VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI-590018, KARNATAKA

8th Semester Main Project (21EIP76)
on

"IoT Based Multiple Tank Level Measurement Using Load Cell"

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CERTIFICATE

This is to Certify that the Project Work entitled **''IoT Based Multiple Tank Level Measurement Using Load Cell''** is carried out by **Mr. MITHUN C M (4UB21EI030), Mr. NAGESH K (4UB21EI031), Mr. NANJANAGOWDRA M ARUNGOWDA (4UB21EI032) and Ms. NAYANA M G(4UB21EI033)**, bonafide students of **University B.D.T. College of Engineering, Davangere**, in partial fulfilment for the award of Bachelor of Engineering in **Electronics and Instrumentation Engineering** of the Visvesvaraya Technological University, Belagavi, during the academic year 2024-25. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report. The report of the Project has been approved as it satisfies the academic requirements in respect of Main Project Work prescribed for the 4th Year Bachelor of Engineering degree.

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1.

2.

ACKNOWLEDGEMENT

The completion of Project Report brings it with a sense of satisfaction, but it is never complete without thanking those people who made it possible and whose constant support has crowned our efforts with success.

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1. ABSTRACT

This project proposes the design and implementation of an IoT-based multiple tank level measurement system using load cells. The system aims to provide real-time monitoring of liquid levels in multiple tanks, enabling efficient management of storage and distribution of liquids in various industries such as water treatment, chemical processing, and oil and gas. The system utilizes load cells to measure the weight of the liquid in each tank, which is then converted to a level measurement. The data is transmitted wirelessly to a central server using IoT protocols, where it can be accessed and analyzed in real-time. The system also includes features such as data logging, alert notifications, and customizable dashboards for easy monitoring and control.

The use of load cells provides a high degree of accuracy and reliability, while the IoT platform enables remote monitoring and control, reducing the need for manual inspections and improving overall efficiency. The system can be easily scaled up or down depending on the specific requirements of the application, making it a versatile solution for various industries. The proposed system has the potential to improve the efficiency, accuracy, and reliability of liquid level measurement in multiple tank applications, enabling better decision-making and resource allocation.

Overall, the proposed IoT-based multiple tank level measurement system using load cells has the potential to improve the efficiency, accuracy, and reliability of liquid level measurement in multiple tank applications, enabling better decision-making and resource allocation. The system's scalability, flexibility, and remote monitoring capabilities make it an attractive solution for various industries, including water treatment, chemical processing, and oil and gas.

2. INTRODUCTION

The Internet of Things (IoT) has revolutionized various industries by providing real-time monitoring and control of physical devices, enabling efficient management of resources and improving overall productivity. One such application of IoT is in the field of tank level measurement, where accurate and reliable measurement of liquid levels is crucial for efficient management of storage and distribution of liquids. Traditional tank level measurement methods, such as float switches and ultrasonic sensors, have limitations in terms of accuracy, reliability, and maintenance. Load cells, on the other hand, offer a high degree of accuracy and reliability in measuring liquid levels, making them an attractive solution for tank level measurement applications [1].

The use of load cells in tank level measurement applications provides several advantages, including high accuracy, reliability, and durability. Load cells measure the weight of the liquid in the tank, which is then converted to a level measurement, providing an accurate and reliable indication of the liquid level. Additionally, load cells are less susceptible to environmental factors such as temperature and humidity, which can affect the accuracy of other level measurement methods[1].

The integration of IoT technology with load cell-based tank level measurement systems can provide real-time monitoring and control of liquid levels, enabling efficient management of storage and distribution of liquids. IoT-based systems can transmit data wirelessly to a central server or cloud platform, where it can be accessed and analyzed in real-time. This enables users to monitor liquid levels remotely, receive alerts and notifications in case of changes in liquid levels, and make informed decisions about liquid storage and distribution.

1.1. Load Cells:

Load cells can be used to measure the level of multiple tanks by indirectly measuring the weight of the contents. By placing load cells under each tank, the total weight of the tank and its contents can be determined, and this weight can be converted to a level reading using known tank dimensions and material densities.

Load cells are transducers that convert a mechanical force (weight) into an electrical signal. When a load cell is placed under a tank, the weight of the tank and its contents presses down on the load cell. The electrical signal from the load cell is then processed to determine the weight of the contents. This weight can be converted to a level reading by using the tank's known dimensions and the density of the material being stored. By using multiple load cells, each placed under a different tank, you can simultaneously measure the level of several tanks.

This method offers high accuracy and reliability, particularly for applications requiring precise measurement of liquids or solids. It is also less susceptible to contamination as the load cells are typically placed outside the tank. Compared to other level measurement techniques that may require multiple sensors inside each tank, load cells offer a cost-effective solution, especially when measuring the status (empty or full) of multiple tanks[2].

3. LITERATURE SURVEY

1. **Consideration in the design and manufacturing of load cell for measuring dynamic compressive loads.**

Author: Ahmad Qandil1, Adnan I. O. Zaid

This paper discusses the design considerations for a load cell to measure dynamic loads, which are loads applied suddenly or rapidly. Unlike quasi-static loads, dynamic loads generate stress waves that travel through the metallic parts of the load cell. The speed of these waves depends on the material properties, such as modulus of elasticity and density. To design a load cell for measuring dynamic loads, three main components must be considered: the metallic part, the strain sensing element, and the measuring device.[1]

The metallic part must be designed to transmit stress waves efficiently, while the strain sensing element must be able to measure dynamic strains accurately. The adhesive used to bond the sensing element to the metallic part must also be carefully selected. The measuring device must be capable of measuring the output of the sensing element quickly and accurately. [1].

2. Developing of High Accuracy and Low-Capacity Strain Gage Based Load Cell for Electronic Scale

Author: Guirong Lu

This paper presents a strain gage-based load cell designed with finite element analysis (FEA) and advanced stabilizing technologies. The load cell incorporates temperature impact compensation, static overload protection, and computer pattern recognition (CPR) technology for dynamic simulation and analysis. Additionally, the multivibration stress release method is employed to enhance performance. The result is a load cell with high accuracy and stability, capable of measuring loads up to 30g. This enables the development of high-precision electronic balances with divisions of 300,000 and a resolution of less than 0.2mg[2].

3. A Continuous Water-Level Sensor Based on Load Cell and Floating Pipe

Author: Sheng-Wei Wang

This paper presents a simple and cost-effective water level measurement system using a load cell and floating body. The system provides high resolution (1-mm level) and stability, making it suitable for flood warning applications. When the water level exceeds a threshold, remote users receive a warning notification. The design aims to provide early warning messages to people before flooding, giving them more time to evacuate. The proposed system is an improvement over existing techniques, such as ultrasonic and radar gauges, and has the potential to be used in various fields, including flood monitoring and management. It's a low-cost solution.[3]

4. Analysis of the Density and Temperature Invariant Displacer-Type Liquid Level Measuring Method

Author: Elyson Carvalho

This paper analyzes a displacer-type liquid level measuring method proposed by Souza, Carvalho, and Canuto. The original simulation results showed high linearity and insensitivity to fluid temperature and density. However, this study investigates the effects of rod buoyancy and the presence of a second phase in the liquid tank. Simulation results reveal that rod buoyancy introduces non-linearity and the second phase adds a small measurement error. A sensor prototype was developed and tested, showing promising results. The study confirms the effectiveness of the method, but highlights the importance of considering rod buoyancy and second-phase effects in practical implementations.[4]

5. Design and Implementation of Load Cell Based Fuel Level Measurement

Author: R. Monisha

This project aims to accurately measure fuel levels in vehicles using a load cell-based system. The system measures fuel levels in real-time and displays the value on a dashboard unit. It also calculates mileage and estimates the remaining distance the vehicle can travel. The system includes a speedometer and GSM module to send fuel consumption data to the owner's mobile phone via SMS. This helps prevent fuel theft and allows owners to monitor fuel usage. The system provides an accurate and transparent way to measure fuel levels, helping to prevent cheating by drivers and promoting more efficient fuel consumption.[5]

6. Design and implementation of load cell-based fuel level measurement

Author: S. Mohanasundaram

A load cell-based fuel measurement system accurately measures fuel levels in vehicles. The system uses a load cell under the fuel tank, a processor, and a dashboard display. It continuously monitors fuel levels, calculates mileage, and estimates remaining distance. The system includes a speedometer and GSM module to send fuel consumption data to the owner's mobile phone via SMS. This prevents fuel theft and allows owners to monitor fuel usage. The system provides an accurate and transparent way to measure fuel levels, helping to prevent cheating by drivers and promoting more efficient fuel consumption. It helps users track fuel usage. [6]

7. IoT-Based Solutions to Monitor Water Level, Leakage, and Motor Control for Smart Water Tanks

Author: Rashad Ahmed

This study reviews IoT-controlled water storage tanks (IoT-WST) to address global water scarcity issues. With many people lacking access to freshwater, IoT technology can efficiently monitor water levels, detect leaks, and auto-refill tanks. The technology provides real-time feedback to users and experts via webpages or smartphones. While existing reviews focus on smart water monitoring, none specifically address IoT-based solutions for individual water consumers. This study fills this gap by surveying current IoT-WST work, elaborating on techniques and technologies, and discussing hardware and secure IoT cloud server selection. The review aims to provide insights into efficient water management solutions. [7]

8. IoT Based Water Tank Level Control System Using Load cell

Author: Methaq A. Ali

This paper presents an Industrial Internet of Things (IIoT) prototype system for artificial control and monitoring. The system utilizes IoT technology to enhance performance and responds to physical variables in real-time. Two control systems are implemented: classical PID and fuzzy logic, with a comparison between them. Fuzzy control is simulated using MATLAB and developed using the Sugeno method in a Programmable Logic Controller (PLC). The system connects to sensors and an OPC server via Modbus protocol and uploads data to the cloud using MQTT. Wireless communication is enabled by ESP8266, allowing remote monitoring and control of industrial processes.[8]

9. Smart two-tank water quality and level detection system via IoT

Author: Christopher N. Asiegbu

This study developed an integrated Android mobile app and control system to manage a two-tank water system. The system assesses water quality and performs level checks in the overhead tank, activating intelligent pumping control. Water quality is evaluated using turbidity and pH signals, while an ultrasonic pulse-echo technique checks water levels. The system has three-level control conditions and two water quality check conditions, regulating flushable poor water quality and good water quality supply. The system showed an absolute relative error of less than 10% when the water volume is below 81%. The average response time is 3 seconds, but internet signal strength affects real-time monitoring and automation. [9]

10. Design of a compliant load cell with adjustable stiffness

Author: Michal Smreczak

This article presents a novel compliant load cell design with adjustable stiffness, allowing for adaptable force sensitivity. The system uses a preloaded spring to store potential energy, compensating for deflection effort. Unlike fragile MEMS, this mechanism can be fabricated at the centimeter-scale, making it more robust and versatile. The design enables a single force sensing device to be used across various applications, including biotechnology and semiconductor nanoprobing. Analytical modeling, finite element method, and experiments validate the stiffness adjustment mechanism, demonstrating a 200-fold stiffness reduction and achieving a force sensing resolution of 0.41 μN.[10]

2.1 Important Findings from Literature

1. Load cells provide accurate, real-time measurements of water level by sensing the weight of the tank.
2. IoT (via ESP32) enables remote monitoring of multiple tanks' water levels and quality through mobile or web interfaces.
3. Water purity (e.g., via TDS or turbidity sensors) can be checked alongside level monitoring, ensuring safe usage.
4. By integrating motorized valves or pumps with the system, automatic equalization of water levels across multiple tanks can be achieved.
5. Alerts can be triggered when tank levels are unbalanced, low, or if impurities are detected.
6. The system reduces manual labour, prevents overflow/wastage, and ensures optimal distribution and usage of water resources.

4. PROBLEM IDENTIFICATION

The IoT-based multiple tank level measurement project using load cells faces several challenges. Technical issues include ensuring accuracy, calibrating the system, integrating sensors, and minimizing interference. Practical concerns involve accommodating varying tank sizes, ensuring easy installation and maintenance, and designing a user-friendly interface.

Operational problems include monitoring tank levels, managing inventory, optimizing supply chains, and ensuring regulatory compliance and cybersecurity. The system must also be scalable and flexible to accommodate future expansions. Addressing these challenges is crucial to develop a reliable and efficient IoT-based tank level measurement system. A comprehensive approach is necessary to overcome these hurdles.

5. MOTIVATION

The motivation for this project is to develop an efficient and accurate IoT-based system for monitoring multiple tank levels using load cells. Key benefits include:

1.Improved Efficiency

- Real-time monitoring and alerts
- Reduced waste and energy consumption

2.Enhanced Safety

- Prevention of accidents and overflows
- Improved maintenance and lifespan of tanks

3.Data-Driven Decision-Making

- Insights and analytics for optimization
- Predictive maintenance and reduced downtime

4.Scalability and Adaptability

- Applicable to various industries and settings
- Driving growth and innovation in industrial automation.

6. OBJECTIVES OF THE PROJECT WORK

- To develop an IoT-based system for real-time measurement of water levels in multiple tanks using load cells.
- To integrate purity checking sensors (e.g., TDS or turbidity sensors) for monitoring water quality in each tank.
- To maintain equal water levels across all tanks by controlling valves or pumps based on load cell data.
- To send live updates to a cloud-based dashboard using ESP32 for remote monitoring and control.
- To generate alerts and reports for maintenance, low water levels, or water contamination.
- To create a scalable, low-cost solution suitable for residential apartments, industrial storage, or agricultural water management.

7. MATERIALS AND METHODOLOGY

7.1 Block Diagram of the Project

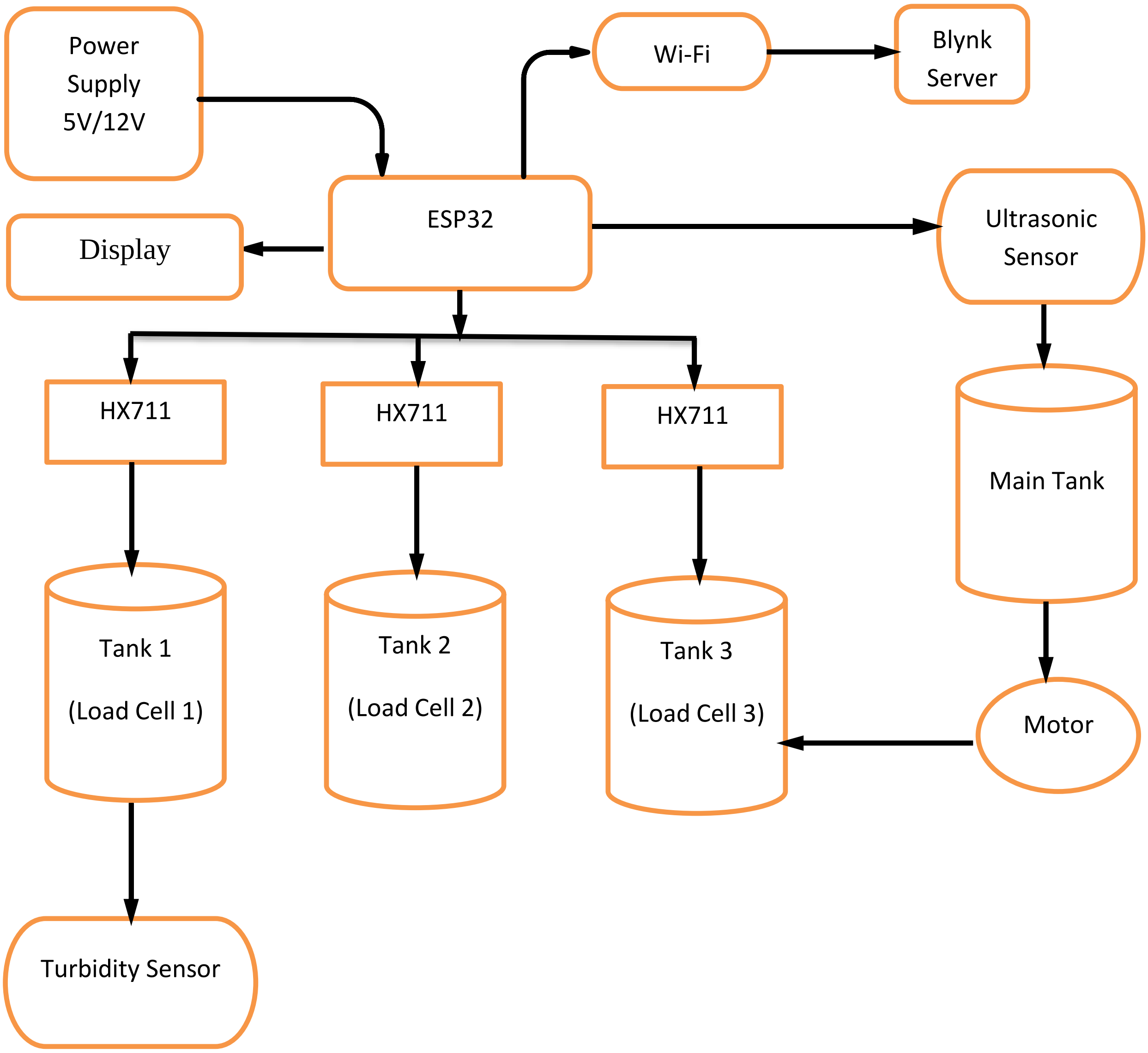


Fig 1: Block diagram

7.2 Working of the Project

A tank level monitoring system is a solution designed to monitor and control the amount of liquid in one or more tanks. This solution involves the use of three essential components:

- Sensors to accurately detect the liquid level;
- The communication layer to transmit the data from sensors to the platform;
- Platforms to store, process, and display the data.

Accurate liquid monitor level in a tank is critical to a wide range of industries, including water treatment, chemical manufacturing, food and beverage, oil and gas, and many others that require precise control of liquid volumes for operational efficiency, safety, and regulatory compliance.

Measurement can be carried out using a variety of IoT-powered liquid level monitoring sensors such as ultrasonic sensors, turbidity sensors, purity sensors, which can measure liquid levels without direct contact with the liquid or by direct immersion in the tank or reservoir. Each of these sensors has its own advantages and is selected based on installation conditions, the geometry of the storage tank, and the construction material of the tank.

7.3 Components used in the Proposed Project

1. Ultrasonic Sensor
2. Turbidity Sensor
3. ESP32
4. Load cell
5. OLED Display
6. HX711 Modules
7. 5V & 12V battery
8. 5V Motor pump
9. Relay Module

1. Ultrasonic Sensor:

Ultrasonic waves detect an object in much the same way as Radar does it. Essentially Ultrasonic uses sound waves whereas Radar uses radio waves. In ultrasonic tank level monitors a signal is targeted towards the water, it is reflected from the surface and the echo returns to the sender. The time travelled by the ultrasonic pulse is calculated. This can then be used to calculate the current level of the water within the tank.

Fig 2. Ultrasonic Sensor

The distance to the liquid surface is based on the speed of sound in air. This distance, D, is subtracted from the height of the tank, H, to give the depth, L, of liquid. The transmitter unit relays the level back to the LCD display to give you the current depth of your tank.

This principle in theory looks quite straightforward, however, in practice there are some limitations that need to be accounted for to ensure a correct level reading. These include:

- ✓ The velocity of sound changes with air temperature, as such tank level sensors should feature an integrated temperature sensor to compensate for these changes
- ✓ Interference echoes can occur from edges, welded joints and the software of the transmitter will compensate for this using interference echo suppression
- ✓ To ensure an accurate reading initial setup of the unit is critical, a correct depth and air gap will need to be set to ensure accurate readings.

Benefits of using:

Accuracy: Ultrasonic sensors can be affected by factors like temperature, pressure, and the presence of solids or bubbles in the liquid. Load cells can be affected by variations in the tank's geometry or material density. By combining the two, the accuracy of the measurement can be improved by cross-validating the data.

Reliability: Load cells can be more reliable in harsh environments or when dealing with liquids that can damage ultrasonic sensors.

Versatility: The combination can be used for a wide range of applications, including measuring the level of liquids in storage tanks, silos, or pipelines.

Specifications:

1. **Operating Voltage**: Typically **3.3V DC**
2. **Detection Range**: **2 cm to 400 cm**
3. **Accuracy**: Around **±3 mm**
4. **Operating Frequency**: Usually **40 kHz**
5. **Output Signal**: **Digital pulse (echo)** – measures time delay between trigger and echo.

2. Turbidity Sensor

In a tank level monitoring system, a turbidity sensor measures the cloudiness or haziness of the water by detecting the amount of light scattered by suspended particles, providing insights into water quality and potentially triggering alerts or actions based on turbidity levels. The working principle of a turbidity sensor involves measuring the intensity of the interaction between light and suspended particles in a liquid sample. The interaction between light and suspended particles affects in two main ways: scattering and absorption. Scattering: Particles in the liquid scatter light.

Fig.3. Turbidity Sensor

Applications:

1. **Water Treatment Plants:** Monitoring the turbidity and level of raw water, treated water, and wastewater in different stages of the treatment process.
2. **Industrial Processes:** Tracking the level and quality of liquids used in various manufacturing processes, such as chemical plants, food and beverage production, and wastewater treatment.
3. **Leak Detection:** Monitoring level and turbidity can help detect leaks in tanks by detecting changes in level and/or sudden increases in turbidity.
4. **Quality Control:** Turbidity data can be used to monitor the quality of water and other fluids, ensuring they meet specific standards.

Specifications:

1. **Measurement Range –** Measures turbidity from 0 to 1000 NTU.
2. **Operating Voltage –** Works at 5V DC power supply.
3. **Output Signal –** Provides analog or digital output for easy interfacing.
4. **Accuracy –** Delivers results within ±5% of full scale.
5. **Response Time –** Reacts in less than 500 milliseconds.

3. ESP32

The ESP32 is a microcontroller used in the IoT-based multiple tank level monitoring system using load cells. It collects data from the load cells, processes it, and transmits it to the IoT platform or cloud server. The ESP32 has Wi-Fi and Bluetooth connectivity, analog -to-digital conversion, and GPIO pins, making it suitable for this application. It can be programmed using various languages, including C++, Python, and Lua. The ESP32 offers advantages such as low cost, low power consumption, and high performance, making it a popular choice for IoT applications. In this system, the ESP32 plays a crucial role in monitoring tank levels, sending alerts, and providing real-time data for efficient management.

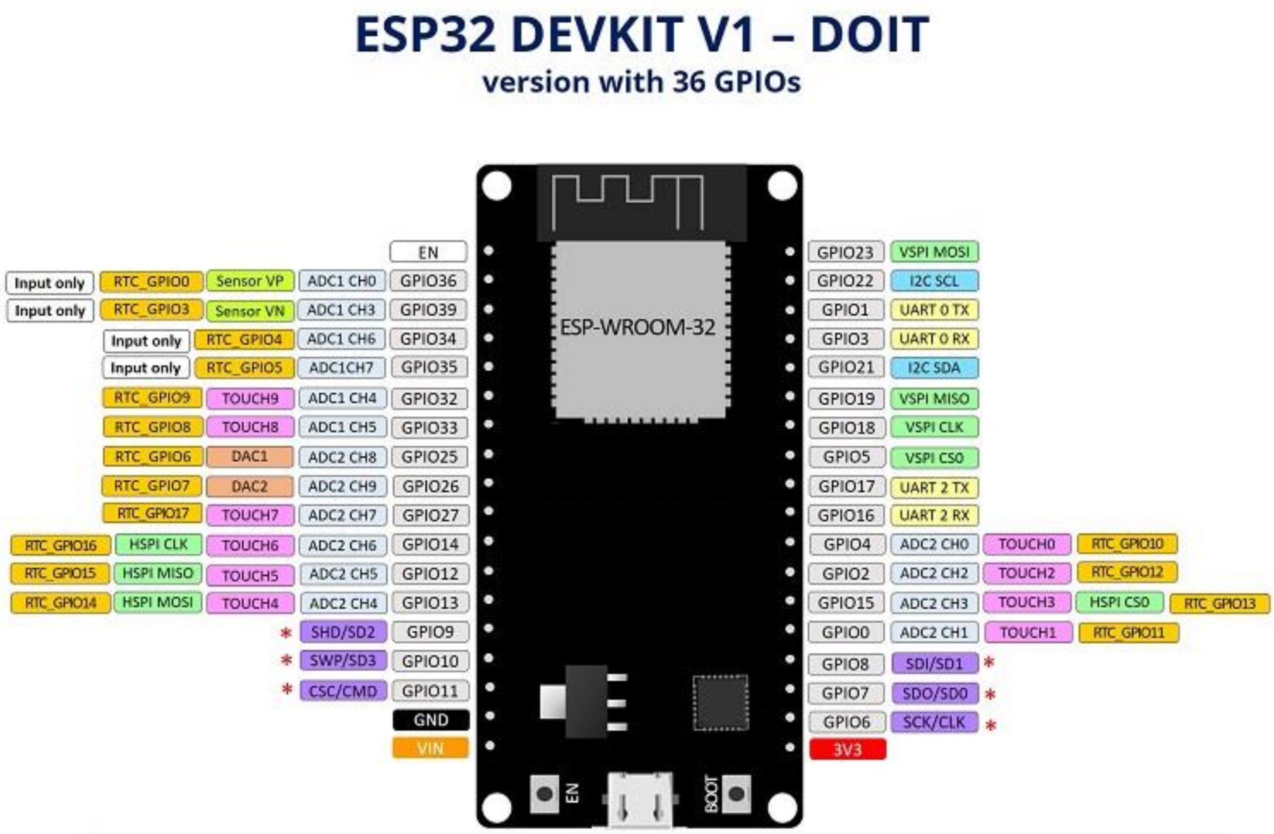


Fig.4. ESP32

ESP32 Specifications:

1. Wireless connectivity WiFi: 150.0 Mbps data rate with HT40

2. Bluetooth: BLE (Bluetooth Low Energy) and Bluetooth Classic

3. Processor: Tensilica Xtensa Dual-Core 32-bit LX6 microprocessor, running at 160 or 240 MHz

4. Memory:

- ✓ **ROM:** 448 KB
- ✓ **SRAM:** 520 KB
- ✓ **RTC fast SRAM**: 8 KB
- ✓ **RTC slow SRAM**: 8KB
- ✓ **eFuse**: 1 Kbit

5.Low Power: ensures that you can still use ADC conversions, for example, during deep sleep.

Advantages of Using ESP32

- Dual-core processor: Handles multiple tasks like sensor reading, processing, and communication simultaneously.
- Built-in Wi-Fi and Bluetooth: No need for external communication modules.
- Low power consumption: Suitable for battery-powered or solar-powered setups.
- Multiple GPIOs: Allows interfacing with multiple HX711 modules for multiple tanks.

4. Load cell

In a multiple tank level monitoring system using load cells, the principle involves converting the weight of the tank's contents into an electrical signal, which is then used to determine the level, by measuring the force exerted on the load cells mounted beneath the tanks.

Fig.5. Load Cell

What is a Load Cell?

A load cell is a transducer that converts the mechanical force into readable electrical units, similar to our regular weighing scales. Their main purpose is to weigh or check the amount of load transferred.

What is the working principle of a load cell?

The load cell principle involves the use of many specific geotechnical instruments. It can't work without being paired up with sensors, one of them being Strain Gauges. **Strain Gauges** are thin elastic materials made up of stainless steel and are fixed inside the load cells using proprietary adhesives. The strain gauge has a specific resistance that is directly proportional to its length and width. When a force is applied to the load cell, it bends or stretches causing the strain gauge to move with it. And, when the length and cross-section of the strain gauge change, its electrical resistivity also gets altered, thereby changing the output voltage.

Load Cell Circuit:

A load cell circuit is also known as a Wheatstone Bridge Circuit.

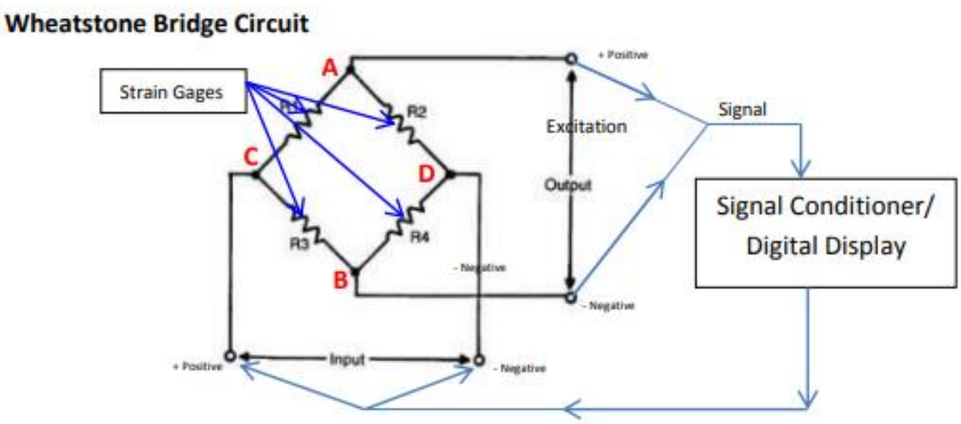


Fig. 6. Load cell Circuit

5. OLED Display

An OLED display can be used to visualize tank levels in a multiple tank level monitoring system, providing real-time updates and alerts. It's connected to a microcontroller (e.g., ESP32) and displays data from load cells, offering high-quality graphics and low power consumption. The OLED display is compact, making it easy to integrate into the system.

Advantages of Using OLED Display

1. **High-Quality Display:** OLED displays offer high-quality graphics and text, making it easy to read and understand the tank levels.

2. **Low Power Consumption:** OLED displays have low power consumption, making them suitable for battery-powered applications.

3. **Compact Size:** OLED displays are compact and lightweight, making them easy to integrate into the system.

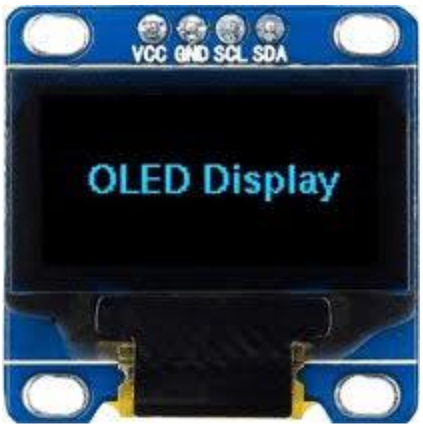


Fig.7. OLED Display

6. HX711 Module

The multiple tank level monitoring system utilizes several key components to provide accurate and real-time monitoring of tank levels. The system employs load cells to measure the weight of the liquid in each tank, which is then amplified and converted to a digital signal by the HX711 module. The digital signal is processed by a microcontroller, such as the ESP32, which can then display the data on an OLED display or transmit it to a cloud server. The system's design is compact and low-power, making it suitable for a variety of applications. The use of the HX711 module and ESP32 microcontroller provides a high degree of accuracy and reliability.

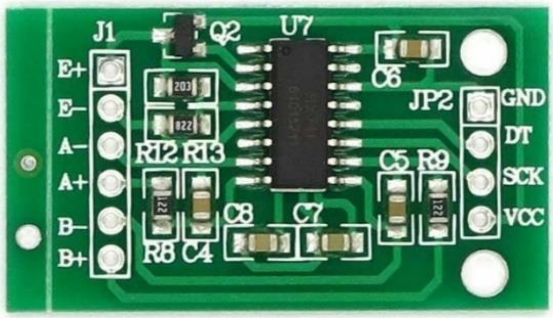


Fig.8. HX71 module

Specification:

- ✓ **Data Accuracy:** 24-bit.
- ✓ **Gain:** Programmable gain of 32, 64, or 128.
- ✓ **Channels:** Two selectable differential input channels.
- ✓ **Data Output:** Digital serial output.
- ✓ **Refresh Frequency:** 80 Hz.
- ✓ **Operating Voltage:** Typically, 2.6V to 5.5V DC.

7. Relay module:

In a tank level monitoring system, a relay module acts as a switch to control external devices such as pumps, valves, and alarms based on the tank level readings. It receives signals from the microcontroller and amplifies them to control the devices, providing electrical isolation and protection. The relay module helps automate tasks, such as filling or draining tanks, and sends alerts when levels reach critical thresholds.

Fig.9. Relay Module

Specification:

- ✓ **Relay type:** Electromagnetic relay
- ✓ **Contact rating:** 10A, 250VAC, 5A 30VDC
- ✓ **Trigger voltage:** 5V
- ✓ **Input logic:** Active low
- ✓ **Power consumption:** < 100mW
- ✓ **Switching time:** < 10ms
- ✓ **Isolation:** 1.5kV
- ✓ **Operating temperature:** -20°C to +70°C

8. Blynk Server:

Blynk is a cloud-based platform that allows you to build and control IoT applications using mobile devices and microcontrollers like ESP32. It provides a real-time dashboard through which sensor data can be monitored, and devices can be controlled remotely.

Key Features of Blynk Server:

- **Real-Time Monitoring:** Receive live data from connected devices (like tank levels, turbidity status, motor ON/OFF).
- **Mobile Dashboard:** Create a custom app interface using widgets like displays, LEDs, graphs, and buttons.
- **Cloud Storage**: Logs data history for future analysis and troubleshooting.
- **Wi-Fi Based Communication:** Works through ESP32's built-in Wi-Fi to communicate with the cloud server**.**
- **Automation Support:** Can trigger actions based on sensor data, like turning ON/OFF a pump or sending alerts.

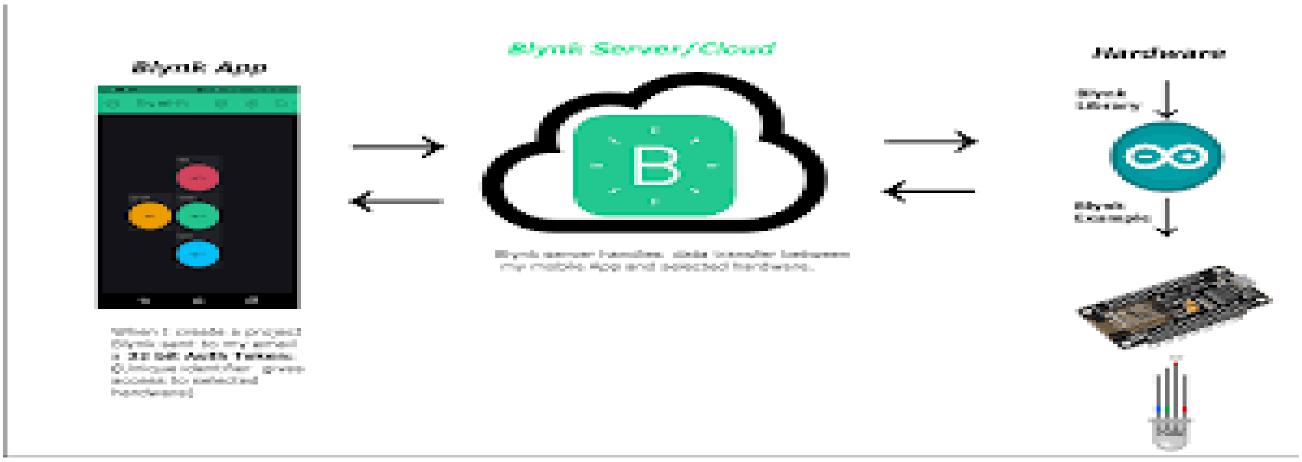


Fig. 10. Blynk Sever

8. Advantages, Limitations and Applications

8.1 Advantages

- ✓ Real-time Monitoring
- ✓ Increased Accuracy
- ✓ Remote Access
- ✓ Automated Alerts
- ✓ Improved Efficiency

8.2 Limitations

- ✓ Cost
- ✓ Connectivity Issues
- ✓ Sensor Calibration
- ✓ Security Concerns

8.3 Applications

- ✓ Agriculture Settings
- ✓ Water Treatment Plants
- ✓ Disaster management
- ✓ Smart Cities
- ✓ Oil and Gas Industry
- ✓ Industrial Settings

9. Conclusions and Scope for Future Work

9.1 Conclusion:

- The IoT-based multiple tank level measurement system using load cells has proven to be a reliable and efficient solution for real-time monitoring of liquid levels.
- By integrating load cell sensors with microcontrollers and cloud-based IoT platforms, the system enables accurate weight-based level detection across multiple tanks simultaneously.
- The data is continuously monitored, logged, and can be accessed remotely, facilitating proactive decision-making and reducing manual intervention.
- The successful implementation of this system demonstrates its potential for applications in industries like water treatment, chemical processing, and agriculture, where precise liquid monitoring is crucial.
- Future enhancements could include automated alerts, predictive maintenance, and integration with control systems for automated filling and draining.

9.2 Scope for Future Work:

1. Integration with Machine Learning for Predictive Analytics
2. Enhanced Sensor Fusion for Improved Accuracy
3. Multi-Tank Management and Automation
4. Scalability for Industrial Applications
5. Self-Calibration and Fault Detection

10.Appendix:

```
#define BLYNK_TEMPLATE_ID "TMPL3IfCAp2A5"

#define BLYNK_TEMPLATE_NAME "IOT Based multi tank measurement using Load cell"

#define BLYNK_AUTH_TOKEN "llwnOaFEjFwajpb4uf9O6K3sF_jNABYe"

#include <WiFi.h>

#include <BlynkSimpleEsp32.h>

#include "HX711.h"

#include <Wire.h>

#include <Adafruit_GFX.h>

#include <Adafruit_SSD1306.h>

// WiFi credentials

char ssid[] = "CMF by Nothing Phone 1_1744";

char pass[] = "567891234";

// HX711 Pins

#define DT1 15

#define SCK1 2

#define DT2 4

#define SCK2 5

#define DT3 18

#define SCK3 19

// OLED Parameters

#define SCREEN_WIDTH 128

#define SCREEN_HEIGHT 64

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);
```

```
// HX711 Objects
HX711 scale1, scale2, scale3;
// Calibration Factors
float calibration_factor1 = -100000.0;
float calibration_factor2 = -100000.0;
float calibration_factor3 = -100000.0;
// Pins
#define TURBIDITY_PIN 34
#define TRIG_PIN      25
#define ECHO_PIN      26
#define RELAY_PIN     32
#define RELAY_ON      LOW
#define RELAY_OFF     HIGH
// Turbidity calibration
const float TURB_SLOPE = 100.0;
const float TURB_INTERCEPT = 0.0;
long readUltrasonicCM() {
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  long duration = pulseIn(ECHO_PIN, HIGH, 25000);
  return (duration > 0) ? (duration * 0.0343 / 2.0) : -1;
}
```

```
void setup() {
  Serial.begin(115200);
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
    while (1);
  }
  display.clearDisplay();
  display.display();
  scale1.begin(DT1, SCK1);
  scale2.begin(DT2, SCK2);
  scale3.begin(DT3, SCK3);
  delay(500);
  scale1.set_scale(calibration_factor1);
  scale2.set_scale(calibration_factor2);
  scale3.set_scale(calibration_factor3);
  scale1.tare();
  scale2.tare();
  scale3.tare();
  pinMode(TURBIDITY_PIN, INPUT);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  pinMode(RELAY_PIN, OUTPUT);
  digitalWrite(RELAY_PIN, RELAY_OFF);
}
```

```
// History for L3 filtering
float L3_history[10] = {0};
int l3_index = 0;
void loop() {
  Blynk.run();
  // --- Load Cell Readings with Noise Filtering ---
  float L1_kg = fabs(scale1.get_units(5));
  float L2_kg = fabs(scale2.get_units(5));
  float rawL3_kg = fabs(scale3.get_units(5));

  if (L1_kg < 0.2) L1_kg = 0.0;
  if (L2_kg < 0.2) L2_kg = 0.0;
  if (rawL3_kg < 0.2) rawL3_kg = 0.0;

  // Filter for L3
  L3_history[l3_index] = rawL3_kg;
  l3_index = (l3_index + 1) % 10;
  float L3_kg = 0;
  for (int i = 0; i < 10; i++) {
    L3_kg += L3_history[i];
  }
  L3_kg /= 10.0;

  // Convert weight to volume (liters)
  float L1_Liters = L1_kg * 1.0;
```

```
float L2_Liters = L2_kg * 1.0;
float L3_Liters = L3_kg * 1.0;

// --- Turbidity Sensor ---
int turbRaw = analogRead(TURBIDITY_PIN);
float turbNTU = map(turbRaw, 0, 432, 1000, 0);
if (turbNTU < 0) turbNTU = 0;
if (turbNTU > 1000) turbNTU = 1000;

// --- Motor Control Logic based on L3 Liters ---
static bool motorOn = false;
if (L3_Liters < 0.4) {
  digitalWrite(RELAY_PIN, RELAY_OFF);
  motorOn = false;
} else if (L3_Liters >= 0.4 && L3_Liters < 1.0) {
  digitalWrite(RELAY_PIN, RELAY_ON);
  motorOn = true;
} else {
  digitalWrite(RELAY_PIN, RELAY_OFF);
  motorOn = false;
}

// --- Ultrasonic ---
long dist = readUltrasonicCM();
if (dist <= 0 || dist > 400) dist = -1;
```

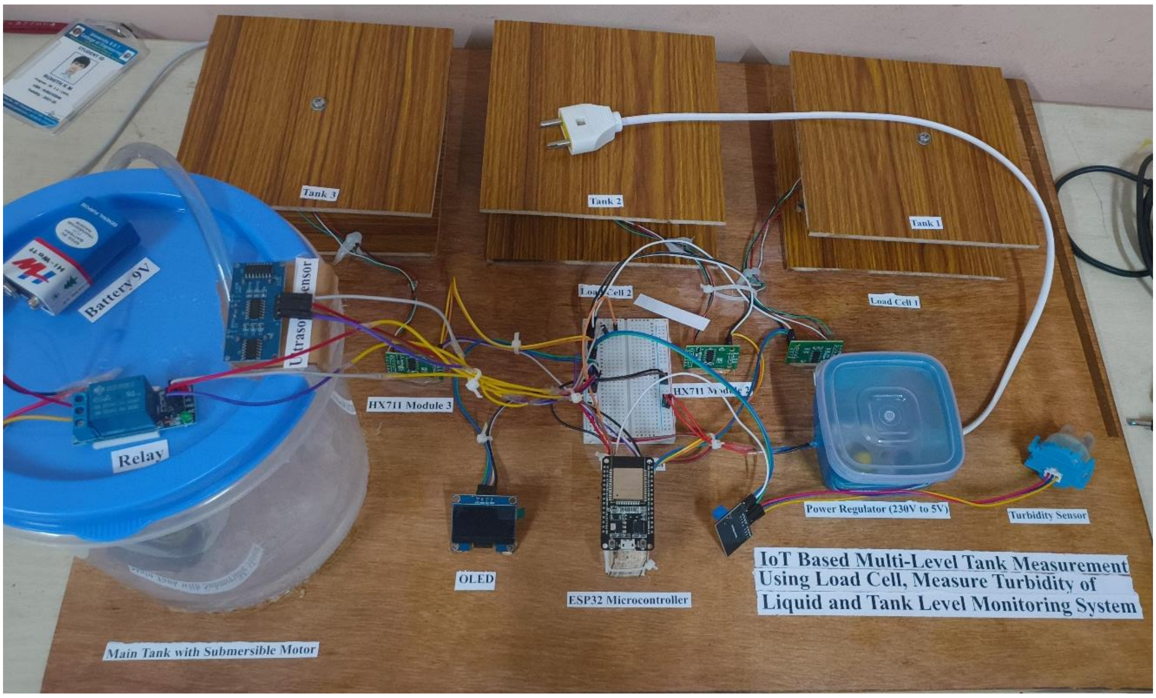
```
String mainStatus;
if (dist == -1)       mainStatus = "Err";
else if (dist >= 17.3) mainStatus = "Empty";
else if (dist >= 15.0) mainStatus = "Less";
else if (dist <= 4.0)  mainStatus = "Full";
else                   mainStatus = String(dist, 1) + " Medium";

// --- Send to Blynk ---
Blynk.virtualWrite(V0, L1_Liters);
Blynk.virtualWrite(V1, L2_Liters);
Blynk.virtualWrite(V2, L3_Liters);
Blynk.virtualWrite(V3, turbNTU);
Blynk.virtualWrite(V4, mainStatus);
Blynk.virtualWrite(V5, motorOn ? 1 : 0);

// --- Serial Debug ---
Serial.print("L1="); Serial.print(L1_Liters); Serial.print("L ");
Serial.print("L2="); Serial.print(L2_Liters); Serial.print("L ");
Serial.print("L3="); Serial.print(L3_Liters); Serial.print("L ");
Serial.print("Motor="); Serial.print(motorOn ? "ON" : "OFF ");
Serial.print("Dist="); Serial.println(dist);

// --- OLED Display ---
display.clearDisplay();
display.setTextSize(1);
```

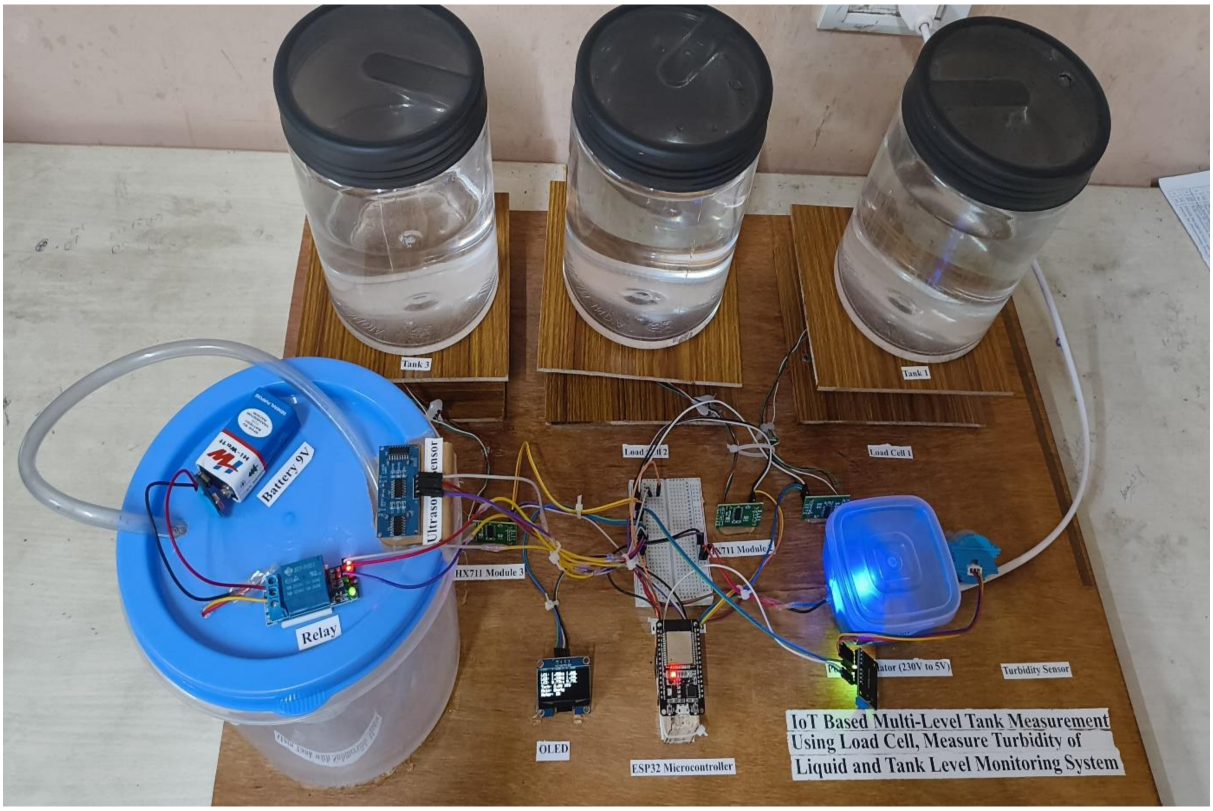
```
  display.setTextColor(WHITE);
  display.setCursor(0, 0);  display.printf("LC1: %.2fkg %.2fL", L1_kg, L1_Liters);
  display.setCursor(0, 10); display.printf("LC2: %.2fkg %.2fL", L2_kg, L2_Liters);
  display.setCursor(0, 20); display.printf("LC3: %.2fkg %.2fL", L3_kg, L3_Liters);
  display.setCursor(0, 30); display.printf("Turb: %.2f NTU", turbNTU);
  display.setCursor(0, 40); display.print("Main: "); display.print(mainStatus);
  display.setCursor(0, 50); display.print("Motor: "); display.print(motorOn ? "ON" :
"OFF");
  display.display();


  delay(300);
}
```

Cost Estimation

Materials / Components	Cost in Rupees (Rs.)
Ultrasonic Sensor	250
Turbidity Sensor	1000
Relay Module	50
ESP32	800
OLED Display	500
3 HX711 Modules	1200
3 Load Cell	600
5v & 12v Battery	100
5v Motor pump	150
Stands	800
Total	**5,450**

Snaps


Tank 3
Tank 2
Tank 1
Battery 9V
Load Cell 1
HX711 Module 3
Relay
OLED
ESP32 Microcontroller
Power Regulator (230V to 5V)
Turbidity Sensor
IoT Based Multi-Level Tank Measurement
Using Load Cell, Measure Turbidity of
Liquid and Tank Level Monitoring System
Main Tank with Submersible Motor


Tank 3
Tank 1
Load Cell 1
Battery 9V
HX711 Module 3
Relay
OLED
ESP32 Microcontroller
Turbidity Sensor
IoT Based Multi-Level Tank Measurement
Using Load Cell, Measure Turbidity of
Liquid and Tank Level Monitoring System

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