PROJECT DOCUMENTATION

Submitted To

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5th Semester Project

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Project Title:

Embedded IoT-based smart water tank level monitoring and automatic pump control system.

Group Members:

- Adeen Asif (23-NTU-CS-**1007)**
- Meerab Zahra (23-NTU-CS-**1049**)

Problem Statement:

In many households and residential areas, there is inadequate or manual water level monitoring which leads to significant problems like water management issues (water shortage or wastage caused by overflows), energy waste due to unnecessary operating of pump and lack of real-time water level information.

Therefore, there is a need for an automated, embedded IoT-based system that provides real-time water level tracking, cloud access and automatic pump control to ensure efficient water management.

Objectives:

Following are the objectives of the project:

- **Real-time Water Level Monitoring:**
  Accurately measure the water tank level using ultrasonic sensor.
- **Automatic Pump Control:**
  Automated control of pump using relay module for efficient water management.
- **Cloud-based Monitoring (Blynk):**
  Provide access to real-time data for effective management.
- **Water Level Display:**
  Display water level locally using OLED display and LEDs.
- **Alert System:**
  Buzzer alerts for critical water level.
- **Resource Optimization:**
  Reduce water and energy wastage.

Tools and Technologies:

Hardware Components:

- **ESP32 (NodeMCU):** For processing data and connectivity.
- **Ultrasonic Sensor (HC-SR04):** To accurately detect the level of water.
- **5V Relay Module:** For automated pump control.
- **Jumper Wires:** For circuit connections.
- **Breadboard:** For circuit prototyping.
- **LEDs:** To indicate different water levels (low, medium or high).
- **Buzzer:** For audio alert.
- **USB Power Source:** Powers ESP32 and other components.
- **OLED Display:** To display water level.
- **Demo Load:** Simulates water pump.

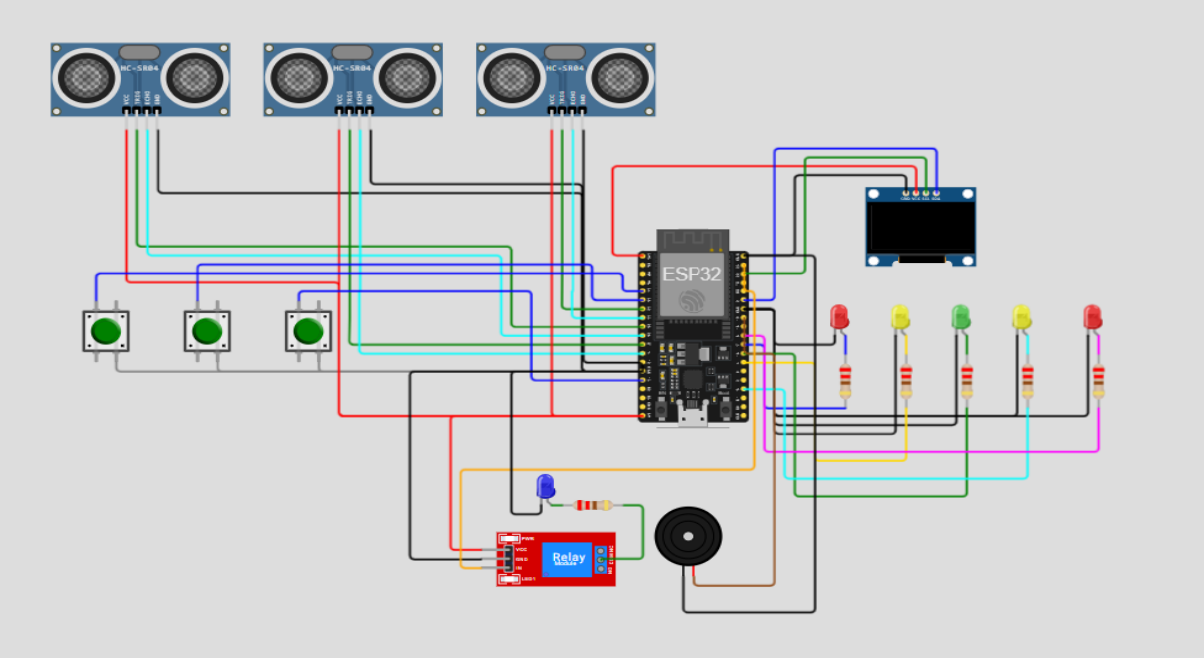
Software Components:

- **PlatformIO / VS Code:** For programming ESP32.
- **ESP32 Libraries**
- **Blynk:** For cloud monitoring and real-time water level monitoring.
- **NODE-Red MQTT**

System Architecture:

The system measures the water level of the tank using ultrasonic sensor, the ESP32 uses this real-time data and control relay module to automatically turn pump ON or OFF. LEDs and OLED display shows water level. Buzzer activates when water level is critical. ESP32 can send data to Blynk for remote monitoring and Node-Red MQTT for central monitoring.

Circuit Diagram:



Hardware Description:

The hardware of the system consists of ESP32 microcontroller, which receives and processes the reading from ultrasonic sensor (HC-SR04) to measure the water level correctly. Based on these readings the 5V relay module controls the automation of the pump. Buzzer and LEDs are used to provide visual and audio alerts. However, OLED displays the current water level. All the components are connected using jumper wires on the breadboard. A demo motor is used to stimulate the operation of pump during testing.

Software Description:

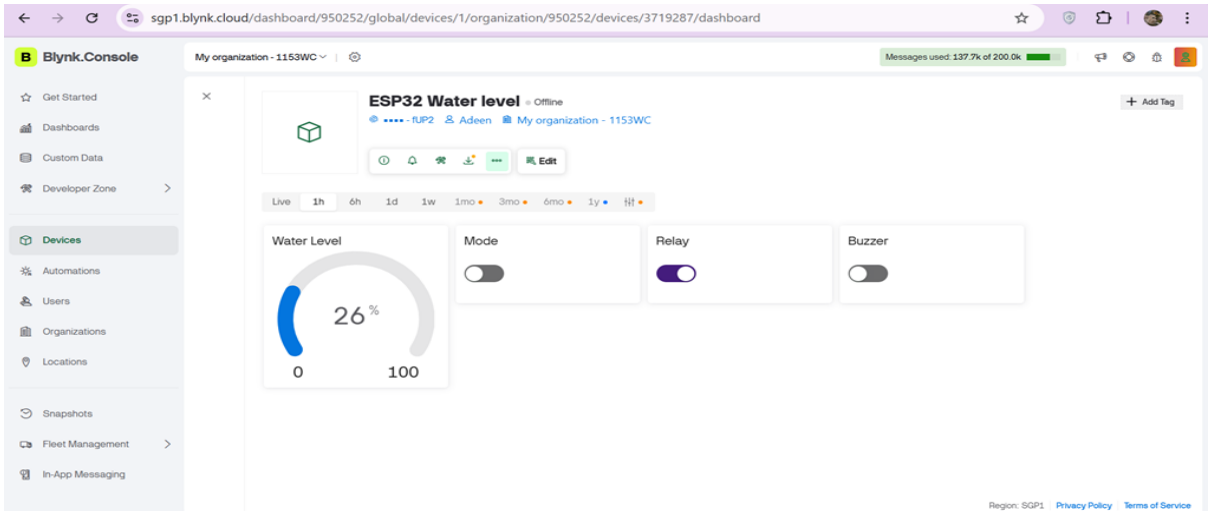
The software is developed using the VS Code, PlatformIO extension using the ESP32 libraries that are essential for sensor working, Wi-Fi connectivity, OLED display and Blynk communication. The program takes the reading from ultrasonic sensor and implements the water level logic accordingly; it also controls the relay for the automation of pump and manages the alerts. Lynk integration enables the cloud-based monitoring, ensuring the real-time visibility of the water level and receiving updates.

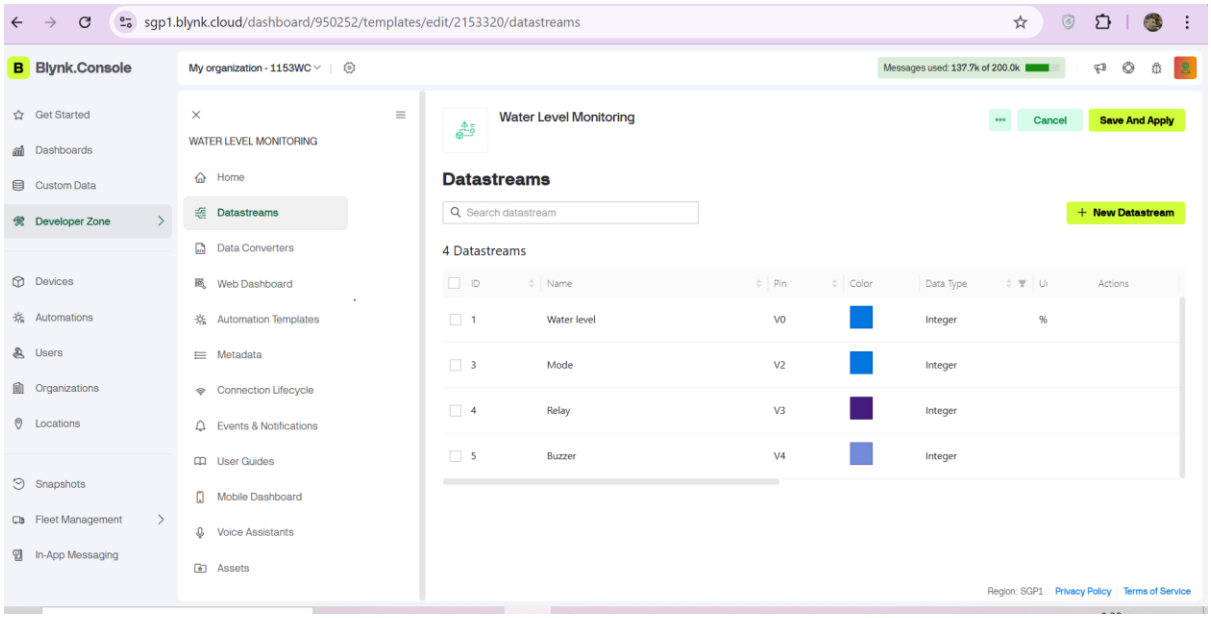
Methodology:

The system uses ESP32 microcontroller, which initializes all the integrated components (sensors, OLED display, Wi-Fi and Blynk). The microcontroller continuously reads the distance values from sensors to determine the level of water and converts them into water-level percentage. Based on the reading, the ESP32 executes the pump-control logic either of automatic or manual mode selected by the user. In automatic mode, pump turns automatically ON when water level falls below 10% and turns OFF when water level reaches 90%. However, in manual mode, ON and OFF is controlled by the user. The data is then processed and displayed on OLED and sent to Blynk. LEDs, Buzzer and Blynk notifications are triggered by the water level accordingly.

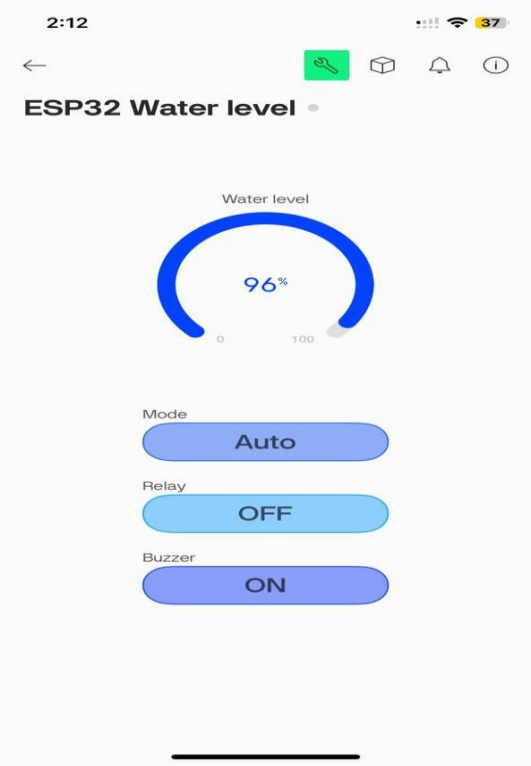
Screenshots:

Blynk Web Dashboard:

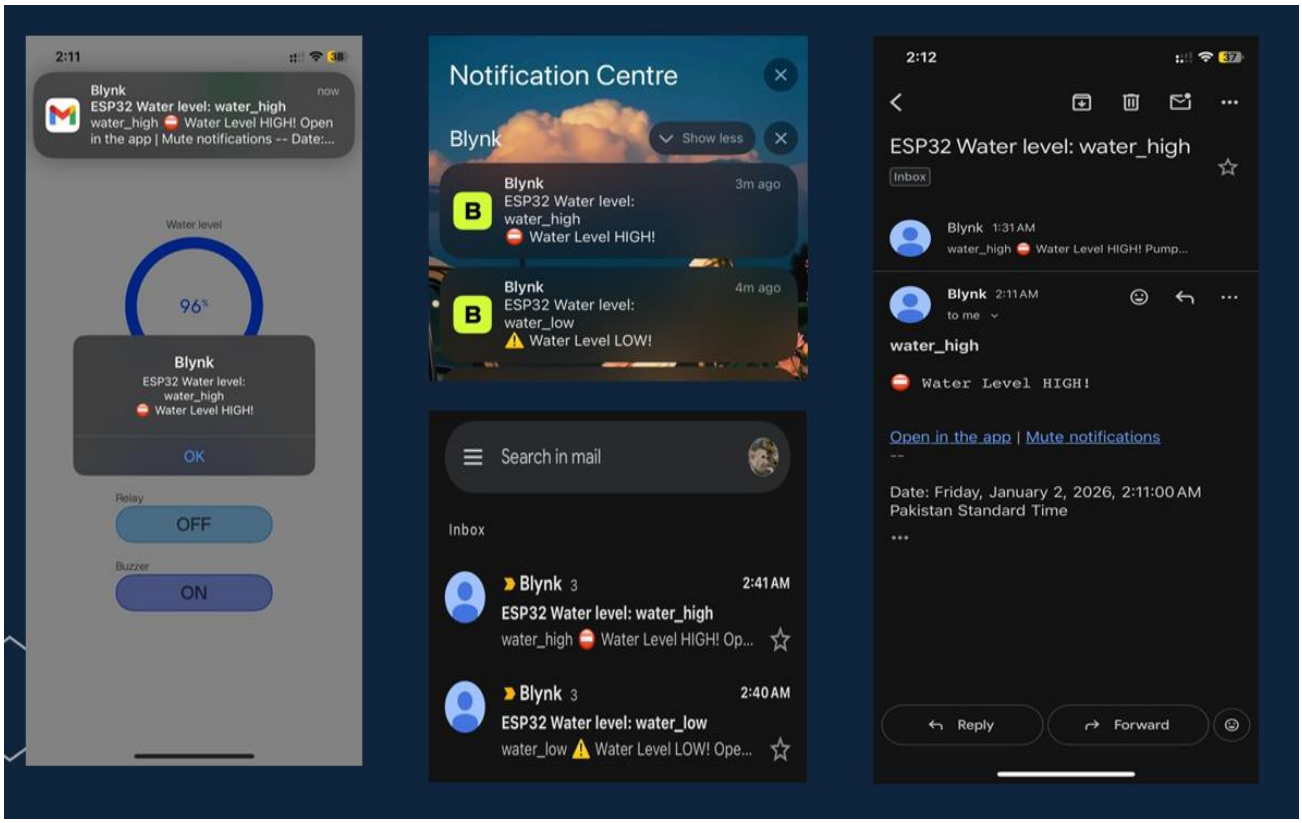




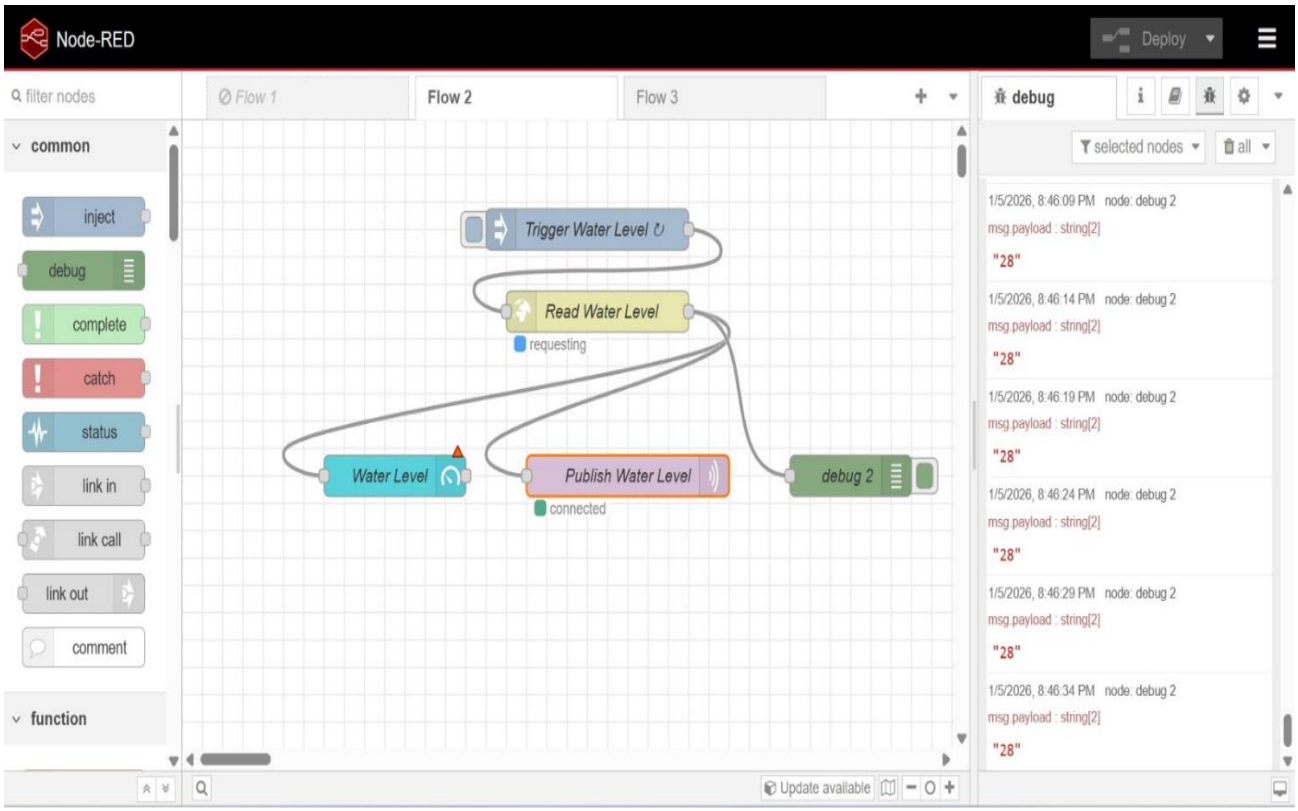
Blynk Mobile Dashboard:

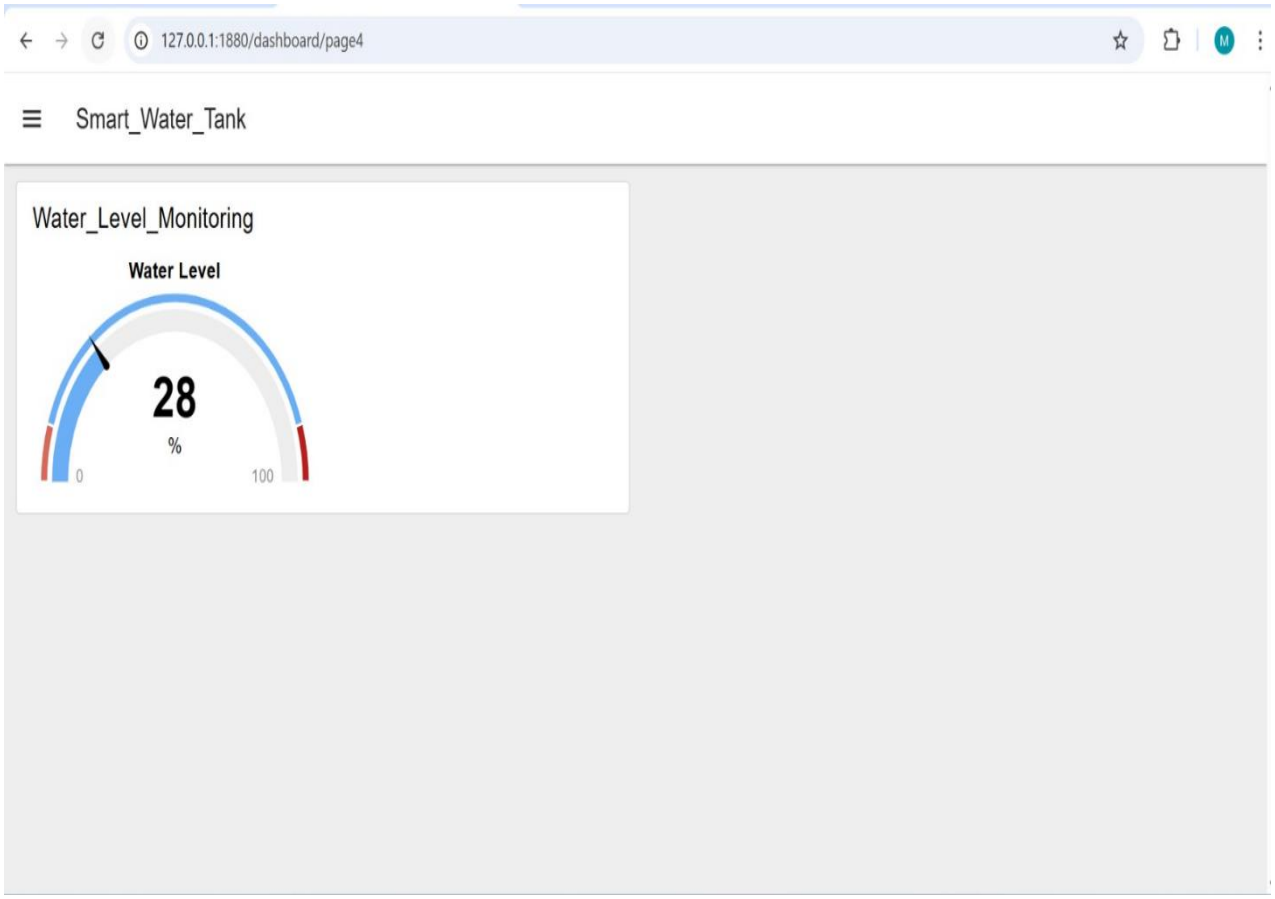


Blynk Notifications:



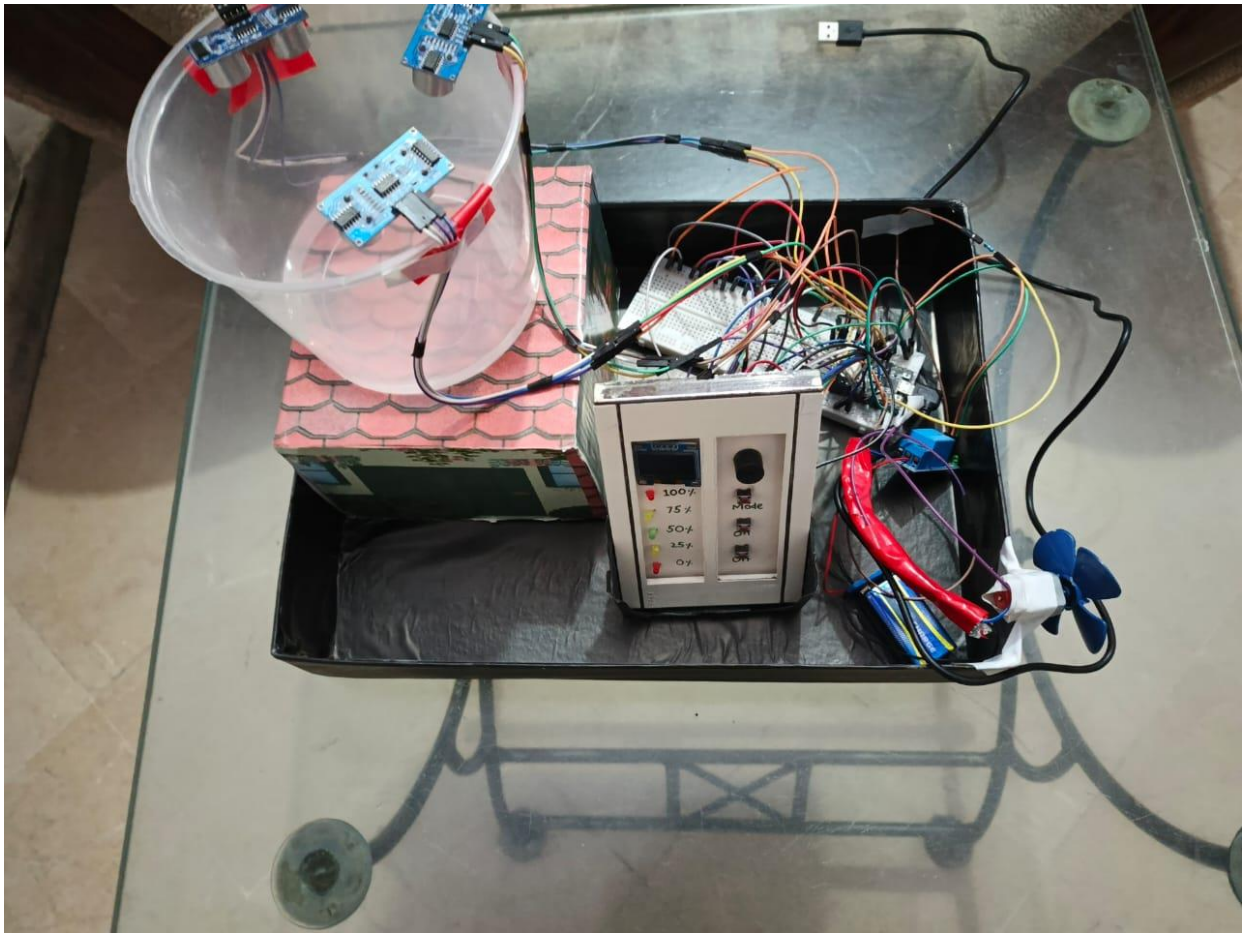
Node-Red MQTT:




127.0.0.1:1880/dashboard/page4
Smart_Water_Tank
Water_Level_Monitoring
Water Level
28
%
0
100

Hardware:


100%
75%
50%
25%
0%
Mode
On
Off



Result:

The system accurately measured the water level using the ultrasonic sensors and displayed the readings on OLED, while real-time data is also updated on the Blynk dashboard. The pump can be operated in both automatic and manual mode, depending upon the mode selected by the user either through Blynk or hardware buttons. Visual and audio alerts (LEDs and Buzzer), and Blynk notifications worked correctly, responding the level of water. And central is implemented using Node-Red MQTT.

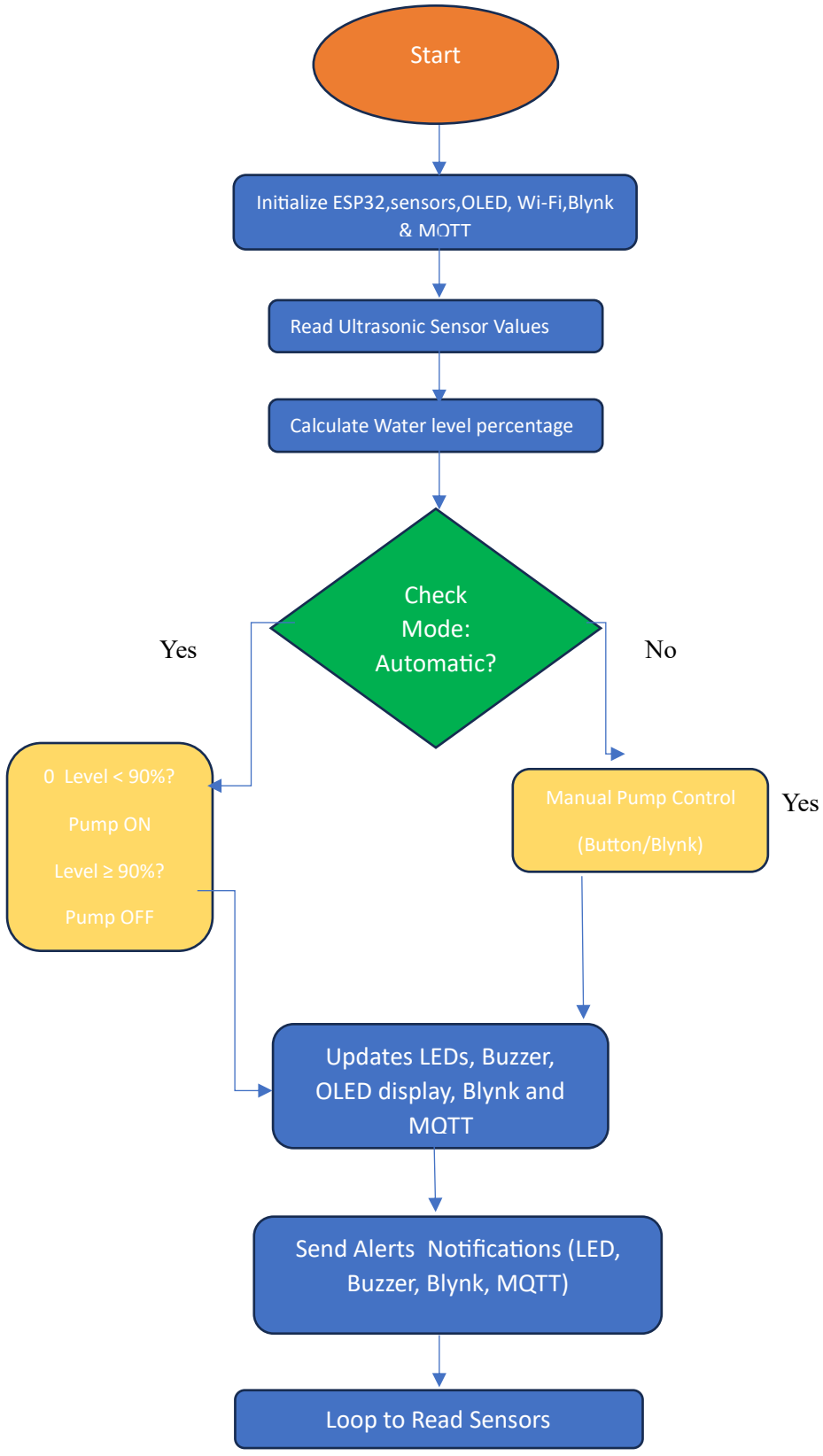
Conclusion:

The project efficiently automates the water tank management, preventing the overflow and dry-run, and enabling the real-time monitoring by integrating the IoT.

Future Scope:

In the future, the system can be enhanced for multi-tank monitoring, integrate with home automation, and use data analytics for better water management.

Flowchart:


Start
Initialize ESP32,sensors,OLED, Wi-Fi,Blynk & MQTT
Read Ultrasonic Sensor Values
Calculate Water level percentage
Check Mode: Automatic?
Yes
No
0 Level < 90%?
Pump ON
Level ≥ 90%?
Pump OFF
Manual Pump Control
(Button/Blynk)
Yes
Updates LEDs, Buzzer, OLED display, Blynk and MQTT
Send Alerts Notifications (LED, Buzzer, Blynk, MQTT)
Loop to Read Sensors