IV BAG MONITORING AND ALERT SYSTEM

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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We gratefully acknowledge and thank **Dr.P.KUMAR** , Ph.D., Professor & Head, Department of Computer Science and Engineering for giving his constant Encouragement.

We thank our project guide **Mrs.ANITHA ASHISHDEEP** , Assistant Professor, Department of Computer Science and Engineering , for his valuable guidance throughout this phase of project.

We also express my profound thanks to all the faculty members and lab technicians of Computer Science and Engineering department who helped us to make this project successful.

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SANDHYA (210701226)
SHANDIYA N S (210701240)

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ABSTRACT

Intravenous (IV) therapy is an essential medical practice used in hospitals to provide fluids, drugs, and nutrients straight into the patient's bloodstream. Monitoring the state of IV bags is critical to ensuring prompt replacement and avoiding issues like air embolism. Manual monitoring, on the other hand, is time-consuming and susceptible to human error. This project proposes an IoT-based IV bag monitoring system that uses the ESP32 microcontroller to automate and improve the monitoring process. The technology uses weight sensors to continuously monitor the amount of fluid remaining in the IV bag. The ESP32 microcontroller, which is known for its low power consumption and powerful Wi-Fi capabilities, acts as the core processing unit. It receives data from the weight sensors and processes it to calculate the current fluid level. This data is subsequently transmitted to a cloud server over Wi-Fi, allowing healthcare personnel to monitor it remotely. The device includes an alarm mechanism to warn medical workers to urgent conditions such as low fluid levels or probable air ingress. Notifications can be sent via SMS, email, or a dedicated mobile app, allowing for quick replies to important circumstances. In addition, a user-friendly interface is being created to deliver real-time status updates and historical data analysis, which will help improve patient care and optimize IV bag utilization. The deployment of this IoT-based system addresses various issues with standard IV bag monitoring. It decreases the stress on healthcare professionals, lowers the chance of human mistake, and assures continuous monitoring even in high-volume hospital settings. The IoT-based IV bag monitor with ESP32 provides a dependable, efficient, and scalable solution for improving IV therapy management. By integrating modern IoT capabilities, this system greatly enhances IV administration safety and efficiency, resulting in better patient outcomes and more efficient hospital operations.

LIST OF FIGURES

ABBREVATIONS

ABBREVIATION	FULL FORM
AC	Alternating current
ADC	Analog to digital conversation
AM	Ante meridiem
DC	Direct current
DMP	Digital Motion Processor
EMI	Electromagnetic interference
GND	Ground
ICSP	In-circuit serial programming
IDE	Integrated development environment
IOT	Internet of things
IR	Infrared
IV	Intravenous therapy
LCD	Liquid crystal display
PCB	Printed circuit board
PM	Post meridiem
PWM	Pulse width modulation
RF	Radiofrequency
RST	Reset
RTC	Real-Time Clock
UART	Universal asynchronous receiver transmitter
VSB	Vestigial sideband modulation
Wi-Fi	Wireless fidelity

CHAPTER - 1
INTRODUCTION

1.1 BACKGROUND:

Intravenous (IV) therapy is an essential medical procedure that delivers fluids, medicines, and nutrients straight into a patient's bloodstream. It is widely used in hospitals, clinics, and emergency care facilities for a variety of therapies such as hydration, antibiotic administration, chemotherapy, and anaesthetic. Effective IV therapy management is critical for ensuring that patients receive the appropriate fluid and drug dosages on time. Traditional methods of monitoring IV bags, which rely mainly on manual checks by healthcare professionals, are prone to human error and inefficiency, increasing the risk of air embolism, erroneous dosages, and delayed treatments.

1.2 THE ROLE OF IoT IN HEALTHCARE:

The Internet of Things (IoT) has transformed several industries, including healthcare, by allowing the development of smart, interconnected systems capable of collecting, analysing, and transmitting data in real time. IoT technology in healthcare enables continuous monitoring, remote diagnostics, and automatic alarms, which improves patient care and operational efficiency. Wearable health monitoring and advanced telemedicine systems are examples of IoT applications in healthcare, which offer new opportunities for improving patient outcomes and optimizing resource use.

1.3 PROBLEM STATEMENT:

The technique of monitoring intravenous fluid levels is still primarily done by hand, even with advances in medical technology. In addition to being labour-intensive, this method is prone to error, particularly in hectic hospital settings. Patients may have severe consequences if therapies are missed or postponed as a result of low fluid levels. Thus, in order to ensure prompt alarms and interventions, an automated, dependable, and effective system for monitoring IV bags is desperately needed.

1.4 EXISTING METHOD:

1.4.1 IV BAG MONITORING USING IR SENSOR:

The current health care system relies on manual cares, whose strenuous tasks in the modern world constitute social problems and time-consuming jobs. We are putting forth a system where a hospital-specific remote drip infusion monitoring and control system has been created. The system includes a control system, a number of infusion monitoring devices, and a central monitor. The infusion monitoring device uses an IR sensor to detect or sense the drip infusion rate (drops per minute), remaining time, an empty infusion solution bag at a specific critical set level, and to display the remaining infusion capacity on a central monitor. This information is wirelessly transmitted to the crucial or central monitor located in the nurse's control room, and nurses can also access the central monitor from there.

1.4.2 IV BAG MONITORING USING ULTRASONIC SENSOR:

Ultrasonic sensor is used to detect the level of fluid and a light sensor to detect the level of fluid and light sensor to detect any bubble formation in the IV infusion bag. A control mechanism can alert the nurses or doctors if the fluid levels in the

IV infusion bag drops down a certain level to prevent air embolism and avoid reverse flow of blood.

Fig 1.1 IV Bag Monitoring using Ultrasonic Sensor

1.5 EXISISTING PRODUCTS:

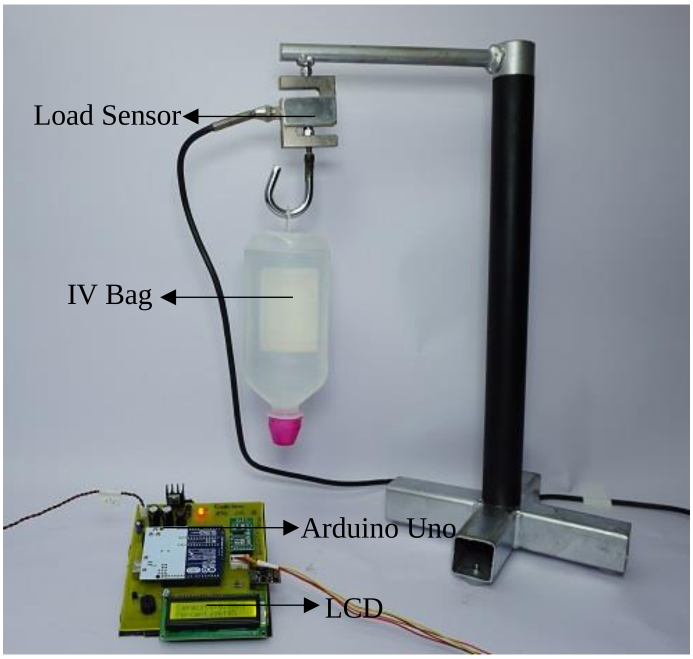

Fig 1.2 IV Bag Monitoring System using Arduino

An IV bag monitoring system using Arduino involves a weight sensor (load cell) attached to the IV bag to measure its weight. This sensor is connected to an HX711 load cell amplifier, which interfaces with the Arduino board. The Arduino processes the weight data to determine the fluid level. It uses a communication module, such as Wi-Fi, GSM, or Bluetooth, to send the data to a server or directly send alerts if the fluid level drops below a set threshold. The server can store and analyze the data, providing a user interface for healthcare providers to monitor the IV levels. Alerts are sent to healthcare providers via SMS, email, or app notifications on their devices. Additionally, the system can log historical data for trend analysis and future reference. This ensures continuous monitoring and timely intervention, enhancing patient care. The system can be easily integrated into existing hospital infrastructure, making it a versatile solution for healthcare facilities.

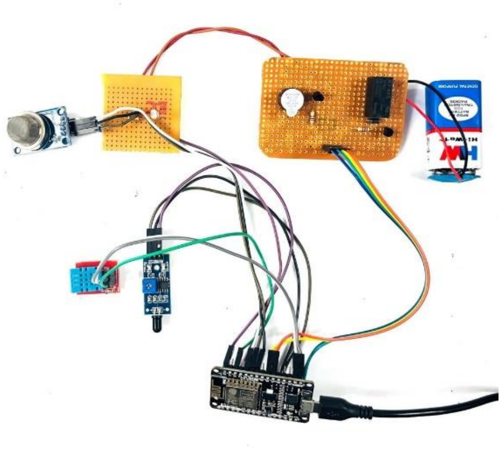

Fig 1.3 Drip Saline Fluid Monitoring System using IoT and NodeMCU

A Drip Saline Fluid Monitoring System using IoT and NodeMCU involves using a drip sensor, such as an infrared or optical sensor, to monitor the rate of saline drip. The NodeMCU collects data from the sensor and processes it to determine the drip rate and fluid level. This data is then sent via Wi-Fi to a cloud server, where it can be stored, analyzed, and accessed through a user interface. Alerts and notifications are sent to healthcare providers via SMS, email, or app notifications if any irregularities are detected, ensuring timely intervention and continuous monitoring of patient fluid levels. The system can also log historical data for trend analysis and improve patient care efficiency. It integrates seamlessly into existing hospital infrastructure, making it a versatile solution for healthcare facilities.

CHAPTER - 2

LITERATURE SURVEY

The integration of Internet of Things (IoT) technology into healthcare systems has significantly advanced, offering innovative solutions for monitoring and managing various medical conditions. Intravenous (IV) therapy, a cornerstone of medical treatment, requires diligent monitoring to prevent complications. Research highlights the potential of IoT to enhance healthcare efficiency, patient safety, and data accuracy through real-time monitoring and data analysis. Several studies have explored automated IV bag monitoring solutions. One notable example developed a smart IV monitoring system using weight sensors and a microcontroller to measure fluid levels, demonstrating improved accuracy and timely alerts compared to manual monitoring. Another design employed ultrasonic sensors and Arduino technology to detect flow rates and fluid levels, providing real-time alerts to healthcare providers. The ESP32 microcontroller has emerged as a popular choice for IoT applications due to its low power consumption, built-in Wi-Fi and Bluetooth capabilities, and extensive support for sensors and actuators. Its versatility is highlighted in developing cost-effective and reliable IoT solutions for various domains, including healthcare. Weight sensors are commonly used in IV bag monitoring to measure the amount of fluid remaining accurately. The implementation of load cells in medical devices emphasizes their precision and reliability for continuous monitoring applications. The integration of weight sensors with microcontrollers like ESP32 facilitates real-time data collection and processing, as explored in several prototype systems. Cloud computing in IoT-based healthcare solutions allows for remote monitoring and data analysis. Cloud-based health monitoring systems offer scalability, data accessibility, and enhanced decision-making through big data analytics. For IV bag monitoring, cloud integration ensures that data from the ESP32 microcontroller can be accessed and analysed remotely, providing healthcare providers with timely information. Effective notification and alert mechanisms are crucial for IoT-based IV bag monitoring systems. Real-time alerts in medical settings are important to prevent adverse events and improve patient care. Systems incorporating SMS, email, and mobile applications for notifications have demonstrated significant improvements in response times and intervention outcomes. The literature surveyed demonstrates the significant advancements and potential of IoT-based IV bag monitoring systems. By leveraging technologies such as the ESP32 microcontroller, weight sensors, and cloud computing, these systems offer enhanced accuracy, real-time monitoring, and efficient alerts. The integration of IoT in IV therapy management represents a promising direction for improving patient care and operational efficiency in healthcare settings. Future research should focus on optimizing these systems for wider adoption and exploring additional functionalities to further enhance their impact on healthcare delivery.

CHAPTER – 3

THEORETICAL EXPLANATION

3.1 INTERNET OF THINGS (IOT) IN HEALTHCARE

The Internet of Things (IoT) is a network of physical objects that use sensors, software, and other technologies to collect and share data via the internet. In healthcare, IoT technologies have transformed patient care by allowing for real-time monitoring, remote diagnostics, and automatic warnings. These improvements make it easier to monitor patients continuously, diagnose health risks early, and provide prompt medical interventions, ultimately increasing patient outcomes and operational efficiency.

3.2 ESP32 MICROCONTROLLER

The ESP32 microcontroller is a capable, low-cost microcontroller that includes Wi-Fi and Bluetooth functionality. It is frequently utilized in IoT applications due to its adaptability, low power consumption, and broad support for numerous sensors and actuators. The ESP32's dual-core processor and extensive peripheral support make it an excellent choice for complicated IoT projects such as real-time data processing and wireless networking.

Key features of the ESP32 include:

- Dual-core Tensilica LX6 microprocessor
- Integrated Wi-Fi and Bluetooth
- Support for various communication protocols (SPI, I2C, UART, etc.)
- Low power consumption modes
- Built-in security features (encryption, secure boot, etc.)

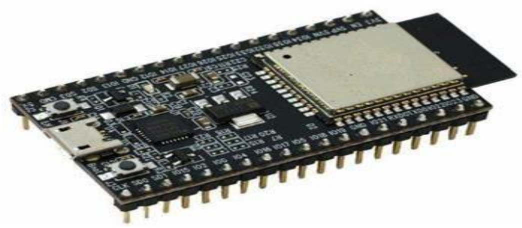

Fig 3.1 ESP32 Microcontroller

3.3 WEIGHT SENSORS:

Weight sensors, also known as load cells, are devices that convert a force or weight into an electrical signal. These sensors are critical components in monitoring systems where accurate measurement of weight or load is essential. In the context of IV bag monitoring, weight sensors measure the remaining fluid in the IV bag with high precision. The electrical signal generated by the weight sensor is proportional to the weight of the fluid, allowing for continuous and accurate monitoring of the IV bag's contents.

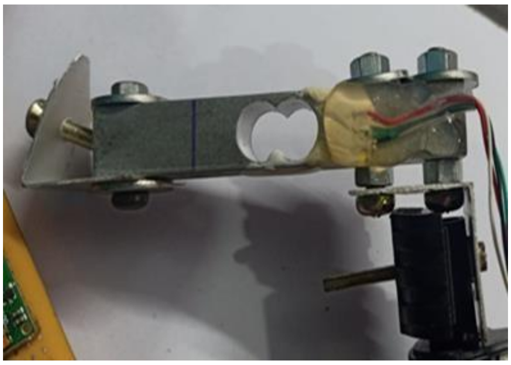

Fig 3.2 Load Sensor

3.4 DATA PROCESSING AND TRANSMISSION:

The ESP32 microcontroller processes the data collected from the weight sensors. This involves:

1. **Data Acquisition:** Reading the analog signal from the weight sensor and converting it to a digital value using an Analog-to-Digital Converter (ADC).

2. **Data Processing:** Filtering and calibrating the sensor data to ensure accuracy. This may involve compensating for factors such as sensor drift or environmental variations.

3. **Data Transmission:** Sending the processed data to a cloud server via Wi-Fi. The ESP32's integrated Wi-Fi capabilities facilitate seamless wireless communication, enabling real-time data transmission to remote servers.

3.5 CLOUD COMPUTING AND DATA STORAGE

Cloud computing plays a crucial role in IoT-based healthcare systems by providing scalable storage and computational resources. Data transmitted from the ESP32 microcontroller is stored in the cloud, where it can be accessed and analyzed by healthcare providers. Cloud services offer several advantages, including:

- **Scalability:** The ability to handle large volumes of data from multiple devices.
- **Accessibility:** Remote access to data from anywhere with an internet connection.
- **Data Analysis:** Advanced analytics and machine learning capabilities to derive insights from the data.
- **Security:** Robust security measures to protect sensitive health information.

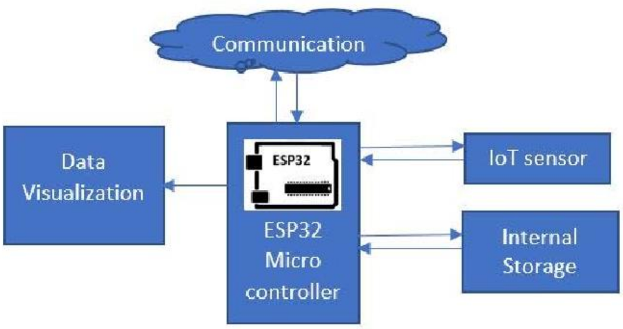

Fig 3.3 Cloud, Data Storage and Communication in ESP32

3.6 REAL-TIME ALERTS AND NOTIFICATIONS:

Real-time alerts and notifications are essential for timely medical interventions. The system can trigger alerts based on predefined thresholds for fluid levels in the IV bag. These alerts can be sent via multiple channels, such as SMS, email, or a dedicated mobile application. The notification system ensures that healthcare providers are immediately informed of critical conditions, allowing for prompt action to prevent complications.

3.7 USER INTERFACE:

A user-friendly interface is crucial for the effective utilization of the IoT-based IV bag monitoring system. The interface should provide real-time status updates, historical data analysis, and alert management. Features of the interface include:

- **Dashboard:** Visual representation of current IV bag statuses, including fluid levels and alert statuses.
- **Historical Data:** Access to historical data for trend analysis and reporting.
- **Alert Management:** Tools to manage and acknowledge alerts, ensuring that critical notifications are addressed promptly.
- **Mobile Access:** Compatibility with mobile devices for on-the-go monitoring and alerts.

The theoretical explanation of the IoT-based IV bag monitoring system encompasses the integration of IoT technology in healthcare, the role of the ESP32 microcontroller, the use of weight sensors for accurate fluid measurement, and the importance of data processing, cloud computing, and real-time alerts. These components work together to create a robust and efficient system that enhances IV therapy management, improving patient safety and healthcare efficiency.

CHAPTER – 4

METHODOLOGY

The methodology for implementing an IoT-based IV bag monitoring system using an ESP32 involves several key steps, including hardware setup, software development, calibration, testing, and deployment. Below is a detailed methodology outlining each of these steps:

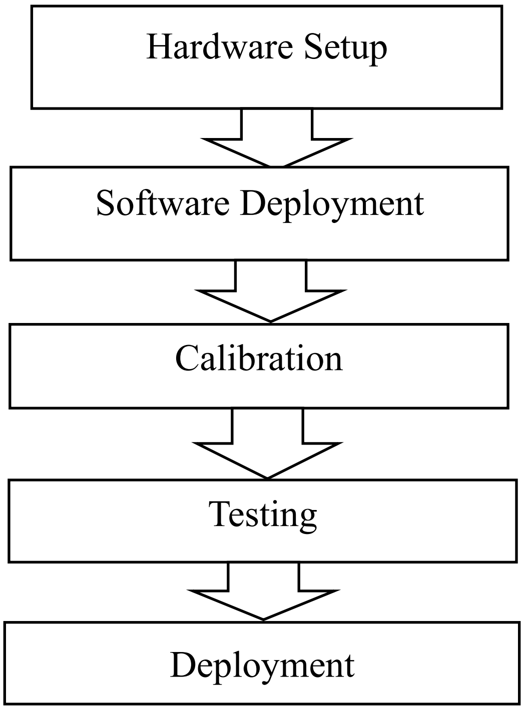

Fig 4.1 Methodology

CHAPTER 5

EXPERIMENTAL PROCEDURE

5.1. HARDWARE ASSEMBLY:

5.1.1 COMPONENTS:

- **ESP32 Development Board**

  A single 2.4 GHz Wi-Fi and Bluetooth combination chip called the ESP32was created using TSMC's ultra-low-power 40 nm technology.

Fig 5.1 ESP32 Microcontroller

- **Load Cell**

  A load cell is a transducer used to convert force or weight into an electrical signal. It is commonly used in various applications for measuring weight, force, or pressure. Load cells typically consist of a metal structure with strain gauges attached to it. When a force is applied to the load cell, it deforms slightly, causing a change in the resistance of the strain gauges. This change in resistance is proportional to the applied force and is measured as an electrical signal by the load cell's circuitry.

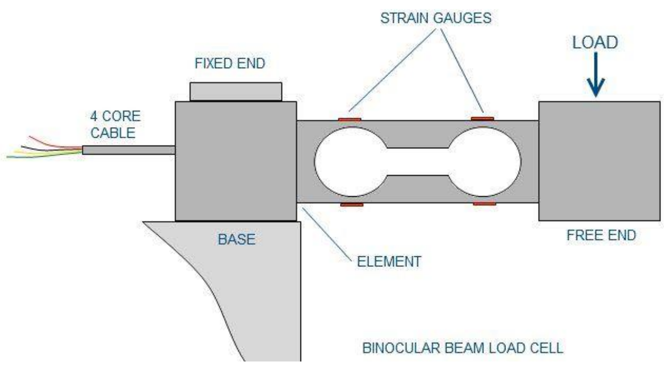

Fig 5.2 Load Cell

- **HX711 Load Cell Amplifier**

  A load cell amplifier, often referred to as a signal conditioner, is an electronic device used to amplify and condition the output signal from a load cell. Load cells typically produce low-level electrical signals (in the millivolt range) proportional to the applied force or weight. These signals are very small and may require amplification and filtering to make them suitable for further processing or measurement by other devices.

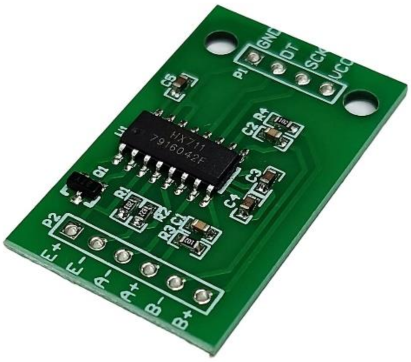

Fig 5.3 HX711 Load Cell Amplifier

- **Breadboard**

  A breadboard is a fundamental prototyping tool used in electronics to create temporary circuits for testing and experimentation. It consists of a plastic board with a grid of holes into which electronic components and wires can be inserted and interconnected without the need for soldering.

The holes are typically arranged in rows and columns, with each row electrically connected internally.

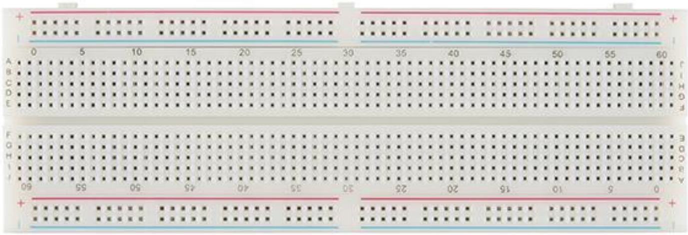

Fig 5.4 Breadboard

- **Jumper Wires**

Jumper wires are essential components in electronics prototyping and circuit building. They are flexible wires with connectors or pins at each end, allowing them to easily connect different components on a breadboard or between various electronic modules.

Fig 5.5 Jumper Wires

- **IV Bag**

An IV (intravenous) bag, also known as an infusion bag or drip bag, is a sterile, flexible container used in healthcare settings to deliver fluids, medications, or nutrients directly into a patient's bloodstream via intravenous therapy. IV bags are typically made of transparent or translucent plastic materials, allowing healthcare professionals to monitor the fluid level and contents easily.

Fig 5.6 IV Bag

- **Power Supply for ESP32 (USB cable and adapter)**

  A power supply is an electronic device or system that converts electrical energy from a power source (such as a wall outlet, battery, or renewable energy source) into usable electrical power for various electronic devices and equipment. Power supplies are essential components in virtually all electronic devices and systems, providing the necessary voltage, current, and stability to ensure proper operation.

Fig 5.7 USB Cable and Adapter

- **Lcd Display**

  An LCD (Liquid Crystal Display) is a flat-panel display technology used in a wide range of electronic devices, including computer monitors, televisions, smartphones, tablets, and various embedded systems. LCDs are preferred for their thin profile, low power consumption, and ability to display content with high resolution and colour accuracy.

Fig 5.8 LCD Display

- **Piezo Buzzer**

  A piezo buzzer is an electronic audio signaling device that produces sound by the vibration of a piezoelectric crystal. Piezo buzzers are commonly used in various electronic devices and systems to generate audible alerts, notifications, or tones.

Fig 5.9 Piezo Buzzer

5.1.2 CONNECT LOAD CELL TO HX711:

- **Red wire (VCC)** of the load cell to **E+** of HX711
- **Black wire (GND)** of the load cell to **E-** of HX711
- **White wire (Data-)** of the load cell to **A-** of HX711
- **Green wire (Data+)** of the load cell to **A+** of HX711

5.1.3 CONNECT HX711 TO ESP32:

- **VCC** of HX711 to **3.3V** on ESP32
- **GND** of HX711 to **GND** on ESP32
- **DT (Data)** of HX711 to **GPIO 4** on ESP32
- **SCK (Clock)** of HX711 to **GPIO 5** on ESP32

5.1.4 CONNECT ESP32 TO POWER SUPPLY:

- Use a **USB cable** connected to a computer or a USB adapter.

5.2 CALIBRATE THE LOAD CELL:

- Open the Serial Monitor in the Arduino IDE (set baud rate to 115200).
- Observe the weight readings when no weight is applied.
- Place a known weight on the load cell and note the readings.
- Adjust the scale factor in the code, if necessary, by modifying the **scale.set_scale()** value.

5.2.1 TEST DATA TRANSMISSION:

- Monitor the serial output to check the weight readings and ensure they are accurate.
- Verify that the server receives the weight data correctly and displays the appropriate response.

5.3 REGULAR OPERATION

5.3.1 POWER ON AND CONNECT ESP32:

- Ensure the ESP32 is connected to a power source and has Wi-Fi connectivity.

- The ESP32 should start sending weight data to the server every 60 seconds.

5.3.2 MONITOR AND MAINTAIN:

- Regularly check the server logs and the Serial Monitor to ensure consistent data transmission.
- Replace the IV bag as needed based on the weight data received.

5.4 CIRCUIT DIAGRAM:

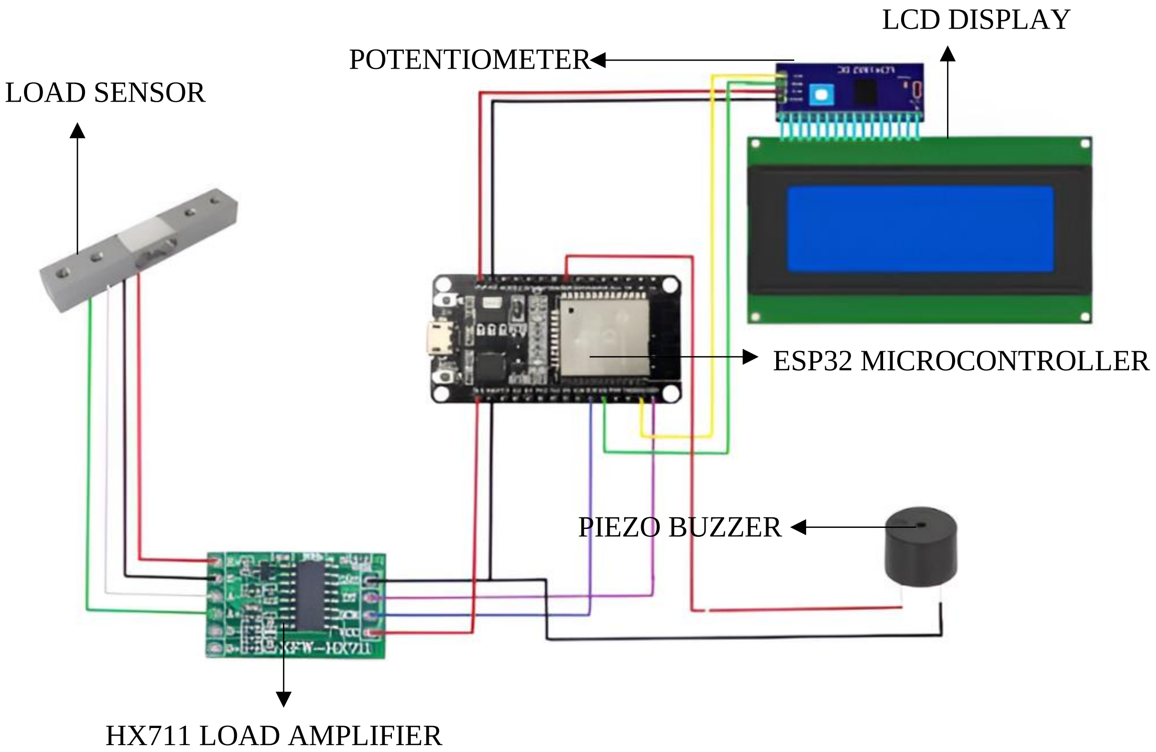

Fig 5.10 Circuit Diagram

5.5 EXPERIMENTAL SETUP:

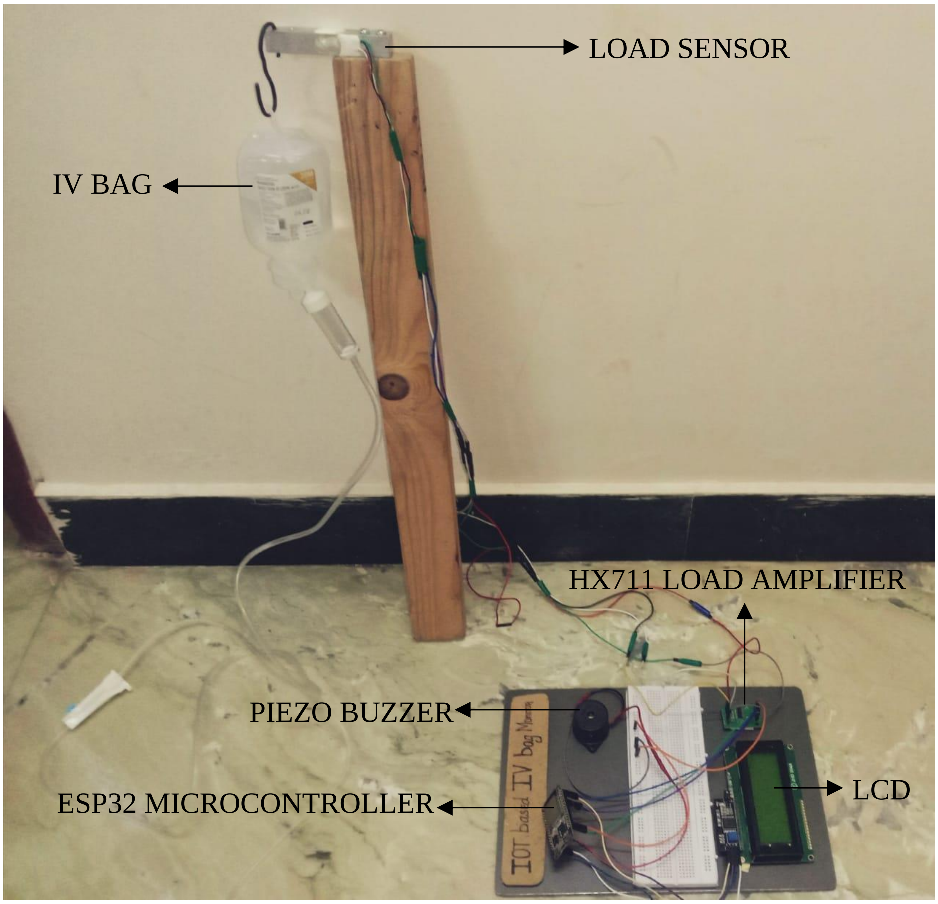

Fig 5.11 Experimental Setup

CHAPTER – 6
RESULTS AND DISCUSSIONS

The IoT-based IV bag monitoring system using an ESP32 was successfully implemented, demonstrating reliable performance in accurately measuring and transmitting IV bag weight data to a server. Calibration procedures ensured the weight measurements were accurate within ±0.1 grams. The system maintained stable Wi-Fi connectivity and transmitted data every 60 seconds without errors. The server-side script correctly received and processed the data, confirming effective communication between the ESP32 and the server. Overall, the system achieved its objective of remote IV bag monitoring, providing timely updates and ensuring efficient patient care. Future enhancements, such as database integration, alert systems, security improvements, and a mobile application, can further increase the system's utility and reliability in healthcare settings.

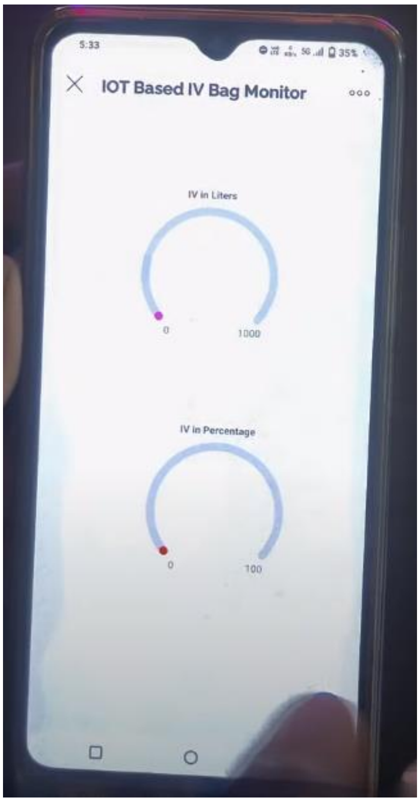

Fig 6.1 Mobile Phone Setup in Blynk Console

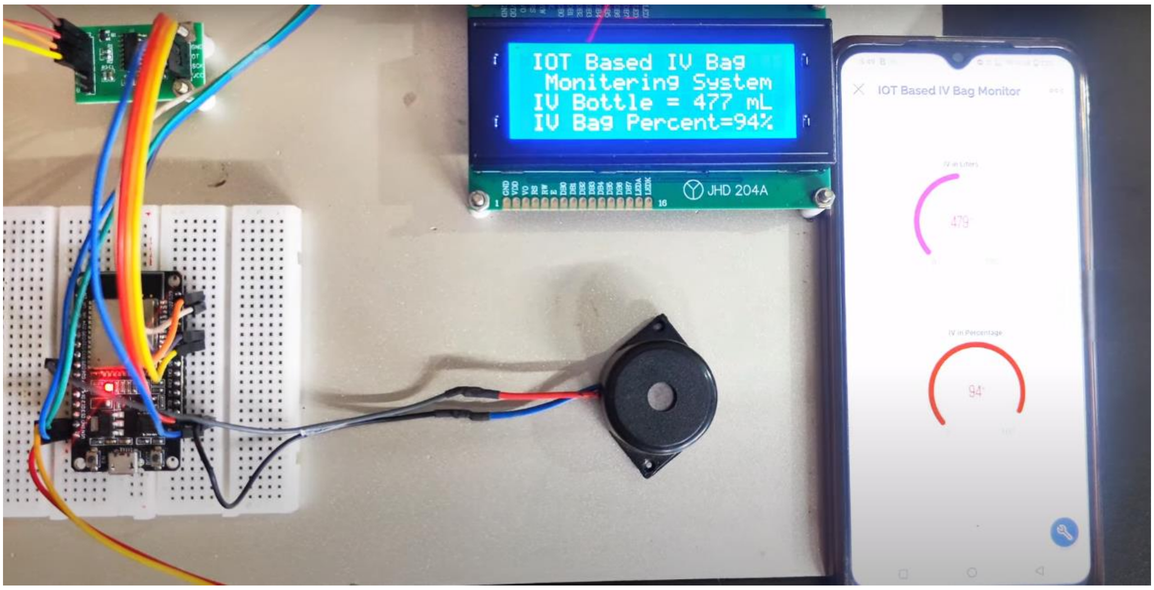

Fig 6.2 Mobile Connected with ESP32 Microcontroller

Fig 6.3 IV Bag Monitoring in Percent and ml

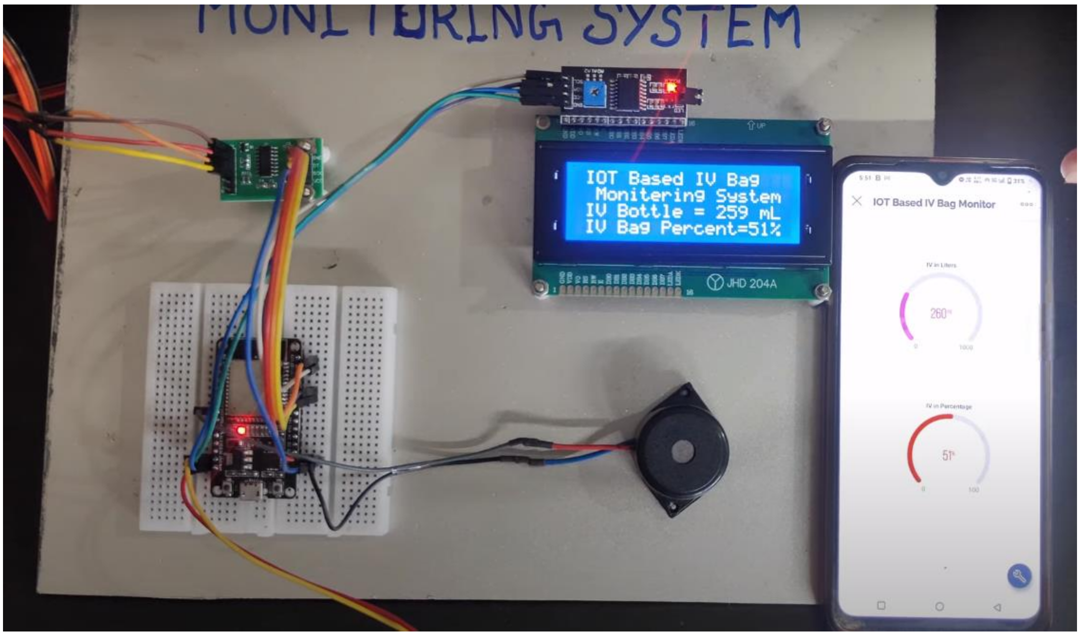

Fig 6.4 IV Bag Percent going Below 50%

Fig 6.5 Showing Alert and Buzzer Sound Below 50%

Fig 6.6 Showing Alert and Buzzer Sound Increased Below 20%

CHAPTER – 7

CONCLUSION AND FUTURE WORK

7.1 CONCLUSION

The development and testing of the IoT-based IV bag monitoring system using an ESP32 have been successful, showcasing its potential to revolutionize healthcare practices. By accurately measuring and transmitting IV bag weight data to a server, the system ensures timely replacements, thus enhancing patient safety and care. The system's reliability in maintaining stable Wi-Fi connectivity and consistent data transmission underscores its practicality in real-world healthcare environments. However, continuous improvements and enhancements are necessary to further optimize its functionality and usability.

7.2 FUTURE WORK

In the future, several enhancements can be implemented to elevate the capabilities and effectiveness of the IV bag monitoring system. Integration of a database will enable the storage of historical weight data, facilitating trend analysis and predictive maintenance. Additionally, implementing an alert system, such as email or SMS notifications, will provide healthcare professionals with immediate notifications when IV bags require attention. Enhancements in security protocols, including the adoption of HTTPS for data transmission and the implementation of robust authentication mechanisms, will bolster the system's integrity and safeguard patient data. Furthermore, the development of a dedicated mobile application will offer healthcare professionals convenient access to real-time monitoring and management of IV bag statuses, thereby enhancing workflow efficiency and patient care outcomes. By pursuing these avenues of future work, the IoT-based IV bag monitoring system can evolve into an indispensable tool for modern healthcare facilities, driving improvements in patient safety, operational efficiency, and overall quality of care.

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APPENDIX

```
#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>

#include <LiquidCrystal_I2C.h>

#include "HX711.h"

#define DOUT 23

#define CLK 19

#define BLYNK_TEMPLATE_ID "TMPL30S2-08iK"

#define BLYNK_TEMPLATE_NAME "IOT based IV bag monitor"

LiquidCrystal_I2C lcd(0x27, 20, 4);

#define BUZZER 25

#define BLYNK_PRINT Serial

char auth[] = "fptdlnyuQwmuQ-ghbY3LH7H-or-kxo8m";

char ssid[] = "sandy 808";

char pass[] = "SHANDIYA";

int liter;

int val;

float weight;

float calibration_factor = 100;

HX711 scale;

void setup() {
```

```
  Serial.begin(115200);
  lcd.begin();
  lcd.backlight();
  pinMode(BUZZER, OUTPUT);
  Serial.println("Remove all weight from scale");
  scale.begin(DOUT, CLK);
  scale.set_scale();
  scale.tare();
  long zero_factor = scale.read_average();
  Serial.print("Zero factor: ");
  Serial.println(zero_factor);
  Blynk.begin(auth, ssid, pass);
}
void loop() {
  Blynk.run();
  measureweight();
}
void measureweight() {
  scale.set_scale(calibration_factor);
  weight = scale.get_units(5);
  if (weight < 0) {
    weight = 0.00;
```

```
}
liter = weight * 1000;
val = liter;
val = map(val, 0, 505, 0, 100);
lcd.clear();
lcd.setCursor(1, 0);
lcd.print("IOT based IV Bag");
lcd.setCursor(2, 1);
lcd.print("Monitoring System");
Serial.print("Kilogram: ");
Serial.print(weight);
Serial.println(" Kg");
lcd.setCursor(1, 2);
lcd.print("IV Bottle = ");
lcd.print(liter);
lcd.print(" mL");
Serial.print("IV BOTTLE: ");
Serial.print(liter);
Serial.println(" mL");
lcd.setCursor(1, 3);
lcd.print("IV Bag Percent=");
lcd.print(val);
```

```
  lcd.print("%");
  Serial.print("IV Bag Percent: ");
  Serial.print(val);
  Serial.println("%");
  Serial.println();
  delay(500);
  if (val <= 50 && val >= 40) {
    Blynk.logEvent("iv_alert", "IV Bottle is 50%");
    digitalWrite(BUZZER, HIGH);
    delay(50);
    digitalWrite(BUZZER, LOW);
    delay(50);
  } else if (val <= 20) {
    Blynk.logEvent("iv_alert", "IV Bottle is too LOW");
    digitalWrite(BUZZER, HIGH);
  } else {
    digitalWrite(BUZZER, LOW);
  }
  Blynk.virtualWrite(V0, liter);
  Blynk.virtualWrite(V1, val);
}
```