SMART WATER TANK

Bachelor of Science (Computer Science)
SESSION (2021-2025)

Submitted by:

Fatima Safdar	**2121110026**
Iqra Hanif	**2121110032**
Laiba Ahmad	**2121110041**
Maryam Safdar	**2121110057**

SUPERVISOR

Ms. Nadia Ilyas
Head of Department

DEPARTMENT OF COMPUTER SCIENCE

GOVT. ISLAMIA GRADUATE COLLEGE (W) COOPER ROAD, LAHORE
AFFILIATED WITH
LAHORE COLLEGE FOR WOMEN UNIVERSITY,LAHORE

SMART WATER TANK

Project

Submitted in Partial Fulfillment

Of The Requirements For

The Degree of

Bachelor of Science (Computer Science)

At the

Govt. Islamia Graduate College Cooper Road, Lahore

By

Fatima Safdar	**2121110026**
Iqra Hanif	**2121110032**
Laiba Ahmad	**2121110041**
Maryam Safdar	**2121110057**

Supervisor

Ms. Nadia Ilyas

Department of Computer Science

Head of Department

Ms. Nadia Ilyas

Department of Computer Science

CERTIFICATE

BY THE PROJECT SUPERVISOR

I certify that the contents and form of the project submitted by **Fatima Safdar (Roll No. 212110026), Iqra Hanif (Roll No. 212110032), Laiba Ahmad (Roll No. 212110041), and Maryam Safdar (Roll No. 212110057)** have been found satisfactory and according to the prescribed format. I recommend that it be processed for evaluation by the External Examiner for the award of the degree **Bachelor of Science (Computer Science).**

Supervisor

Signature: _____

Name: Ms. Nadia Ilyas

Designation: Head of Department

In the Name of Allah, the Entirely Merciful, the Especially Merciful

Al-Fatihah [1: 1], Nobel Quran

DEDICATION

With profound gratitude, we dedicate this work to **Allah Almighty**, whose endless blessings and guidance have been our strength throughout this journey. Our heartfelt appreciation goes to our **beloved parents**, whose unconditional love, prayers, and unwavering support have been our greatest source of motivation. We extend our sincere gratitude to our **teachers** for their wisdom and dedication, and to our **friends**, whose encouragement and companionship have been invaluable.

A special tribute is reserved for our esteemed **supervisor, Ms. Nadia Ilyas**, whose invaluable guidance, patience, and encouragement have inspired us to push our boundaries and strive for excellence. Her unwavering belief in our potential has been instrumental in shaping this work, making it as original and meaningful as possible.

ACKNOWLEDGEMENT

First and foremost, we express our deepest gratitude to **Allah Almighty** for granting us the strength, wisdom, and perseverance to successfully complete this project. His blessings have guided us at every step, ensuring that no obstacle could hinder our progress.

We would like to extend our heartfelt thanks to **Ms. Nadia Ilyas**, Lecturer in Computer Science at **Govt. Islamia Graduate College Cooper Road, Lahore**, for being the ideal project supervisor. Her exceptional guidance, unwavering support, and valuable insights have been instrumental in shaping this project and ensuring its success. Her suggestions, direction, and consistent encouragement have not only refined our approach but also empowered us to reach new heights of excellence.

We are deeply appreciative of her willingness to offer feedback at every stage of the project, which has been crucial in helping us overcome challenges and enhance the quality of our work. Her dedication to our success is something we will forever be grateful for.

ABSTRACT

Water scarcity has become a significant issue, necessitating systems that prevent wastage and ensure efficient utilization. The proposed system introduces an intelligent, IoT-enabled framework for real-time water level monitoring and management, along with environmental condition tracking. A mobile application has been developed to determine the water level in a tank, allowing users to monitor the system remotely.

An ultrasonic sensor, fixed on the water tank, continuously detects the water level. When the water level decreases below a predefined threshold, the motor is automatically turned **ON**, and when the water level exceeds a particular limit, the motor is automatically turned **OFF**, ensuring optimal water usage. The water level is displayed as a percentage on the mobile application for user convenience.

Additionally, a weather monitoring system is integrated into the setup. This system measures and reports temperature and relative humidity of the surrounding environment using a **DHT11 sensor**. The temperature readings are transmitted to the user via the mobile application, providing additional insights into the environmental conditions.

A red **LED** indicator is used as an alert mechanism, turning on when water overflows, indicating that the motor has not been switched **OFF**. This visual warning system adds an extra layer of safety and efficiency.

By incorporating reliable and accurate components such as the **ESP32 microcontroller**, **ultrasonic sensor**, and **DHT11 sensor**, the proposed system ensures timely actions to prevent water wastage and provides comprehensive data about water levels and environmental conditions. This system is a practical and efficient solution for managing water resources in residential and industrial settings.

Contents

Chapter 1: Introduction

1. INTRODUCTION

Water is one of the most precious resources, yet its availability is declining at an alarming rate, especially in countries like Pakistan, where water crises are a growing concern. Mismanagement, wastage, and inefficient monitoring of water resources have further aggravated the issue. The traditional methods of monitoring water levels, such as manual checks, are not only labor-intensive but also prone to inaccuracies and inefficiencies. These challenges necessitate the development of a modern, automated solution to conserve water and optimize its usage.

This project introduces an IoT-based smart water monitoring and management system to address these critical concerns. The proposed system leverages modern technologies to provide an efficient way to monitor, manage, and maintain water levels in real-time. By integrating sensors, a microcontroller, and a mobile application, the system can not only monitor the water level but also measure the surrounding environmental conditions, such as temperature and humidity, using a **DHT11 sensor**.

The smart water tank system is equipped with an automatic motor control feature, which ensures that the motor turns ON when the water level drops below a certain threshold and switches OFF when the tank is full. Additionally, the system includes an overflow detection mechanism, where a red LED is activated to alert users in case the motor continues to run despite the tank being full.

The ultimate goal of this project is to save water, reduce wastage, and offer users a reliable and efficient way to manage water resources. By providing real-time data and automation, the system is particularly useful for households, industries, and agricultural applications.

1.1 SCOPE AND IMPORTANCE

The smart water monitoring and management system holds significant importance in addressing Pakistan's water crisis, which is fast becoming a national emergency. Water scarcity not only affects daily life but also threatens agriculture, industry, and overall economic stability. This project aims to tackle this issue by introducing a smart, automated solution that reduces water wastage and ensures optimal water utilization.

1.1.1 SCOPE

The scope of this system extends to:

1. **Automatic Water Level Management**: Using a water level sensor, the system can detect the current water level in the tank and control the motor automatically to maintain optimal levels.
2. **Real-Time Monitoring**: Data regarding water levels and environmental conditions, such as temperature and humidity, is collected by sensors and displayed on a user-friendly mobile application.

3. **Environmental Monitoring**: The system employs the **DHT11 sensor** to monitor the surrounding temperature and humidity, providing additional information for better resource management.
4. **Overflow Detection**: The system includes a red LED as a visual alert mechanism to notify users in case of water overflow due to motor malfunction.

1.1.2 IMPORTANCE

1. **Conservation of Water**: By automating water level management, the system helps to minimize wastage, which is a key step in addressing Pakistan's water crisis.
2. **Time and Labor Efficiency**: Traditional methods of monitoring water levels require manual effort and time, which this system eliminates by providing a fully automated solution.
3. **Reliability and Precision**: The use of advanced sensors and a microcontroller ensures accurate data collection and reliable system performance.
4. **User Convenience**: The integration with a mobile application allows users to monitor and control the system remotely, offering unparalleled convenience.
5. **Cost-Effectiveness**: By preventing water wastage and reducing manual labor, the system proves to be cost-effective in the long run.

The smart water tank system is not just a technological advancement but also a necessity in the current times of resource scarcity. Its implementation can bring significant improvements in water management at both residential and industrial levels, ensuring a sustainable future.

Chapter 2: SOFTWARE REQUIREMENT SPECIFICATION

2. OVERALL DESCRIPTIONS

The primary goal of this project is to create an IoT-based smart water tank system that monitors and displays real-time data using a mobile application. The system automates water level management, detects environmental conditions, and provides visual alerts to ensure water conservation and efficient management.

Before developing this system, a comprehensive analysis of the water tank structure was conducted to understand the placement and functionality of its components. The smart water tank system comprises the following main components:

1. **Water Tank**: The physical reservoir where water is stored.
2. **Sensors**:
    - **Ultrasonic Sensor**: Measures the water level in the tank by detecting the distance to the water surface.
    - **Temperature and Humidity Sensor (DHT11)**: Monitors the environmental conditions surrounding the tank.
3. **LED Indicators**: Provide visual feedback for specific conditions, such as water overflow.
4. **Microcontroller**: Processes data from the sensors and communicates with the mobile application.

The system gathers real-time data from the sensors, which is processed and displayed on the mobile application. For instance, the **humidity sensor** continuously monitors and sends humidity data, while the **ultrasonic sensor** measures the water level in real-time. This data is visualized in the mobile app, where users can monitor the system's performance, detect abnormalities, and control the motor.

The system also judges the stability of each device based on the data collected, ensuring optimal performance.

2.1 MODULES OF THE SYSTEM

The smart water tank system consists of two main modules:

1. Hardware Module:

This module includes all the physical components required to collect data and manage the water level. The key hardware components are:

- **Ultrasonic Sensor**: Detects the water level by measuring the distance to the water surface, ensuring accurate and reliable readings.
- **Temperature and Humidity Sensor (DHT11)**: Measures the surrounding environmental temperature and humidity, providing additional insights.
- **LED Indicators**:
    - A **red LED** is used to indicate water overflow conditions.

- Ensures visual alerts for scenarios where immediate user attention is required.

2. Software Module:

This module consists of the software tools and platforms used to process data and provide an interface for user interaction. The software components include:

- **Android Studio**: Used to develop the mobile application that displays water level and environmental data in a user-friendly format.
- **Arduino IDE**: Provides a platform to write, compile, and upload code to the microcontroller for managing sensors and communication.

2.2 TOOLS AND TECHNOLOGY WITH REASONING

The proposed system utilizes several tools and technologies to ensure efficient performance and real-time monitoring:

2.2.1 Wi-Fi Module:

- The **ESP8266 Wi-Fi module** is used to connect the Arduino microcontroller to the mobile application, enabling seamless communication between the hardware and the user interface.
- The Wi-Fi module ensures real-time transmission of sensor data to the mobile application, allowing users to monitor the water level, temperature, and humidity remotely.

2.2.2 ULTRASONIC SENSOR:

An **ultrasonic sensor** measures distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and detects the wave reflected back from the target. By calculating the time interval between wave emission and reception, the sensor determines the distance to the target.

In the context of the smart water tank system, the ultrasonic sensor is used to measure the water level within the tank. The measurement is converted into a percentage value, allowing users to monitor the water level in real time. Once the distance is calculated, the sensor sends the information to the Arduino microcontroller for further processing. This data is then displayed on the mobile application for user convenience.

Key Features of the Ultrasonic Sensor:

- Accurate distance measurement using ultrasonic waves.
- Operates effectively even in diverse environmental conditions.
- Used for real-time monitoring of water levels to prevent overflows or shortages.

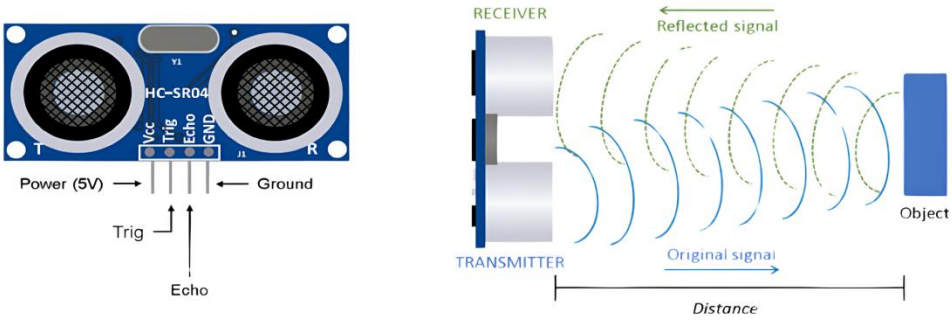


Figure 2.1: Ultrasonic Sensor

2.2.3 TEMPERATURE AND HUMIDITY SENSOR (DHT11):

The **DHT11 sensor** is a basic, low-cost, digital sensor used to measure temperature and humidity. It combines a capacitive humidity sensor and a thermistor to measure environmental parameters such as temperature and humidity. This sensor outputs data as a digital signal, making it easy to integrate with microcontrollers like Arduino.

In this system, the DHT11 sensor is mounted near the water tank to measure environmental conditions around the tank. While it does not directly measure water temperature, it provides valuable information about the surrounding atmosphere, including wind and rain.

Key Features of the DHT11 Sensor:

- **Operating Voltage:** 3V to 5V.
- **Measurement Range:**
    - Temperature: 0°C to 50°C.
    - Humidity: 20% to 90% RH (relative humidity).
- **Accuracy:** ±2°C for temperature and ±5% RH for humidity.
- Outputs data as a digital signal, simplifying integration.
- Compact, cost-effective, and energy-efficient.

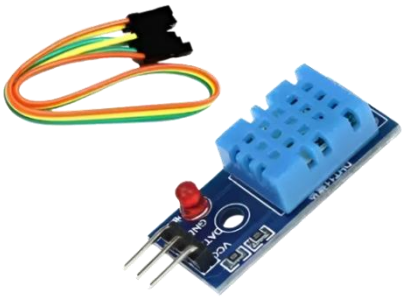


Figure 2.1: Ultrasonic Sensor

2.2.4 ANDROID STUDIO

Android Studio is the official Integrated Development Environment (IDE) for developing mobile applications specifically for the Android platform. It provides a robust and user-friendly interface for designing creative user interfaces (UIs) and includes powerful tools for building, debugging, and testing Android applications.

In this project, Android Studio is utilized to develop a mobile application that acts as the user interface for monitoring the water tank system. The application receives real-time data from sensors via the Arduino microcontroller and presents it in an intuitive format to the user.

Key Features of Android Studio:

- **Powerful Code Editor:** Supports advanced code editing features to simplify application development.
- **Built-in Emulator:** Includes emulators for different Android versions, allowing developers to simulate sensor operations and test applications without needing physical devices.
- **Real-time Updates:** Displays sensor data, such as water levels and environmental humidity, to provide users with actionable insights.

Role in the System:

Android Studio is used to create a mobile application that connects to the system's Wi-Fi module and retrieves data from the sensors. Users can easily monitor water levels, humidity, and other parameters via their smartphones.

2.3 SYSTEM SPECIFICATIONS

System specifications define the requirements and constraints necessary for the successful operation of the water monitoring system. These include both the hardware and software prerequisites for the mobile application.

Mobile Specifications for Application Usage:

- **Android Version:** Compatible with Android versions higher than or equal to KitKat.
- **Memory Requirement:** Minimum of **512 KB RAM** for smooth operation.
- **Network Connectivity:** A stable internet connection is necessary for real-time data updates.

2.3.1 EXISTING SYSTEM

Existing water management systems typically rely on manual or mechanical methods to monitor and manage water levels. While these systems incorporate water pumps, they lack technological integration and real-time monitoring capabilities.

Limitations of Existing Systems:

- Require manual intervention, making them time-consuming and less efficient.
- Cannot provide real-time data about water levels or environmental conditions.
- Lack connectivity with mobile devices, limiting user convenience.

2.3.2 Scope of the System:

Our project aims to revolutionize water management with an innovative and automatic water level monitoring system. By integrating advanced sensors and Arduino technology, the system provides real-time data on water levels, temperature, and humidity directly to mobile devices. This smart, reliable, and cost-effective solution not only ensures efficient resource management but also helps in conserving water and energy. With its user-friendly interface, our system offers a sustainable approach to managing water usage, significantly contributing to addressing the water crisis in Pakistan.

2.4 Summary of Requirements (Initial Requirements):

The proposed system is built with the following initial requirements:

- **Mobile Application**:

  The heart of the system is the mobile application, which allows users to effortlessly track and monitor the data collected by sensors. With a simple touch, users can view real-time task completions by the sensors directly on their phones.

- **Updateable Environment**:

  The Arduino chip continuously updates the information received from the sensors to the mobile application, ensuring the data is always current and accurate. Through regular updates, the system enhances its performance and keeps users informed at all times.

2.5 Identifying External Entities:

The following external entities are vital for the functioning of the project:

- **Water Level**: Displaying the current water level in the tank.
- **Temperature**: Showing the temperature outside the water tank.
- **Rain**: Indicating the presence of rainfall.
- **Humidity**: Providing real-time humidity readings.

a) Over Specify Entities from Abstract:

Based on the abstract, several entities are identified that form the foundation of the problem, enabling us to develop a more detailed and precise solution for effective water management.

b) Perform Refinement:

- **Application User**: The end-user who interacts with the mobile application to monitor and control the water system.
- **Our Team**: The team responsible for designing, developing, and maintaining the system, ensuring smooth operation and continuous improvements.

2.6 Summary of Requirements (Initial Requirements):

The proposed system is designed to fulfill the following essential requirements:

1. **Admin Configuration and User Setup**: The admin plays a crucial role in configuring the system, assigning unique system IDs to users, and managing access. Users will then log in to the mobile application to request data readings.

2. **Automatic Water Level Management**: Once the system is configured, it automatically maintains the water level. If the water drops below a certain threshold, the system will automatically turn on the pump. Similarly, when the water reaches a predefined high level, the pump will be automatically stopped to prevent overflow.

3. **Temperature Monitoring and Protection**: The system checks the temperature outside the water tank using a water flow switch, preventing the pump from running dry. Additionally, the system collects data from various sensors and updates the web server for real-time monitoring.

4. **User Interaction**: After the data is fetched from the server, users can check the water level, humidity, and temperature of the surrounding environment through the mobile application. In cases where the water flow is extremely low, users can manually start the motor to ensure a steady supply of water.

Chapter 3: DESIGN

Chapter 3: DESIGN

Design represents the development phase for any engineering product or system. It is defined as the of applying various techniques and principles for the purpose of defining a process of a system in at detail. Design is the first step in moving from problem domain to the solution domain. The goal of the process is to produce a model or representation of a system, which can be used later to build that system. own as **Abstract Design**. It is a creative process where one tries to establish a system organization that satisfy the functional and non-functional requirements of the system. It represents the structure of data and 1 components. It represents a set of abstraction that enable software engineers to describe architecture in able ways. The product of the architectural design process is an architectural design document which graphic representations of the system along with associated descriptive text.

'architectural Design process is concerned with the establishment of a structural framework. It defines the components of a system and communication between those components.

Introduction:

Phase represents the system working state, sequence of process, structure of model and different process include in system. Following UML Diagram Elaborate how system work and what process it has.

1. Design Class Diagram

2. System Sequence Diagram

3. Block Diagram

4. Data Flow Diagram

5. Use case Diagram

6. Activity Diagram

7. ER Diagram

we discuss these artifacts one by one as follows:

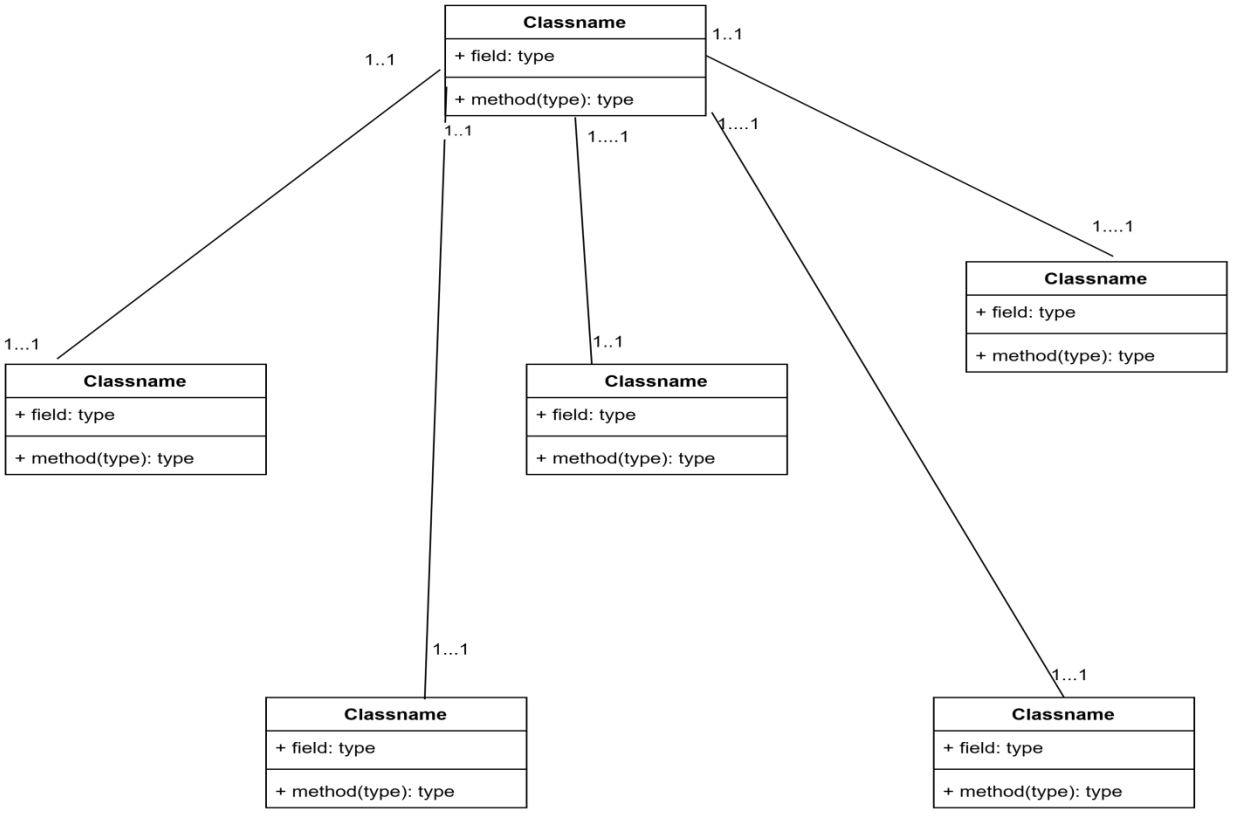
3.1 System Class Diagram:

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application. Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class

diagrams are widely used in the modeling of object-oriented systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages. Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram.

The following points should be remembered while drawing a class diagram:

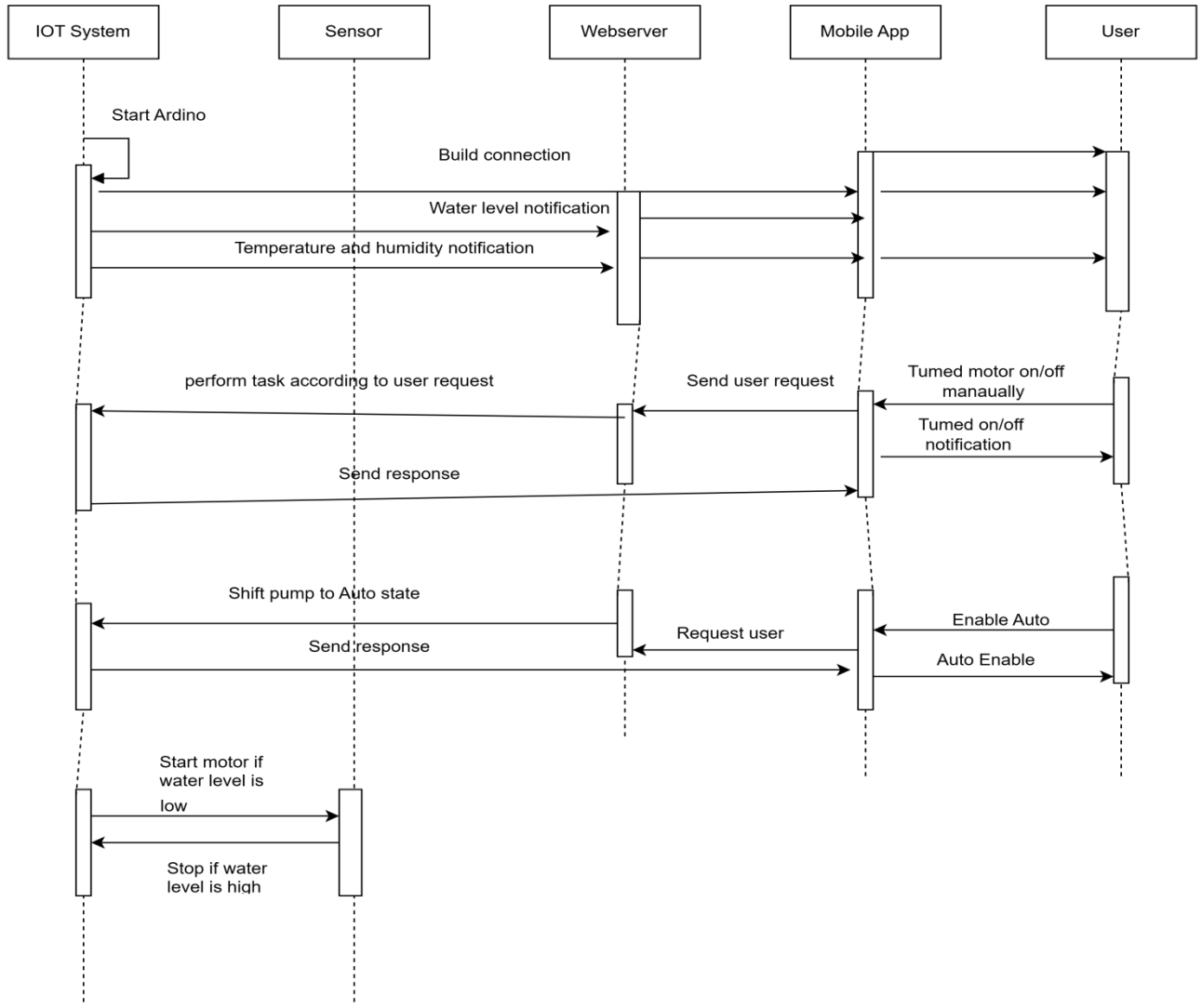
- The name of the class diagram should be meaningful to describe the aspect of the system.
- Each element and their relationships should be identified in advance.
- Responsibility (attributes and methods) of each class should be clearly identified.
- For each class, minimum number of properties should be specified, as unnecessary properties will make the diagram complicated.
- Use notes whenever required to describe some aspect of the diagram. At the end of the drawing it should be understandable to the developer/coder.
- Finally, before making the final version, the diagram should be drawn on plain paper and reworked as many times as possible to make it correct.



3.2 System Sequence Diagram:

A sequence diagram shows the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with the use case realization in the Logical View of the system under development.

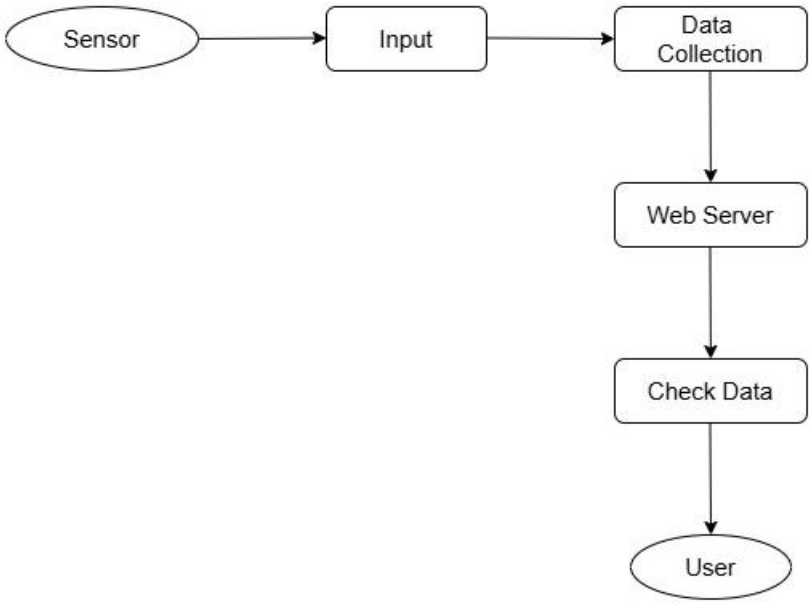
In the sequence diagram, each actor as well as system is represented by a vertical line called the life line an each message by a horizontal arrow from sender to receiver. The parallel vertical lines show different objec that live simultaneously. Time proceeds from top to bottom in this diagram.



3.3 Data Flow Diagram:

DFD is the graphical representation of the flow of data between the various processes in the system. Each actor is involved in triggering various events that lead to the data transmission among various components. A DFD is een used as a preliminary step to create an overview of the system, which can later be elaborated. DFD's ca also be used for the visualization of data processing. A DFD shows what kind of information will be inputt and output from the system, where the data will come from and go to, and where the data will be stored.

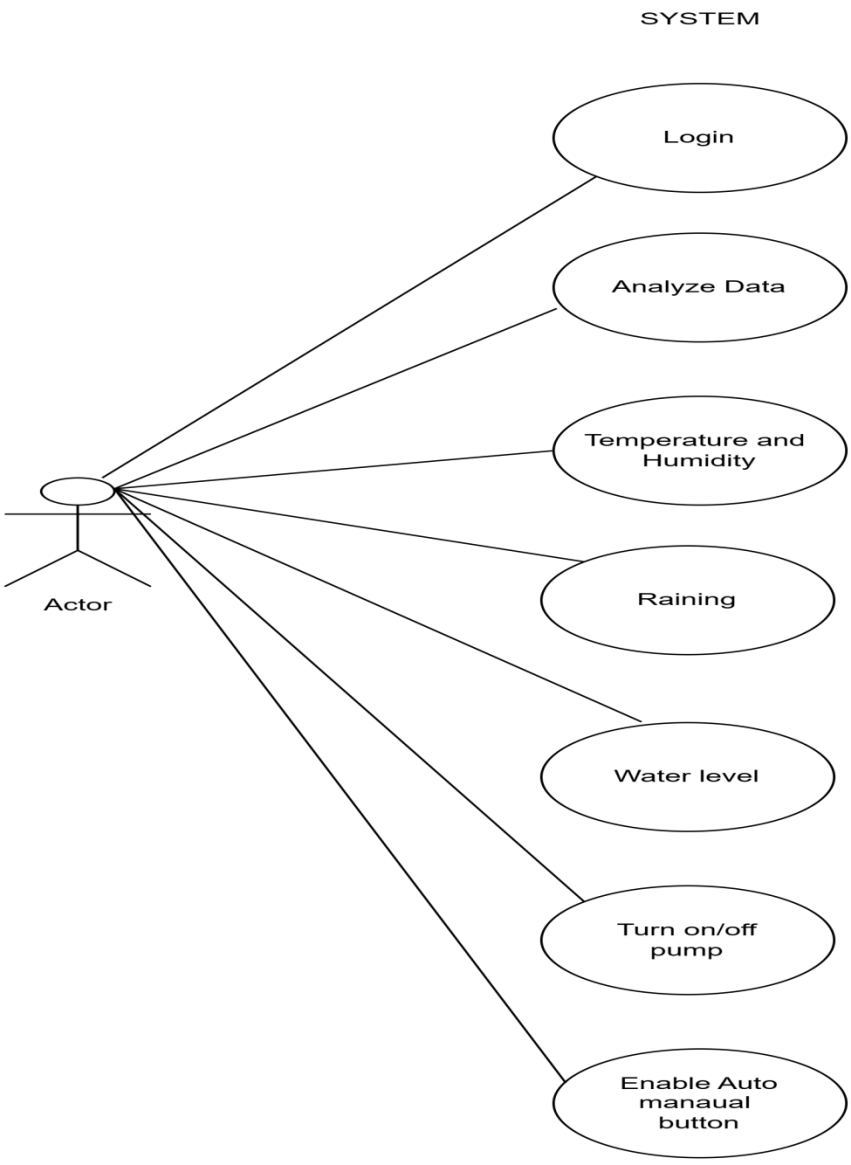
Shape	Purpose
	Used to represent processes in a system
	Used to present " External Entities".It may be a source of data, source of information, sender or maybe it's a receiver.
	Used to represent a flow of data by pointing towards a process or entity.These flow lines maybe incoming or outgoing.



3.4 Use Case Diagram:

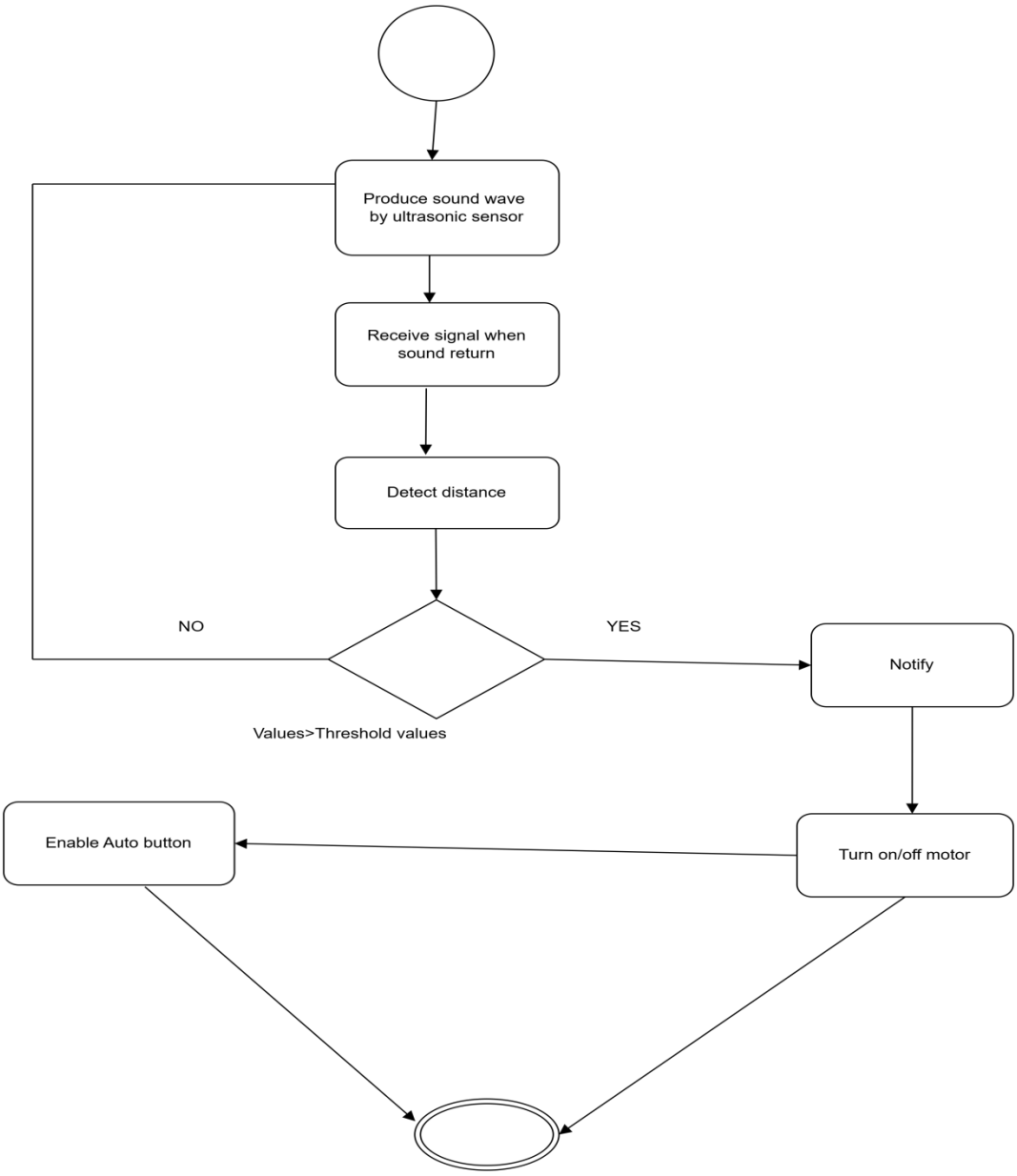
The use case diagram is a graphical notation of the interaction among elements. A use case is a list of actions or steps typically defining the interactions between a role and a system, to achieve a goal. The use case Bagram is used to identify the primary elements and the processes that form the system.The primary elements e called as "actors" and the processes are called as "use cases".The use case diagram consists of ellipses containing name of the use case and a stick figure that depict the actor with his name. All use cases are enclosed within a rectangle.

Actors	The users that interact with the system.An actor can be a person, an organization, or an outside system that interact with your system and application.
System	A specific sequence of actions and interactions between the actors or system.
Goals	The end result of most use cases.



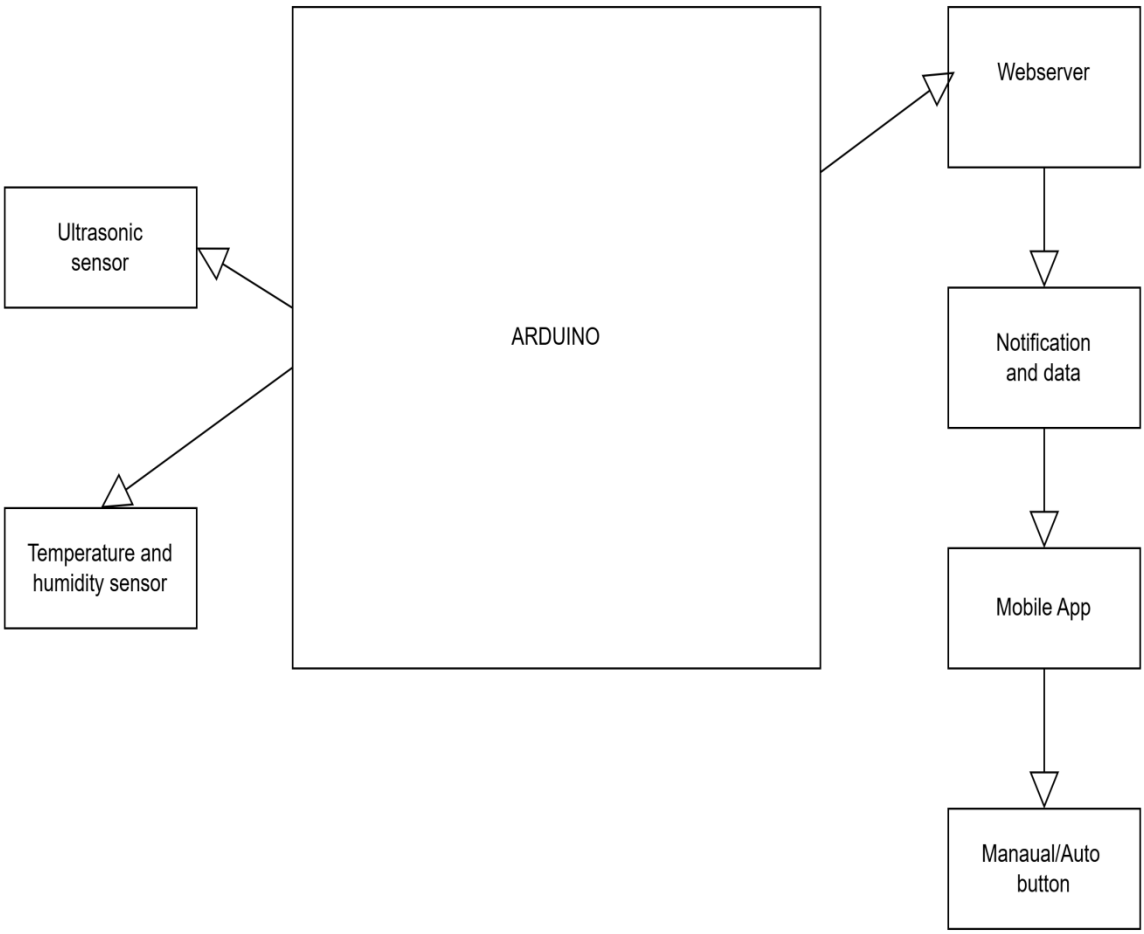
3.5 Activity Diagram:

Activity diagram is another important diagram in UML to describe dynamic aspects of the system. diagram is a flow chart to represent the flow form of one activity to another activity. The activity can be described as an operation of the system. This flow can be sequential, branched or concurrent. Activity diagram As with all types of flow control by using different elements like fork join etc. Activity Diagram also useful mulating a use case by describing what action needs to take place and when they should occur. It describes implicated sequential algorithm and modeling applications with parallel processes.



3.6 BLOCK DIAGRAM:

Block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks.[1] They are heavily used in engineering in hardware design, electronic design, software design, and process flow diagrams.


Webserver
Ultrasonic sensor
ARDUINO
Notification and data
Temperature and humidity sensor
Mobile App
Manaual/Auto button

Chapter 4: USER INTERFACE DSIGN

4. Introduction:

Interface design consists of three main parts. Page elements should be visualized on paper before wing them in the computer. Just as you draw a site map to plan the site, use cartoons and storyboards to blocking out the site's appearance and navigational scheme.

a. Sitemaps
b. Storyboards
c. Navigational maps
d. Traceability Matrix

41 Sitemaps:

A site map's main benefit is to give users an overview of the site's areas in a single glance by dedicating an entire page to a visualization of the information architecture. Here is the site map for our application.

4.2 Storyboard

The project is about to facilitate user and give detail about water level, temperature, humidity weather station flow rate and pump status. Firstly, user login or sign in then user can go for check sensor's reading on application user can also set buzzer alarm according to the water level.

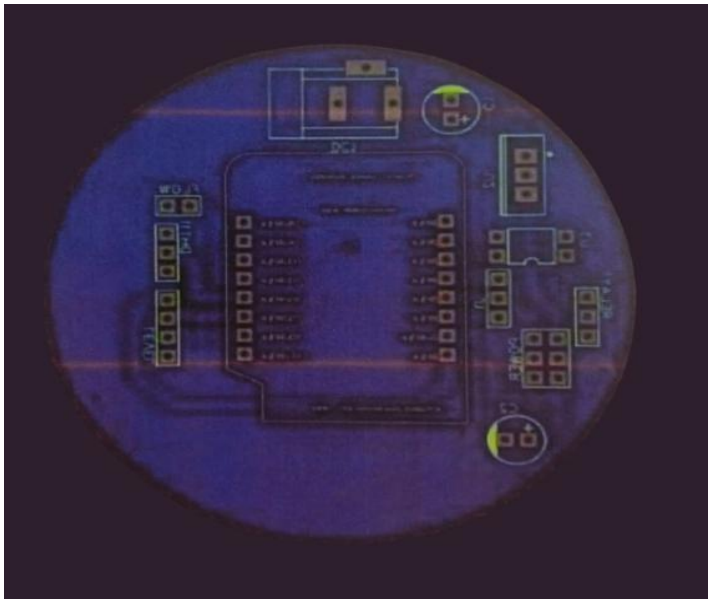


Figure 4.1 View

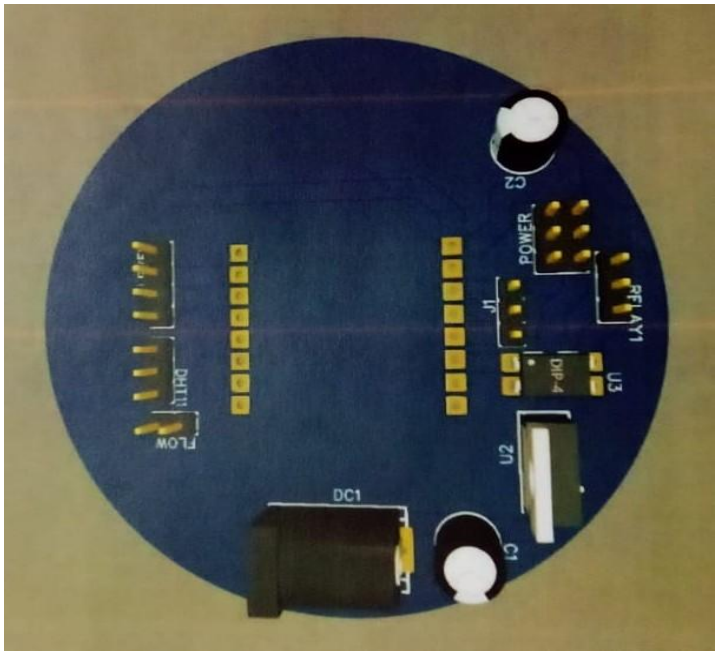


Figure 4.2 3D View

4.2.1 Home Screen

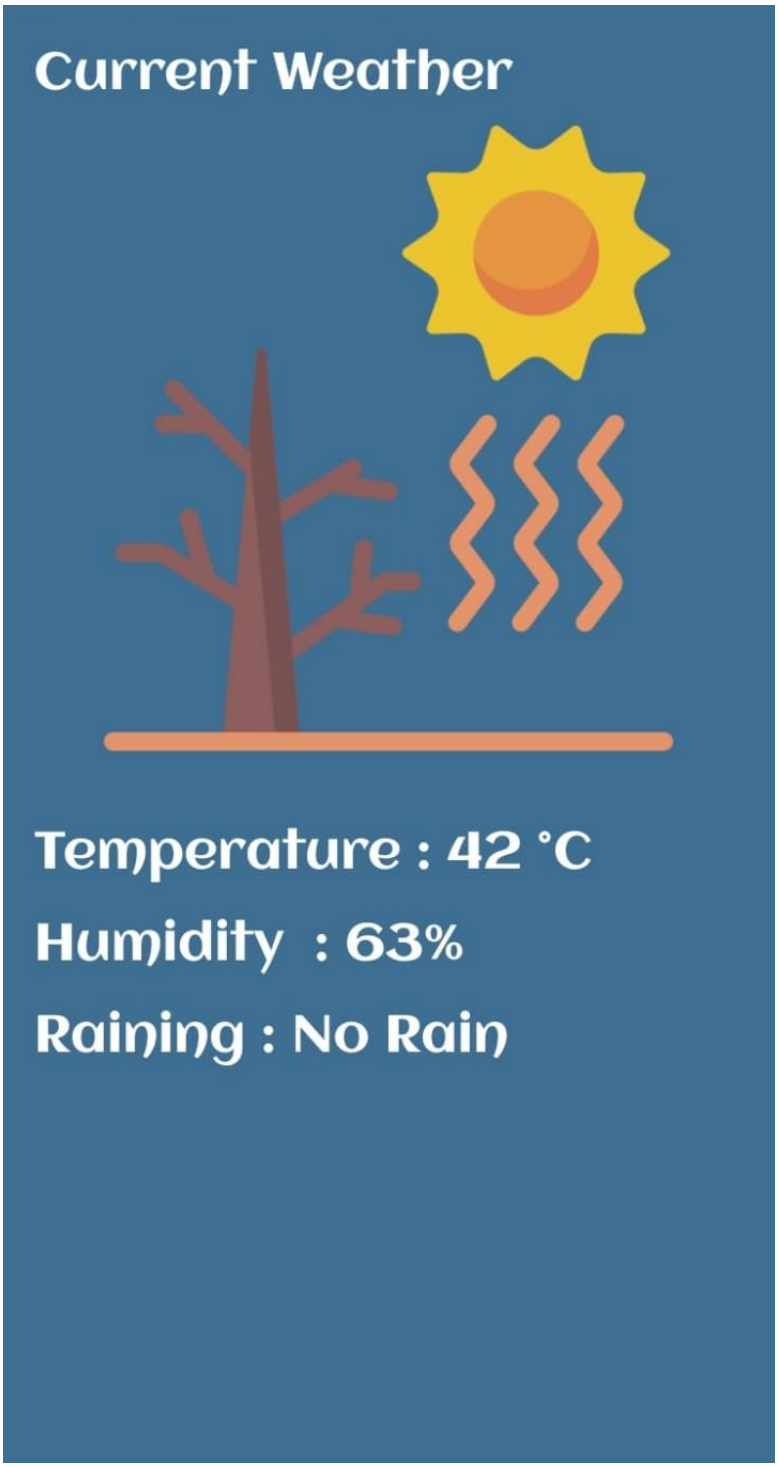
Figure 4.3 Home Screen

4.2.2 Water Level Monitoring:

4.2.3 Manual Start:

Figure 4.4 Water Level Monitoring Manual Start

4.2.3 Real Time Weather:



Real Time Weather

4.2.4 Settings:

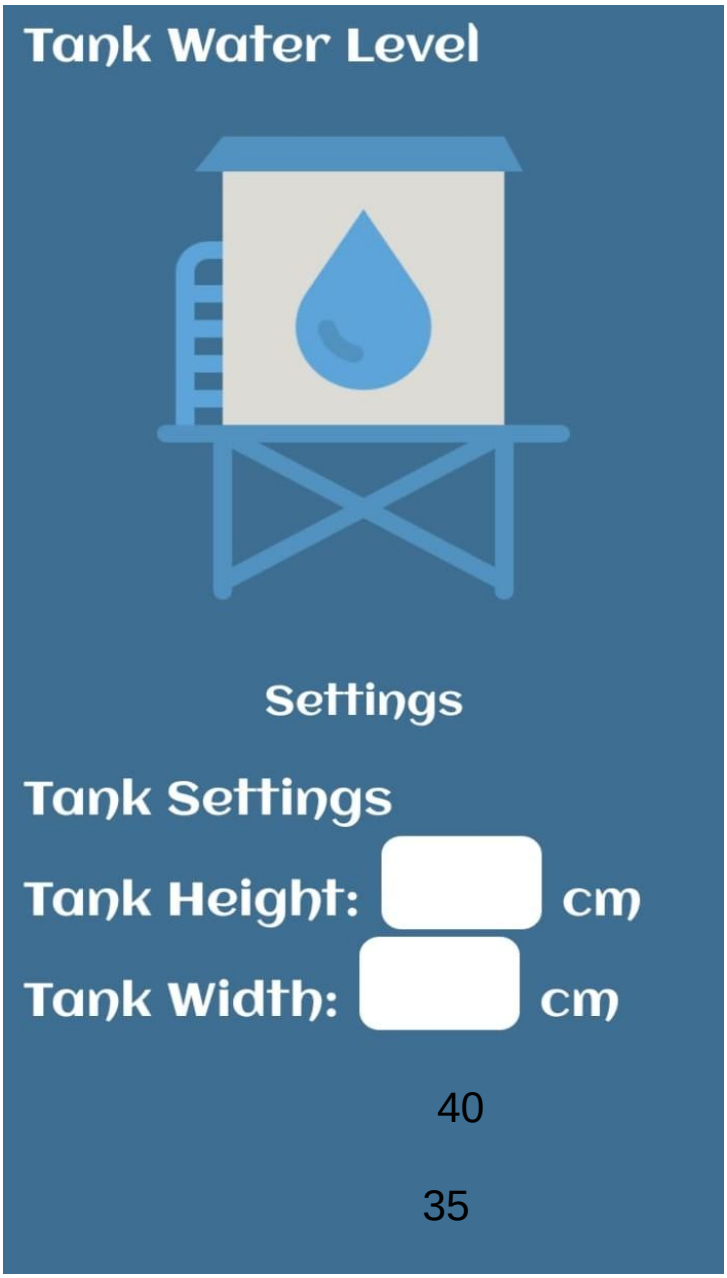
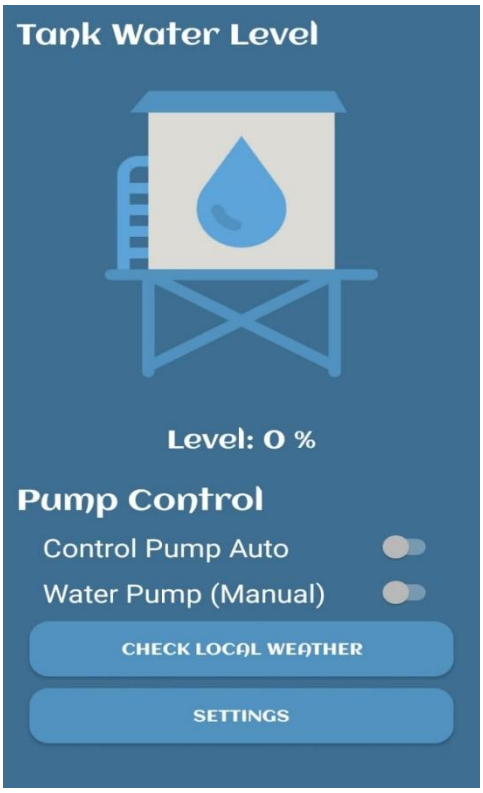


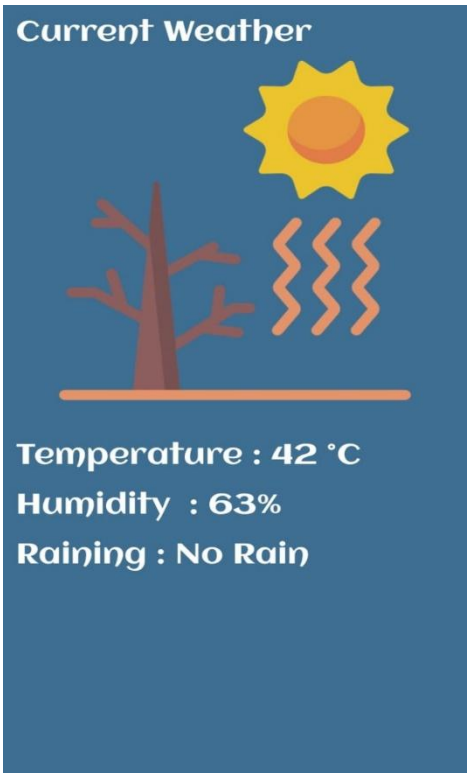
Figure 4.5

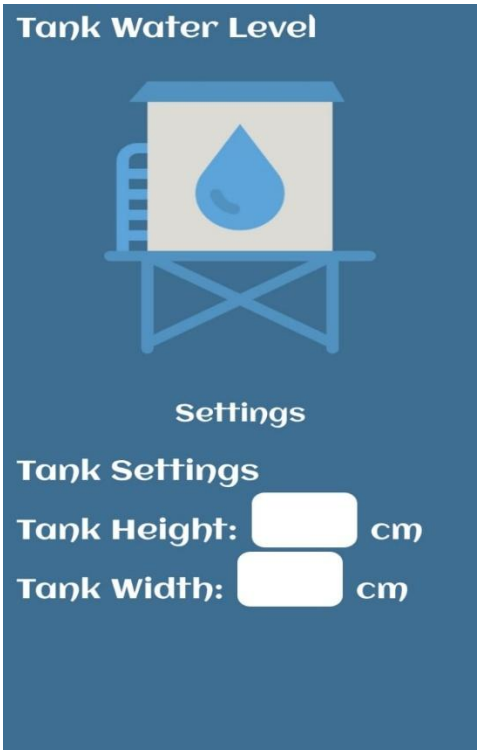
Figure 4.6 Settings



4.3 Navigational Maps:

The next step is of navigational maps. In these maps, the storyboards are used as an input. The different display buttons or action buttons show the navigation from one screen to the other. In other words when one action button is pressed it would lead to other screens. This path and navigation would be shown





40

35

Figure 4.6 Navigating Map