SCIENCE PROJECT

WATER LEVEL CONTROLLER SYSTEM

Prepared By:

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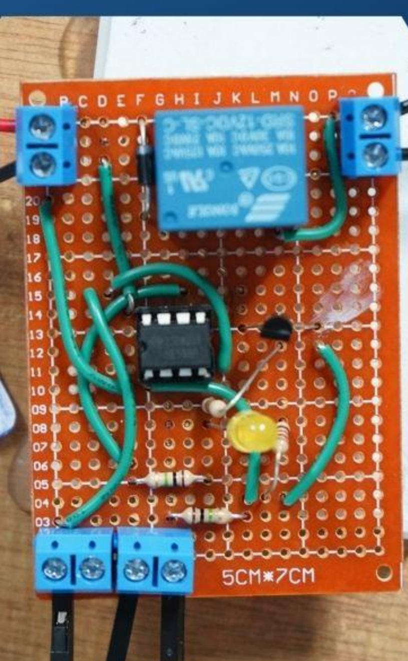

Puttisopon School
Chiang Mai Primary Education Service Area Office 1

Northern English Medium Instruction Programes
Open House 2025

Science Project

Water Level Controller System

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Preface

This project explores the design and construction of a DIY automatic water level controller. It aims to provide a cost-effective solution to automatically manage the water levels in tanks or reservoirs. The controller system is built using basic electrical components such as sensors and a relay system to control the flow of water. This book details the entire research process, including the background, methodology, and findings of the project.

The project also aims to address common issues faced by individuals and industries that rely on water tanks for storage, such as water wastage, overflow, and inefficient usage. By automating the water level control process, the system ensures that water is only pumped or released when necessary, preventing both excess consumption and potential damage caused by overflows. Moreover, the project demonstrates the practicality of integrating simple, affordable technologies to create functional, energy-efficient systems.

Throughout this book, readers will gain insight into the process of designing a DIY automatic water level controller, from selecting the appropriate sensors to configuring the relay system for controlling the water flow. The methodology used in this project combines both theoretical knowledge and hands-on experimentation, ensuring that the system is adaptable to various tank sizes and requirements. Additionally, the findings and challenges encountered during the research process provide valuable lessons for anyone interested in developing similar automation projects in the future. This project serves as a starting point for exploring broader applications of automation in everyday life, offering a solution that can be easily replicated and customized for diverse needs.

Acknowledgement

The researchers would like to express their deepest gratitude to all those who have supported and contributed to the successful completion of this project. First and foremost, they would like to thank their teachers, Teacher Pratya Jeeraya and Teacher Raymond Ong Samporna for their invaluable guidance and encouragement throughout this entire process. The teacher's expertise and advice were critical in helping to develop and refine ideas, and their constant support motivated the researchers to push through any challenges encountered. The researchers are also grateful to their friends and family for their patience and belief, offering emotional and practical support when needed. Their encouragement kept the researchers going during moments of doubt and difficulty.

The researchers would like to extend their thanks to the experts in the field of electronics who generously shared their knowledge and experience. Their insights were instrumental in the design and functionality of the automatic water level controller. Through their guidance, the researchers were able to better understand the technical aspects of the project and apply the right tools and materials effectively.

Lastly, the researchers are grateful for the input and feedback from their peers and colleagues, who took the time to review their work and suggest improvements. Their contributions played a key role in enhancing the quality and efficiency of the project. This project would not have been possible without the support of all these individuals, and the researchers are thankful for the opportunity to learn and grow with their help.

Abstract

The DIY Automatic Water Level Controller project is designed to create an affordable, easy-to-build system that automatically regulates the water level in tanks. Using sensors to detect the water level, the system controls the flow of water through relays, ensuring that the tank neither overflows nor runs dry. This project aims to provide an efficient solution for managing water levels in various applications, from household water tanks to larger industrial reservoirs. The controller not only helps in preventing water wastage but also reduces the need for manual intervention in monitoring water levels.

This paper covers the entire process of designing, constructing, and testing the automatic water level controller. The findings demonstrate the system's effectiveness in maintaining optimal water levels, highlighting its potential applications in everyday life. The project showcases the practicality of automation for water management, offering a simple yet reliable solution that can be easily replicated for diverse water storage needs.

Chapter 1: Introduction

1.1 Background of the Project

In many parts of the world, people use water tanks to store water for everyday tasks like drinking, cooking, cleaning, and irrigation. This is especially important in places where water isn't always available or where it changes by season. Tanks, big or small, are a reliable way to store water. However, checking and maintaining the water levels in these tanks can be tiring and inefficient, especially when the tanks are large or hard to reach. People often need to check the water levels often to prevent overflow or running out, which takes time and can lead to mistakes.

Managing water levels is even more important in places with limited water or unstable water supply. Overflowing water can be wasted, and running out of water at the wrong time can cause problems for household systems. To solve this, an automatic water level controller is needed. This system automatically controls the water flow in and out of the tank using sensors that measure the water level. It turns the water supply on or off as needed, so people don't have to check it manually. This helps prevent overflow, ensures the tank has enough water, and reduces human error.

An automatic water level controller saves time, helps conserve water by preventing waste, and is especially useful in places where water is limited. It can be used in homes, industries, or farms to make sure water is used wisely. This project aims to create an affordable, easy-to-use system that can be applied to many different water storage needs, helping conserve water and making water management easier.

1.2 Objectives of the Project

To design and build a low-cost automatic water level controller module that is easy to use.

1.3 Hypothesis of the Project

It is believed that by using a simple sensor and relay system, a low-cost and easy-to-use automatic water level controller can be developed that operates efficiently and reliably to manage water levels in tanks.

1.4 Scope of the Project

The scope of this project includes designing and building a simple, low-cost automatic water level controller using basic components. The system uses water level sensors and relays to control water flow automatically and is designed to be easy to use for small to medium-sized water tanks.

1.5 Definitions

1) Automatic Water Level Controller: A device that automatically manages the water levels in a tank by turning the water inlet on or off.

2) Pulse: In electronics, the pulse is a rectangular DIRECT CURRENT voltage SIGNAL produced by a pulse GENERATOR.

3) Relay: An electrical switch used to control high-voltage devices (such as water pumps) using low-voltage signals.

4) LED: Light Emitting Diode) is a type of light source that emits light when an electrical current passes through it.

5) Sensor: A device that detects the water level in the tank and sends signals to the controller to act accordingly.

6) Components: Are individual parts that make up an electronic circuit or device.

Chapter 2: Review of Related Literature

This chapter reviews previous studies, research, and innovations related to automatic water level control systems. Over the years, various technologies have been developed and implemented to monitor and control water levels in tanks, reservoirs, and other water storage systems. These technologies range from simple mechanical mechanisms to advanced electronic and sensor-based systems.

The effectiveness and efficiency of each water level control method depend on factors such as cost, complexity, accuracy, maintenance requirements, and suitability for different applications. Some systems are designed for industrial use, while others are more suitable for household or small-scale applications. Therefore, understanding the strengths and limitations of each method is essential in selecting an appropriate technology for a low-cost and easy-to-use automatic water level controller.

This review focuses on three commonly used water level detection technologies: float switches, ultrasonic sensors, and capacitive sensors. The working principles, applications, advantages, and limitations of each method are discussed to provide a foundation for the design choices made in this project.

2.1 Float Switches

Float switches are one of the most traditional and widely used methods for controlling water levels. The basic design involves a buoyant float that rises and falls with the water level. When the water reaches a predetermined level, the float activates or deactivates a switch, which in turn controls a pump or valve.

This simple mechanical mechanism has been used for decades and remains common in both domestic and industrial water control systems. Float switches are known for their reliability, durability, and ease of use. Since they operate using mechanical movement, they do not require complex electronic circuits or advanced programming.

However, float switches also have limitations. Mechanical components may wear out over time, and performance can be affected by debris, corrosion, or water contamination. Additionally, their physical size and moving parts may not be suitable for compact or sealed systems. Despite these limitations, float switches remain a cost-effective solution for basic water level control applications.

2.2 Ultrasonic Sensors

Ultrasonic sensors provide a more modern and non-contact method for measuring water levels. These sensors work by emitting high-frequency sound waves toward the surface of the water and measuring the time taken for the sound waves to reflect back to the sensor. The distance between the sensor and the water surface is calculated based on the time delay of the echo.

One of the main advantages of ultrasonic sensors is that they do not require direct contact with water. This makes them suitable for applications where contamination, corrosion, or mechanical wear could be problematic. Ultrasonic sensors are commonly used in industrial tanks, wastewater systems, and applications requiring precise distance measurements.

Despite their advantages, ultrasonic sensors tend to be more expensive than mechanical solutions and may require additional signal processing or microcontroller programming. Their performance can also be affected by environmental factors such as temperature, humidity, or turbulence on the water surface. As a result, ultrasonic sensors may not be the most suitable option for low-cost or beginner-level water level control systems.

2.3 Capacitive Sensors

Capacitive sensors detect water levels by measuring changes in capacitance caused by the presence of water near a sensing probe. Since water is a conductive material, it alters the electric field around the probe, resulting in a measurable change in capacitance. By monitoring these changes, the sensor can determine the presence and level of water.

Capacitive sensors are valued for their high sensitivity, accuracy, and ability to operate in various environments. Like ultrasonic sensors, they can be designed as non-contact sensors, reducing mechanical wear and increasing system durability. These sensors are often used in applications requiring precise and continuous water level monitoring.

However, capacitive sensors may require careful calibration and more complex circuitry. Their performance can be influenced by variations in water conductivity, temperature, or surrounding materials. Additionally, the cost and complexity of capacitive sensing systems may be higher compared to simple mechanical or relay-based solutions.

2.4 Comparison of Water Level Detection Technologies

Based on the literature review, each water level detection method has its own advantages and limitations. Float switches offer simplicity and low cost but rely on mechanical movement. Ultrasonic sensors provide non-contact measurement with good accuracy but involve higher cost and system complexity. Capacitive sensors offer precise detection but may require careful calibration and advanced electronic design.

For a project aimed at developing a low-cost and easy-to-use automatic water level controller, the choice of technology should prioritize affordability, simplicity, reliability, and ease of assembly. Therefore, simpler sensor-based methods combined with basic electronic components, such as relays and timing circuits, are more suitable for small to medium-sized water tanks.

2.5 Relevance to the Present Project

The review of related literature highlights the importance of selecting appropriate water level detection technology based on project objectives. While advanced sensors offer high precision, they may not align with the goal of creating a low-cost and user-friendly system.

This project builds upon the principles of existing water level control methods by integrating simple water level sensors, relay-based control, and basic electronic components. By focusing on simplicity and affordability, the project aims to develop an automatic water level controller that is practical, reliable, and suitable for everyday use in household and small-scale applications.

Chapter 3: Research Methodology

This chapter describes the research methodology used in the design, construction, assembly, and testing of a low-cost automatic water level controller module. The methodology emphasizes simplicity, safety, and ease of use in order to meet the project objective of developing a practical system suitable for real-world applications.

3.1 Research Design

This project adopts an experimental research design. The automatic water level controller is designed, built, and tested under controlled conditions to evaluate its functionality, reliability, and usability.

Low-cost and readily available electronic components are selected and assembled into a prototype system. The system is tested by simulating different water level conditions inside a water tank to verify that it can automatically control the operation of the water pump correctly. The experimental process focuses on ensuring that the system is easy to assemble, safe to operate, and suitable for small to medium-sized water tanks.

3.2 Conceptual Framework

The conceptual framework of this project is based on the relationship between water level input, control processing, and output action.

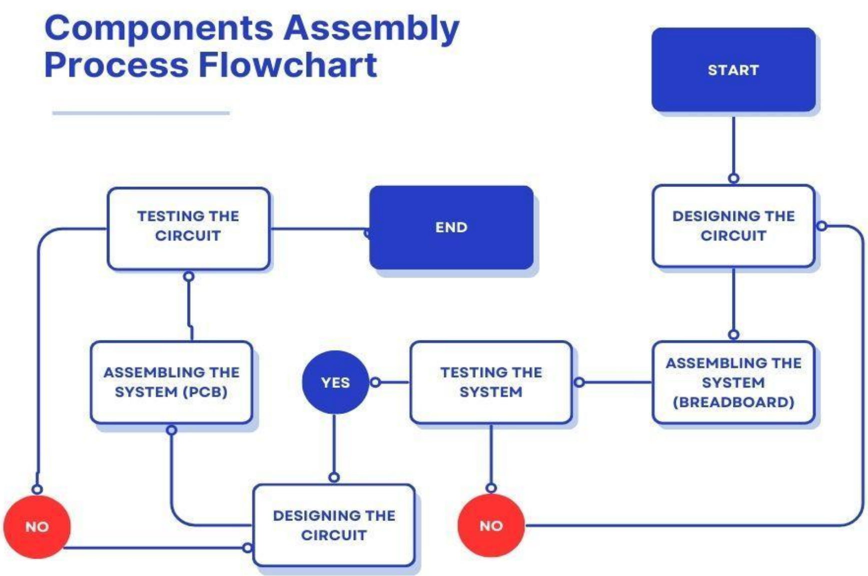


Fig. 3.1 Components Assembly Process Flowchart

3.2.1 Input

Water level conditions (low, medium, and high levels)

3.2.2 Process

1) Water level detection using jumper wires as sensors

2) Signal processing using IC 555

3) Switching control through BC547 transistor and relay

3.2.3 Output

1) Pump ON when the water level is low

2) Pump OFF when the water level is high

This framework supports automatic water level management with minimal user intervention and aligns with the objective of developing a simple, low-cost, and easy-to-use system.

3.3 Components and Tools

Table 3.1 Components Used in the Project

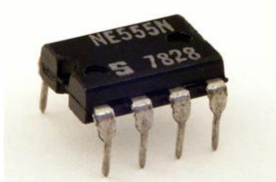
No.	Components	Function	Image
1	IC 555	Acts as the main control and timing device for processing sensor signals and controlling the relay.	
2	BC547 transistor	Used as a switching device to control the relay using low-power signals from the IC 555.	
3	Resistors (1 kΩ and 1 MΩ)	Limit current flow and set timing intervals for stable circuit operation.	
4	Relay	Controls the ON/OFF operation of the water pump or valve based on control signals.	

Table 3.1 Components Used in the Project

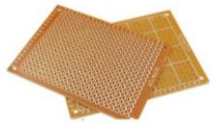
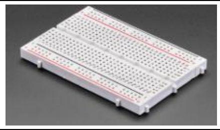
No.	Components	Function	Image
5	Diode	Protects the relay and other electronic components from voltage spikes (back EMF).	
6	Printed Circuit Board (PCB)	Provides a permanent and reliable platform for assembling the circuit.	
7	Breadboard	Used for prototyping and testing the circuit before PCB assembly.	
8	jumper wires (Red, Yellow, Green)	Act as water level sensors to detect low, medium, and high water levels.	
9	DC power supply (Adapter)	Supplies electrical power to the water level controller system.	
10	DC jack connector	Allows safe and convenient connection of external power to the system.	
11	Water pump or valve	Pumps water into the tank or stops water flow when required.	
12	Transparent Plastic Enclosure (11 × 11 cm)	Houses and protects the electronic circuit, providing a compact and safe enclosure for the system.	
13	Water Tank	Stores water and is used for testing and system operation.	 

Table 3.2 Tools Used in the Project

No.	Tools	Function	Image
1	Soldering iron	Used to solder electronic components onto the PCB.	
2	Wire strippers and cutters	Used for cutting and stripping insulation from electrical wires.	
3	Screwdriver	Used for assembling components and installing the system into the enclosure.	

3.4 System Design Overview

The system is designed to:

1) Detect water level conditions using simple jumper-wire sensors

2) Automatically control the ON/OFF operation of the water pump

3) Use basic electronic components with low cost and simple structure

4) Allow easy external connection of power, pump, and sensors

3.5 Water Level Sensor Setup and Operation

3.5.1 Jumper-Wire Sensor Configuration

In this project, three jumper wires are used as water level sensors. Each jumper wire has a specific color and is connected externally through the enclosure:

1) Red jumper wire: Low-level water sensor

2) Yellow jumper wire: Medium-level water indicator

3) Green jumper wire: High-level water sensor

Openings are provided on the enclosure to allow the jumper wires to be connected from outside the device, making sensor installation and adjustment simple and convenient.

3.5.2 Operating Principle of the Sensors

When water comes into contact with the jumper wires, which act as conductive probes, the circuit is completed and a signal is sent to the control circuit. The system operates as follows:

1) When the water reaches the green sensor (high level), the pump is turned OFF to prevent overflow.

2) When the water level drops below the green and yellow sensors, the pump remains OFF.

3) When the water level drops to the red sensor (low level), the pump is turned ON to refill the tank.

This method reduces unnecessary pump switching and improves system efficiency.

3.6 Control Circuit Configuration

The IC 555 functions as the main control unit of the system. It processes signals received from the water level sensors and controls the relay accordingly.

The IC 555 operates together with the BC547 transistor, which drives the relay to control the water pump based on detected water level conditions.

3.7 Relay and Protection Circuit

A relay is used to control the high-power water pump using low-power control signals.

1) The relay coil is driven by the BC547 transistor.

2) A flyback diode is connected across the relay coil to protect the circuit from voltage spikes (back EMF).

3) Normally Open (NO) relay contacts are used to switch the pump power.

3.8 Breadboard Assembly and Testing

Before permanent assembly, the circuit is assembled and tested on a breadboard:

1) All components are connected according to the circuit design.

2) The operation of the red, yellow, and green sensors is tested.

3) Pump ON/OFF control is verified under different water level conditions.

3.9 PCB Design and Assembly

Once the circuit operates correctly on the breadboard, it is transferred to a Printed Circuit Board (PCB) to improve reliability and durability for practical use.

3.10 Enclosure Design and External Connections

To improve usability and practicality, the completed circuit is installed inside a plastic enclosure with external connection points.

1) DC Jack 1: Used to receive 12 V DC power from an external power adapter and supply power to the circuit.

2) DC Jack 2: Used to connect the system to the water pump.

3) Openings are provided on the enclosure for connecting the red, yellow, and green jumper-wire sensors from outside the device.

This design allows easy installation, replacement, and maintenance of the power supply, pump, and sensors without opening the enclosure, supporting the goal of creating a user-friendly module.

3.11 Final Testing and Calibration

After enclosure installation:

1) The system is tested with a real water tank

2) Sensor positions are adjusted if necessary

3) The IC 555 timing is fine-tuned for stable operation

4) The system is verified to operate correctly without false triggering or overflow

3.12 Final Integration and Application

After successful testing, the system is ready for real-world applications such as:

1) Household water tank management systems

2) Small-scale automated irrigation systems

3) The system operates automatically as follows:

4) The pump turns ON when the water level reaches the red sensor (low level)

5) The pump turns OFF when the water level reaches the green sensor (high level)

Chapter 4: Results and Discussion

This chapter presents the results obtained from testing the DIY automatic water level controller and discusses the system's performance in relation to the project objectives. The system was designed to automatically monitor water levels using simple jumper-wire sensors and control the water pump through a relay-based circuit. The main objective was to develop a low-cost, reliable, and easy-to-use system capable of maintaining water levels within predefined limits without human intervention.

The performance of the system was evaluated under various testing conditions, including different water levels, pump flow rates, and pump power ratings. The results demonstrate the practicality of the design choices discussed in Chapters 2 and 3, particularly the use of simple conductive sensors and basic electronic components.

4.1 Performance Evaluation

The performance of the automatic water level controller was tested under simulated real-world conditions to evaluate its functionality, reliability, and responsiveness. The testing scenarios were designed to represent typical household and small-scale applications, including fluctuating water levels and the use of water pumps with different capacities.

The evaluation focused on key performance indicators, including the accuracy of water level detection, the response time of the relay, and the efficiency of pump control.

4.1.1 Performance with a 12 VDC 4 L/min, 4.2 W Submersible Water Pump

The system was first tested using a low-power submersible water pump operating at 12 VDC with a flow rate of 4 liters per minute and a power rating of 4.2 watts. This configuration represents a typical small-scale or household application.

Findings	Calibration	Remarks
Accuracy of water detection	Detects at ±2 cm	No missed detection
Response time of the relay	0 seconds delay	Consistent
Efficiency of pump control	0 seconds delay	Effecient

The results indicate that the system was able to accurately detect water levels using the color-coded jumper-wire sensors and control the pump without noticeable delay. The relay responded immediately to changes in water level, demonstrating stable and reliable operation with low-power pumps.

4.1.2 Performance with a 12 VDC 19 W, 800 L/hour Submersible Water Pump

To further evaluate system robustness, the controller was tested with a higher-power submersible pump operating at 12 VDC with a power rating of 19 watts and a flow rate of approximately 800 liters per hour. This test was conducted to assess whether the low-cost control circuit could reliably handle higher pump loads.

Findings	Calibration	Remarks
Accuracy of water detection	Detects at ±2 cm	No missed detection
Response time of the relay	0 seconds delay	Consistent
Efficiency of pump control	0 seconds delay	Effecient

Despite the increased power and flow rate of the pump, the system maintained consistent performance. The relay switched reliably, and the pump responded correctly to sensor signals. These results confirm that the relay-based design described in Chapter 3 is suitable for controlling both low- and moderate-power pumps in practical applications.

4.2 Challenges and Solutions

Although the system performed well overall, several challenges were encountered during the design and testing process. These challenges were addressed through iterative improvements, as outlined below.

4.2.1 Sensor Calibration Issues

One of the initial challenges involved calibrating the water level sensors to ensure consistent detection. During early tests, slight variations in sensor sensitivity resulted in minor inconsistencies in water level detection.

This issue was resolved by adjusting resistor values in the sensor circuit to improve signal stability and by carefully positioning the jumper-wire probes to ensure sufficient contact with water. Additional calibration tests were conducted using different water volumes to fine-tune the detection thresholds. After these adjustments, the sensors consistently detected water levels within an acceptable accuracy range.

4.2.2 Relay Control Stability

During early testing, occasional relay instability was observed, particularly when controlling higher-power pumps or during frequent switching cycles. This issue was traced to voltage spikes generated by the inductive load of the pump motor, which interfered with the transistor driving the relay.

To address this problem, a flyback diode was added to the circuit to suppress voltage spikes caused by back electromotive force (EMF). This modification significantly improved relay stability and ensured reliable pump control, even under higher load conditions.

Chapter 5: Conclusion

This project successfully achieved its objective of designing and building a low-cost, easy-to-use automatic water level controller module capable of monitoring and maintaining water levels in a tank without human intervention. The system effectively integrates simple water level sensors, an IC 555–based control circuit, a relay, and a water pump to automate water management, preventing both overflow and dry-running conditions.

In accordance with the literature reviewed in Chapter 2, the project demonstrates that simple sensor-based methods can provide sufficient accuracy and reliability for household and small-scale applications. Rather than relying on complex or expensive sensing technologies, the use of conductive jumper-wire sensors proved to be a practical and cost-effective solution.

The system design described in Chapter 3 was validated through experimental testing presented in Chapter 4. The controller demonstrated accurate water level detection with a tolerance of approximately ±2 cm, which was adequate for the intended applications. The relay responded immediately to changes in water level, allowing the pump to be switched ON and OFF without noticeable delay. The system maintained stable performance across different pump flow rates and power ratings, confirming its flexibility and robustness.

Although several challenges were encountered during development, including sensor calibration issues and relay control stability, these challenges were resolved through simple and effective refinements. Adjusting resistor values improved sensor sensitivity and consistency, while the addition of a flyback diode successfully suppressed voltage spikes generated by the pump motor. These improvements enhanced the overall reliability and durability of the system.

Overall, the results confirm that the proposed DIY automatic water level controller meets the project objectives and offers a practical solution for water level management. The system is affordable, reliable, and easy to operate, making it suitable for a wide range of real-world applications such as household water tank management and small-scale automated irrigation systems.

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Electronics Hub - Water Level Controller Circuit

Simple Water Level Indicator with Alarm (3 Tested Circuits)

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LM555 Timer datasheet (Rev. D)

Datasheet for BC547 Transistor (e.g., On Semiconductor)

BC547 Datasheet(PDF) - Fairchild Semiconductor

Datasheet for 12DCV SPDT Relay

JQC-3FF SPDT 12V 5A PCB Relay Datasheet

Appendix

A. **Materials and Cost Breakdown**

This section provides an itemized list of materials required to build the DIY Automatic Water Controller System. Included are estimates for costs, along with recommended suppliers and alternative options where applicable. The costs provided below are approximate and may vary based on location, supplier, and market fluctuations.

Item	Description	Cost in Thai Baht	Supplier
NE555	generating delayed on/off timings or triggering events like activating a relay at specific intervals.	10	precharelectronics
Transistor BC547	switching component, controlling the flow of current to activate or deactivate various system components	3	precharelectronics
12v SPDT Relay	an electromechanical switch that allows you to control a high-current load	30	precharelectronics
PCB Board 4x4	rigid board made from a non-conductive material	10	precharelectronics

Resistor 1k Ohm	in sensor circuits, for voltage dividers, or as part of timing circuits	1	precharelectronics
Resistor 1M Ohm	in sensor circuits, for voltage dividers, or as part of timing circuits	1	precharelectronics
Diode 1N4007	flyback protection when switching inductive loads like motors or relays	1	precharelectronics

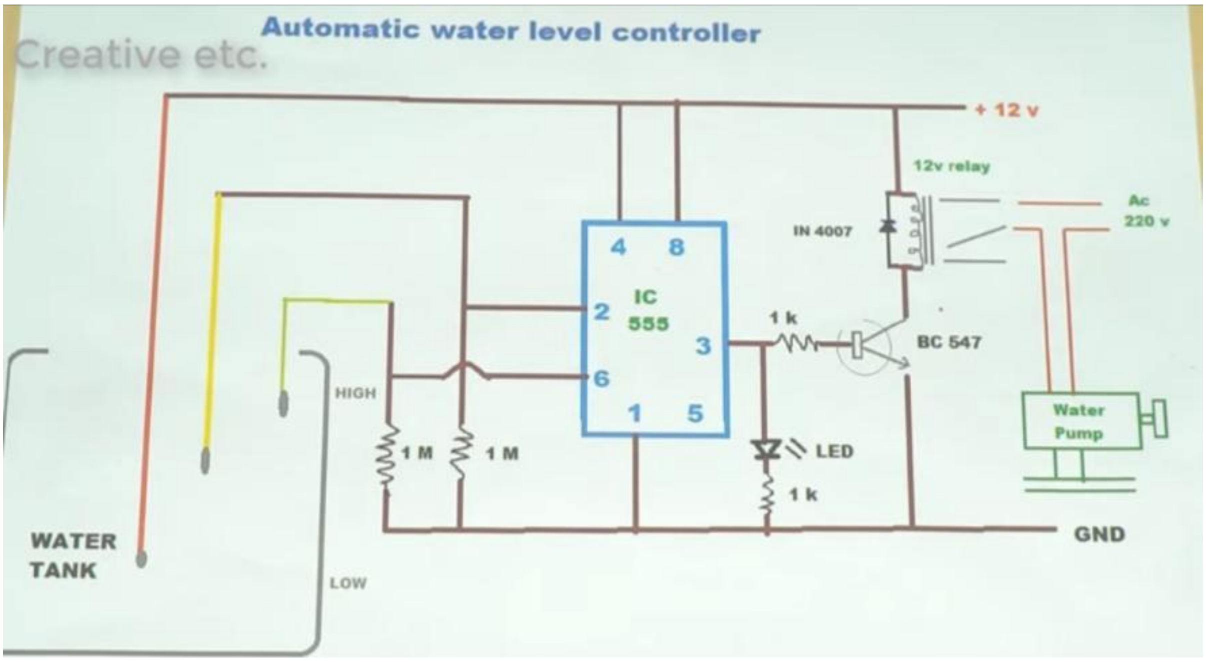
Estimated Total Project Cost

The total cost for building the Automatic Water Controller System is approximately 56 THB, depending on the choice of components and supplier.

Cost-Saving Tips

1. **Bulk Purchasing**: Many components, such as jumper wires and sensors, can be purchased in bulk to save money.
2. **Reusing Materials**: If you have old electronics lying around (e.g., sensors from other projects or unused power supplies), consider repurposing them to reduce costs.
3. **Local Electronics Shops**: Explore local hardware or electronics stores as they may offer competitive pricing compared to online retailers, and you can save on shipping costs.

Circuit diagram used to design the project



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