WATER LEVEL MONITORING AND ALARM SYSTEM

A Thesis or Dissertation
Presented to the Faculty of the Electronics Technology of
Eastern Visayas State University

Presented by:

Jenson F. Mosing
Caryll Keen E. Wenceslao
Dennis Rey A. Nitgano
Art Joseph C. Timtim
Sunnymar C. Barabad

In Partial Fulfillment
of the Requirements for the Degree of
Bachelor of Science in Industrial Technology Major in Electronics

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APPROVAL SHEET

In partial fulfillment of the requirements for the degree of Bachelor in Science and Industrial Technology Major in Electronics, this research paper is entitled **WATER LEVEL MONITORING AND ALARM SYSTEM** has been prepared and submitted by **Jerson Mesias, Caryll Keen Wenceslao, Dennis Rey Hitgano, Art Joseph Timtim,** and **Sunnymar Barabad** who are recommended for Final Oral Defense.

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Abstract

Almost all aspects of advancement life undergone rapid development. This development is supported by the advance of electronics and information technology. With the era of globalization today, especially in the Philippines, massive flash floods and storm surge caused by severe rainfall highly put every individuals-domestic pets, properties and lives in to risk. The primary and main reason for all of this is climate change.

In the local city (Ormoc City, Leyte, Philippines) there are areas that are prone to massive flash floods. This research is designed to solve the problem by monitoring the water level and providing water alarm through the system receiver. Furthermore this research is designed to digitally detect the water level of an area in order to minimize manual checking, but notified that there is an exposure of water around the system.

The experimental result of trial and errors endorse the reliability and feasibility of the proposed system to provide a solution for similar problems in industrial liquids treatment process application.

Capstone Project Description

1.1. Overview of the Current State of Technology /Background of the Study

Monitoring the water level is done in order to keep an eye on it while also spotting and foreseeing potential flood hazards in order to take action as soon as possible. (Indrasari, W., & Kadarwati, L. V. , 2022). To show whether a body of water has a high or low water level, a water level indicator system sends data back to a control panel. Some water level indicators monitor the level of the water by using a mix of probe sensors and float switches. In fact, the operation of a water level indicator is fairly straightforward. Water level indicators use sensor probes to show the amount of water in a storage tank. These probes relay data to the control panel in order to activate an alert or indication. As previously noted, the control panel can be programmed to automatically activate your pump so that the water can be refilled. For many different sectors, water level gauges are crucial. For instance, cooling towers utilize water level indicators to track the amount of water in a tank and take remedial action as needed. If a water tank lacked water level indicators, you would have to manually check to see if there was enough water in it. If your tank were to ever run dry, your chiller might overheat. Water level indicators enable remote water level monitoring and automatically implementing remedial measures so you may concentrate on more crucial problems. According to Peacock (2018), water level monitoring has numerous environmental advantages in addition to time-saving ones, such as increased awareness of potential flood conditions. In the event that levels get too high or low, it is significantly simpler to quickly implement countermeasures by using water level monitoring devices. Water level recorders are extremely sensitive pressure sensors that can notice even the smallest variations in the level of the water and can send alerts to specified contacts to let them know what is happening.

Natural disasters are renowned experts in annihilation and destruction. Natural disasters leave a trail of destruction in their wake. Some of its negative side effects include destroyed buildings and infrastructure, compromised economic stability, reduced agricultural productivity, and fatalities. One of these disastrous natural events is flooding, which is the rising and overflowing of a body of water, particularly into typically dry terrain. According to records, floods are the most frequent tragedy with

72 incidences, according to the Senate Report from 2013. Floods can be divided into two categories: location-based or place-based classifications, and duration-based classifications. River floods may or may not be considered floods, depending on where they occur. A river system with tributaries that drain large areas with multiple distinct river basins floods the neighboring low lying areas when there is a lot of rain. These floods could continue a few hours or several days, depending on the force, volume, and distribution of the rainfall (PAG-ASA, 2016). The Philippines is especially susceptible to river floods due to the 421 principal river basins that are distributed around the island (JICA, 2008).

According to Kwon (2013), flooding is a possibility in over 70% of cities and municipalities in the entire country. Metro Manila alone is made up of 16 cities and 1 municipality that are all located on top of a large flood plain. A flood plain is a region of level, flat ground that is surrounded by streams or rivers that regularly overflow during periods of heavy rain, he explained. Furthermore the Pasig River, the primary river in Metro Manila, is loaded with tributaries and canals that branch out in different cities and towns. Metro Manila is vulnerable to flooding due to two major tributaries, the Marikina and San Juan Rivers. As severe rainfall falls along the escarpment, runoff reaches the streams very rapidly, giving local communities little time to prepare just like what happened in the situations of the typhoon "*Ondoy*" and "*Sendong*".

Featuring a total population of 215,0312 and a population growth rate of 2.6% that is greater than the national average, Ormoc is a first-class, independent city and a significant regional hub in Eastern Visayas. The city is recognized as a growth hub, ready for significant development and support from the federal government. The population is anticipated to reach 300,688 by 2030, and it might quadruple by the middle to end of the 2040s.

Ormoc has undergone significant urban and socioeconomic development over time, but the city is vulnerable to the effects of climate change due to its exposure to climate-related hazards like flood, storm-surge, and rain-induced landslides, as well as the vulnerability of its residents. For instance, the Anonang-Lobi Mountain Range of the Eastern Visayas Biodiversity Corridor, which connects to the Bao River's important watershed, is connected to forest area that is prone to landslides. cultivation land suitable for both seasonal and year-round crop cultivation is vulnerable to flooding. Flooding and storm surge are thought to be a risk in the ancient urban core and its development expansion southwestward towards the coastal barangays. The entire city is also vulnerable to earthquakes, which can result in liquefaction and tsunami and exacerbate climate-related risks such significant flooding brought on by heavy rain.

Several dendritic river systems, or those with multiple contributing streams, such as the Pagsangaan, Malbasag, and Anilao Rivers, are also present in the city. As towns are established along their tributaries in Ormoc City, these systems frequently interact with the built environment. When these structures block water from draining into rivers, flooding has happened in the past and could happen again, especially during typhoons when these places experience significant water runoff.

Residents of Brgy.Liloan, Ormoc City typically face torrential rain and typhoons, which result in flash floods in the area. In a report of ABS - CBN news through Reuters and Ormoc City Police Office on December 18, 2017, massive flooding was brought on by Tropical Storm Urduja's heavy rains in Eastern Visayas and affected Tzu Chi Village in Brgy. Liloan, Ormoc City one week before Christmas.

In November of 2014, construction on the Tzu Chi area was finished. The ground where the water river flows through is supposed to be gradually damaged by Pagsangahan River after a few years and the storms that have passed. It is claimed that it only floods because tiny drainages or structures were built nearby. This paper suggests a prototype system design, implementation, and description of necessary devices and technologies based water level monitoring and keep track of frequent water level in buckets, rivers, waterways, lakes, and ponds that might be used in the future.

The Water Level Monitoring and Alarm System is a fundamental technique for identifying and notifying river water level flow to detect potential water rise in Brgy. Liloan in Ormoc City's Tzu Chi. a typical design is a small device that rests on a post with levels and depends on the electrical conductivity of water. In the event that addition to sending a signal to the next step. In order to alert residents in flood-prone areas and to keep track of the flow of water toward its rise, particularly when rain is continuously falling in the area that is vulnerable to flooding.

The severity of the harm caused by climate-related catastrophes has highlighted the necessity for information-dissemination initiatives that can assist individuals in minimizing the dangers posed by these catastrophes. This emphasis on spreading information is based on the idea that good communication helps individuals better comprehend risks, which in turn encourages them to adopt behaviors and views that can help them minimize those risks' effects. (Andrey & Mortsch, 2000).

1.2. Capstone Project Objectives

1.2.1. General Objective

The water level alarm and warning system primary aims is to alert residents of an impending flood. By providing early warning, people can take action to protect themselves, their homes, and their property.

1.2.2. Specific Objects

- Detect any potential flooding risks by monitoring changes in water levels over time.
- To provide early warning of potential flood.
- Make the device users updated on the current situation of the water level, thus enabling them to take appropriate actions based on the data received.
- To reduce the risks of loss of life and property.
- To improve disaster awareness.
- To promote community safety.
- To provide an affordable and effective solution.

1.3. Scope and Limitations of the Project

This study analyzes the environmental performance of the Water level monitoring and alarm system. This study will explore an environmental monitoring which is the use of water level monitoring and alarm system. The target population of this study was identified in Ormoc City, Leyte Brgy. Liloan where there is a history of rising water levels from year to year and incessant flooding that causes property rising water levels from year to year and incessant flooding that causes property damage. In addition, this study will be conducted from August 2022 until June 2023. Limitations of this type of monitoring include the cost and complexity associated with installing and maintaining the necessary equipment, as well as potential inaccuracies due to environmental factors such as wind or waves. Additionally, it may not be possible to monitor all areas due to access restrictions or other logistical issues.

Figures from Ormoc City's Case Study on the Road to Climate Resilience

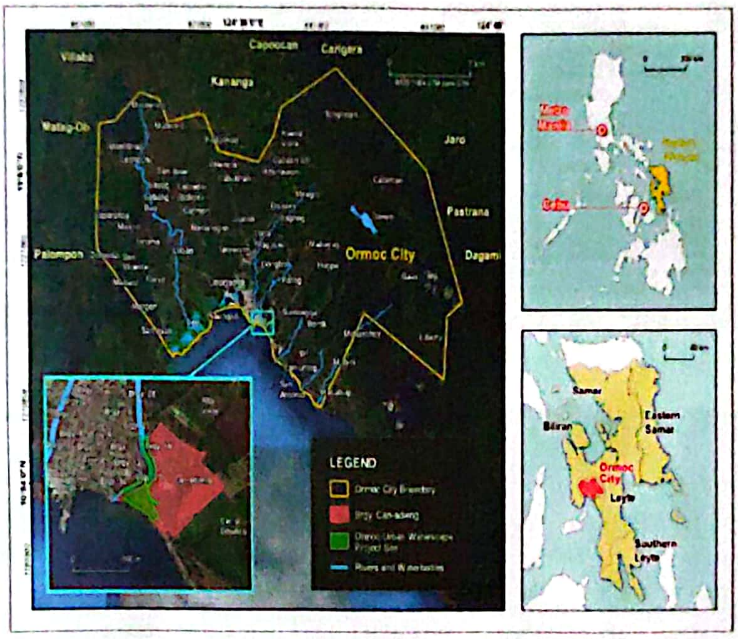

Figure 1. *Map of Ormoc City and Brgy. Liloan, Ormoc City.*

Figure 2. *During a typhoon, considerable water runoff occurs in some sections of Ormoc City, generating flooding that affects the local population.*

Figure from LiDAR Surveys and Flood Mapping in Pagsangahan River

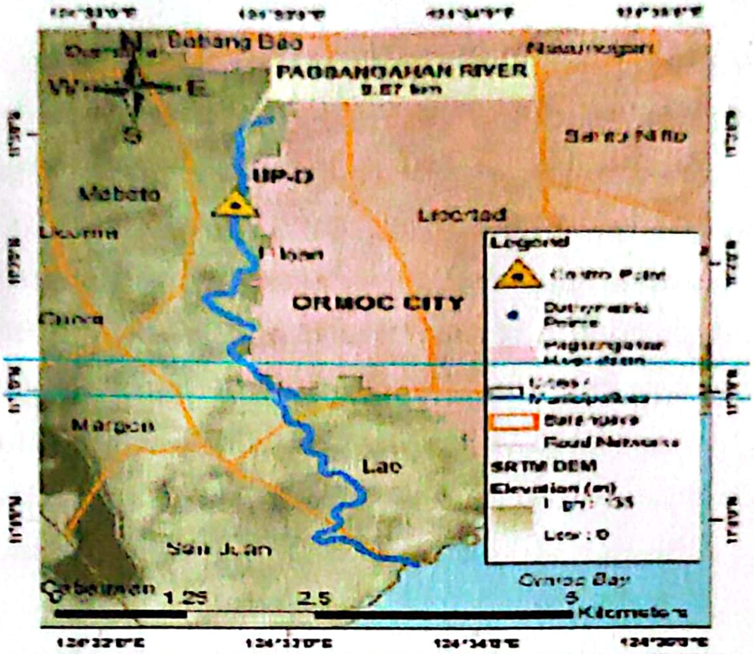

Figure 3. *Extent of the LiDAR ground validation survey of the Pagsangahan River.*

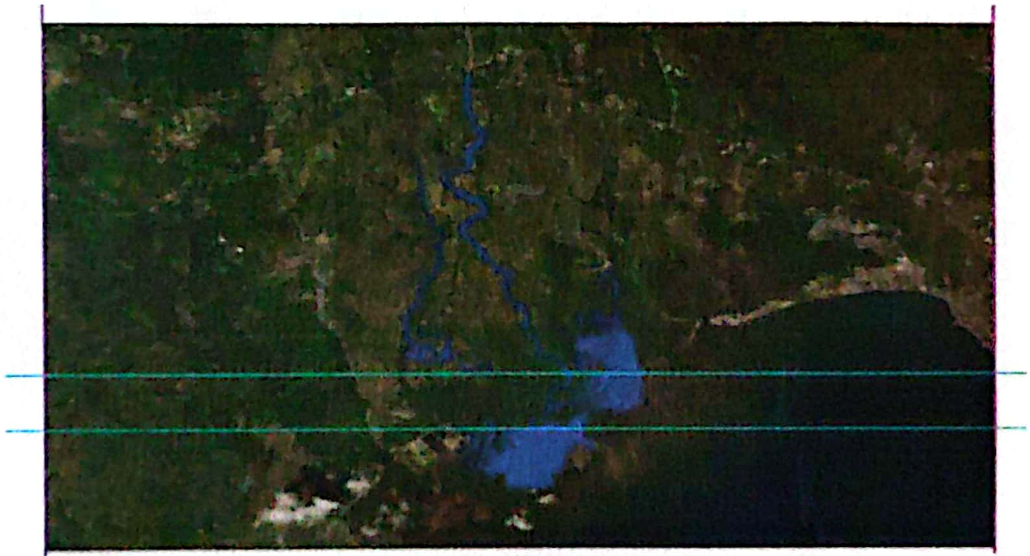

Figure 4. *Sample output map of the Pagsangahan River.*

1.4 Significance of the Capstone Project

Water level monitoring is a high priority in the electronics sector as it plays a key role in preventing equipment damage or loss due to flooding. Detecting potential water problems can also improve system efficiency and reliability, and reduce maintenance costs. Additionally, water level monitoring is useful for environmental monitoring, enabling water resource management, flood risk assessment, and water quality monitoring. In industrial automation, water level monitoring helps control water flow, adjust when tanks are filled or emptied, but requires sophisticated sensors and control systems. Overall, water level monitoring can drive advances in electronics technology and open up new opportunities for sensor designs, control systems, and IoT devices that benefit the environment and industry.

Review of Related Literature

In today's technology, computer control systems can also be used to optimize river management to reduce flooding from water inundation (Jatmiko *et. al.*2012). The height of the river water level can be used as an input parameter for management and can be used to control the locks that line the river flow. Using an ultrasonic sensor (ping sensor), water level is measured without making direct physical contact between the sensor and the water's surface. An ultrasonic transducer is a device that transforms energy into ultrasound or sound waves at temperatures above those experienced by humans. High frequency sound waves are produced by ultrasonic sensors, and the echoes the sensor receives are analyzed. The Ping sensor measures water level by reflecting sound waves. The time it takes to send and receive a reflected ultrasonic wave is multiplied by the sound speed through water to get the distance. Calculations are performed using C language software installed on the ATMega8535 microcontroller. Distance measurements are sent over your wireless network. The AT89S51 microcontroller is used to send the distance value received by the receiving module to the computer and display the water level every 5 cm. then the water level will be displayed. A buzzer sounds when the water level suddenly changes and becomes very dangerous. Water level information is also displayed on the LCD.

The exchange of information wirelessly between two or more unconnected places is referred to as wireless communication. The distances can be brief. Infrared, microwave, and radio frequency transmission are all forms of wireless communication. A typical 27MHz wireless remote control module with a maximum range of five meters is used by the system.In this study, a wireless water level sensing system prototype is shown. A tank or reservoir's water level could be measured using the technology. A sensor, a wireless module, a microcontroller, and a battery make up the prototype. The sensor was used to gauge the water level, and the wireless module and micro-controller were utilized to send the information to a distant display. Power for the components came from the battery. Through placing the sensor in a tank with varying quantities of water, the system was put to the test. Results indicated that the device could accurately detect changes in water level. Results also indicated that the technology could transmit data wirelessly over a distance of up to 100 meters. A gap in this research is that developer have not explored the potential applications of a prototype water level detection system using wireless technology in other fields. This method, for instance, can be used to create water supply and irrigation systems for agriculture. It can find water levels in networks or even in remote locations without access to traditional water level sensing devices. It makes no recommendations regarding the need for additional research.

A. K. Sharma *et. al.*, (2018) discusses the creation of an Automatic Water Level wireless monitoring system. The system is intended for low-cost, high-performance autonomous water level monitoring. To increase accuracy and dependability, it makes use of a number of technologies, including GSM, Android apps, and wireless sensor networks. In order to evaluate the performance, a performance evaluation efficiency of the system. The creation of a "AWLMS" (automatic water level monitoring system) is the main subject of this study. Wireless enabled, the system is created to continuously monitor and manage water levels in reservoirs and tanks time, enhancing management and effective use of water resources. the device comprises of a central controller, a transmitter, and a receiver that communicate utilizing the ZigBee wireless protocol. The system has undergone testing and evaluation in a lab setting and has proven to be capable of reliably and accurately detecting changes in water level. The system is low-cost, extremely dependable, and has many uses in industries like agriculture, water conservation, and environmental monitoring. Overall, this study shows that the suggested wireless automatic water level monitoring system is a dependable and affordable water level monitoring solution.

The research by A. K. Sharma *et. al.*, (2018) focused on creating and evaluating low-cost wireless water level monitoring systems. Although there are some research gaps. For instance, the paper makes no mention of how the system might be scaled up or tailored to various water levels. Furthermore, this study did not investigate how the technology would affect water management or other uses. Last but not least, the research makes no mention of potential energy savings or financial gains from deploying such systems. These holes could be filled by additional study of the system's deployment, scalability, prospective applications, and ramifications.

Murugan *et. al.* (2020) worked on creating a water level monitoring system based on the Internet of Things (IoT). The apparatus includes a water level sensor, an both a Wi-Fi module and an Arduino microcontroller. The tank's water level can be determined, and the data can be sent to the cloud for storage and analysis. The technology performed well throughout testing in a real-world setting. The study also discovered that the device could reliably and somewhat accurately identify changes in water level. The findings of this study indicate that a number of applications can make use of these water level monitoring devices.The current study provides an overview of the design and development of an IoT water level monitoring system. However, this study focused on the system's potential uses or performance in real-world situations rather than the safety concerns of using such technologies in water management systems. The system's flexibility to various water level monitoring scenarios and its cost-effectiveness in terms of energy and infrastructure requirements were also not considered in this study.

To discover water leaks in underground pipelines using infrared technology, a Comparative Study of Using High and Low Resolution Infrared Cameras for Evaluating Distant Remote Detection was carried out. By Li, Y., and Zhang, X. in 2020. In order to find water leaks in underground pipes, this study examined the efficiency of high- and low-resolution infrared cameras. To assess the effectiveness of two cameras in remotely locating water leaks, the authors conducted a comparison research. Their result showed that high-resolution cameras are more effective in detecting leaks and have higher accuracy than low-resolution cameras. The study concluded that high-resolution infrared cameras are superior at detecting water leaks in buried pipes. A gap in this study is that the environmental conditions in which infrared technology is used have not been considered. Certain environmental conditions such as temperature, humidity, and even dust can affect accuracy. The study does not consider the cost of using infrared technology to detect water leaks. The effectiveness of employing infrared technology to find water leaks is assessed after accounting for equipment expenses and maintenance costs. Before deploying the technology, it should be evaluated for any potential dangers related to using infrared technology in these circumstances.

Ehikhamenle *et. al.* (2020) presented a water level simulation design system for controlling a reservoir. Proteus software was utilized in this work to imitate the test and validate the model, use MATLAB and system. The simulated design of the system featured the employment of water pumps, analog-to-digital converters, binary switches, and tanks. The technique used in this work also permits the system to keep an A PI (Proportional Integral) controller was used to achieve the tank's ideal water level proposed. The system was able to maintain the desired water level, according to the results very little to no inaccuracy in the tank. The research found that the suggested system might uccessfully manage the tank's water level. In this investigation, a simulated design is used the method used to create a water level control system. This study employs software called MATLAB/Simulink is used to model and simulate system components their performance under different circumstances. The system's components include reservoirs, controls, valves, and pumps. Water is stored and delivered using reservoirs, and water is transferred from reservoirs to valves using pumps. Control is achieved through valves the system's water supply's water flow from the reservoir. The regulator is utilized to modify the examine the simulation results to determine the valve setting to maintain the appropriate water level analyze the system's performance under various scenarios. The outcomes are applied to identify the system's ideal combination of parameters to attain optimal performance. The study also assesses the system's resilience and dependability, and its capacity to adapt to system environment changes and disturbances. Finally, the report offers suggestions for enhancing system functionality and reliability. Although this study was able to successfully design the system, it did not explore the system's performance or the full range of possible applications to evaluate the performance of the system under conditions and further investigate all uses of the system (for example, water purification systems, irrigation systems, etc.). This will help to better understand the capabilities and limitations of the system. Additionally, this study did not consider the potential social and environmental impacts of using such automated water control systems, so this could also be an area for further research.

Technical Background

3.1. Technicality of the Capstone Project

Several technical terms are used in our project: Node MCU, Water Level Sensor, DHT11, Jumper Wires, Arduino IDE. Some of the terminologies being stated above are also the technology used in our project. The proponents have used Cross Platform Application wherein the users can access it through the Arduino IDE.

3.2. Details of the Technology to be used

To run the system, this project will be available on laptops and computers. The project will be developed using the following technological tools:

- **ARDUINO IDE**

  The development board integrates the main processing chip with communication interfaces and peripherals. Now, with the popularity of the ESP32 processor, there are also more hardware variants and software development branches to choose from. The simplest method to begin developing code for the ESP32 platform is via the Arduino platform.

- **WATER LEVEL SENSOR**

  Water level sensors are crucial tools for measuring river water levels. This can be used in applications such as fish tanks, aquariums, swimming pools, and others. The sensor benefits in ensuring that the right amount of water is utilized and that the tank does not overflow by keeping an eye on the water level.

- **ESP32**

  A high-performing, inexpensive, and power-efficient microcontroller is the ESP32. Additionally equipped with Wi-Fi and Bluetooth radios, the ESP32 is a great choice for a variety of IoT applications. The ESP32 may be used for a variety of projects and applications through to its extensive feature set, from straight forward wireless a network to sophisticated IoT systems.

Expressive Systems' ESP32 is a system-on-chip (SoC) with excellent performance and comprehensive features. It is a low-cost, low-power microcontroller with Wi-Fi and Bluetooth capabilities that is gaining popularity for usage in many Internet of Things projects.

- **JUMPER WIRES**

They provide as a link between components on printed circuit boards. or to link two devices. Any electronics project needs jumper wires because they make connecting components to one another quick, simple, and reliable.

- **MICRO USB CABLE**

Micro USB cables are the most popular type of USB cable used to connect computers to devices like smartphones, tablets, and other digital cameras. It is simpler to connect these devices with a micro USB cable because it is smaller than a conventional USB cord. The device is powered by the cable's four pins, which also connect the device to the computer. Micro USB cables are a terrific method to connect all of your devices and ensure that they communicate and operate as one unit.

- **DHT11**

It makes use of a sensor and a capacities humidity sensor element to a digital signal is output on the data pin after measuring the surrounding air. The several applications for the low-cost, low-power DHT11 sensor exist applications requiring measurements of humidity and temperature. The DHT11 sensor combines a resistive element and an NTC sensor in a moisture sensitive network.

3.3. How the Project will Work

The chosen research methodology is the prototype methodology. This methodology was chosen because its fundamental tenet is that needs are better recognized through the creation of a quick prototype than by having them frozen before design or coding can start. This prototype was made using the currently understood requirements. Prototyping approach is a guide for creating software.

Prototype use enables user evaluation. The definition of prototype technique in the context of software development is the construction, testing, and revision of a prototype to produce an acceptable prototype. Although the requirements of the system are currently reasonably understood, they could change in the future. The production quality system is created using the final requirements specification, which is produced after the initial requirements are amended in response to input. The following diagram illustrates the stages of the prototyping process.

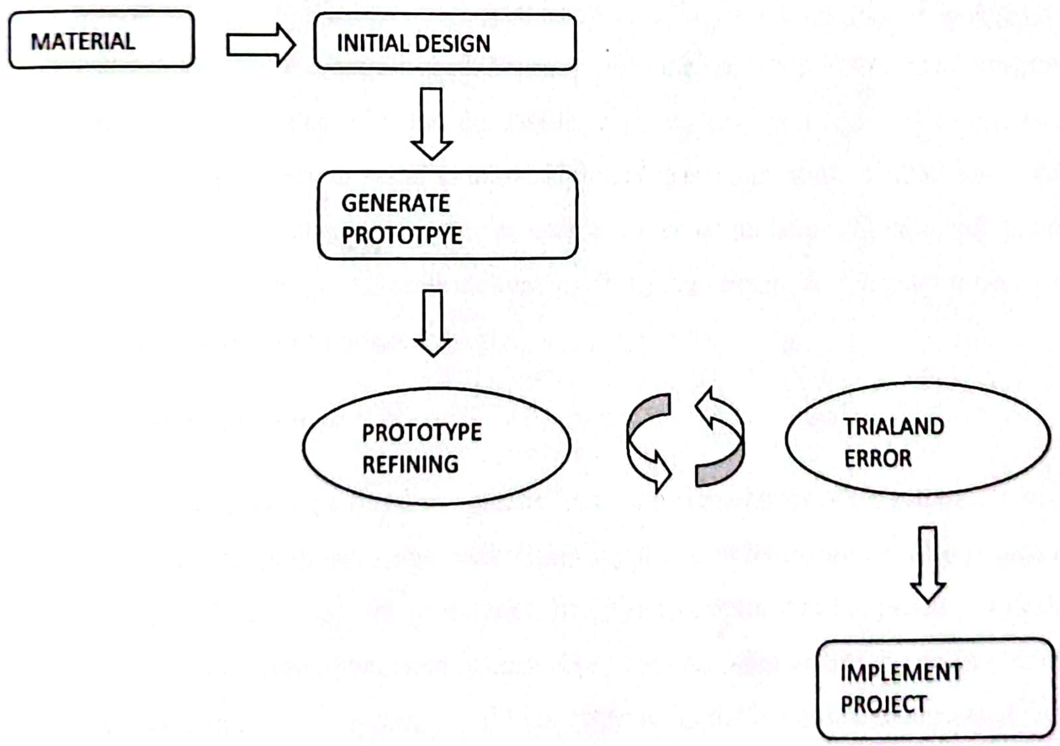

***Diagram 1**. Phase of the prototype process*

For complex systems without a manual approach to assist in establishing the requirements, prototyping is an appealing option. Iterative, trial-and-error processes are used by the developer.

Gathering hardware and software materials

- Arduino IDE
- NodeMCU ESP32
- Water Sensor
- DHT11
- Jumper Wires

Connect the water sensor and DHT11 to the ESP32 according to its appropriate pinouts using jumper wires from ground to ground, VCC to the 3v3 pinout of the ESP32, and the Signal connected to the analog pinout that gives the value reading of the sensor used. Moving on to the next step is to write a program in the Arduino IDE that will read the data from the water sensor and DHT11 and display it on an LCD screen or serial monitor. Upload the program to the ESP32 and test it by placing it in a container of water or near a source of moisture. Finally, adjusting the code as needed to get an accurate reading from the sensors and display it on an LCD screen or serial monitor accordingly.

System Requirement

The prototype requires specific hardware elements or other software resources to function properly on a computer. Choosing the right hardware can also reduce costs and development time for prototypes. In order to ensure that the product is designed to meet user requirements and is error-free, it is crucial to utilize the proper hardware and software. This sub-chapter will concentrate on the hardware requirement and the software requirement categories of system requirements.

Hardware Requirement

A list of hardware requirements for developing proposal application is shown in Table 1.

Table 1. Hardware Requirement

HARDWARE	SPECIFICATIONS	DESCRIPTIONS
Random Access Memory	4.00 GB	Stores information on the computer including files and software programs.
Input Devices	Keyboard and Mouse	Input device to enter data.
Processor	Intel® Core ™ i3-1005G1 CPU @1.20 GHz 1.19 GHz	Indicates how fast computer performs certain functions.
NODEMCU	ESP32	There are open source prototyping board designs for open source firmware.
Sensor	Water Level Sensor DHT11	A device that recognizes and reacts to a certain kind of input from the outside world. The input can be any number of environmental events, including light, heat, motion, moisture, and pressure.

Software Requirement

A list of software requirements for developing proposal application is shown in Table 2.

Table 2. Software Requirements

SOFTWARE	SPECIFICATIONS	DESCRIPTIONS
Cross Platform Application	ARDUINO IDE	Writing and uploading programs to Arduino-compatible Additionally, various vendor development boards can be created with the use of third-party cores.
System Operating	Single-language Microsoft Windows 11 Home (64 bit)	For many online programs, the most recent operating system is necessary.

The first step in monitoring water levels is to install the model at the desired location. This model can be either mechanical or electronic device that can measures the depth of the body of water at regular intervals and records it on a serial monitor. The type of device chosen depends on factors such as cost, accuracy, and ease-of-use. For example, mechanical gauges are often cheaper but less accurate than electronic ones, however they may be easier to install and maintain in remote locations where power source are not available.

Once installed, data from these device must be collected regularly so that changes in the level can be monitored over time. This data collection manually reading off values from device at predetermined intervals for later analysis by the responsible authorities who specialize in interpreting this information for decision making purposes such as determining when flooding might occur due to heavy rains upstream.

In addition to digital readings taken from the device installed at specific locations along rivers and lakes, sensing technologies such as Digital Humidity Temperature sensor can also provide valuable information about changes in surface elevation which can inform the temperature and humidity level surrounding the installed device.

INITIAL DESIGN PHASE

An immediate design or preliminary design was created at this stage. It gives the user a quick overview of the system. This stage aids in the prototype's development. The sketch and schematic diagrams of the research are shown in the figures below.

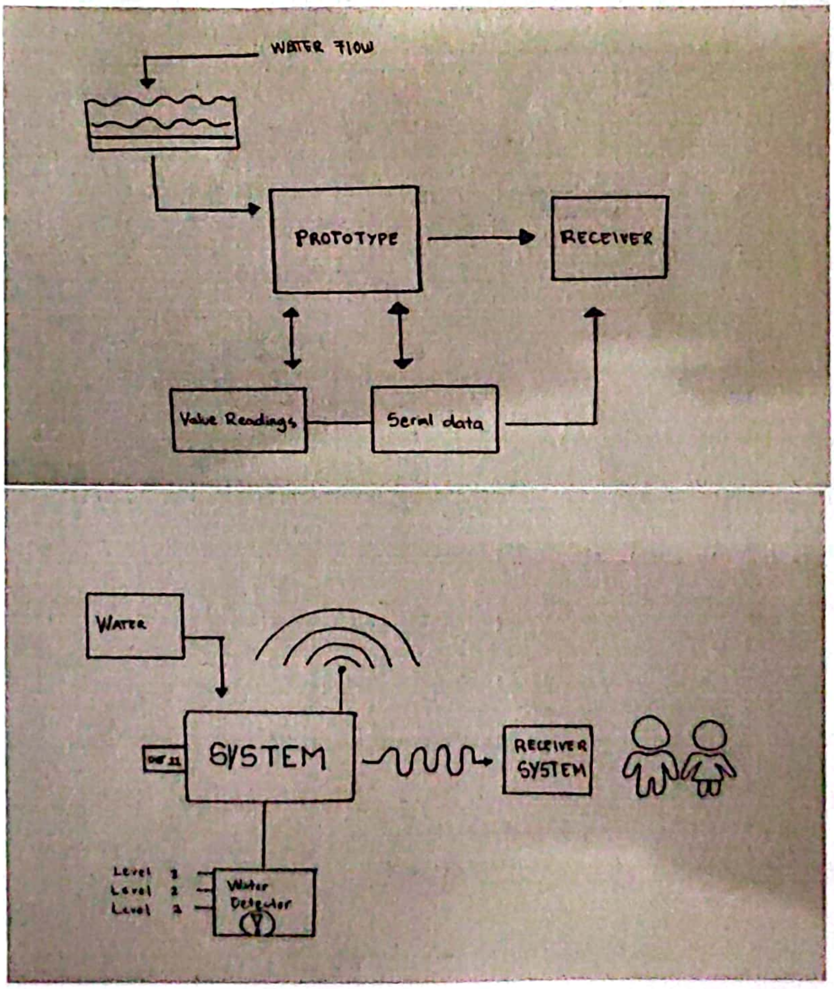

***Figure 5**. Sketch Diagram*

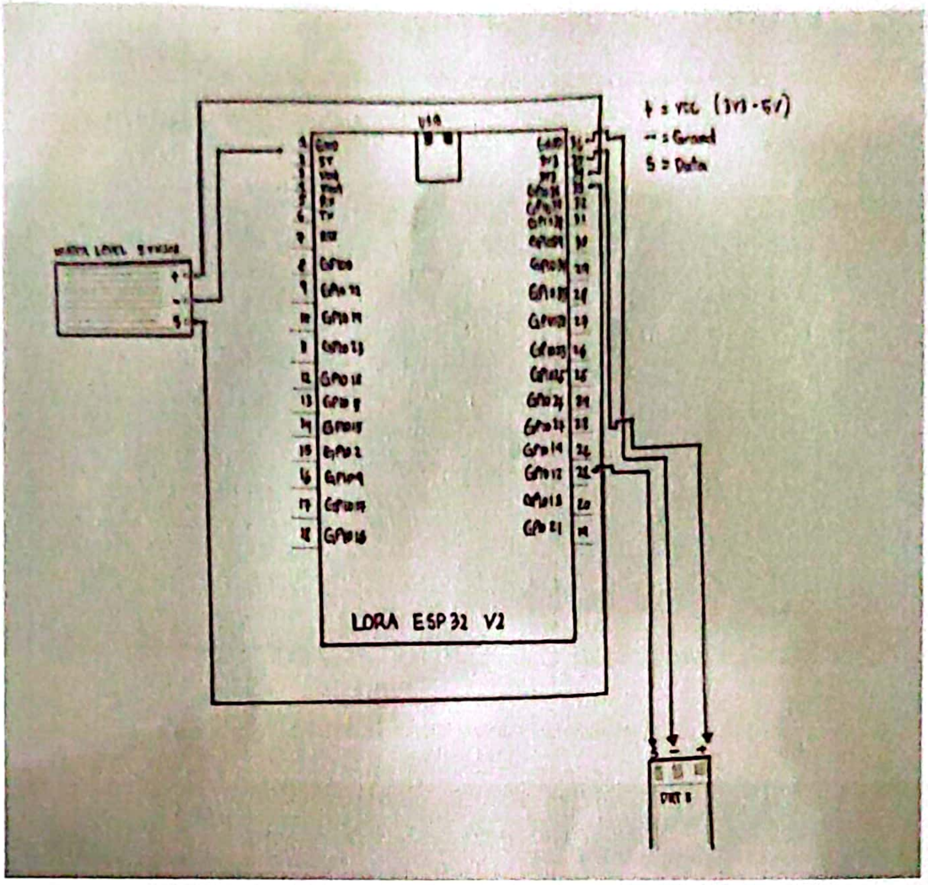

Figure 6. Schematic Diagram

Building Prototype Phase

In this stage, a real prototype is created using the data from the fast design phase. It is a scaled-down functioning prototype of the needed system. All of the requirements that were previously outlined must be met by the prototype that will be built. The prototype phase of water level monitoring system typically involves the following steps:

1. **Design and build the hardware components:** This includes designing and constructing the sensors, NodeMCU and other necessary hardware components.

2. **Develop software for data analysis:** This includes developing software to collect data from the sensors.

3. **Test the system in a laboratory environment:** This involves testing all of the components together in a controlled environment to ensure that they are working properly before deploying them in a actual field setting.

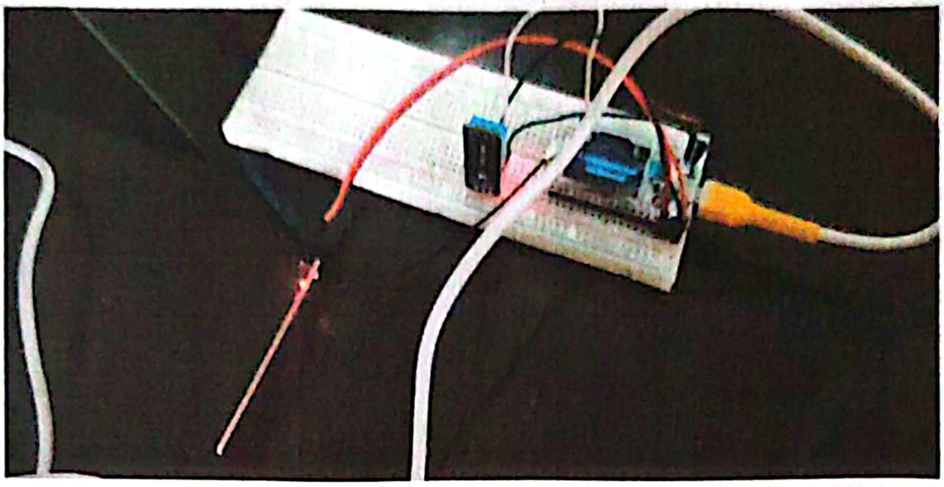

Figure 7. *Hardware Components*

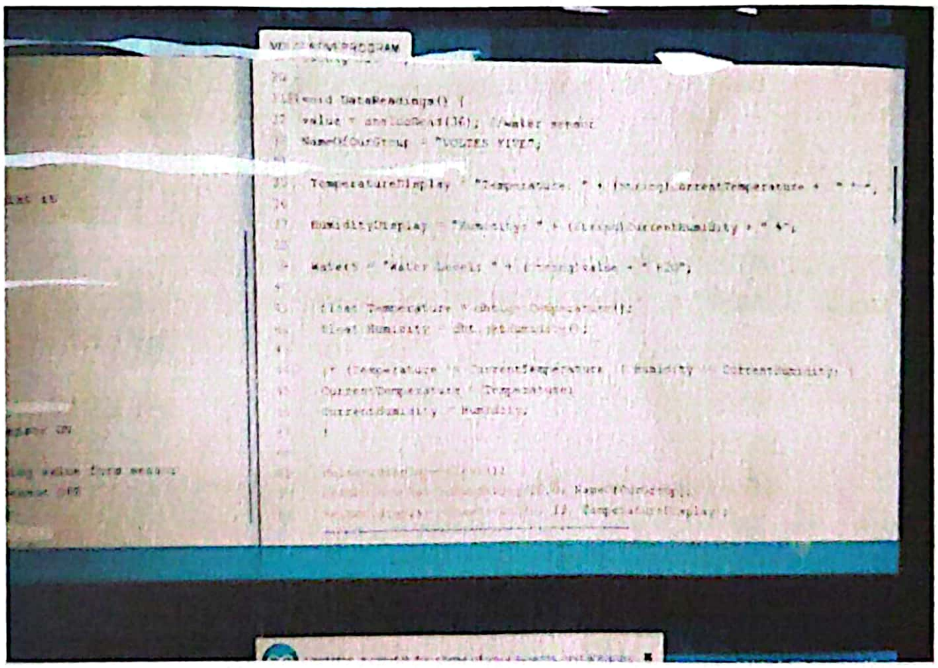

Figure 8. *Software Components*

Water Level Monitoring System

Specification

The Arduino IDE software maintains monitor of water levels, identify dangerous situations, and sound alerts in the natural environment to prevent flooding or to ensure resource management.

This Arduino IDE Software must accurately and reliably collect data on water level from the attached sensor.

The Arduino software when water levels go above certain limits, alarms should sound to alert people to possible flooding or dangerously low levels.

The Arduino IDE software should use low-power levels to save energy while inactive, which is crucial for battery-powered systems.

Functional Requirements:

Sensor

Configure the water level sensor's pins and libraries for use. At certain times, read the sensor's data on the water level continuously. For the purpose of converting unprocessed sensor data into accurate measurements of the water level, scale and adjust the data properly.

Alarms

Define and establish alarming high and low water level limits. Water levels should be continuously monitored, and when thresholds are crossed, alarms (LED, buzzers) must turn to remove.

Power Efficiency

To increase battery life when not in use, use low-power modes.

Environmental

Determine that the software is reliable and stable in the environment where the system is used.

4.1. Sytem Overview

Water Sensor

The water sensor serves a pivotal role in accurately measuring the river's water level, providing real-time and precise information. Its primary function is to aid in the efficient management of water resources and to proactively prevent potential flooding by continuously monitoring and promptly reporting any changes in water levels. The capabilities of the water sensor encompass enabling early warning systems, offering immediate access to real-time water level data, actively supporting water resource management efforts, and playing a key role in mitigating the risk of flooding.

Buzzer

As a sound alert device, the buzzer produces a loud noise when the water level hits particular levels. The alarm function of the water level monitoring system is significantly improved by this feature which makes sure that the buzzer will make a lot of noise when the water level is crucial. This capability acts as a vital early warning system, efficiently advising communities and pertinent professionals about the impending threat of floods and increasing general security and flood protection actions.

Lora ESP32

The ESP32 LoRa module is crucial for allowing wireless communication. It allows remote monitoring and control of the water level monitoring system by facilitating long-distance data transfer from the water sensor to a central control station or data collector. This capacity enables remote oversight and management of the system, ensuring quick and effective responses to changes in water levels. The LoRa success stays in its ability to create a solid connection that ensures a continuous supply of critical water level data, improving the system's ability to be remotely controlled and monitored.

LED

The LED serves an essential function as an indicator, providing an indication of the condition of the water level monitoring device. It offers useful insights into the operation of the device through providing rapid feedback on how well it is performing.

The layout of the LED allows it to indicate whether the system is ready for use, actively monitoring water levels, or in alarm mode due to emergency conditions. This feature of the LED is crucial because it gives users a clear and simple way to comprehend the performance of the system at any given time. The LED serves as an efficient tool for users to evaluate the system's preparedness and current status since it illuminates the system's state and helps users better comprehend how the water level monitoring system operates.

Power supply

The power source is important since it provides electrical power to the entire system, ensuring the continuous operation of crucial parts like the water sensor, LoRa ESP32 module, buzzer, LED, and other essential components. In order for the system to successfully carry out its monitoring functions, it must maintain continuous operation. A backup power supply may be included to improve system dependability, further ensuring continuous functioning. This capability of having a backup power source ensures that crucial components, such as the water sensor, LoRa ESP32, buzzer, LED, and others, stay active without interruption, increasing the system's resilience and its capacity to withstand continuous monitoring.

4.2. System objective

- To regularly and accurately measure the river's water level.
- To reduce the risk of flooding through sending early warnings and messages when water levels exceed specified limits.
- To avoid possible damage that could happen to structures, properties, and the environment as a result of sudden changes in water level.
- To help in environmental monitoring and preservation efforts, it is important to understand how variations in water level affect communities.
- To reduce energy use especially in battery-powered systems to extend the life of the equipment.
- To improve public safety through quick and immediate warning about any possible concerns related to water.

4.3. System Function

Figure 9. Level of Water Sensor.

Water sensor

Technical function

The sensor's ability to monitor water levels, detect changes in it's declare or determine if water is present or not. This aptitude is necessary for keeping monitors on water levels and detecting floods. The accuracy of the sensor's measurements indicates how accurately it can identify changes in water level.

Software function

Collecting information that is meaningful from the sensor's initial data. Determine exact levels for alarm or notification triggering based on sensor data. When sensor data exceeds specified levels, alerts or notifications are generated.

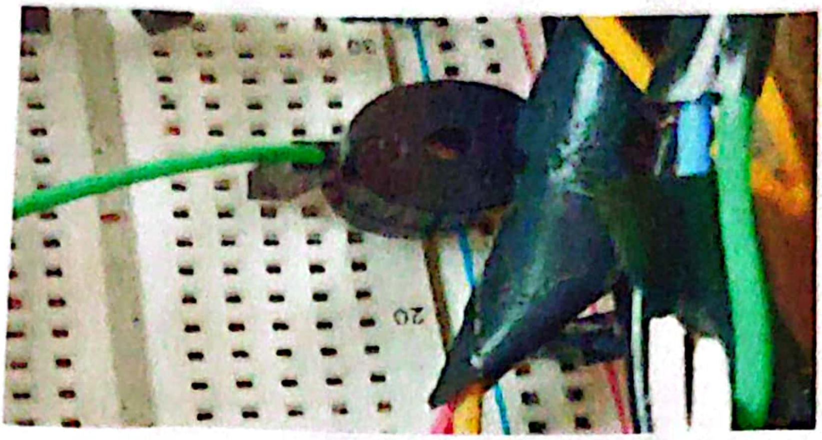

Figure 10. Buzzer.

Buzzer

Technical function

The main technical purpose of the buzzer in the water level alarm and monitoring system is to produce an audible warning. When specific water level levels are exceeded, it creates sounds that act as alarms or notifications, warning of impending floods or dangerous water conditions. A power source is necessary for the buzzer to operate. The system must power the buzzer, and it must be integrated with the water level monitoring system's primary power supply system. The operational voltage of the buzzer needs to work with the system's power source. By doing this, you can be certain that the buzzer will receive the right voltage and produce the desired sound level.

Software function

The water level alarm and monitoring system's software regulates when the buzzer sounds. Based on the water level measurements it receives from sensors, the program can instruct the buzzer to sound an alarm when the water level exceeds a specified levels, warning of a potential flood or other critical water conditions.

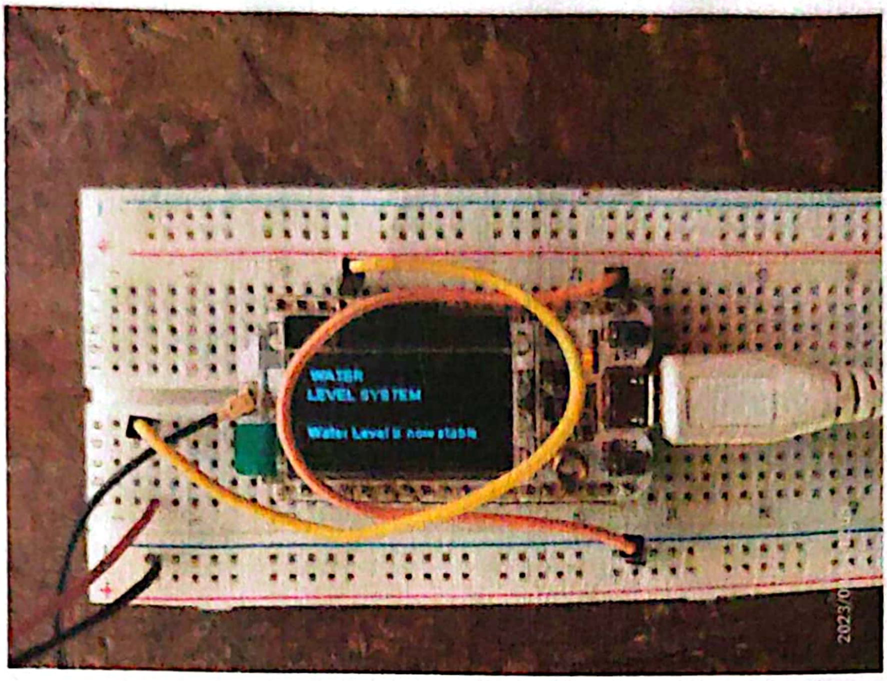

Figure 11. *Communication/ Notification System.*

Notification

Technical function

The system requires connections for sending and receiving data, such as serial connections, Internet ports, wireless (Wi-Fi, cellular), or IoT protocols (LoRa). Information exchange is made possible between these interfaces and the central monitoring unit.

Software function

Software processes are used to control the beginning, middle, and end of data transfer between the system's many components. Method also includes handling potential issues, managing data buffers, and generating communication channels.

Figure 12. LED Notification.

LED

Technical function

The main function of an LED in the water level monitoring and alarm system is as a visual indicator. It blinks light when engaged as a visual signal for expressing system status, alarms, or emergencies related to water levels. LEDs are energy-efficient and consume less power. They can be integrated into the system without significantly raising the total electrical demand, even when used for continuous visual alerts. To color-code system status or display different warning levels, different colored LEDs can be employed. For instance, red LEDs may signal dangerously excessive water levels, whereas green LEDs may signal normal operating conditions.

Software function

The program maintains the LED to show the current system condition. A red light may indicate a problem or a dangerously high water level, while a green light may mean everything is in working order and the water levels are within the acceptable range.

4.4. System scope and limitations

The scope of this project is to accurately measure river water level using reliable sensors, processing, and real-time transmission. Ensure water levels exceed limits, communicate warnings, and protect communities. Utilize predictive algorithms and automated alerts to monitor and prevent water level changes, study environmental impact, optimize battery-powered systems, and enhance public safety by establishing reliable communication infrastructure. Furthermore the device monitors water levels, detects changes, and determines water presence for flood detection. Accurate measurements impact water quality identification. It collects data, generates alerts, and manages data transfer. Energy-efficient and color-coded, it requires compatible power supply and integration.

4.5. Physical Environment and Resources

Table 3. Hardware Used.

Details	Function
Water Sensor Type: Ultrasonic water level sensor Measuring Range: 0 to 5 meters Accuracy: ±0.5% FS Resolution: 1 cm Output Signal: 0-5V analog voltage Operating Temperature Range: -10°C to 60°C Protection Rating: IP68 Power Supply: 12V DC Material: Stainless steel housing	Environmental monitoring, water resource management, and flood monitoring are all made possible by the sensor's precise measurements and dependable performance. It permits quick responses to fluctuating water levels and the sending of notifications or sirens when water levels approach crucial levels, resulting in improved disaster preparedness and resource management.
LoRa ESP32 Chipset: ESP32 (dual-core Tensilica LX6 microcontroller) Communication Protocol: LoRa (Long Range)	The ESP32 microcontroller offers strong processing capability together with integrated Bluetooth and Wi-Fi capabilities. On the other hand, the LoRa enables low-power, long-range

Frequency Bands: Various options available (e.g., 433MHz, 868MHz, 915MHz) Modulation: LoRa spread spectrum modulation Data Rate: Configurable, typically ranging from 300 bps to 37.5 kbps Transmit Power: Configurable, commonly up to 20 dBm (100mW) Range: Several kilometers in open areas with line-of-sight, depending on the frequency and environmental conditions. Antenna: External antenna required for better performance (SMA or IPEX connector) Memory: Flash memory and RAM available for program storage and data processing I/O Pins: GPIO, UART, I2C, SPI, ADC, etc. Power Consumption: Configurable power modes for low-power operation Development Environment: Arduino IDE or PlatformIO with ESP32 board support	communication, making it appropriate for a range of Internet of Things applications, monitoring, and sensor data transmission.

Buzzer Type:Electromechanical or piezoelectric buzzer Operating Voltage: Typically 3V to 12V Sound Output: Measured in decibels (dB), usually ranges from 70 dB to 120 dB Frequency: Produces a specific tone or sound frequency (e.g., 2.5 kHz, 4 kHz) Mounting: Through-hole or surface mount package Current Consumption: Typically low power consumption Activation: Activated by applying the rated voltage	The control center or microcontroller turns on the alarm when the water level reaches one of the predetermined thresholds. Depending on the water level situation, suitable workers, authorities, or residents can act after hearing the audible signal. This could involve taking precautions against flooding, leaving the area, or activating flood control devices.
Resistor Resistance: 10,000 ohms (10kΩ) Tolerance: Typically 5% or 1% Power Rating: Commonly 1/4 watt or 1/8 watt Package: Through-hole axial lead or surface mount	To restrict or regulate the passage of electric current in a circuit, a 10k resistor is a passive electrical component. In a variety of electronic applications, it is one of the resistor values that is most frequently employed. Its resistance value of 10,000 ohms is indicated by the "10k" in the specification.
LED Type: Light-Emitting Diode Voltage Rating: Typically operates at low voltage (e.g., 1.8V to 3.3V for standard LEDs) Current Rating: Typically requires low current (e.g., 10mA to 30mA) Forward Voltage Drop: The voltage drop across the LED when it is forward-	A LED is a semiconductor device that releases light when a forward-flowing current passes through it. It has two leads, one of which is positive (the anode) and the other is negative (the cathode).

biased (e.g., around 2V for standard LEDs) Color: Available in various colors, including red, green, blue, yellow, white, etc. Luminous Intensity: Measured in millicandela (mcd) or candela (cd), indicating the brightness of the LED. Viewing Angle: Specifies the angle over which the LED emits light (e.g., 120 degrees)	

4.6. Architectural Design

Structure design:

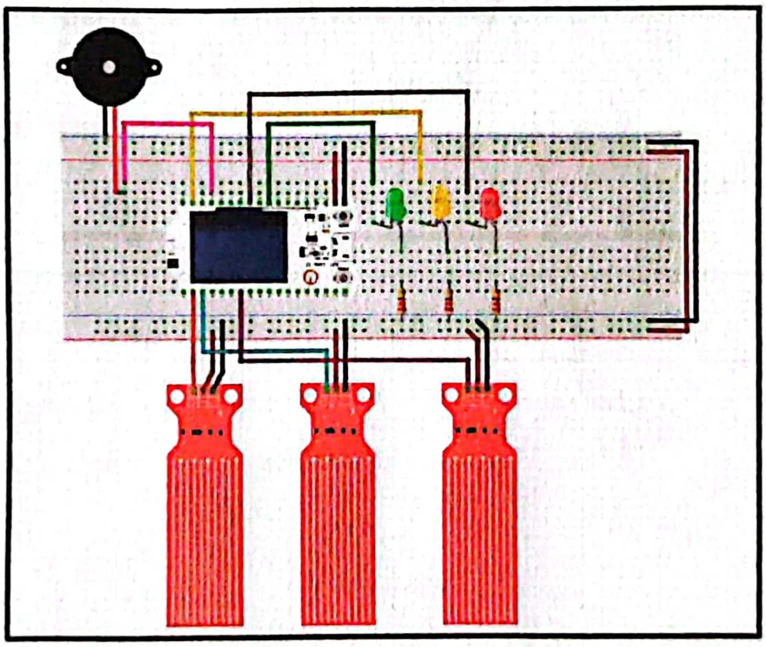

Figure 13. Structure/ Design of the water level monitoring system.

The structure design of a water level monitoring and alarm system transmitter entails developing a tool that can accurately measure the water level in a river and send this information to a receiving unit.

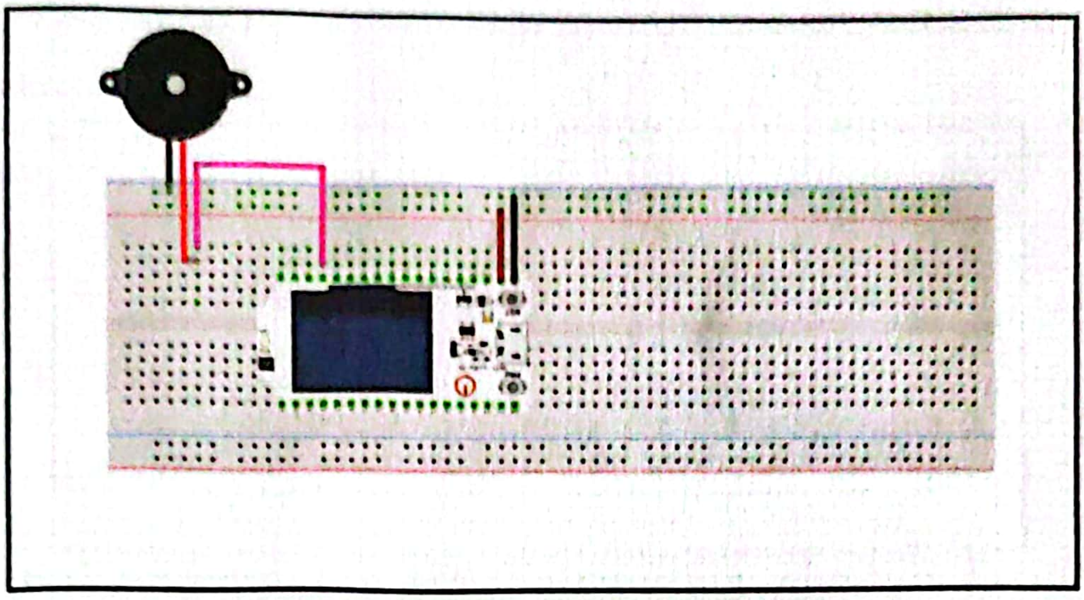

Figure 14. Structural design of receiver.

The structure design of a water level sensor receiver entails developing a device that can take in and analyze the water level information given by the water level sensor transmitter.

Schematic Design:

Transmitter

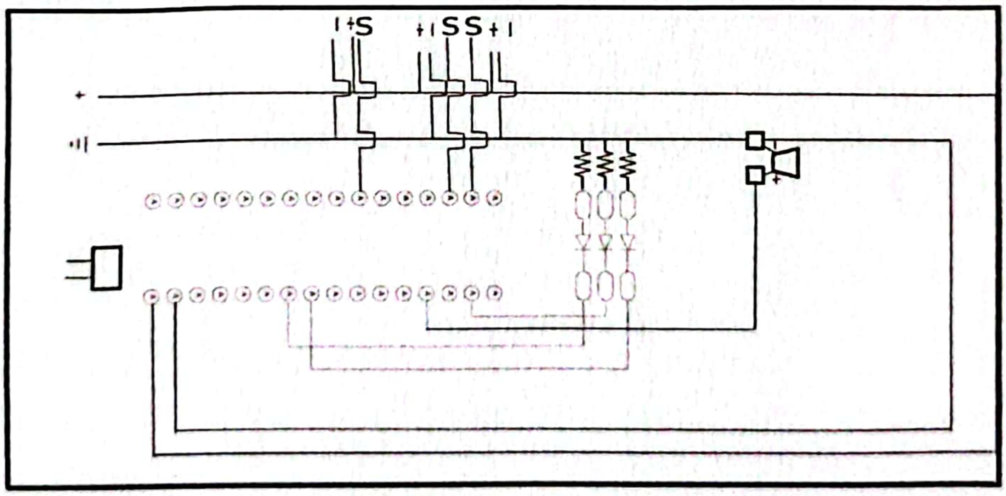

Figure 14. Schematic diagram of the transmitter.

The electrical circuitry and components needed to process sensor data and send it wirelessly must be represented visually in the schematic design of a water sensor transmitter.

Receiver

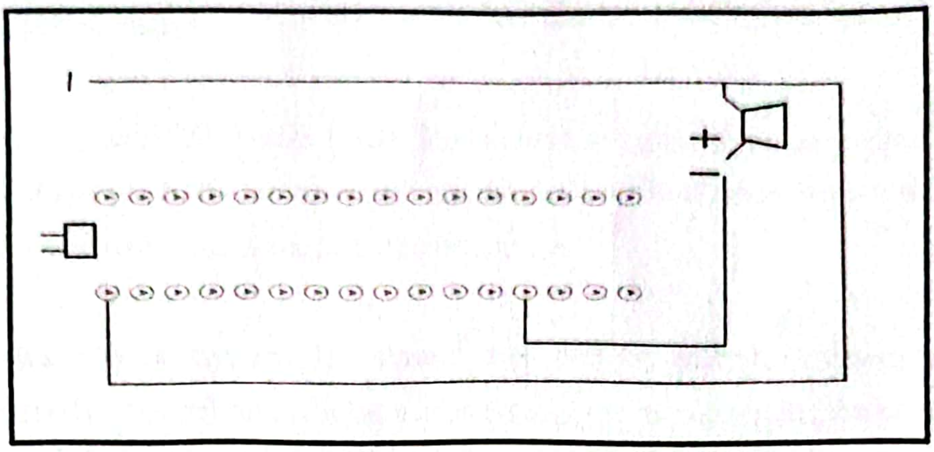

Figure 15. Schematic diagram of the receiver.

The electrical circuitry and components needed to receive and process the data given by the water sensor transmitter are represented visually in the schematic design of a water sensor receiver.

Design and Implementation Issues

Design Components

Sensors: Successfully installed water level sensors along the Pagsangahan River are part of the system. These sensors each measure the water level where they are placed and send the information to a central control device.

Central Control System: The sensors' data must be gathered, processed, and evaluated by this component. It has a microprocessor or microcontroller that can talk to the sensors and handle the incoming data.

Communication: The sensors use wireless communication protocols like Wi-Fi, LoRa, or cellular networks to send data to the central control unit. Real-time data transfer and remote monitoring capabilities are therefore maintained.

Alarm System: The system informs necessary authorities and participants when the water level exceeds an established limit. Alarms may include messages by notifications.

Implementation Steps

Sensor Deployment: Along the Pagsangahan River, sensors are carefully positioned to take look at positions that are vulnerable to flooding or unexpected increment in water levels.

Setup of the central control unit: The microprocessor or microcontroller is programmed to receive data from the sensors and process it. Additionally, it has to be able to connect with the user interface and set off alarms.

Setting up a communication channel: The sensors are set up to send data to the central unit using the selected wireless communication protocol. To protect data integrity, safety measures like protection can be used.

Configuring an alarm: Using acceptable water level limitations as a guide, users can define alarm levels. The alarm system is activated when the water level rises beyond each of these levels.

Alert System: The system is set up to deliver messages to the appropriate individuals by notifications and alarm, among other communication methods.

Major Issues and Problems Encountered

Accurate sensors: Incorrect measurements of the water level might be caused by sensors with calibration problems or necessary flaws.

Electricity Outages: Power outages could interfere with the system's operation and damage its capacity to send out alerts in the right moment.

False Alarms: Individuals can become annoyed and insensitive to actual notifications as a result of improperly adjusted levels or sensor issues.

Communication problems: If the system depends on communication sections, network problems could suppress notifications from reaching the proper personnel.

Design Tools

Arduino IDE: microcontroller and microprocessors are usually programmed for such applications using these development environments.

Libraries for communication: The inclusion of communication capabilities is made easier by libraries for Wi-Fi, GSM, or other communication devices.

Result and Observations

Test 1: First Normal Operation

Observation: No warnings have been set off by the sensors' precise detection of the normal river level.

Result: The system looks to be operating as intended under normal conditions.

Test 2: In the Tzu Chi community, a river flood is recreated. A first water sensor is set up at a water level of 20.23 cm, and the system is tested with a water level sensor and alert.

Data result:

- Monitoring 1 of a water sensor: Water Levels Measured(cm):[1,5,10,15,20,25]
  Standard set 20.23 cm
- Monitoring 2 water sensors: Water Levels Measured (cm): [20,25,30,35,40,45]
  Standard set 40.63 cm
- Monitoring of Water Sensors 3: Water Levels Measured (cm): [40,45,50,55,60,65]
  Standard set: 60.96 cm

Observations: Considering the flood situations, all sensors generated measurements that are within an acceptable range. All sensors gathered up on the high water level. Even when the observed water levels change slightly, the alarm system ensured certainty that timely flood warnings were provided.

Test 3: Long-Term Flood Conditions. In the course of several days, evaluate the water sensors' long-term stability during a simulate river flood in the Tzu Chi community.

Data result:

Water Sensor Monitoring 1:

- Measured Water Levels (cm) = [1, 10, 6, 14, 16] (Day 1 of First Calibration).
- Measured water levels (cm) for Day 1 of Water Sensor Monitoring are [17, 19, 20, 23,]
- Alarm System Triggered: Yes (at 20.23 cm) for water sensor 1 (alert). Alarm System Triggered.
- Notification: Brgy. Liloan Station
- Distance of communication: 4.7 kilometers

Observations: During the flood scenario, the water sensor correctly recognized the presence of water at a level of 20.23 cm, which is comparable with the results from the water level sensor. When the water level crossed the high-water sign, the alarm system successfully proceeded off to alert the community of the flood situation. Even with a comparison lower water level, the set-up of the water sensor, water level sensor, and alarm system offers an effective flood monitoring solution.

Water Sensor Monitoring 2:

- Measured Water Levels (cm) = [20,29,24,30,32] (Day 2 second Calibration)
- Measured water levels (cm) for Day 1 of Water Sensor Monitoring 2 are: [32, 35, 36, 40, 44].
- Alarm System Triggered: For water sensor 2 (Warning), yes (at 40.63 cm).
- Notification: Brgy. Liloan Station
- Distance of communication: 4.7 kilometers

Observations: The first water sensor reliably detects the presence of water at a level of 20.32 cm, resulting in an integer response. The first water sensor continues to give a single value as the water level increases until it reaches the level of the second water sensor. As soon as the water level reaches the second water sensor, which has been placed at a preset level of 40.63 cm, an alarm is set off. Once the high-water threshold is reached, the alarm system well goes off, alerting the residents to the flood situation.

Water Sensor Monitoring 3:

- Water Sensor Monitoring 3 (Day 3 of third Calibration) are [41,53,49,51,56]
- Measured water levels (cm) for Day 3 of Water Sensor Monitoring are [56, 49, 59, 60, 64].
- Alarm System Triggered: Yes (at 60.96 cm) for water sensor 3 (evacuation).
- Notification: Brgy. Liloan Station
- Distance of communication: 4.7 kilometers

Observation: Until the water level reaches the third water sensor at 60.96 cm, the second water sensor detects the presence of water. The measurements from the water level sensor reflect the water level's slow increment, which results in an evacuation warning when the water level reaches 60.96 cm. The evacuation warning was successfully triggered by the alarm system, informing the residents that they must leave because of the flooding.

Observations: Throughout the three-day flood simulation in the Tzu Chi community, all sensors showed stable measurements. Similar movement layouts throughout were displayed by Sensors 1, 2, and 3, indicating constant functioning. Throughout the three-day flood simulation in the Tzu Chi community, all sensors show stable measurements. The alarm system successfully addressed the dangerous water levels, resulting in active flood warnings. When the water level crossed the high-water level of 20.23 cm to 60.96 cm, Brgy Liloan station, which is 4.7 kilometers from the detector, immediately received data and notification.

Conclusion and Recommendations

Conclusion

The project's successful completion is evidence of the efficient execution and accomplishment of each stated goal. The Water Level Monitoring and Alarm System has been effectively created, installed, and used to handle the urgent problem of flood risk management in Tzu Chi, Liloan, Ormoc City through rigorous planning, resource allocation, and cooperative effort. The primary goal of giving potential hazard notification and early notice to those affected by floods has been accomplished with amazing success. The system's capability to track changes in water levels and swiftly alert locals has demonstrated its value as a tool for anticipating flood occurrences. This goal has not only been fulfilled, but even exceeded, due to the availability of timely alerts and real-time data, enabling people to take precautions well in advance. Furthermore, the project has effectively reduced the risks to life and property, aligning with another crucial objective. The system's capacity to detect flood risks and disseminate information has minimized the potential for loss, enabling residents to make informed decisions to protect themselves and their belongings. By delivering accurate and actionable data, this objective has been realized to its fullest extent. The Water Level Monitoring and Alarm System has greatly improved public awareness of potential disasters. Residents can now be bitterly prepared and attentive during crucial situations since they are more aware of the dynamics of flooding and its possible effects. This achievement highlights the significance of technology and its function in promoting awareness and knowledge among the community. The project's accomplishment also demonstrates its capacity to advance neighborhood safety. Residents now have the necessary information at their fingertips, enabling them to take an active participation in risk reduction and safeguarding their well-being. This result has been a significant accomplishment, illustrating the beneficial effects of technology when used in conjunction with a dedication to the well-being of the community. In conclusion, the success of this project demonstrates how well its goals were achieved. The Water Level Monitoring and Alarm System has provided early warning, reduced hazards, improved disaster awareness, and promoted community safety, going above and beyond expectations. The knowledge gained from this work will surely guide future initiatives in Ormoc City that aim to improve the resilience and security of the city for all of its citizens.

Recommendation

In the Tzu Chi community, the proponents fervently support the use of solar panels as part of the water level monitoring and alarm system. The use of solar panels to power the water level monitoring and alarm system indicates a commitment to environmentally friendly and sustainable practices while also guaranteeing the sensors' continuing and uninterrupted operation. Even in remote or difficult places, like the Tzu Chi community, solar panels can provide a steady energy source for the water level sensors by harnessing the power of the sun. The recommended employment of solar panel and of the use of solar energy works in complete adherence to Tzu Chi's values of environmental awareness and compassionate action.

In addition to providing an effective and self-sufficient energy source for the sensors, the installation of solar panels will serve as an educational model for the locals and surrounding towns, motivating them to adopt comparable environmentally friendly technologies. By effectively monitoring water levels, the Tzu Chi community can improve its preparedness for disasters and advance the larger objective of building a more sustainable.

PERSONAL INFORMATION

❖ NAME	:	Sunnymar C. Barabad
❖ DATE OF BIRTH	:	June 11,1996
❖ PLACE OF BIRTH	:	Ormoc City
❖ SEX	:	Male
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❖ WEIGHT	:	65 Kls.
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❖ CELLPHONE NUMBER	:	09952141548

FAMILY BACKGROUND

❖ SPOUSE'S NAME	:	
❖ OCCUPATION	:	
❖ EMPLOYER	:	
❖ EMPLOYER'S ADDRESS	:	
❖ TELEPHONE NUMBER	:	
❖ NAME OF CHILDREN	:	
❖ FATHER'S NAME	:	Sunny L. Payod
❖ MOTHER'S NAME	:	MARILOU BARABAD

PERSONAL INFORMATION

- NAME : Dennis Ray A. Hitgano
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FAMILY BACKGROUND

- SPOUSE'S NAME : N/A
- OCCUPATION :
- EMPLOYER :
- EMPLOYER'S ADDRESS :
- TELEPHONE NUMBER :
- NAME OF CHILDREN :
- FATHER'S NAME : Reynaldo T. Hitgano
- MOTHER'S NAME : Genie A. Hitgano

PERSONAL INFORMATION

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- CITIZENSHIP : Filipino
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- WEIGHT : 63 Kls.
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FAMILY BACKGROUND

- SPOUSE'S NAME :
- OCCUPATION :
- EMPLOYER :
- EMPLOYER'S ADDRESS :
- TELEPHONE NUMBER :
- NAME OF CHILDREN :
- FATHER'S NAME : Santos F. Mesias Sr.
- MOTHER'S NAME : Melita R. Mesias

PERSONAL INFORMATION

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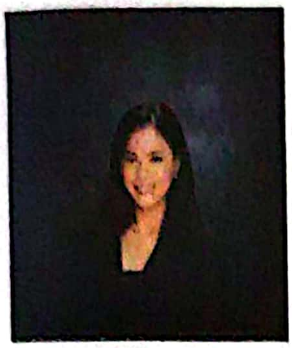
FAMILY BACKGROUND

- SPOUSE'S NAME :
- OCCUPATION :
- EMPLOYER :
- EMPLOYER'S ADDRESS :
- TELEPHONE NUMBER :
- NAME OF CHILDREN :
- FATHER'S NAME : Arturo T. Abad
- MOTHER'S NAME : Jennifer T. Abad



PERSONAL INFORMATION

- NAME : Caryll Keen E. Wenceslao
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- WEIGHT : 38 Kls.
- BLOOD TYPE : B+
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- CELLPHONE NUMBER : 09202726023

FAMILY BACKGROUND

- SPOUSE'S NAME :
- OCCUPATION :
- EMPLOYER :
- EMPLOYER'S ADDRESS :
- TELEPHONE NUMBER :
- NAME OF CHILDREN :
- FATHER'S NAME : Jonathan C. Wenceslao
- MOTHER'S NAME : Flordilez E. Wenceslao

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CERTIFICATION

This is to certify that the Capstone Project entitled **"Water Level Monitoring and Alarm System"** prepared by **Sunnymar C. Barabad, Dennis Rey A. Hitgano, Jerson R. Mesias, Art Joseph C. Timtim and Caryll Keen E. Wenceslao** has been edited for grammatical correctness and language effectiveness only, leaving the format and style to the school's prescribed rules, and is therefore ready for final printing upon approval by the adviser and committee.

This certification is issued this 29th day of August 2023 at the Valencia National High School, Valencia, Ormoc City for whatever purpose it may serve him.

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