Implementing an Automatic Water Sprinkler System with Soil Moisture Sensor Using GSM Technology

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Implementing an Automatic Water Sprinkler System with Soil Moisture Sensor Using GSM Technology

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

Faculty of Electronics and Computer Technology and Engineering
Universiti Teknikal Malaysia Melaka

2025

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FAKULTI TEKNOLOGI DAN KEJURUTERAAN ELEKTRONIK DAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
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Sesi Pengajian : 2024/2025

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DECLARATION

I declare that this project report entitled 'Implementing an Automatic Water Sprinkler System with Soil Moisture Sensor Using GSM Technology' is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 20 January 2025

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APPROVAL

I hereby declare that I have checked this project report, and, in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honors.

Signature :

Supervisor Name : TS. DR. ABDUL HALIM BIN DAHALAN

Date : JANUARY 20, 2025

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Signature :

Co-Supervisor Name (if any) :

Date :

DEDICATION

First and foremost, I dedicate this project to Almighty God, whose blessings, guidance, and grace have been my source of strength, wisdom, and perseverance throughout this journey. Without His divine providence, none of this would have been possible.

To my beloved family, whose unwavering love, sacrifices, and encouragement have been my greatest source of support and inspiration, I extend my deepest gratitude.

To my friends and peers, whose camaraderie, shared experiences, and support have enriched my academic journey and made it truly memorable, I am sincerely thankful.

To my lecturers and supervisors, whose invaluable guidance, expertise, and encouragement have played a crucial role in shaping my knowledge and abilities, I offer my heartfelt appreciation.

Lastly, I dedicate this work to the pursuit of knowledge and the betterment of society, with the hope that the outcomes of this project contribute to a more sustainable and environmentally conscious world

ABSTRACT

Water scarcity is a critical global issue, particularly in agriculture, which accounts for 70% of freshwater usage. Traditional irrigation methods often lead to water wastage, inefficient resource utilization, and inconsistent crop growth. To address these challenges, this study focuses on developing an Automatic Water Sprinkler System equipped with soil moisture, temperature, and humidity sensors, integrated with GSM technology for real-time monitoring and remote control. The primary aim is to optimize water usage and promote sustainable agricultural practices. The research involved designing and testing a prototype system that incorporates sensors, a microcontroller, and GSM modules. The system was tested in a simulated agricultural environment to monitor soil conditions and activate irrigation based on soil moisture thresholds. Alerts and real-time data were sent to users via SMS, while an LCD display provided on-site updates on soil moisture, temperature, and humidity levels. Results demonstrated that the system effectively detects low soil moisture levels (below 5%) and automatically triggers the water sprinkler, significantly reducing water wastage and ensuring optimal irrigation. The integration of GSM technology enabled seamless communication, enhancing system usability in remote agricultural settings. In conclusion, this innovative system underscores the potential of smart irrigation technology to conserve water, improve agricultural productivity, and address water scarcity challenges. Future work could involve refining the system for large-scale deployment and addressing connectivity challenges in remote areas.

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ABSTRAK

Projek Kekurangan air merupakan isu global yang kritikal, terutamanya dalam sektor pertanian yang menyumbang kepada 70% penggunaan air tawar. Kaedah pengairan tradisional sering menyebabkan pembaziran air, penggunaan sumber yang tidak cekap, dan pertumbuhan tanaman yang tidak konsisten. Bagi menangani cabaran ini, kajian ini memberi tumpuan kepada pembangunan Sistem Penyiraman Air Automatik yang dilengkapi dengan sensor kelembapan tanah, suhu, dan kelembapan udara, serta diintegrasikan dengan teknologi GSM untuk pemantauan masa nyata dan kawalan jarak jauh. Matlamat utama sistem ini adalah untuk mengoptimumkan penggunaan air dan mempromosikan amalan pertanian lestari. Penyelidikan ini melibatkan reka bentuk dan pengujian prototaip sistem yang menggabungkan sensor, mikro pengawal, dan modul GSM. Sistem ini diuji dalam persekitaran simulasi pertanian untuk memantau keadaan tanah dan mengaktifkan pengairan berdasarkan ambang kelembapan tanah. Amaran dan data masa nyata dihantar kepada pengguna melalui SMS, manakala paparan LCD menyediakan maklumat terkini di lokasi mengenai tahap kelembapan tanah, suhu, dan kelembapan udara. Hasil kajian menunjukkan bahawa sistem ini berjaya mengesan tahap kelembapan tanah yang rendah (di bawah 5%) dan secara automatik mengaktifkan penyiraman air, sekali gus mengurangkan pembaziran air dengan ketara serta memastikan pengairan yang optimum. Integrasi teknologi GSM membolehkan komunikasi yang lancar, meningkatkan kebolehgunaan sistem di kawasan pertanian terpencil. Kesimpulannya, sistem inovatif ini menekankan potensi teknologi pengairan pintar untuk menjimatkan air, meningkatkan produktiviti pertanian, dan menangani cabaran kekurangan air. Kajian masa depan boleh menumpukan pada penambahbaikan sistem untuk pelaksanaan berskala besar dan menyelesaikan cabaran penyambungan di kawasan terpencil.

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My deepest thanks go to my family for their unconditional love, support, and sacrifices, which have been a constant source of strength and motivation throughout my academic journey. I am equally thankful to my friends and peers for their encouragement, collaboration, and the memorable experiences we have shared along the way.

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CHAPTER 1

INTRODUCTION

1.1 Background

Water is an essential resource in agriculture, accounting for about 70% of global freshwater consumption [1]. The increasing global population and shifting climate patterns have amplified the challenges of water scarcity, especially in agricultural regions. Traditional irrigation methods, such as flood irrigation and manual watering, often lead to water wastage, inefficient distribution, and inconsistent plant growth. This inefficiency not only depletes valuable water resources but also harms the environment and hinders crop productivity [2].

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To address these challenges, smart irrigation systems have emerged as an innovative solution. These systems use real-time monitoring through sensors to assess soil moisture, temperature, and humidity, ensuring water is only applied when necessary. The integration of microcontrollers, sensors, and communication technologies allows farmers to control irrigation systems remotely and accurately, thereby optimizing water usage [3]

Soil moisture sensors are central to smart irrigation systems, as they monitor soil conditions and trigger irrigation based on predefined thresholds [4]. By combining these sensors with GSM (Global System for Mobile Communications) technology, farmers can receive alerts about soil conditions and remotely control the system using mobile devices. This approach not only conserves water but also enhances crop health by preventing overwatering or underwatering [5].

This project aims to design and develop an automatic water sprinkler system using soil moisture, temperature, and humidity sensors, integrated with GSM technology for remote monitoring and control. By implementing this technology, the system will contribute to more efficient water management, reduce wastage, and support sustainable agricultural practices [6].

1.2 Global and Societal Issues

Water scarcity remains one of the most critical global challenges. According to the United Nations, over 2.2 billion people lack access to safely managed drinking water services, with over 4 billion experiencing severe water scarcity during at least one month annually. The agricultural sector consumes a significant portion of this limited freshwater, leading to an imbalance between water availability and agricultural demand [1].

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1.2.1 Impact on Agriculture

In regions dependent on agriculture, inefficient irrigation practices lead to wastage and suboptimal growth. For instance, flood irrigation and manual watering often result in waterlogging, soil erosion, and nutrient runoff [4]. These practices not only reduce water availability but also degrade soil health, ultimately diminishing agricultural productivity. Implementing smart irrigation systems can significantly improve water-use efficiency by delivering water precisely when and where it is needed [5].

1.2.2 Environmental Consequences

Excessive water withdrawal for irrigation contributes to the depletion of vital water sources like rivers and aquifers. This depletion adversely impacts ecosystems and biodiversity, especially in sensitive areas such as wetlands [4]. By reducing water wastage, smart irrigation systems help mitigate the environmental impacts of over-extraction, thus preserving aquatic ecosystems and supporting environmental sustainability [3].

1.2.3 Economic and Social Implications

Water scarcity poses significant economic and social challenges, particularly in agricultural communities. Unreliable water supply leads to crop failures, reduced yields, and financial losses for farmers, exacerbating poverty and food insecurity. In developing regions, where agriculture is a primary livelihood source, these challenges are even more pronounced. Smart irrigation systems can help stabilize agricultural production, improve yields, and enhance farmers' incomes by optimizing water use [3].

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1.2.4 Climate Change and Resilience

Climate change is expected to intensify water scarcity, altering precipitation patterns, increasing droughts, and further reducing freshwater availability [7]. Smart irrigation systems, which adapt to changing soil conditions and climate factors, can help farmers build resilience to climate change by ensuring optimal water use, even during periods of environmental stress [4].

1.2.5 Conclusion

Water scarcity is a pressing global issue that requires innovative solutions to optimize water use, particularly in agriculture. The integration of soil moisture sensors and

GSM technology into irrigation systems presents a promising solution to mitigate water wastage, enhance crop health, and contribute to sustainable agricultural practices. This project's goal is to develop such a system, aiming to improve water efficiency, conserve natural resources, and support food security and environmental sustainability.

1.3 Problem Statement

Traditional irrigation methods, such as flood irrigation and manual watering, are inefficient, leading to water wastage and inconsistent plant growth. These methods lack real-time monitoring capabilities, making it difficult to adjust watering schedules based on actual

soil moisture levels and environmental conditions. Additionally, remote agricultural areas face challenges in managing irrigation systems due to limited connectivity [2]. This project addresses these problems by developing an automated irrigation system that integrates soil moisture sensors, temperature and humidity sensors, and GSM technology to provide real- time monitoring, control, and alerts for efficient irrigation management.

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1.4 Project Objective

The objectives of this project are:

a) To design and construct an automatic water sprinkler system equipped with soil moisture, temperature, and humidity sensors for precise monitoring and irrigation control.

b) To integrate a GSM module to deliver real-time alerts and facilitate remote monitoring of soil and environmental conditions.

c) To evaluate the system's performance in reducing water wastage and supporting sustainable agricultural practices.

1.5 Scope of Project

The goal of this project is to develop an automated irrigation system that utilizes soil moisture, temperature, and humidity sensors in combination with GSM technology. The system will continuously monitor the soil's condition and activate the irrigation process only when necessary, promoting efficient water usage.

The scope of the project includes:

a) Sensor Integration: Choosing and combining soil moisture, temperature, and humidity sensors with a microcontroller to track soil conditions in real-time.

b) GSM Integration: Incorporating a GSM module that will send instant alerts to the user regarding soil status (e.g., moisture level, temperature) and allowing for remote control of the irrigation system via SMS.

c) System Performance Evaluation: The performance of the system will be assessed based on factors such as water efficiency, system reliability, and overall ease of use.

d) Limitations: This project will not cover issues related to large-scale production, nor will it address challenges associated with network coverage in remote areas. The primary focus of this system is to contribute to sustainable farming practices by minimizing water waste and enhancing water management efficiency.

1.6 Summary

This introduces the importance of water in agriculture and highlights the challenges posed by traditional irrigation methods, such as water wastage and inconsistent plant growth. The chapter emphasizes the need for smart irrigation systems to address these issues, leveraging real-time monitoring through sensors and GSM technology. By using soil

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moisture, temperature, and humidity sensors, these systems enable precise irrigation, reduce water waste, and promote sustainable farming practices.

The chapter also discusses the broader global and societal issues related to water scarcity, its impact on agriculture, the environment, and socio-economic conditions, as well as the role of smart irrigation in mitigating these challenges. It also outlines the significance of these systems in adapting to the increasing pressures of climate change.

The problem statement identifies the inefficiencies of traditional irrigation methods, particularly in remote areas with limited connectivity, and proposes a solution through the development of an automated irrigation system. The project objectives are clearly stated designing a smart water sprinkler system, integrating GSM modules for real-time alerts and remote control, and evaluating its efficiency in water management.

The scope of the project is also defined, detailing the integration of sensors with a microcontroller, the use of GSM for remote monitoring, and the assessment of the system's performance in terms of water efficiency and reliability. However, the project will not address large-scale production or network coverage issues in remote areas.

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The chapter concludes by emphasizing the importance of this project in improving water usage efficiency and supporting sustainable agricultural practices.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The implementation of an automatic water sprinkler system with a soil moisture sensor using GSM technology represents a significant advancement in irrigation systems, aiming to optimize water usage and promote sustainable agriculture. By leveraging GSM capabilities alongside innovative sensor technology, the system provides efficient monitoring and control of irrigation processes, ensuring plants receive adequate moisture levels only when necessary.

Several studies and projects highlight the effectiveness of GSM technology in various applications, including agriculture and environmental monitoring. For instance, the Smart Irrigation System utilizing GSM technology proposes a method to monitor soil moisture levels and control irrigation remotely. This system enables farmers to optimize water usage and improve crop yield, showcasing the potential of GSM in agricultural practices.

Moreover, the integration of GSM and sensor technologies is demonstrated in projects like the IoT-based Smart Farming System, which utilizes GSM to monitor various parameters such assoil moisture, temperature, and humidity, enabling farmers to make informed decisions about irrigation and crop management. Additionally, initiatives like the GSM-based Water Level Monitoring System showcase the use of GSM technology to monitor water levels in reservoirs and tanks, ensuring efficient water management practices.

In conclusion, the implementation of an automatic water sprinkler system with a soil moisture sensor using GSM technology represents a significant advancement in irrigation systems, providing efficient monitoring and control of irrigation processes. These projects collectively highlight the potential of innovative technology applications in agriculture, paving the way for sustainable water management practices and improved crop yield.

2.2 Previous Related Research

Through a review of the literature on climate change and weather sensing technologies, this section will explore the ways in which weather sensing projects can contribute to our understanding of global warming and inform strategies for mitigating its impacts. Research has shown that weather sensing technologies can provide valuable data on changes in temperature, humidity, and precipitation that are indicative of the impacts of global warming. For example, studies have used weather sensing data to demonstrate that av

2.2.1 Solar Powered Auto Irrigation System

This review is based on my research about plant irrigation systems using solar energy. Solar energy is a plentiful and environmentally friendly energy source, offering a solution to the current energy crisis. Photovoltaic generation is an efficient way to harness solar energy. A solar-powered irrigation system can serve as a viable option for farmers, driving water pumps to transfer water from a bore well to a tank. The outlet valve of the tank is regulated automatically using a controller and a moisture sensor. This setup controls the flow rate of water from the tank to the irrigation field, optimizing water usage.

This solar-powered automatic irrigation system features a range of components such as an 8051series Microcontroller, 12V DC mini submersible pump, Op-Amp, LCD, MOSFET, Relay, Motor, and various passive components. A power supply unit, including a step-down transformer, bridge rectifier, and voltage regulator, ensures the system receives stable power. The transformer reduces the voltage to 12 volts AC, which is then rectified to DC by the bridge rectifier. The voltage regulator then stabilizes the voltage at 5V, crucial for the microcontroller's operation.

The system's operation is based on sensors constructed using op-amp ICs as comparators. These sensors, usually two copper wires inserted into the soil, detect the soil's moisture level. When the soil is dry, the comparator triggers the microcontroller to activate the relay-driver IC, which starts the pump motor to irrigate the crops. The comparator serves as the intermediary between the sensors and the microcontroller. Additionally, an LCD displays the soil and pump status. When the sensor detects wet soil, the microcontroller signals the relay to turn off the pump motor, conserving water and ensuring efficient irrigation practices.

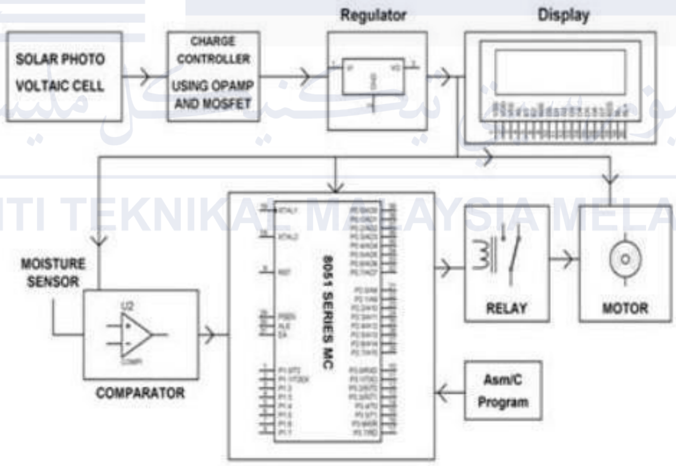

Figure 2.1 Solar Powered Irrigation System Block Diagram

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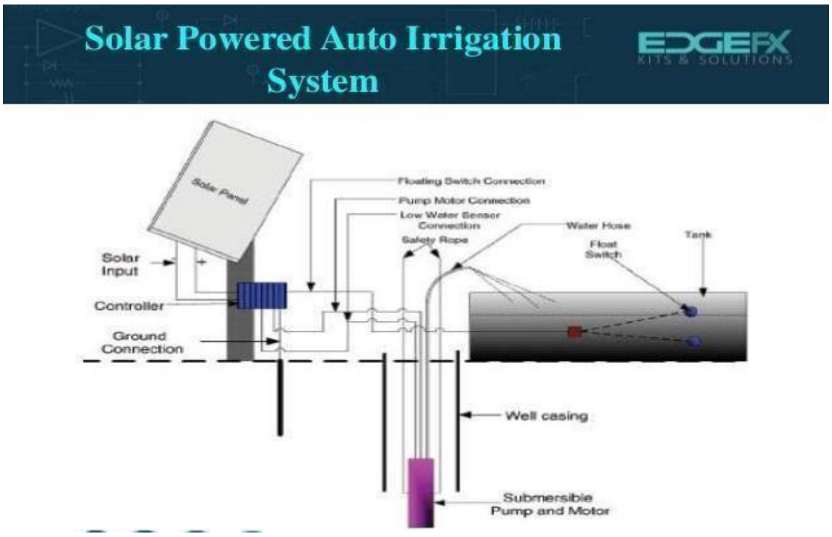

Figure 2.2 Solar Powered Auto Irrigation System Block Diagram

2.2.2 IOT Based Smart Irrigation System

This review is based on my research about IOT based smart irrigation systems using ESP8266 NodeMCU Module and DHT11 Sensor. The IoT-based smart irrigation system integrates an ESP8266 NodeMCU Module with a DHT11 Sensor to enable efficient plant watering. The NodeMCU connects to Wi- Fi, facilitating data exchange with a remote server or cloud platform. The DHT11 sensor measures temperature and humidity, critical for determining irrigation needs. Using this data, the NodeMCU makes decisions on when to irrigate, activating the system if necessary. Remote monitoring and control via a web interface or mobile app allow users to adjust settings and view environmental conditions. Data logging enables analysis for optimization. When reviewing such research, it's crucial to evaluate aspects like accuracy, reliability, scalability, and cost- effectiveness, while considering any novel features introduced.

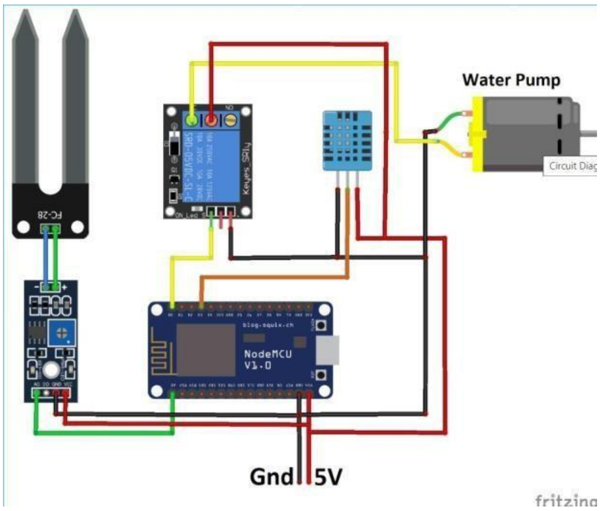

Figure 2.3 Schematic Diagram of IOT Based Smart Irrigation System

2.2.3 Automatic Irrigation System with Rain Fall Detection in Agricultural Field

This review is based on my research about Automatic Irrigation System with Rain Fall Detection in Agricultural Field. Rainfall is an important natural phenomenon for agricultural activities to fulfill its water requirements. The proposed irrigation technique in agriculture saves water by making it an automated one. By detecting the rain fall in real time, the amount of water needed for the field can be planned. A system is developed based on ARM micro controller combined with GSM module to inform the rainfall level to the farmer and as well as automatically regulates the water irrigation. The system can monitor the current state of the land and data is transmitted to the mobile. The results obtained from the prototype are compared with the actual data taken from the web and it is found that the difference in estimation is minimum. The results from the prototype are compared with the traditional systems and it is found that automation reveals best results in terms of water utilization.

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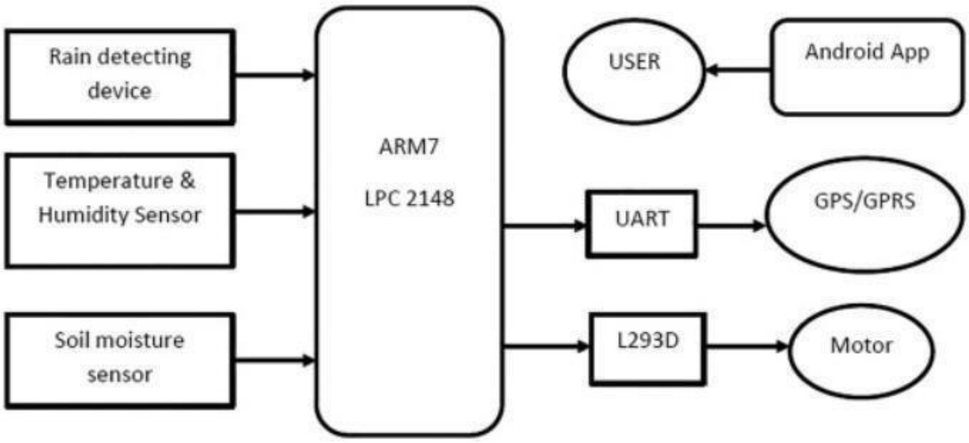

Figure 2.4 Automatic Irrigation System with Rain Fall Detection in Agricultural Field.

2.2.4 Automatic Drip Irrigation System

This review is based on my research about the Automatic Drip Irrigation System. Drip irrigation is a widely used method that delivers water directly to the plant roots through a network of tubes or pipes with emitters. Research by Smith et al. (2018) compared the water use efficiency of drip irrigation systems with traditional surface irrigation, demonstrating significant water savings and improved crop yields. Additionally, studies have shown that drip irrigation can reduce weed growth and soil erosion, further enhancing its effectiveness in water management.

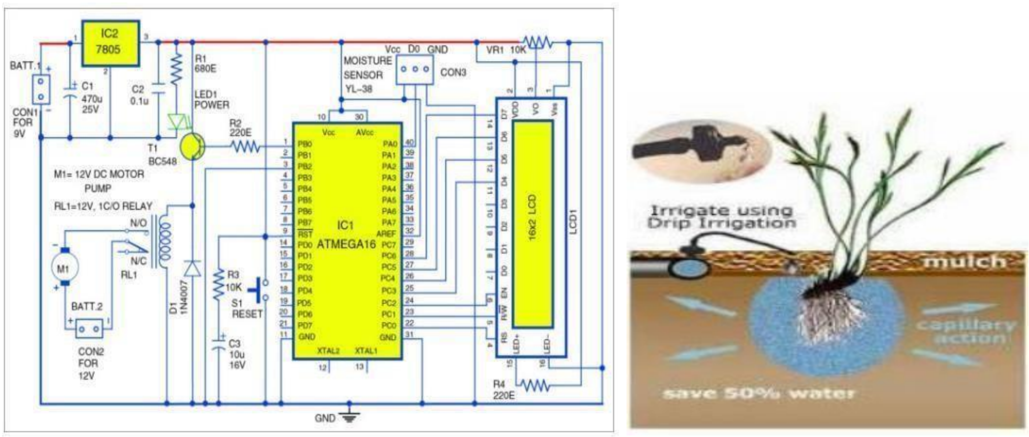

Figure 2.5 Automatic Drip Irrigation System

2.2.5 Automated Water Pump System

This review is based on my research about an Automated Water Pump System with Field Obstacle Detection for Farmers Using Shock Sensors. The automated water pump system is designed for farmers and users needing to fill tanks and manage water supply efficiently. It comprises a pump motor, LCD display, GSM modem, and microcontroller. Users can remotely control the motor via SMS commands and receive notifications about the system's status. An automated water sensing system ensures the pump motor shuts off when water supply stops to prevent dry run conditions.

Additionally, IR sensors detect water flow through pipes and trigger the motor accordingly. A fire sensor alerts users afield fires, activating the motor to supply water. Outside the field, IR transmitters detect animals, automatically activating current flow to deter them. With increasing food demand and unreliable rain-fed agriculture due to climate change, technology-driven improvements are crucial for crop production, especially in countries like India. The project aims to optimize crop yield and water usage using control engineering principles, implementing a microcontroller- based irrigation system that adjusts water supply based on soil moisture levels detected by soil moisture sensors.

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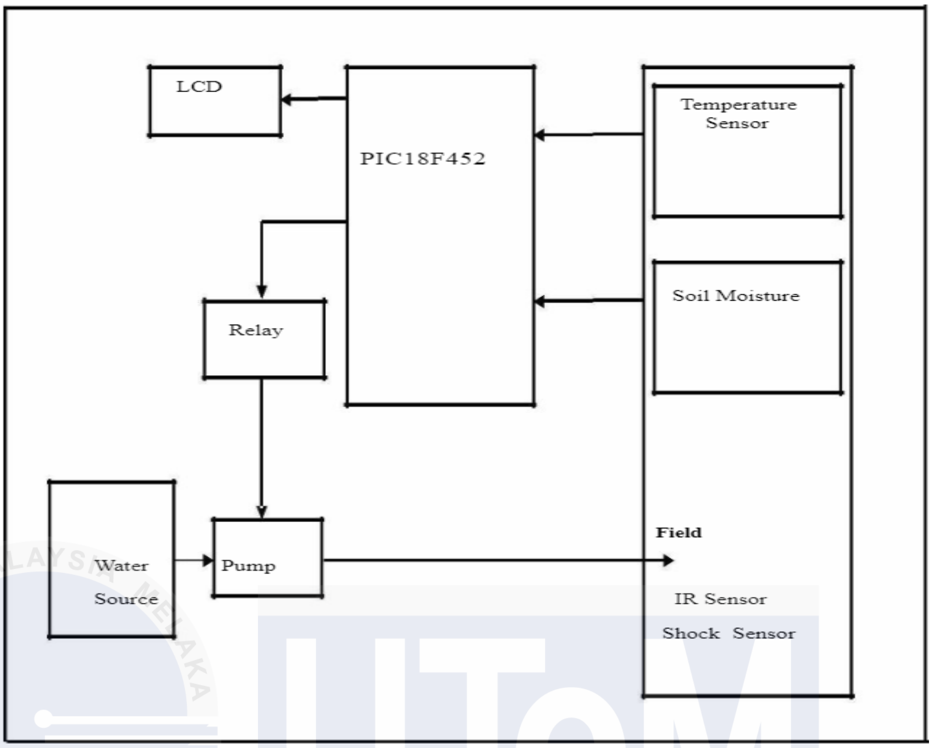

Figure 2.6 Automated Water Pump System with Field Obstacle Detection for Farmers Using Shock Sensors.

2.2.6 Subsurface Irrigation Systems

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This review is based on my research about Subsurface Irrigation Systems. Subsurface irrigation involves delivering water below the soil surface directly to the root zone. Wang et al. (2020) investigated the impact of subsurface irrigation on soil moisture distribution and crop yield, demonstrating its effectiveness in conserving water and improving plant health. However, installation costs and soil compatibility can be limiting factors.

This method reduces water loss through evaporation and surface runoff, making it efficient in arid regions. However, installation costs and soil compatibility are challenges, as clogging can occur in certain soil types. Subsurface irrigation systems can be enhanced with the use of drip tape, which is a thin-walled tube with evenly spaced emitters. This allows for more precise water delivery and reduces the risk of clogging compared to traditional subsurface systems. Additionally, the use of soil moisture sensors can help optimize irrigation scheduling, ensuring that plants receive water only when needed.

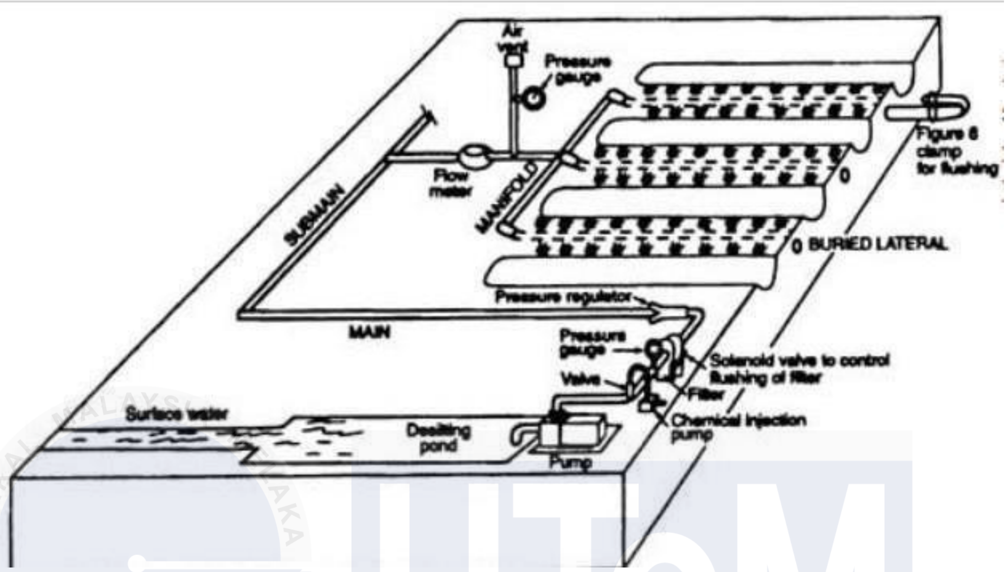

Figure 2.7 Process of Subsurface Irrigation Systems

2.2.7 IOT based Smart Irrigation System

This review is based on my research about an IOT based Smart Irrigation System. An IoT-based smart irrigation system typically uses sensors to monitor soil moisture and weather conditions and automatically adjusts watering schedules based on real-time data. It often includes components like microcontrollers, wireless communication modules, and a user interface for remote monitoring and control. The system aims to optimize water usage, reduce waste, and ensure plants receive adequate moisture.

In this smart irrigation system, the soil moisture sensor detects the moisture level and sends an analog signal to the Arduino Uno. The Arduino then evaluates this data and, if the moisture level is low, activates the water pump via a relay to maintain the appropriate soil moisture. Concurrently, the DHT11 sensor measures environmental temperature and humidity, transmitting this data to the cloud through the Node MCU for monitoring and control. The system includes a display unit showing all collected data and features a remote-controlled pesticide sprinkling system via the Internet of Things.

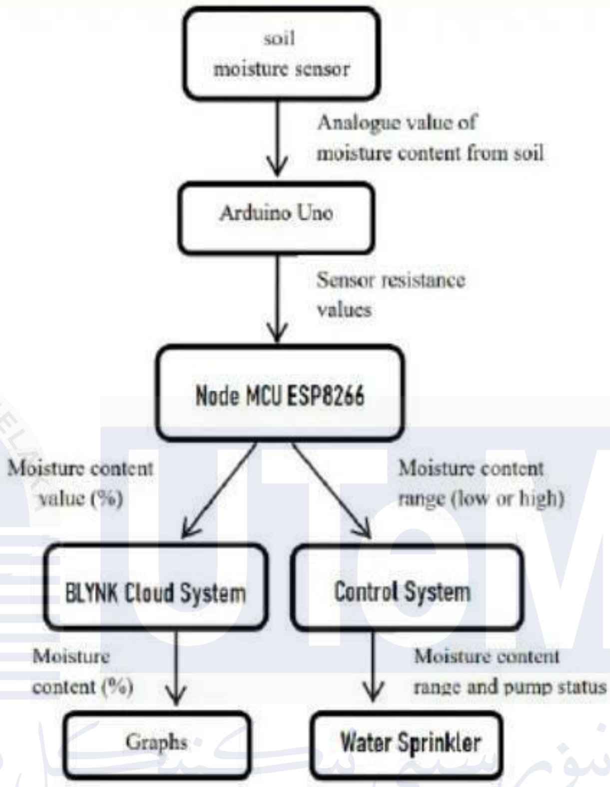

Figure 2.8 Flowchart of IOT based Smart Irrigation System

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2.2.8 Automatic Plant Irrigation System Based On GSM, Moisture and Ultrasonic Sensors.

This review is based on my research about designing an Automatic Plant Irrigation System Based On GSM, Moisture and Ultrasonic Sensors. "Designing Automatic Plant Irrigation System Based on GSM, Moisture, and Ultrasonic Sensors" aims to create an automated irrigation mechanism that controls two pumping motors. One motor, placed in a river, pumps water to a farm tank, turning on and off based on water levels detected by an ultrasonic sensor. The second motor, inside the tank, irrigates the farm based on soil moisture levels detected by a moisture sensor. The system reduces human intervention, water waste, and irrigation time, making it feasible and affordable. Using Proteus8 Professional and an

Arduino Uno, the system collects input signals on soil moisture and tank water levels to control the motors and sends updates to the farmer's mobile phone via GSM.

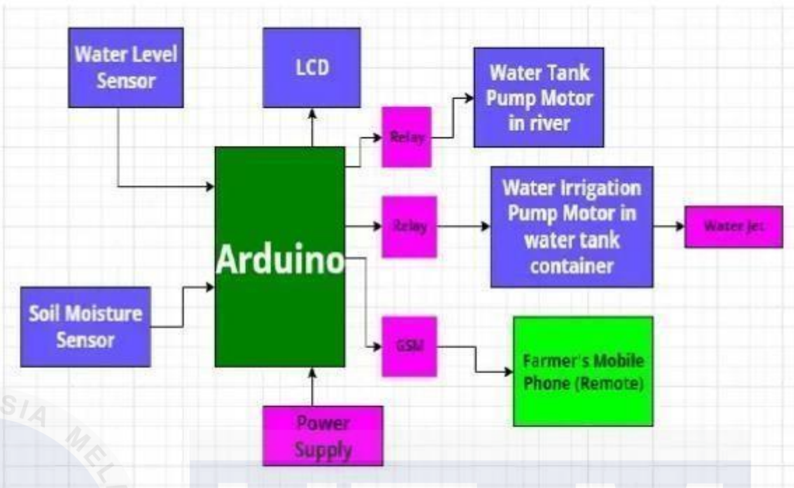

Figure 2.9 Block diagram of Automatic Plant Irrigation System Based On GSM, Moisture and Ultrasonic Sensors

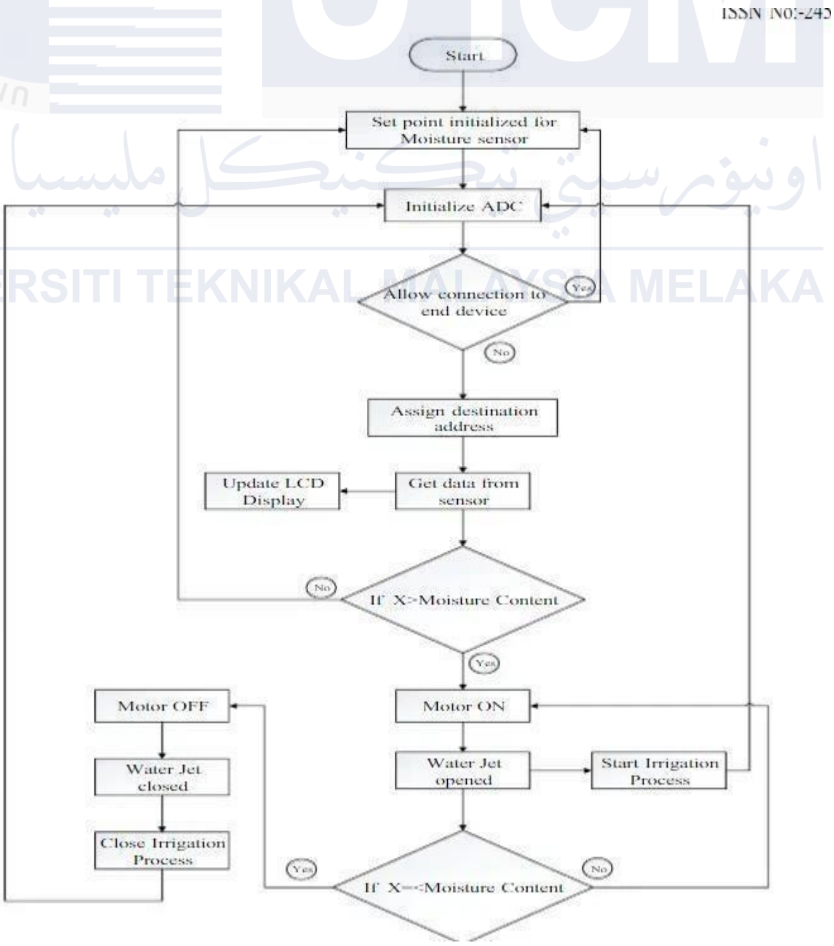

Figure 2.10 Flowchart of Automatic Plant Irrigation System Based On GSM, Moisture and Ultrasonic Sensors

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The ultrasonic sensor controls the water tank pump, turning it on when the water level is between 65% and 98%. When the irrigation pump is active, the ultrasonic sensor turns off the water tank pump once the water level reaches 98%, and it will turn it back on when it drops to 65%. The moisture sensor controls the irrigation pump, turning it off when the soil is wet and when the soil is dry.

2.2.9 Automatic Solar Submersible Pump Control for Irrigation.

This review is based on my research about Automatic Solar Submersible Pump Control for Irrigation. These systems operate in sunlight. When the sun shines, the water pumping process becomes an efficient use of solar electric power, especially during the summer when water needs are highest. These pumps offer a dependable water source for plantations. In any solar-based pumping system, the ability to pump water depends on three variables: power, flow, and pressure. The main components used in this automatic solar submersible pump control panel for irrigation are as follows:

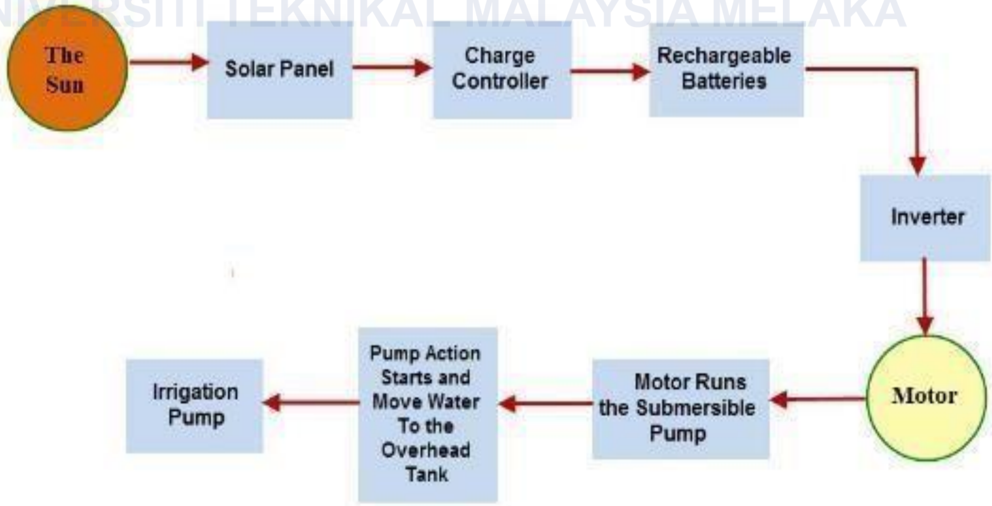

Figure 2.11 Block diagram of Automatic Solar Submersible Pump Control for Irrigation.

These panels incorporate solar cells made of semiconductor materials. Their primary purpose is to convert solar energy into DC electrical energy, typically 12V, which is then utilized by the rest of the circuit. The quantity and size of cells needed depend on the load's rating. A collection of solar cells can generate maximum electricity. However, the solar panel must be positioned precisely at right angles to the sun's rays.

2.2.10 PLC Based Automatic Irrigation System

This review is based on my research about a PLC Based Automated Irrigation System. Implementing new technologies in agriculture can enhance irrigation efficiency, promote water conservation, and reduce environmental impacts. Such systems can also help farmers save time and effort. With increasing water demands and the importance of protecting aquatic habitats, cost-effective and efficient water conservation practices are essential. Precision irrigation, which minimizes water and energy waste while maximizing crop yields, is crucial in this regard.

Real-time monitoring of soil moisture and direct water application based on soil hydrological properties are effective methods for determining crop water demands. Using soil moisture sensors can reduce water wastage and prevent excessive irrigation. Programmable Logic Controllers (PLCs) offer several advantages, including pre-stimulation in PCs before implementation, easy troubleshooting, adaptability to various environments, and the ability to change or increase inputs/outputs according to requirements.

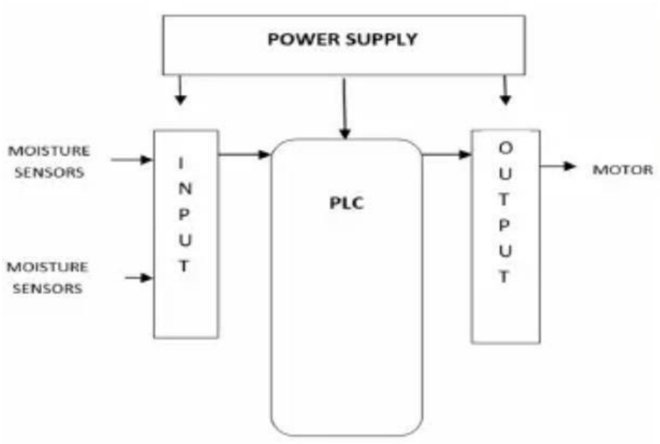

Figure 2.12 Block of PLC Based Automated Irrigation System

2.3 Summary

Table 2.1 Summary table regarding previous related work

No	Title	Description	Method/Components	Advantages
1	Solar-Powered Plant Irrigation [8]	Utilizes solar energy for irrigation with an automatic system controlled by an 8051 series Microcontroller and moisture sensor.	8051 series Microcontroller, moisture sensor, 12V DC mini submersible pump, Op- Amp, LCD, MOSFET, Relay, Motor, power supply unit.	Efficient use of renewable energy, optimized water usage.
2	IoT-Based Smart Irrigation [9]	Integrates ESP8266 NodeMCU Module and DHT11 Sensor for remote monitoring and control, optimizing watering schedules.	ESP8266 NodeMCU Module, DHT11 Sensor, Wi-Fi connectivity, web interface or mobile app.	Real-time data for precise irrigation, remote access and control.
3	Automatic Irrigation with Rainfall Detection [10]	Uses ARM microcontroller and GSM module to automate irrigation based on real-time rainfall data, optimizing water usage.	ARM microcontroller, GSM module, rain sensor, water pump, moisture sensor.	Efficient water management, automated irrigation.
4	Automatic Drip Irrigation [11]	Delivers water directly to plant roots through a network of tubes, improving water efficiency and crop yields.	Drip irrigation system, tubes, emitters.	Water savings, reduced weed growth and soil erosion.

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No	Title	Description	Method/Components	Advantages
5	Automated System Water Pump [12]	Remote-controlled water pump system with shock sensors for efficient water supply management.	Pump motor, LCD display, GSM modem, microcontroller, shock sensors, IR sensors, fire sensor.	Remote control, prevention of dry run conditions.
6	Subsurface Irrigation Systems [13]	Delivers water below the soil surface, conserving water and improving plant health.	Subsurface drip irrigation system, drip tape.	Reduced water loss, improved plant health.
7	IoT-Based Smart Irrigation System [14]	Use sensors and IoT technology for real-time monitoring and control of irrigation, optimizing water usage.	Soil moisture sensor, microcontroller, wireless communication module, user interface.	Real-time data for precise irrigation, remote access and control.
8	Automatic Plant Irrigation Based on GSM, Moisture, and Ultrasonic Sensors [15]	Controls two pumping motors based on ultrasonic sensors for water tank and moisture sensor for soil, reducing human intervention and water waste.	Ultrasonic sensor, moisture sensor, GSM module, microcontroller, pumping motors.	Automated irrigation reduced water waste.
9	Automatic Solar Submersible Pump Control [16]	Uses solar power for irrigation with efficient water pumping process, especially during high-demand periods.	Solar panels, submersible pumps, control panel.	Dependable water source, efficient use of solar power.
10	PLC Based Automated Irrigation System [17]	Implements PLC technology for precision irrigation, minimizing water and energy waste.	Programmable Logic Controller, soil moisture sensors.	Precision irrigation reduced environmental impact.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology for implementing an Automatic Water Sprinkler System with Soil Moisture Sensor using GSM Technology is designed to provide a systematic approach to developing a reliable, efficient, and autonomous irrigation system. This system aims to conserve water by ensuring that plants receive the right amount of moisture based on real-time soil conditions. In addition to the soil moisture sensor, the integration of the DHT11 sensor for monitoring temperature and humidity allows for more accurate decision-making in irrigation, considering environmental factors that can influence plant health.

The GSM module integration provides remote monitoring and alerts, enhancing the system's usability and effectiveness by allowing the user to receive notifications and control the system remotely. The methodology is structured into three main tasks: Planning, Design, and Implementation. Each task is critical to the success of the project and involves several detailed steps, which include analyzing the data from both the soil moisture and DHT11 sensors to optimize water usage and improve plant growth.

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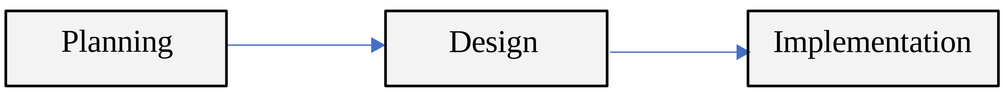

Figure 3.1 The methodology of significant steps

3.2 Planning

Project planning is a fundamental process in project management, serving as the compass that guides an endeavor from its conceptualization to successful completion. It minimizes uncertainty, allocates resources efficiently, ensures stakeholder alignment, manages time effectively, controls budget, maintains quality standards, enhances client satisfaction, and promotes continuous improvement. In today’s dynamic business landscape, effective project planning is essential for project success and overall business performance. Additionally, in this project, planning involves selecting the appropriate sensors, microcontroller, and communication technologies (GSM, DHT11 sensor, and soil moisture sensor) to build a system that can effectively monitor, and control irrigation based on real-time data.

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3.2.1 Flowchart depicting the PSM's general flow

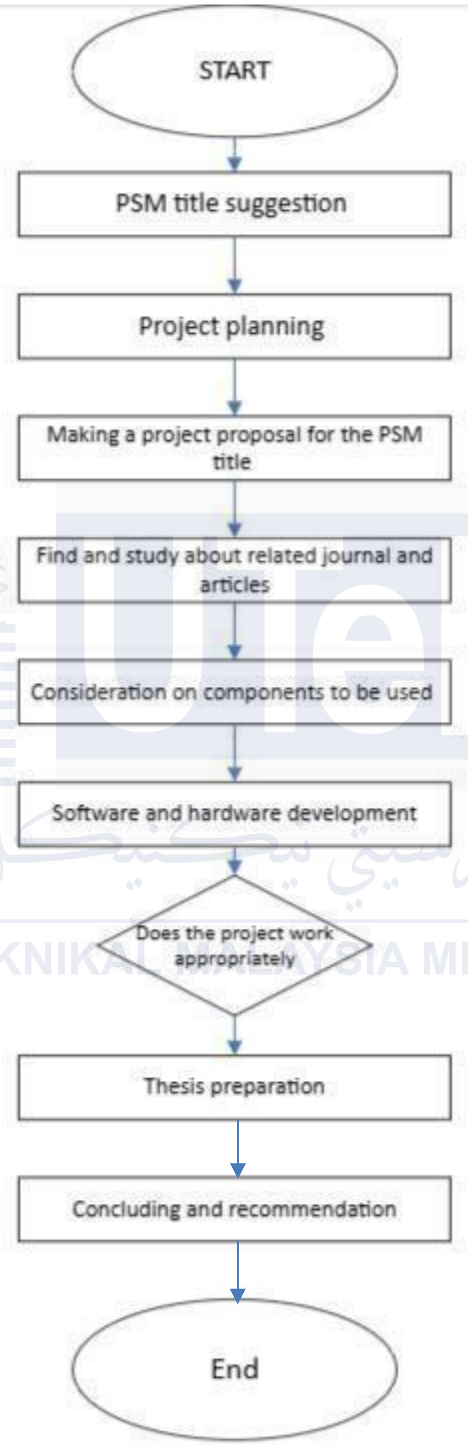

Figure 3.2 Flowchart depicting the PSM's overall flow

3.3 Project Methodology

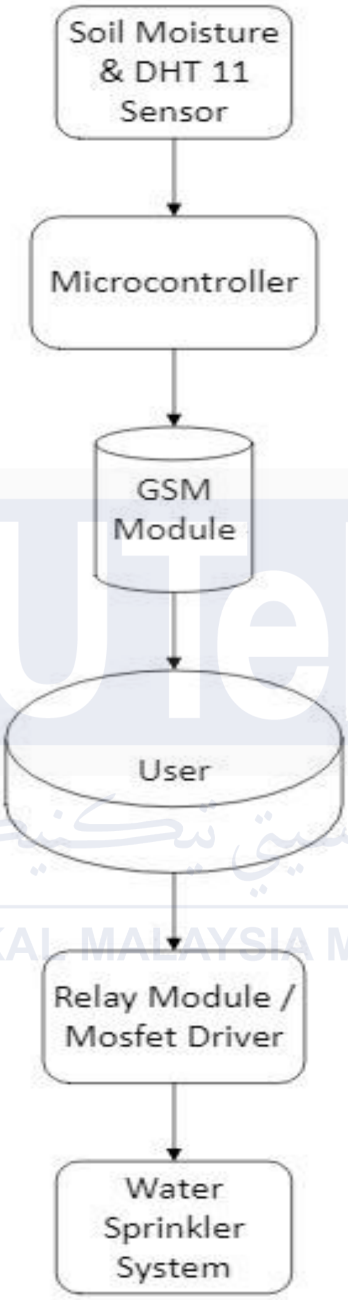

Figure 3.3 System information flow diagram based on the GSM Module

3.3.1 Soil Moisture & DHT11 sensor Detection

- The soil moisture sensor continuously monitors the soil's moisture level to detect any changes in soil hydration. If the moisture level falls below a predefined threshold, the system automatically sends an SMS notification to the user and activates the water pump to begin irrigation.
- The DHT11 sensor is employed to measure the ambient temperature and humidity. This data helps optimize irrigation control by factoring in environmental conditions, not just soil moisture.
- If the ambient temperature exceeds a certain threshold, the system will send an additional SMS alert to the user, notifying them of the high temperature, which could require adjustments in irrigation or other actions. [18].
- Data from both the soil moisture sensor and the DHT11 sensor is continuously sent to the microcontroller for processing. The microcontroller uses this data to make real-time decisions, ensuring the irrigation system responds to both soil moisture and environmental conditions effectively.

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3.3.2 Data Processing and Decision Making

- The Microcontroller processes the data received from the Soil Moisture Sensor and DHT11 sensor to evaluate the soil's moisture level and environmental factors.
- If the soil moisture level is below a pre-defined threshold or if the environmental conditions require it, the Microcontroller will decide to send an alert to the user, indicating that irrigation is needed.

3.3.3 GSM Communication

- The microcontroller monitors the soil moisture level using the soil moisture sensor. Once the soil moisture falls below a predefined threshold, indicating that irrigation is required, the microcontroller sends a signal to the SIM800 GSM module.
- The SIM800 GSM module, which operates within a voltage range of 3.8V to 4.2V, sends an SMS alert to the user's mobile device.
- The SMS alert informs the user about the low soil moisture levels and notifies them of the system's status. This allows the user to remotely monitor the system and take necessary actions, such as manually controlling the irrigation process if required.

3.3.4 User Interaction

- Upon detecting that the soil moisture level is below the pre-defined threshold or that the temperature is high, the system automatically sends an SMS alert to the user, notifying them about the low moisture or high temperature condition.
- The system automatically turns on the water pump or sprinkler to irrigate the plants without requiring any input from the user.
- If the temperature exceeds the pre-set threshold, the system will send a separate alert indicating the high temperature condition as well.

3.3.5 Relay Activation

- The GSM Module receives the user's command and forwards it to the Microcontroller.
- The Microcontroller processes the user's command and activates the Relay Module, which is responsible for controlling the water pump or sprinkler system.

3.3.6 Water Sprinkling

- The Relay Module triggers the Water Sprinkler System, starting the irrigation process.
- The system waters the plants until the soil moisture reaches the desired level, based on the Soil Moisture Sensor readings.
- The Soil Moisture Sensor continuously monitors and sends updated data to the Microcontroller to stop the sprinkler once the desired moisture level is achieved, ensuring that no over-watering occurs.

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3.4 Experimental Setup

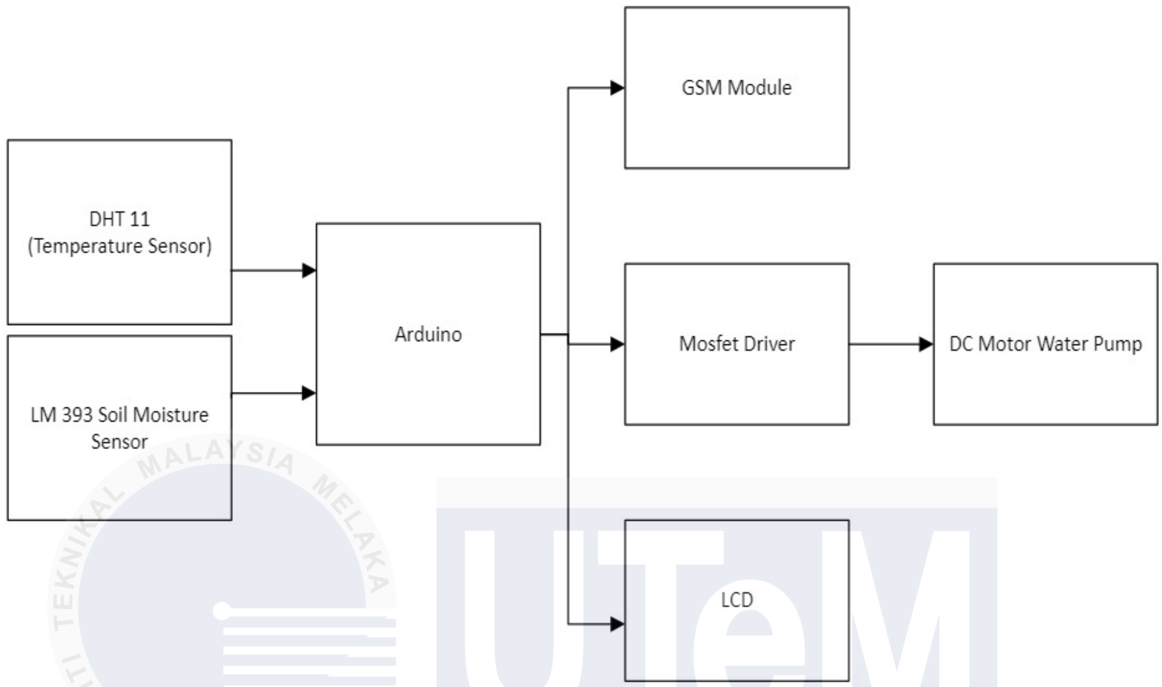

Figure 3.4 Schematic of project blocks

3.4.1 Importance of the Experimental Setup

The experimental setup is crucial for testing and validating the functionality of the automatic water sprinkler system. It allows you to:

- Simulate Real-World Irrigation Scenarios: The setup replicates real agricultural conditions to observe how the system performs in different environments.
- Test the Accuracy of the Soil Moisture Sensor: Ensures that the soil moisture sensor accurately measures soil moisture levels, which is essential for triggering irrigation at the right time.
- Monitor Temperature with the DHT11 Sensor: The DHT11 sensor monitors the ambient temperature, sending data to the microcontroller to trigger an alert if the temperature exceeds a certain threshold.

- Evaluate the System's Response Time to Changes in Soil Moisture and Temperature: Assesses how quickly the system can detect and react to changes in both soil moisture and temperature.
- Monitor Water Usage: Tracks the water consumption to assess the system's efficiency and minimize waste.
- Refine Control Algorithms for Optimal Irrigation: Provides valuable data to improve the algorithms for better decision-making, ensuring efficient water use and proper system functioning.

3.4.1.1 Microcontroller (Arduino)

The microcontroller is the brain of the system. It receives data from the soil moisture sensor and the DHT11 sensor, processes the data, and sends a signal to the relay module to turn the water pump on or off based on the conditions.

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3.4.1.2 Soil Moisture Sensor

This sensor detects the moisture level in the soil. When the moisture level falls below a preset threshold, the sensor sends a signal to the microcontroller, triggering irrigation.

3.4.1.3 DHT11 Sensor

The DHT11 sensor measures the ambient temperature and humidity levels. When the temperature exceeds a pre-defined threshold, it sends data to the microcontroller, which may trigger an alert and activate irrigation if needed to prevent plant stress.

3.4.1.4 Relay Module

The relay module acts as a switch that controls the water pump. When the microcontroller sends a signal, the relay module turns on the water pump, starting the irrigation process.

3.4.1.5 Water Pump

The water pump supplies water to the sprinkler system, ensuring that plants receive the necessary moisture based on the soil's condition.

3.4.1.6 GSM Module

The GSM module enables remote communication with the system. It allows you to receive SMS alerts about soil moisture levels and temperature, and it enables control of the irrigation system remotely via mobile phone.

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3.4.1.7 16x2 LCD (optional)

A 16x2 LCD can be interfaced with the Arduino to display real-time soil moisture readings and system status messages, providing visual feedback on the system's operation.

3.4.2 Flowchart project

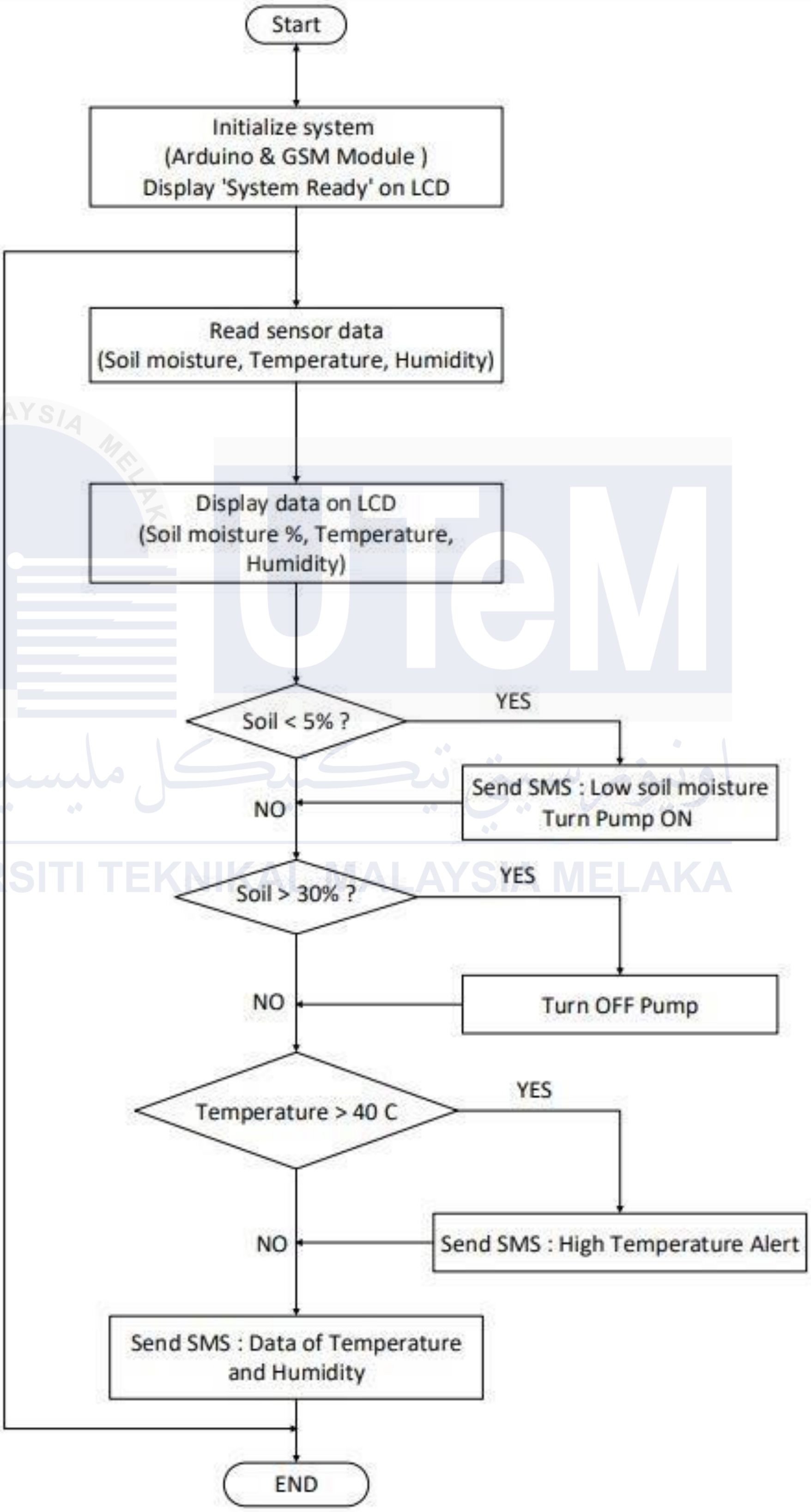

Figure 3.5 The flowchart general flow PSM

3.4.3 Parameters

3.4.3.1 Soil Moisture Sensor

- Type: Capacitive or resistive, chosen based on budget and accuracy.
- Moisture Threshold: Set the critical level to trigger alerts, based on plant needs.
- Calibration: Adjust the sensor to match your soil type for accurate readings.

3.4.3.2 DHT11 Sensor

- Type: Measures temperature and humidity.
- Threshold: Sends alerts if the temperature exceeds the set range.
- Accuracy: Suitable for general use; upgrade to DHT22 for higher precision.
- Use: Monitors for environmental conditions for optimal irrigation.

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3.4.3.3 GSM Module (SIM800)

- Compatibility: Works on quad-band GSM (850/900/1800/1900 MHz).
- SIM Card: Requires an SIM card with SMS capability.
- Power: Needs 3.7-4.2V for stable operation.
- Features: Sends alerts via SMS; integrates easily with Arduino.

3.4.4 List of the Equipment's

3.4.4.1 Arduino uno

Figure 3.6 Example of Arduino Uno

In this project, the Arduino Uno serves as the central microcontroller, responsible for interfacing with the soil moisture sensor, GSM module, and relay module to control the water pump. The Arduino reads data from the soil moisture sensor to determine the soil's moisture level and compares it to a predefined threshold. If the moisture level is below the threshold, the Arduino activates the water pump through the relay module and sends an SMS alert using the GSM module. The simplicity and versatility of the Arduino Uno, along with its ample input/output pins and compatibility with various sensors and modules, make it an ideal choice for managing the automated water sprinkler system efficiently.

3.4.4.2 GSM (Global System for Mobile Communication)

Figure 3.7 Example of GSM

In this project, the GSM module is used to provide remote communication capabilities, allowing the system to send SMS alerts to the user. When the soil moisture sensor detects that the moisture level is below a predefined threshold, the Arduino Uno triggers the GSM module to send an SMS notification indicating that the water pump has been activated to irrigate the plants. This feature enables remote monitoring and management of the irrigation system, ensuring that users are promptly informed about the system's status and any actions taken, even when they are not physically present on-site. The GSM module thus enhances the system's functionality by integrating real-time communication and alerts [19].

3.4.4.3 LM 393 Soil Moisture Sensor

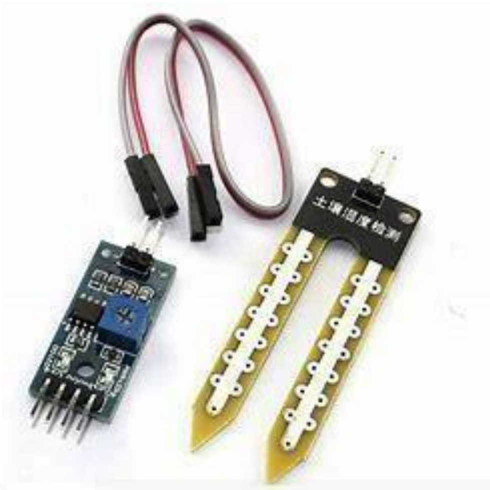

Figure 3.8 Example of Soil Moisture Sensor

The soil moisture sensor is a critical component that measures the moisture content in the soil, providing real-time data to the Arduino Uno microcontroller. The sensor continuously monitors the soil's moisture levels and sends the data to the Arduino, which processes this information to determine whether the soil is dry or adequately hydrated. If the moisture level falls below a predefined threshold, indicating that the soil is too dry, the Arduino triggers the water pump to irrigate the soil. This automated monitoring and response system ensures that plants receive the right amount of water, preventing both underwatering and overwatering, thereby promoting healthier plant growth and efficient water usage.

3.4.4.4 Submersible Water Pump

Figure 3.9 Example of Submersible Water Pump

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The water pump is a crucial component responsible for delivering water to the irrigation system based on the soil moisture levels monitored by the sensor. Controlled by the Arduino Uno through the relay module, the pump is activated when the soil moisture falls below a set threshold, ensuring that water is provided to the plants as needed. The pump's operation is automated, turning it on to irrigate the soil when it is too dry and turning off once adequate moisture levels are achieved. This automation ensures efficient water usage and maintains optimal soil conditions for plant growth, reducing the need for manual intervention in the irrigation process.

3.4.4.5 Jumper Wire

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Figure 3.10 Jumper Wire (Male to Female) and (Male to Male)

Jumper wires are essential in electronics for their ease of use, versatility, and reusability, facilitating circuit setup and modification without soldering. They come in three types: male- to-male, male-to-female, and female-to-female, each serving specific connection needs. Male- to-male wires connect points on a breadboard or link a breadboard to a microcontroller with female headers. Male-to-female wires connect a breadboard or microcontroller with male headers to modules with female headers. Female-to-female wires directly link components or modules with male header pins. For example, in an irrigation system project, male-to-male jumper wires can connect the VCC, GND, and data output pins of a soil moisture sensor to an Arduino, while male-to-female wires can connect the power, ground, and communication pins of a GSM module to the Arduino. These wires are fundamental for building and testing prototypes efficiently, making them cost-effective for experimentation.

3.4.4.6 MOFSET Driver

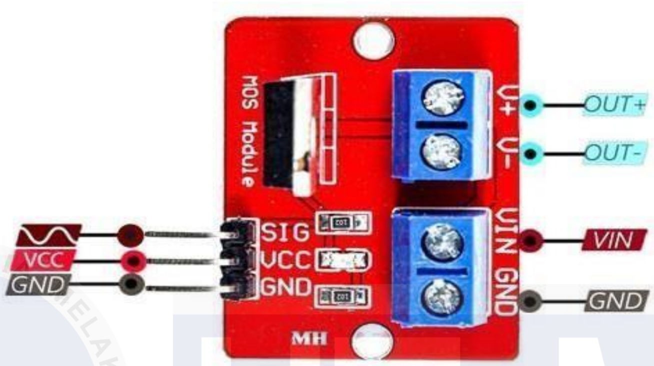

Figure 3.11 Example of MOFSET Driver

MOSFET drivers are used to efficiently control the water pump, providing the necessary power handling and switching capabilities required for the pump's operation. The MOSFET driver acts as an interface between the Arduino Uno and the high-power water pump, enabling the low-voltage control signals from the Arduino to switch the higher voltage required by the pump. This ensures that the pump can be turned on and off reliably and efficiently based on the soil moisture sensor's readings. The use of a MOSFET driver is crucial for handling the high current and voltage demands of the pump while protecting the microcontroller from potential damage due to high power loads [20].

3.4.4.7 LCD Display

Figure 3.12 Example of LCD Display

In this project, an LCD display is used to provide real-time visual feedback on the system's status, including soil moisture levels, pump activation status, and any error messages. By displaying this information, the LCD allows users to quickly and easily monitor the operation of the automatic water sprinkler system without needing to connect to a computer or other external devices. This enhances user interaction and system transparency, making it easier to verify that the system is functioning correctly and to make any necessary adjustments. The inclusion of an LCD display thus improves the overall usability and effectiveness of the irrigation system.

3.4.4.8 DHT 11 Sensor

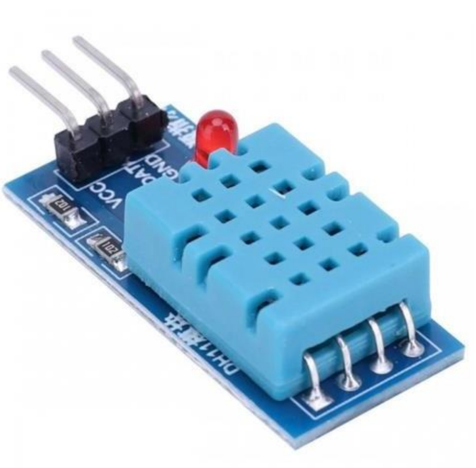

Figure 3.13 Example of DHT11 Sensor

The DHT11 sensor is a low-cost digital sensor used to measure temperature and humidity. It has a temperature range of 0-50°C and a humidity range of 20-80% RH, with moderate accuracy. It communicates via a single digital pin and is commonly used in projects like weather stations, home automation, and agriculture for monitoring environmental conditions. The sensor is easy to use, has low power consumption, and is suitable for basic applications but has a limited range and accuracy compared to more advanced sensors.

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3.4.4.9 Arduino IDE

Figure 3.14 Example of Arduino IDE

The Arduino Software with IDE, commonly known as the Arduino Software, has a message area, a toolbar, a text terminal, and a code editor with menus and standard job buttons. It attaches to the hardware of the Arduino and uploads the program.

3.5 Circuit construction

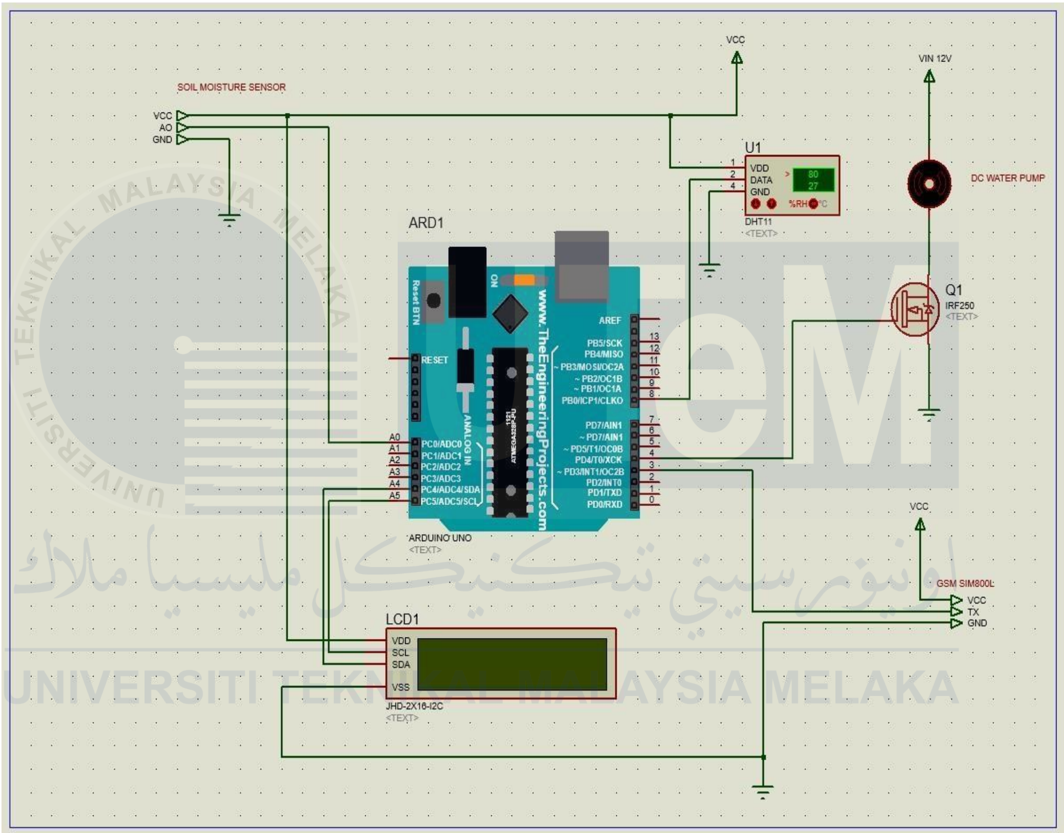

Figure 3.15 Circuit construction in progress

3.6 Summary

In this chapter, the methodology for implementing an Automatic Water Sprinkler System with Soil Moisture Sensor using GSM Technology was outlined. The project methodology is structured into planning, design, and implementation phases, ensuring a systematic approach to achieving the project objectives. The integration of key components such as the Arduino microcontroller, soil moisture sensor, DHT11 sensor, GSM module, and relay module forms the foundation of the system. These components work cohesively to monitor soil moisture and environmental conditions, trigger irrigation processes, and provide real-time alerts to users.

The experimental setup emphasizes testing the system's accuracy, response time, and efficiency, simulating real-world irrigation scenarios. Detailed specifications and functionalities of individual components, including the Arduino Uno, GSM module, soil moisture sensor, and water pump, were discussed to highlight their roles in achieving automated irrigation. This chapter establishes the groundwork for implementing and refining the system, ensuring efficient water usage and promoting sustainable agricultural practices.

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CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the comprehensive results obtained from the final implementation and testing of the automatic water sprinkler system, which integrates soil moisture, temperature, and humidity sensors, along with GSM technology. The DHT11 sensor has been included to monitor temperature and humidity levels, further enhancing the system's capability to assess environmental conditions.

The primary objective of this phase is to evaluate the system's overall functionality, including its ability to monitor soil moisture and environmental conditions, send notifications via GSM, and automate the irrigation process effectively. By incorporating temperature and humidity monitoring with the DHT11 sensor, the system ensures better decision-making for irrigation while providing real-time data for improved efficiency.

Building upon the preliminary results, where the focus was on the basic performance of the soil moisture sensor and pump operation, this phase expands the system's features to include temperature and humidity monitoring, GSM communication, and system alerts. These enhancements aim to optimize irrigation efficiency, minimize water wastage, and provide remote control capabilities for greater flexibility. The results and analysis are discussed in detail, highlighting the system's strengths, addressing limitations, and proposing future improvements to support sustainable agricultural practices.

4.2 Result

The automatic water sprinkler system was tested in various environmental conditions to evaluate its functionality and effectiveness. The results are presented based on the system's response to soil moisture, temperature, and humidity levels, as well as the performance of GSM notifications and water pump activation.

a) **Soil Moisture Monitoring**

- The soil moisture sensor successfully monitored real-time moisture levels.
- The system activated the water pump when the soil moisture dropped below 5%.
- SMS alerts were sent to the user when the soil moisture was critically low (1% or 4%), ensuring timely action.

b) **Temperature and Humidity Monitoring (DHT 11 sensor)**

- The DHT11 sensor effectively measured environmental temperature and humidity.

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- An SMS alert was sent to the user when the temperature exceeded 40°C (measured at 41°C in testing), helping prevent potential heat stress on plants.
- Humidity levels were monitored, but no significant impact on irrigation was observed.
- These readings, however, provide valuable environmental context for future improvements.

c) **GSM Module Behavior**

- The GSM module sent alerts efficiently under normal conditions, with a blinking interval of 3 seconds.

- Occasional delays (1-second blinking intervals) were observed, potentially indicating minor power or signal issues.

d) **Irrigation Timing and Efficiency**

- The pump operated for 5–6 seconds, ensuring efficient watering based on soil moisture readings.
- The system demonstrated effective water conservation by activating irrigation only when necessary.

e) **System Alerts**

- The system sent alerts to the user when soil moisture was below 5% or temperatures exceeded 40°C, ensuring remote monitoring and timely response.

Summary of Results Analysis

A detailed analysis of the system's performance is summarized in the table below:

Table 4.1 Data taken throughout analysis

Time	**Soil Moisture (%)**	**Temp (˚c)**	**Humidity (%)**	**GSM Blinking Interval (s)**	**Pump Status**	**SMS Sent (Yes/No)**
2:00pm	1	36	55	3	On	Yes
2:30pm	50	35	70	1	Off	No
4:40pm	4	41	53	3	On	Yes
8:00pm	8	37	60	1	On	No
1:00am	2	29	98	3	On	Yes

4.2.1 Expected outcome & Prototype

Figure 4.1 Plant got irrigated and the system SMS the reading

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The soil moisture sensor monitors the soil's moisture content as a percentage. If the moisture level drops below 5%, the soil is identified as dry, prompting the pump to activate and irrigate the plant. The system also sends moisture readings to the user via SMS, along with an alert message when the soil moisture is critically low. Additionally, an LCD screen provides real-time monitoring by displaying the soil moisture, temperature, and humidity levels of the irrigation system.

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Figure 4.2 The irrigation stops once the soil moisture exceeds the threshold.

The soil moisture sensor measures the soil's moisture content in percentage and if it is above 30%, the soil is considered wet, and the pump is turned off to prevent over-irrigation. Additionally, an LCD screen provides real-time monitoring by displaying the soil moisture, temperature, and humidity levels of the irrigation system.

4.3 Summary

This chapter presents the comprehensive results obtained from the final implementation and testing of the automatic water sprinkler system, which integrates soil moisture, temperature, and humidity sensors along with GSM technology. The system has been tested in various environmental conditions to evaluate its functionality in real-time.

Key results show that the soil moisture sensor effectively monitors moisture levels, activating the water pump when the soil moisture drops below 5%. SMS alerts were sent to the user when soil moisture levels were critically low, ensuring timely irrigation. The temperature and humidity sensors (DHT11) successfully measured the environmental conditions, with alerts sent when the temperature exceeded 40°C, preventing potential heat stress on the plants. However, no significant impact on irrigation was observed from humidity levels during testing.

The GSM module performed well, sending alerts with a typical blinking interval of 3 seconds. Minor delays were observed, which may indicate minor power or signal issues. The irrigation process was efficient, activating the pump for 5-6 seconds when needed, demonstrating effective water conservation by only irrigating when necessary.

System alerts for both soil moisture and temperature were triggered, ensuring remote monitoring and allowing timely actions to be taken. The system's ability to monitor and control irrigation remotely supports water-saving efforts and offers flexibility for agricultural applications. Overall, the testing results confirmed the functionality and efficiency of the system, with additional improvements proposed for future versions.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The implementation and testing of the automatic water sprinkler system using soil moisture, temperature, and humidity sensors, along with GSM technology, have demonstrated its effectiveness in optimizing irrigation practices. The system successfully monitors soil moisture levels and environmental conditions, triggering irrigation when necessary and sending alerts to the user when critical thresholds are reached. The inclusion of the DHT11 sensor added a valuable layer of environmental monitoring, ensuring the system could also respond to temperature changes and prevent heat stress on plants.

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The system was able to conserve water efficiently by activating the water pump only when the soil moisture dropped below a certain threshold, and by providing real-time monitoring via SMS notifications. GSM communication ensured remote control of the irrigation system, enhancing flexibility and responsiveness. Although minor delays were observed with the GSM module under certain conditions, overall, the system functioned as expected, providing an innovative solution for automated irrigation in agriculture.

In conclusion, the project successfully met its objectives by creating a smart irrigation system that reduces water wastage, improves irrigation efficiency, and supports sustainable farming practices. The integration of GSM technology, along with the soil moisture and environmental sensors, paves the way for more efficient and remote-controlled agricultural systems.

5.2 Future Work Recommendations

Although the system has proven effective, there are several opportunities for improvement. First, enhancing the accuracy of soil moisture sensors would improve the system's reliability. Integrating multiple sensors in different field locations could provide a more comprehensive view of the soil conditions; while adding other environmental sensors such as light sensors would allow for more informed irrigation decisions.

In terms of communication, while the GSM module performed well, occasional delays were noted. Upgrading the GSM module or exploring alternative communication technologies like Wi-Fi or LoRa could improve performance, particularly for large-scale applications. Additionally, incorporating weather data through APIs could optimize irrigation scheduling by anticipating rainfall or temperature changes, reducing water wastage.

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Finally, the system could benefit from the development of a mobile application for more intuitive control and monitoring. The app could offer features like real-time notifications, historical data analysis, and remote control of the irrigation process. In the long term, integrating renewable energy sources, such as solar panels, would make the system more sustainable, especially in remote agricultural settings. These enhancements will help scale the system and improve its overall efficiency in real-world applications.

5.3 Potential for Commercialization

This project has significant potential for commercialization due to the increasing global demand for efficient water management solutions in agriculture. With water scarcity becoming a growing concern, there is a clear market for automated irrigation systems that help conserve water and improve crop yields. Smart irrigation solutions are gaining traction in the agricultural industry, with both government initiatives and private investments supporting sustainable farming technologies.

The system is scalable, making it suitable for both small-scale and large commercial agricultural operations. The integration of GSM technology enables remote monitoring and control, which is an attractive feature for commercial farmers. This scalability, combined with the ability to cover large areas, opens up opportunities for expanding the system across various farming environments.

In terms of business model, the system could be marketed to small, medium, and large-scale farmers, with potential revenue streams coming from the sale of hardware components (sensors, GSM modules, etc.), software subscriptions, and maintenance services. Additionally, farmers could benefit from data analytics services that provide insights on irrigation efficiency and soil health.

However, challenges such as high initial costs, limited GSM coverage in rural areas, and the need for farmer education could hinder widespread adoption. Addressing these challenges would involve strategic partnerships with agricultural organizations and government programs to promote and support the commercialization of this system. Despite these hurdles, the environmental and economic benefits of the system make it a promising solution for the agricultural sector's future.

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APPENDICES

Appendix A Coding

UNO_SOIL_GSM.ino

```
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <dht.h>


LiquidCrystal_I2C lcd(0x27, 16, 2);

SoftwareSerial ss(2, 3); //(RX,TX)

int Mode=0;
unsigned long delayTime;


dht DHT;


#define PUMP 4   //Relay utk pump
#define DHT11_PIN 8    //Sambung ke pin A1



int MP=0;
int Timerx=0;
String Status="STOP";
float Hum,Temp,Sens1;
float Soil;
float Water=0;
int Alarm=0;
int Alarm1=0;
int Alarm2=0;
String USER1 = "\"0176993269\"";

```

UNO_SOIL_GSM.ino

```
void setup(void)
{
 Serial.begin(9600);
 ss.begin(9600);
 pinMode(PUMP,OUTPUT);

  lcd.begin();
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Initialize..");
 // lcd.setCursor(0,1);
 // lcd.print(" ");
 delay(20000);

  Serial.println("AT");
  ss.println("AT");
  delay(2000);
  Serial.println("AT+CMGF=1");
  ss.println("AT+CMGF=1");
  delay(2000);
  Serial.println("AT+CMGD=1");
  ss.println("AT+CMGD=1");
  delay(2000);
  Serial.println("AT&W");
  ss.println("AT&W");
  delay(2000);

  Serial.print("AT+CMGS=");
  delay(300);
  Serial.println(USER1);
  ss.print("AT+CMGS=");
  delay(300);
  ss.println(USER1);
  delay(1000);
```

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UNO_SOIL_GSM.ino

```
    ss.print("SYstem Ready");
    delay(200);
   Serial.println(char(26));
    ss.println(char(26));
    delay(4000);


    delay(3000);// 3 saat delay
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print(" -- WELCOME --");
    delay(1000);
//delay(15000);


}

void loop(void)
{

  int chk = DHT.read11(DHT11_PIN);
  switch (chk)
  {
    case DHTLIB_OK:
    //Serial.print("OK,\t");
    break;
    case DHTLIB_ERROR_CHECKSUM:
    //Serial.print("Checksum error,\t");
    break;
    case DHTLIB_ERROR_TIMEOUT:
    //Serial.print("Time out error,\t");
    break;
    case DHTLIB_ERROR_CONNECT:
        //Serial.print("Connect error,\t");
```

UNO_SOIL_GSM.ino

```
  Temp=DHT.temperature ;
  Hum=DHT.humidity;


//-------------------------------SOIL INPUT-------------------------------
    Sens1 = analogRead(A1);          //read the value from the sensor
  Soil= (5.0 * Sens1)/1024.0;  //convert the analog data to moisture level
Soil=100-((Soil/5)*100.0);


//-----------------------------------PIR MOTION-----------------------------

lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("SOIL:");
  lcd.print(Soil,0);
  lcd.print("%");
  lcd.setCursor(0,1);
  lcd.print("T:");
    lcd.print(Temp,1);
      lcd.print(" H:");
    lcd.print(Hum,0);

  Timerx++;
  if (Timerx>20){

Serial.print(Soil);
Serial.print("\t");
Serial.print(Temp);
Serial.print("\t");
Serial.print(Hum);
  Serial.println();

  ss.print("*");
ss.print(Soil);
```

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UNO_SOIL_GSM.ino

```
    Serial.println();

    ss.print("*");
  ss.print(Soil);
  ss.print("*");
  ss.print(Temp);
  ss.print("*");
  ss.print(Hum);
  ss.print("#");
    ss.println();
    Timerx=0;

    if (Soil<5){
    if (Alarm1==0){
      SMS1();
      Alarm1=1;
    }
  }
    }
  delay(200);



  if (Alarm1==1){
    if (Soil < 10 ){
    digitalWrite(PUMP,HIGH);
  }

  if (Soil > 30){
    digitalWrite(PUMP,LOW);
    Alarm1=0;
  }
  }
```

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