lessened, time is saved, and farmers are given the opportunity to perform different productive activities. Such improvements support rural livelihood enhancement.

Negative Impacts:

Socially speaking, the project might be limited in certain aspects despite the positive side it has. As a consequence of this increasing engagement with technology, that is automation, there might be a substantial decrease in the need for traditional irrigation labor in which case the ones who are currently engaged in such activities will lose their source of income. Inhabitants of some communities with limited digitization knowledge may experience difficulty in accepting new technology, because IoT systems are alien to them and they may find it hard to understand the sensor data or to operate the manual override controls. If a low-cost sensor is not maintained properly, it may sometimes give inaccurate read data which would result in irrigating the crops either too much or too little, thus indirectly resulting in decreased crop yield and farmer livelihood. Furthermore, poor internet access in remote areas may restrict the use of certain features such as remote monitoring.

8.2 Legal Aspects

This section assesses the legal issues that arise from the development and deployment of the Smart Irrigation System. It also presents ways to address these issues through data protection, compliance with standards, and the responsible use of embedded hardware in the agricultural environment.

- **Compliance With Electronic and IoT Regulations**

The system is an electronic product that requires the use of a micro controller, a relay, and sensors, which must meet the standards for electrical safety and low voltage. To ensure that the hardware complies with the basic electronic equipment guides, it is necessary to make sure it works within the recommended voltage levels (3.3V DC control wiring and relay-isolated AC pump switching). For IoT, Wi-Fi-enabled devices must meet local wireless communication regulations to prevent communication problems and legal network usage.

- **Intellectual Property Considerations**

Project-wise software, hardware, and logic are the author's original ideas, so these should be protected by the intellectual property law. The creator must not break the open-source library license terms or use any proprietary code duplication blindly. If external libraries or frameworks are used in the project, the correct credits must be given to them.

- **Legal Responsibility and Safe Deployment**

The device must be mounted in the real farm areas in such a manner that the electrical disaster caused by the leaked current, pump malfunction, or property damage of any kind resulting from the installation will be avoided. Good insulation, relay isolation, grounding, and waterproofing crates are among the safety measures that must be taken to meet the standard requirements. In case of an illegal installation or the improper use of the device, the users should know that the developers are not responsible for the mishandling of the operation.

- **Environmental and Water Usage Regulations**

By not wasting water, the project is an indirect way of supporting the water conservation laws. For instance, in an area where extracting groundwater is controlled, farmers that use an automated system like this are guaranteed to avoid over-irrigation and will be compliant with the law.

8.3 Ethical Aspects

1. **Ensures responsible use of technology by preventing water wastage:**

   The system irrigates crops only when soil moisture falls below the required level, avoiding unnecessary water usage. This supports ethical water management, especially in drought-prone regions.

2. **Provides transparent system behavior through real-time LCD status updates:**

   Users can always see what the system is doing, including pump status and sensor readings. This transparency builds trust and prevents hidden or unpredictable system actions.

3. **Respects user autonomy by offering a manual override control option:**

   Farmers can intervene at any time to turn the pump ON or OFF based on real-world observations. This ensures that automation does not remove human decision-making authority.

4. **Delivers accurate sensor data to avoid misleading irrigation decisions.**

Proper calibration and real-time sensing ensure that the system provides truthful and reliable information. Ethical data handling prevents crop loss caused by wrong or manipulated readings.

5. **Minimizes negative social impact and supports farmer livelihoods:**

   The system aims to assist farmers, not replace essential labor, by reducing workload while increasing efficiency. It supports equitable technology access, especially for small-scale farmers.

6. **Promotes environmentally ethical practices through sustainable irrigation:**

   By preventing over-irrigation, the system conserves groundwater and energy resources. This aligns with broader environmental ethics and sustainable agricultural development.

8.4 Sustainability Aspects

- Sensors in the automatic irrigation system make it possible to irrigate when required, thus eliminating the overuse of electrical and fuel-based pumps and promoting water conservation over time, which is an important environmental objective.
- By utilizing optimized irrigation practices, soil health is improved and over-watering and under-watering is avoided, further reinforcing sustainably farmed crops.
- Automated pump-control, rain detection, and tank-level sensing have resulted in a decrease in electricity consumption, thereby enhancing energy sustainability.
- The low-cost, low-power Internet of Things (IoT) components enable easy scalability and environmental friendliness by reducing resource consumption.
- The automated irrigation system benefits sustainable farming by lessening the human impact and increasing the crop productivity.

8.5 Safety Aspects

- **Electrical safety ensured through relay isolation and low-voltage control :**The pump is run with an isolated relay module, thus a high-voltage AC is not allowed to reach the micro controller. In this way, the possibility of an electric shock or a failure of the electronic components is minimized.

- **Prevents pump dry-run using water-tank level detection :**The float switch that stops the pump when the tank is empty, thus protecting the motor from overheating. This safety device not only helps to prolong the life of the pump but also prevents the occurrence of mechanical failure.
- **Rain detection avoids unnecessary or unsafe irrigation during wet conditions :**The automatic pump shutdown during a rainy period is a preventive measure against water logging, which causes slips and accidents in the field. At the same time, it helps in reducing the chances of electrical risks that may be the result of pumps operating during rain.
- **System stability maintained through non-blocking code execution :**Employing Millis() in place of delay() keeps the controller responsive and prevents system freezes. Consistent software behavior is a must for a safe and reliable system.
- **Buzzer alerts notify users about critical conditions :**If it rains and the water level in the tank is low then an audible buzzer will be activated to warn of that fault so that it can be detected immediately. This lowers the chances of the system malfunctioning and water shortage occurring without the user's knowledge.
- **Secure enclosure protects electronics from environmental damage :**Sensors and the controller are in waterproof or dust-proof housings. This avoids situations like short circuits, rusting, and even the risk of a fire due to the device being exposed to moisture or dirt.

Chapter 9

Conclusion

The Smart Irrigation System for Precision Farming is a brilliant example of how embedded electronics, IoT concepts, and automatically controlled logic can enhance agriculture to a great extent. By the system integration of soil moisture sensing, rainfall detection, temperature and humidity monitoring, and water-level protection, it sends out an unfailing and intelligent signal for the most suitable irrigation management.

The project comes up with its main goal – to water the plants only when it is necessary, thus cutting the loss to the minimum, saving groundwater, and improving crops. The automation of this task lowers the dependence on manual labor, so farmers can use their time for more important works, which results in higher productivity.

Working with hysteresis, the system's threshold-based moisture control is smooth and, therefore, it ensures the pump is running normally without it being switched on and off rapidly. Safety features like rain override and low-tank protection make the design stronger. The manual override option gives the user power and thereby allows farmers to step in during the conditions that are special, thus, assuring flexibility and practicality in the scenarios of the real world.

An LCD interface offers straightforward and instantaneous feedback, which is very helpful and transparent. Though cloud involvement is a plus for the sake of remote monitoring, the logic of the system on the edge ensures that the fundamental irrigation decisions can be made without a connection to the internet.

Test results before execution corroborate the accuracy, efficiency, and safety of the device, thereby confirming the proper functioning of both hardware and software. The done-up project of integrating inexpensive sensors coupled with the efficient automation technique is a living example that precision agriculture can not only be affordable but also attractive to small and marginal farmers.

Moreover, the modular-style design meets the scalability criterion enabling future extension by means of more advanced sensors or pre-emptive machine-readable models.

Hence, the program becomes a useful, environmentally friendly, and financially sound solution to contemporary agriculture. By advocating the wise use of water, lowering energy consumption, and increasing the crop's dependability, the Smart Irrigation System is a win-win situation for the future of precision farming and sustainable agricultural development.

9.2 Future Work

The present Smart Irrigation System manages the watering process automatically based on the environmental changes, but it still leaves several possibilities to be improved and extended to make the system more intelligent, scalable, and friendly for its users in the real world. The mobile application dashboards and cloud-based analytics integration is one of the significant directions of the system updates in the future. It would allow the farmers to check remotely the field condition, irrigation history, and by their own will, pump-control through smartphones or web platforms, which is a way of making the system more understandable and available to a great number of people. Another enhancement is to involve advanced machine learning or AI-based prediction models that rely on the historical data, soil characteristics, and weather forecasts to schedule the irrigation in a foresighted way rather than simply responding to sensor values. The predictive model will be instrumental in optimization the irrigation cycles and water saving to a great extent, especially if the crop-specific use cases are considered. The integration of solar-powered energy systems, on the other hand, can make the device completely independent and thus, a perfect fit for the agricultural areas in the mountains or deserts where the access to electricity is minimal. Besides that, the extension of the system sensing capability with the inclusion of the pH, nutrient levels (NPK), and light intensity sensors can make it an advanced precision farming tool. The deployment of wireless sensor networks (WSN) can be an option for large-scale implementation in different farm areas with a single control point as well.

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Base Paper

The “Smart Irrigation System Using IoT” illustrates a method for automating irrigation through the Internet of Things (IoT) with the help of soil-moisture, temperature, and humidity sensors. The developers envision a setup wherein the environmental factors are constantly checked and the water pump is automatically regulated to make the usage of water efficient and save the trouble of manual intervention. The paper highlights the features of real-time data acquisition, wireless monitoring, and energy-efficient irrigation, which, together, provide a solid conceptual basis for the creation of advanced precision-farming solutions. The methodology employed in this work is a direct facilitation of the goals set forth in this research endeavor, sensor-based automation, water saving, and smart agricultural management, in particular.

Title: The Smart Irrigation System Using IoT

Authors: C. K. Gomathy, A. Vamsikumar, B. Karthik, and A. Purushothamreddy

Journal/Conference: International Research Journal of Engineering and Technology (IRJET) — Volume 08, Issue 10, October 2021

Publisher: IRJET / ESRA Publications

Link:
https://www.researchgate.net/publication/357748563_THE_SMART_IRRIGATION_SYSTEM_USING_IOT

Appendix-A

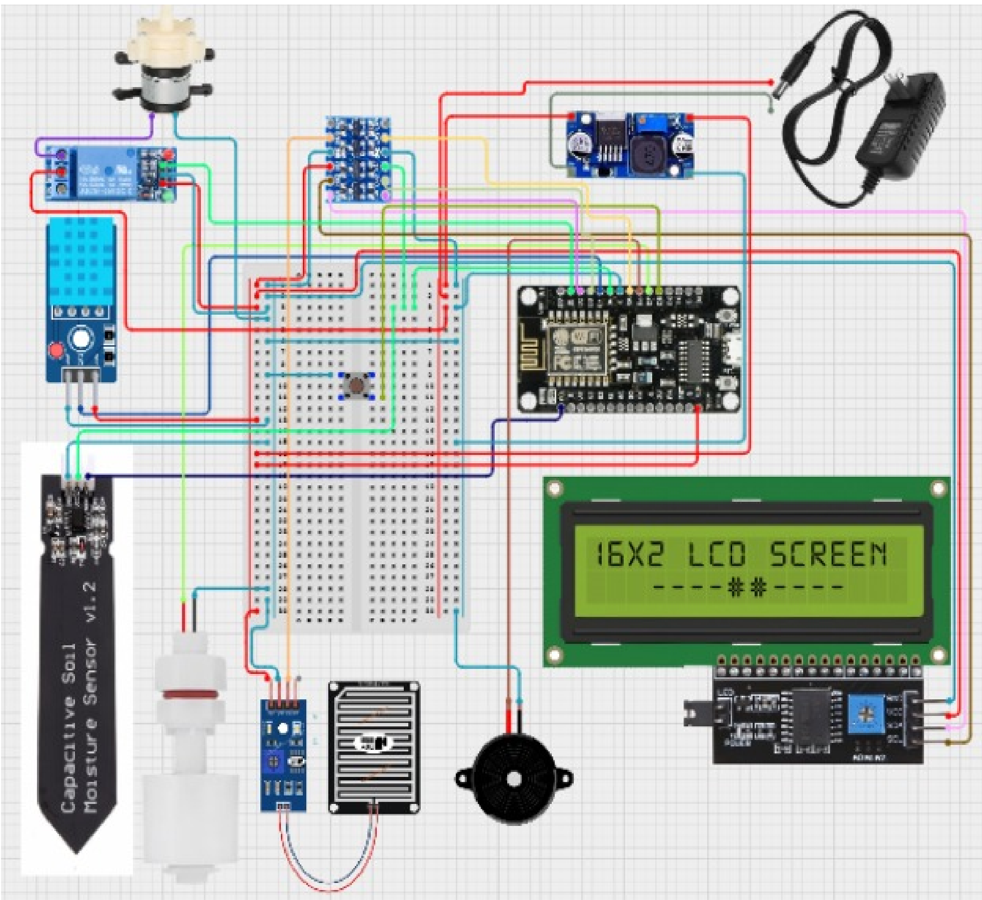
Appendix 1: Hardware Specifications

This section lists the detailed specifications and data sheets of key hardware components used in the project:

1. ESP8266 NodeMCU Microcontroller – Wi-Fi enabled IoT module
2. Soil Moisture Sensor (Capacitive Type)
3. DHT11 Temperature and Humidity Sensor
4. Rain Detection Sensor Module
5. Float Switch (Water Level Sensor)
6. Channel Relay Module (5V)
7. 16×2 LCD with I2C Interface
8. DC Water Pump (12V)

Appendix 2: Circuit Diagram

Fig 9.1 Circuit Diagram of project



Appendix 3 – Code (Source Code)

Appendix C consists of the complete code used in the Smart Irrigation System, which includes the following features:

- Initialization of the sensors
- Moisture threshold logic
- Rain and tank level over-rides
- Updating the LCD Display

Appendix 4: System Output Screenshots

Screenshots demonstrating successful execution during testing:

- Serial Monitor Outpuut
- LCD Status Display
- Pump On/OFF State Transitions
- Water Tank level State

1. The LCD display in the smart irrigation system shows the real-time status of soil moisture and pump operation. In the displayed image, the LCD reads:

M=0%

PMP=OFF

“RAINING”

Fig 9.2 LCD Displaying Moisture levels,Pump State

This indicates the following:

M: 0% → The soil moisture sensor is detecting *very low moisture level*, close to dry conditions.

PMP: OFF → Even though the soil is dry, the **water pump remains OFF**.

RAINING ! → The rain sensor has detected rainfall.Since the system is designed to **stop irrigation during rain**, the controller automatically keeps the pump OFF to avoid unnecessary watering and conserve water.

2. The LCD display in the smart irrigation system shows the real-time status of soil moisture and pump operation. In the displayed image, the LCD reads:

   M=0%

   PMP=OFF

   T=27 and H=59%

Fig 9.3 LCD Displaying Moisture levels,Pump State and Temperature and Humidity Levels

This indicates the following:

M: 0% – The soil moisture level is 0%, indicating that the soil is completely dry.

PMP: ON – Because the soil is dry and no rain is detected, the system has automatically turned the water pump ON to irrigate the field.

T: 27 – The temperature sensor is reading **27°C**, representing the current ambient temperature.

H: 59% – The humidity sensor is reading **59%**, showing the level of atmospheric humidity

3. The LCD display in the smart irrigation system shows the real-time status of soil moisture and pump operation. In the displayed image, the LCD reads:

   M=0%

   PMP=OFF

   "WATER LOW"

Fig 9.4 LCD Displaying Moisture levels,Pump State and Water tank level State

This indicates the following:

M: 0% – The soil moisture level is extremely low, indicating that the soil is dry.

PMP: OFF – The water pump is turned OFF.

WATER LOW ! – This warning indicates that the **water level in the tank is low**, so the pump is stopped to prevent dry running and damage.

Appendix-B

Publication - Acceptance Letter

International Conference on Sustainable Developments in Computer Engineering, Green Technology & Smart Systems : Submission (924) has been created. Inbox x

Microsoft CMT <noreply@msr-cmt.org> 14:16 (6 minutes ago)

to me

Hello,

The following submission has been created.

Track Name: Track 34: Intelligent Cyber-Physical Ecosystems for Autonomous Mobility and Smart Infrastructure

Paper ID: 924

Paper Title: Smart Irrigation System for Precision Farming

Abstract:
Agriculture is still grappling with problems like water scarcity, besides facing inefficient irrigation practices and relying heavily on manual monitoring. These issues can be solved with the help of their project as they have come up with a Smart Irrigation System for precision farming with the help of IoT-based automation. The system utilizes sensors such as soil moisture, temperature, humidity, rain detection, and a water level float switch to keep the environment under observation in real-time. In response to these factors, the ESP8266 microcontroller is switching the pump ON/OFF by the relay module connected to it through the water pump, which is then done physically

a manual override switch and an LCD display offer user control and system transparency, whereas the buzzer alerts abnormal situations like the tank empty or rain detected. The main focus of the execution is on energy-saving, resource management, and lessening of human intervention. Both the simulation and the testing are proving

Appendix-C

Project Report Similarity Report

turnitin Page 2 of 56 - Integrity Overview Submission ID trn:oid:::1:3431802632

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Github-Link:https://github.com/Tejeswar55/SMART-IRRIGATION-SYSTEM-FOR-PRECISION-FARMING-