IES International Journal of Multidisciplinary Engineering Research

Cloud Based Intravenous Drip Monitoring System

Aliya Shirin [1], Aslam V A [2], Mrinal M L [3], Suvitha P S [4]

[1, 2, 3] *Student, Electronics & Communication Engineering, IES College of Engineering, Kerala, India*

[4] *Assistant Professor, Electronics & Communication Engineering, IES College of Engineering, Kerala, India*

Email_id: aliyashirin12@gmail.com , mrinalml77@gmail.com , aaslu5272@gmail.com , suvithaps@iesce.info .

Abstract

The Cloud-Based Intravenous (IV) Drip Monitoring System is a next-gen healthcare solution designed to enhance accuracy, safety, and efficiency in clinical IV therapy. Unlike traditional manual monitoring, which is prone to human error and inconsistency, this system uses smart IoT integration to automate the process. With real-time sensors, it tracks the drip rate, fluid level, and infusion status, transmitting the data wirelessly to a cloud platform. Healthcare professionals can remotely access this information through mobile and web applications, enabling them to monitor and adjust parameters as needed. The system sends instant alerts when irregularities occur, ensuring timely intervention. It also logs a detailed infusion history, aiding in treatment analysis and optimization. By reducing manual workload and enhancing patient safety, this system makes IV therapy more reliable and efficient, especially in high-demand settings like hospitals and emergency care units.

Keywords: IV drip monitoring, IoT healthcare, Cloud based platform, Infusion status, Wireless communication.

DOI: https://doi.org/10.5281/zenodo.15153211

1. Introduction

IV therapy is a key part of modern medicine. It's how doctors deliver medications, fluids, and nutrients directly into a patient's bloodstream. But while it's effective, it comes with its challenges. Human errors, incorrect flow rates, and the constant need for monitoring can sometimes lead to complications. Traditionally, nurses and doctors manually check IV drips, which are time-consuming and takes away from the time they could be spending with patients.

That's where the Cloud-Based IV Drip Monitoring System comes in. This smart solution aims to make IV therapy safer, more accurate, and less labor-intensive. The system uses smart infusion pumps with built-in sensors that keep track of the flow rate and the amount of fluid being administered. All this data is sent in real-time to a cloud platform, making it accessible to healthcare professionals from their smartphones, tablets, or computers. Whether they're at the hospital or monitoring remotely, they can keep an eye on the patient's IV status without being physically present.

One of the biggest perks of this system is its alert mechanism. If something goes wrong—like a blockage, air bubbles, or an irregular flow rate—the system immediately sends a notification to the medical team. This allows them to act quickly, preventing potential complications. Beyond just monitoring, the system also offers data insights. By collecting and analyzing the IV therapy data, healthcare providers can spot trends, optimize treatment protocols, and even use the data for research. Over time, this can lead to more effective IV practices and better patient outcomes.

Finally, this tech-driven approach helps streamline hospital workflows. By automating routine checks and data logging, it frees up nurses and doctors to spend more time focusing on patient care. Plus, by reducing manual errors, hospitals can cut costs linked to adverse events and corrective treatments.

2. Objectives

The Cloud-Based IV Drip Monitoring System aims to make IV therapy safer, smarter, and more efficient. Its primary goal is to reduce human errors and ensure that patients receive the correct dosage and flow rate at all times. By using real-time monitoring, the system helps detect irregularities early, preventing complications like fluid overload or under-infusion.

Another key objective is to enhance patient safety through instant alerts. If the system detects blockages, air bubbles, or flow rate deviations, it immediately notifies healthcare staff. This ensures faster intervention and reduces the risk of serious complications.

The system also focuses on remote accessibility. Since all data is sent to the cloud, doctors and nurses can monitor patients from anywhere—whether they're on a different hospital floor or off-site. This makes healthcare more flexible and responsive.

In addition to improving patient care, the system also optimizes hospital workflows. By automating routine IV checks and data logging, it frees up medical staff to spend more time with patients. This boosts overall efficiency and reduces the chances of manual documentation errors.

Lastly, the system aims to leverage data analytics. By collecting and analyzing IV therapy data over time, hospitals can identify trends, refine protocols, and improve treatment accuracy. This makes the system not just a monitoring tool but also a valuable resource for future medical research.

3. Materials

Integrating the ESP8266 microcontroller with a load cell, servo motor, and MAX30102 heartbeat sensor enables the creation of an automated IV fluid monitoring system that is both efficient and remotely accessible. The ESP8266 acts as the central unit, handling data processing, sensor integration, and communication via Blynk for real-time monitoring.

A load cell with an HX711 amplifier measures the remaining IV fluid weight, providing accurate data to track depletion levels. The servo motor controls IV fluid flow based on predefined thresholds, ensuring a regulated and automated approach. Unlike ultrasonic sensors, this method prevents unnecessary bag modifications while maintaining precision.

To ensure patient safety, a MAX30102 sensor monitors heart rate, offering an additional layer of health tracking. A 16x2 LCD (I2C) displays fluid levels, heart rate readings, and critical alerts for local monitoring. Additionally, a buzzer sounds alarms when IV fluid levels drop beyond a safe threshold, notifying healthcare staff. The system operates directly on 5V and 3.3V power sources from the ESP8266, eliminating the need for a separate voltage regulator. Proper power management ensures stable operation without fluctuations that could cause ESP8266 reboots or sensor malfunctions.

By integrating these components, the system provides automated IV fluid monitoring, precise flow control using a servo motor, real-time patient monitoring, and remote access via Blynk, making it a practical and cost-effective solution for hospital wards.

3.1 Circuit Diagram.

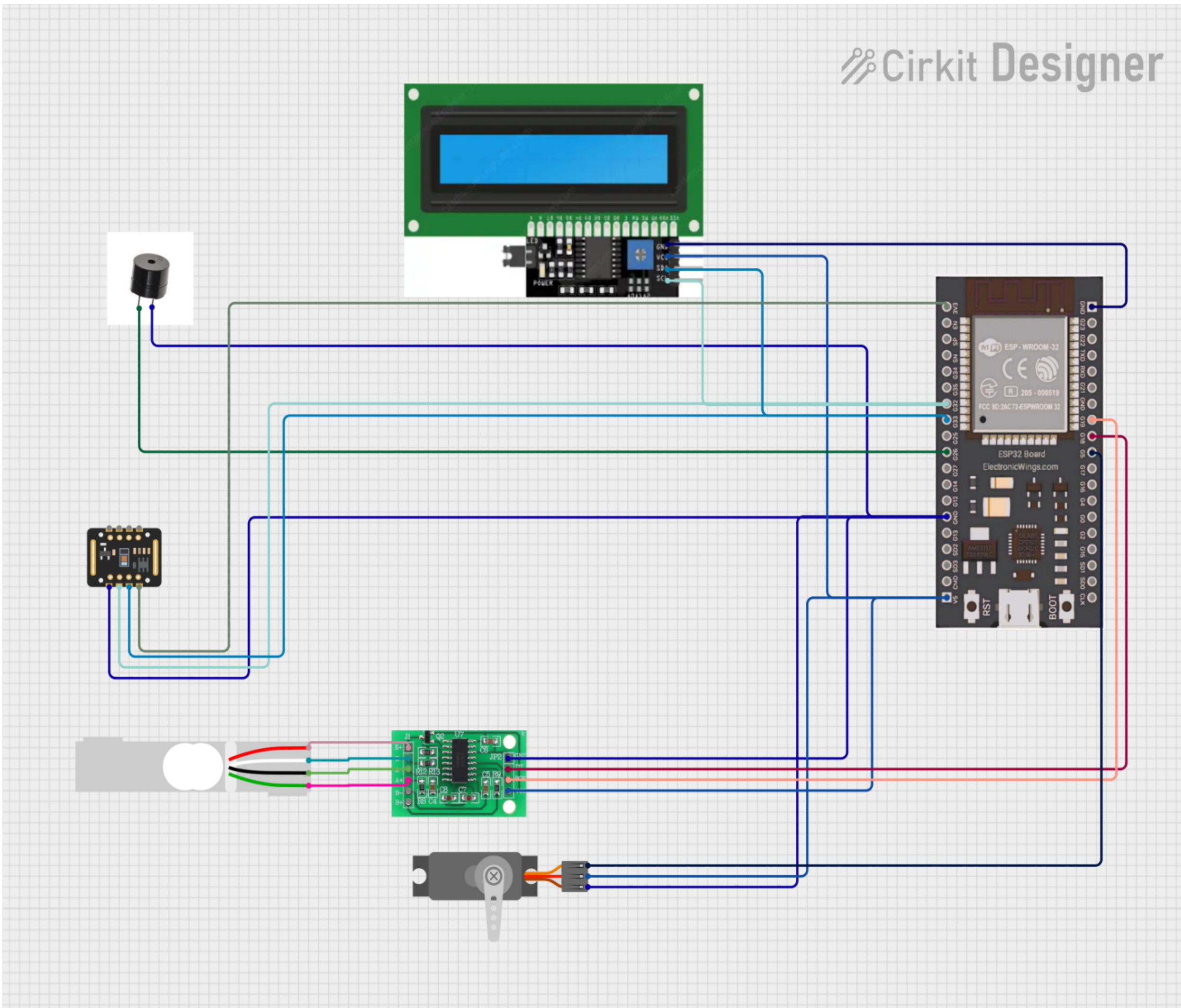

Figure 1: Circuit Diagram

This schematic diagram represents an IV Drip Monitoring System using an ESP32 microcontroller. Here's a detailed explanation of the components and their roles in the system:

Main Components and their functions:

1. ESP32 Microcontroller
Acts as the brain of the system, controlling all sensors, the servo motor, and the display Receives inputs from the load cell and MAX30102 heartbeat sensor, processes data, and triggers outputs like the servo motor and buzzer.

2. Power Supply System

The system operates on 5V and 3.3V directly supplied to the ESP8266 and sensors, ensuring efficient and stable performance.

3. Sensors

Load Cell with HX711 Amplifier: Measures the remaining IV fluid weight and detects depletion.IR Sensors (x3): Used to monitor the levels of rice, wheat, and grains. Each sensor sends a signal when the respective container is low or full.

4. LCD Display (16x2 I2C)

Displays fluid levels, heartbeat readings, and system alerts.

Provides real-time information for medical staff.

5. Buzzer

Sounds alerts when IV fluid levels are critically low, prompting immediate attention.

6. Servo Motors

Controls IV fluid flow by regulating the IV tube clamp based on weight-based depletion

Replaces the need for an ultrasonic sensor, ensuring non-invasive monitoring.

7. Wireless Connectivity (Blynk Integration)

Sends fluid level and heartbeat data to the Blynk app for remote monitoring by doctors or nurses.

Working Principle

1. Power Supply:

The ESP8266 and components operate using 5V and 3.3V power, eliminating the need for additional voltage converters.

2. Input Detection:

The load cell continuously measures IV fluid levels.

The MAX30102 sensor monitors the patient's heartbeat.

If the IV fluid reaches a critical level, an alert is triggered.

3. User Interaction:

Doctors/nurses can view real-time fluid status on the LCD display or remotely via Blynk.

4. Automated IV Flow Control

When the fluid level drops, the servo motor adjusts the IV tube clamp to control the drip rate or pause the flow to prevent air embolism risks.

5. Alerts and Display

The buzzer sounds if IV fluid levels become too low.

The LCD provides continuous updates on fluid status and heartbeat readings.

Blynk notifications ensure remote monitoring access.

4. Result

Figure 2: Result

5. Conclusions

The automated IV fluid monitoring system successfully combines an ESP8266, a load cell, a servo motor, and a MAX30102 heartbeat sensor to create a cost-effective and reliable solution for hospital wards. By swapping the ultrasonic sensor with a servo motor, the system offers precise IV flow control without the need to modify IV bags—overcoming a key flaw of previous designs.

With real-time monitoring through Blynk, healthcare providers can remotely track fluid levels and patient vitals, reducing manual intervention and improving patient safety. The built-in buzzer alert ensures that critical conditions, like low fluid levels, are quickly flagged, preventing potential risks. Meanwhile, the LCD display offers local, real-time monitoring, making the system easy and practical for hospital staff to use.

This project demonstrates that automating IV fluid monitoring is not only feasible but also affordable using readily available components. Future upgrades could include battery backup, extra safety features, and integration with hospital management systems for larger-scale clinical adoption.

By improving efficiency, reducing human errors, and enabling remote patient monitoring, this system provides a scalable and practical solution that could significantly enhance modern healthcare operations.

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