# IOT-BASED IV BAG MONITORING SYSTEM

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*Abstract*— Intravenous (IV) therapy is a critical procedure in healthcare, requiring precise monitoring of fluid levels to avoid complications like air embolism, blood reverse flow, or dehydration. Traditionally, the monitoring of IV fluid levels is done manually by healthcare professionals, which may lead to errors or delays in fluid replacement. This paper proposes an **IoT-based IV Bag Monitoring System** that utilizes **ESP8266 microcontroller**, **16×2 LCD display**, **PCF 8574 I2C expander**, **HX711 load cell amplifier**, and a **10kg load cell** to automate the monitoring process. The system continuously measures the weight of the IV bag, and when the fluid level falls below a predefined threshold, it triggers a notification through IoT to alert healthcare providers. Additionally, the data is displayed on the LCD for immediate visual verification. The use of wireless communication enables real-time remote monitoring and minimizes human error in critical care environments. This system not only enhances patient safety but also improves workflow efficiency for healthcare providers, making it a significant advancement in the medical field, especially in the context of the increasing demand for automated healthcare systems.

***Index term—IV bag monitoring system, Provide Alerts, Real time monitoring , uses IOT.***

## I. INTRODUCTION

[1] S. Velmurugan et al. (2021) proposed a fully automated saline fluid flow control system that not only monitors IV fluid levels but also switches IV containers automatically when one is empty. This system integrates real-time monitoring and automatic container switching, ensuring a continuous and uninterrupted infusion process for patients. The automation significantly reduces the workload of nurses, who typically have to monitor and replace IV bags manually. By incorporating intelligent flow control, the system helps in preventing human errors such as delays in IV replacement, which can lead to complications like dehydration or embolism. The innovation in this research is particularly useful for hospitals with high patient loads, where timely IV monitoring and replacement are crucial.

[2] Debjani Ghosh et al. (2018) introduced a smart saline level monitoring system using the ESP32 microcontroller and MQTT-S protocol to facilitate low-power wireless data transmission. The system continuously monitors the saline level and sends alerts when the fluid drops below a critical threshold. The use of MQTT-S, a lightweight protocol, ensures efficient data transfer with minimal power consumption, making it ideal for battery-powered medical devices. Additionally, this system enhances remote patient monitoring by allowing hospital staff to receive notifications on their smartphones, reducing the need for constant bedside monitoring. The approach is particularly beneficial in large hospitals, where real-time communication about IV status can help streamline medical care.

[3] Mohammed Arfan et al. (2020) developed an IoT-enabled IV infusion rate monitoring and control device aimed at providing precision care with portability. Their system utilizes flow sensors, cloud analytics, and mobile app integration to ensure accurate IV administration. Unlike traditional IV monitoring, which relies on manual observation, this system provides real-time alerts and remote access to IV status, allowing healthcare providers to intervene promptly. The portability aspect makes this system suitable for home-based patient care, where continuous monitoring by a nurse is not always feasible. This research highlights the importance of IoT in modern healthcare, ensuring safer and more efficient IV administration.

[4] Shyama Yadav and Preet Jain (2016) presented a real-time cost-effective e-saline monitoring and control system

that utilizes low-cost sensors and microcontroller-based decision-making. The primary objective of this system is to develop an affordable IV monitoring solution that can be widely implemented in developing countries and rural healthcare settings. By automating IV flow regulation, the system eliminates the need for constant manual supervision, thereby reducing the chances of errors such as air embolism and excessive infusion. The affordability of this system makes it a feasible solution for healthcare centers with limited resources, ensuring that patients receive timely IV fluid administration without requiring a large workforce.

[5] S. Preethi et al. (2020) proposed an IoT-based healthcare monitoring system that integrates intravenous flow control with real-time cloud updates. The system continuously tracks the IV bag's fluid level and transmits data to a cloud server, enabling healthcare providers to monitor patient IV levels from remote locations. The integration of automated infusion adjustments minimizes the risk of over-infusion or under-infusion, thus improving patient safety. The study emphasizes the significance of cloud-based medical data management in modern hospitals, where automation and efficiency play a crucial role in patient care. This approach not only improves workflow efficiency but also reduces the dependency on manual monitoring.

[6] Monisha K. Bhavasaar et al. (2016) designed an automated intravenous fluid monitoring and alerting system using pressure sensors and Wi-Fi communication. Unlike traditional volume-based methods of monitoring IV fluid levels, this system detects variations in pressure within the IV tube and generates alerts accordingly. The use of Wi-Fi connectivity ensures real-time updates to healthcare professionals, allowing them to take immediate action when required. This research highlights the advantages of using pressure-based detection over conventional volume measurement techniques, as it provides higher accuracy in determining fluid depletion and enhances patient safety.

[7] Pratiksha W. Digarse and Sanjaykumar L. Patil (2017) developed a wireless health monitoring system using Arduino UNO and GSM technology, specifically targeting low-resource hospitals. The system employs a load cell to measure saline weight and sends SMS alerts via GSM when the IV bag is about to be empty. This approach ensures that the system remains functional even in areas with limited or no Wi-Fi connectivity, making it an ideal solution for rural healthcare centers. The study underscores the importance of cost-effective IV monitoring systems, as they help reduce the burden on healthcare staff while ensuring timely IV replacement..Overall, these studies emphasize the importance of IoT, automation, and wireless communication in modern IV fluid monitoring systems. By leveraging technologies such as cloud computing, pressure sensors, load cells, GSM, and programmable logic controllers, researchers have developed innovative solutions that reduce human intervention, enhance patient safety, and optimize hospital workflow. Future advancements in AI-driven predictive analytics and improved sensor technology could further revolutionize IV monitoring, making healthcare smarter and more efficient.

## II. CONCEPT MAKING AND SYSTEM MODELLING

The IoT-based IV Bag Monitoring System is designed for ease of use, ensuring that healthcare professionals can quickly adopt and operate it with minimal training. The system automatically monitors the IV bag's fluid level, reducing the need for manual checks. The real-time data is displayed on an LCD, providing immediate visual feedback, and notifications are sent via a mobile app when the fluid level falls below the threshold, alerting healthcare providers promptly. The use of the ESP8266 microcontroller and wireless communication ensures that the system can be easily integrated into existing healthcare setups. With simple setup procedures and user-friendly interfaces, this system minimizes human error, enhances patient safety, and improves the workflow of healthcare providers, making it both efficient and convenient to use in a clinical environment.

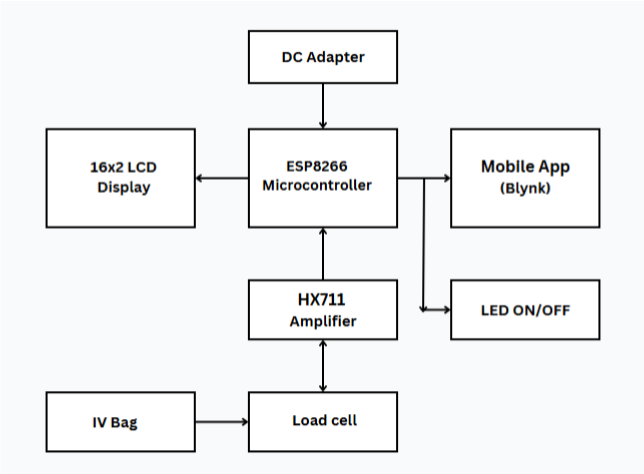

Fig.1.Block diagram of the proposed system

The block diagram of the IoT-based IV Bag Monitoring System represents the flow of information and interaction between the components involved in the project. The DC Adapter serves as the power source for the entire system, providing the necessary voltage and current to the microcontroller and other components. This steady power supply ensures that the system operates continuously without interruptions.

The ESP8266 Microcontroller plays the crucial role of processing the data from the sensors and controlling the overall system. It receives the data from the HX711 amplifier, which is connected to the Load Cell. The load cell measures the weight or fluid level in the IV bag, and its output is amplified by the HX711 amplifier before being sent to the microcontroller for analysis. The microcontroller also interfaces with the 16x2 LCD Display, showing real-time data about the fluid levels in the IV bag for immediate reference by healthcare providers.

Additionally, the microcontroller sends notifications to the Mobile App (Blynk), alerting healthcare professionals if the fluid level falls below a predefined threshold, making it easy for the staff to monitor the IV bag remotely. The LED acts as a local visual indicator, turning on to alert the healthcare provider when the fluid level in the IV bag is low, providing an extra layer of alertness.

In summary, this system leverages wireless communication, sensor technology, and real-time monitoring to automate the tracking of IV fluid levels, improving efficiency and safety in healthcare environments. It allows for immediate alerts through mobile notifications and provides both visual and digital indicators to ensure that critical tasks are not overlooked.

## III. ACCESSORIES OF THE PROPOSED SYSTEM

A specified number of electrical components must be employed to achieve a specific goal.The components are required to be correctly connected in order to operate synchronously.In this section,the major components like the ESP8266 Microcontroller, Load cell, HX711 Amplifier, PCF8574, and the LCD of the designed prototype have been briefly discussed.

### *1. ESP8266*

The ESP8266 is a highly popular, low-cost Wi-Fi module used in various IoT and embedded systems applications. It integrates a microcontroller and Wi-Fi networking capability in one chip, which makes it ideal for small, wireless devices that require internet connectivity. The module can operate as a Wi-Fi access point or a client, allowing it to connect to a local network or even act as its own network. It is built with low-power consumption in mind, which is essential for IoT applications that rely on battery power for extended periods.The ESP8266 is highly flexible, supporting protocols such as TCP/IP, HTTP, and MQTT, allowing seamless communication with web servers, cloud services, or other IoT devices. One of its key features is its compatibility with the Arduino IDE, enabling easy programming and fast prototyping for developers, engineers, and hobbyists. It also provides GPIO pins, PWM, and analog-to-digital converters, making it suitable for controlling various sensors and actuators in real-time.

### *2. Load Cell*

A load cell is a type of sensor used to measure force or weight by converting mechanical force into an electrical signal. It works on the principle of strain gauges that change their resistance when stretched or compressed. The most common types of load cells include strain gauge load cells, hydraulic load cells, and pneumatic load cells, with strain gauge load cells being the most widely used in various applications. In a strain gauge load cell, the strain gauges are bonded to a metal element, which deforms when a force is applied. The deformation causes a change in the electrical resistance of the strain gauges, which is measured and converted into a corresponding weight or force value. This electrical signal is typically very small and is often amplified using devices like the HX711 amplifier, which boosts the signal to a readable level.Load cells are commonly used in applications such as weight scales, industrial automation, and load measurement systems. They can measure weight, force, or torque, depending on the application. In IoT-based systems, load cells can be connected to microcontrollers like the ESP8266, allowing for real-time monitoring and data transmission over the internet for further analysis or control.

### *3. HX711 Amplifier*

The HX711 amplifier is a precision 24-bit analog-to-digital converter (ADC) designed specifically for weight scales and other force-sensing applications. It is widely used with load cells to amplify the tiny electrical signal generated by the load cell into a signal that can be read by a microcontroller, like the ESP8266 or Arduino. This amplification process allows for precise weight or force measurements to be captured.The HX711 amplifier operates by receiving an analog signal from the load cell. The load cell generates an extremely small signal that is proportional to the applied force or weight. The HX711 amplifies this signal, converting it to a 24-bit digital signal, which provides high resolution and accuracy for measurement. The converted digital signal is then sent to a microcontroller for processing.The HX711 has two input channels, allowing it to handle two load cells if necessary, and it also includes a built-in clock generator to simplify timing for conversions. Its low power consumption and simple interface make it ideal for IoT applications, where it can be used to collect weight data from load cells and transmit it over networks like Wi-Fi for further processing or monitoring, often through apps or cloud systems. This makes it an essential component in IoT-based weight or force monitoring systems.

### *4. PCF8574*

The PCF8574 is an I²C-based GPIO (General Purpose Input/Output) expander, typically used to increase the number of input/output pins available for a microcontroller. It allows microcontrollers like the ESP8266 or Arduino to control more devices or read more sensors without needing additional pins. It works by communicating with the microcontroller via the I²C bus, which uses just two wires (SDA for data and SCL for clock) for communication. The PCF8574 can provide 8 additional I/O pins, each of which can be configured as either an input or an output. This flexibility allows it to be used for controlling LEDs, switches, or sensors in an IoT-based system like the IV bag monitoring system, where limited I/O pins on the microcontroller may require expansion.For example, when interfacing with a 16x2 LCD display that uses I²C communication, the PCF8574 can be used to control the data and control pins of the LCD, reducing the number of digital pins required on the microcontroller. This makes it an important component in minimizing the number of pins used while still maintaining full functionality in projects that need more I/O control.

### *5. 16x2 LCD Display*

A 16x2 LCD (Liquid Crystal Display) is a commonly used screen in embedded systems and IoT projects, such as the IoT-based IV bag monitoring system. This display features 16 columns and 2 rows of characters, making it suitable for displaying basic text information such as sensor readings, status messages, or alerts in various applications.

In the IV bag monitoring system, the 16x2 LCD display can be used to show real-time data, such as the weight of the IV bag, fluid levels, or system status. The display is usually controlled via an interface like I2C or parallel communication, with I2C being more commonly used for saving input/output pins on the microcontroller, especially in compact projects where pin availability is limited. The display is ideal for showing user-friendly information and making the system easily understandable for operators. It can display simple messages such as "IV Bag Low," "System Ready," or "Fluid Level OK," enhancing the ease of monitoring the IV bag remotely or in hospital settings.

## IV. PROJECT DESIGN AND WORKING PRINCIPLE

The proposed system's circuit diagram is shown in Fig. 2

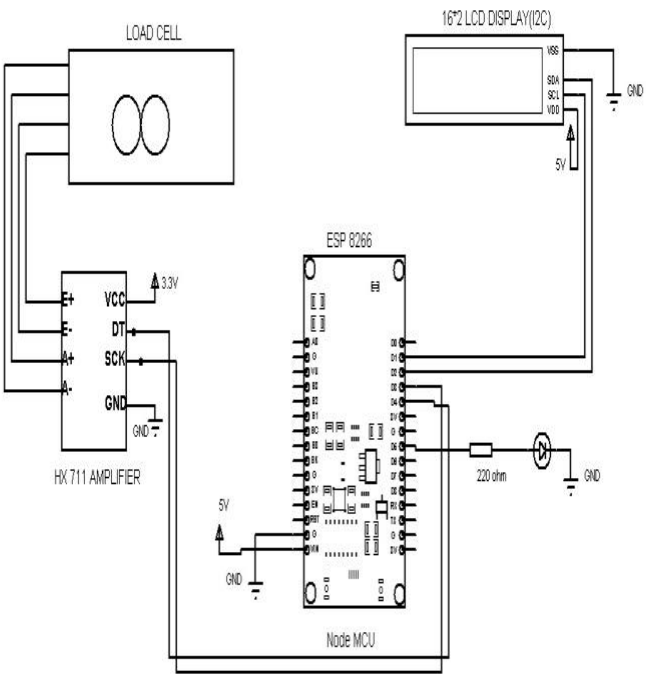


Fig.2. Circuit diagram of the proposed system

Working principle of the IoT based iv bag monitoring system involves several steps:

**Step 1: Initialize the System**

- Power Up: Initially, the ESP8266 microcontroller and all connected components (load cell, HX711 amplifier, LCD, and LED) are powered up by the power supply (e.g., 5V adapter or battery).
- Component Initialization: The ESP8266 initializes the sensors (HX711 with load cell), LCD screen, and other components. The system is ready to begin monitoring the IV bag.

**Step 2: Reading the Load Cell Value**

- Load Cell Function: The 10kg load cell detects the weight of the IV bag. The load cell reacts to the weight of the IV bag (filled with fluid or running low on fluid). It converts the applied force into a tiny electrical signal (analog).
- Signal Amplification: Since the load cell's signal is very small, it requires amplification. The HX711 amplifier increases the analog signal to a level that can be processed by the ESP8266 microcontroller.
- Data Conversion: The HX711 then converts the amplified analog signal into a digital signal, which the ESP8266 microcontroller can process.

**Step 3: Signal Processing by ESP8266**

- Processing the Weight Data: The ESP8266 receives the digital data from the HX711. It processes the data to calculate the weight of the IV bag.
- Threshold Comparison: The ESP8266 compares the weight with a pre-set threshold value (e.g., a weight limit indicating the IV bag is running low on fluid). The threshold is set based on the required amount of fluid for the patient.

**Step 4: Displaying the Data on LCD**

- 16x2 LCD Display: The weight of the IV bag is displayed on the 16x2 LCD screen. This shows real-time data for healthcare staff to monitor the current weight of the IV bag. It uses the PCF 8574 I2C module, which helps to reduce the number of connections and make wiring more manageable.
- Data Update: The LCD updates the displayed weight value periodically so that healthcare staff can see the real-time status of the IV bag.

**Step 5: Alert via LED and Mobile App**

- Threshold Monitoring: If the weight of the IV bag falls below the threshold, it means the IV fluid is about to finish. The ESP8266 microcontroller triggers an LED indicator (Red LED) to turn ON, signaling to the healthcare team that the IV bag needs attention.
- IoT Notification: Simultaneously, the ESP8266 sends the data to a Blynk App (or any other IoT platform). This notification alerts the healthcare staff remotely that the IV bag is almost empty, and it needs a refill or replacement.

**Step 6: LED Indicator**

- The LED will stay ON as long as the IV bag's weight is below the set threshold, giving a visual alert to nearby personnel. This serves as an immediate indication that action needs to be taken.
- The LED turns OFF once the weight goes above the threshold, indicating that the IV bag is within an acceptable weight range.

**Step 7: Power Supply Management**

- The system runs on a 5V DC power supply to provide power to the ESP8266, LCD, and other components. Depending on the project setup, this power could come from an AC adapter or a 12V battery.

**Step 8: Remote Monitoring**

- Blynk App: The ESP8266 sends real-time data to a mobile app (such as Blynk) via Wi-Fi. This app can show the current weight of the IV bag and send notifications when the weight falls below the threshold. This ensures healthcare professionals can monitor multiple patients' IV bags from a remote location.

**Step 9: System Reset**

- When the IV bag is replaced or refilled, the weight goes back up above the threshold. The system resets, and the LED turns OFF, with notifications cleared from the mobile app.

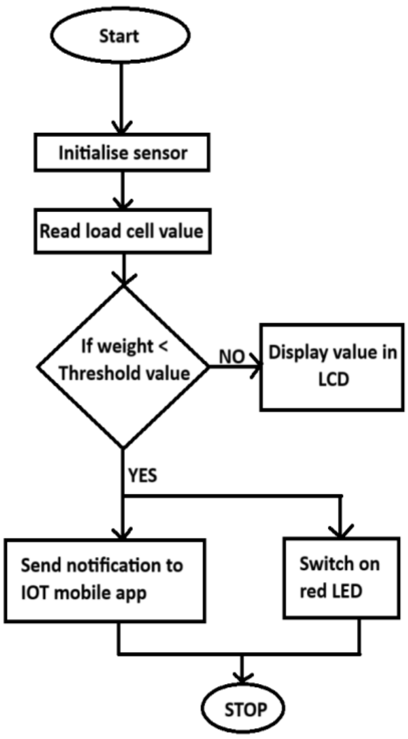


Fig.3. Flow chart of the proposed system

Fig.3 shows a flow chart that illustrates the signal flow of the whole proposed IV fluid monitoring system and the decision-making scenario.

## V. RESULT AND CONCLUSION


(a)Top view


(b) Side view

Fig.4. Prototype of the proposed IV fluid monitoring system

The IoT-based IV Bag Monitoring System represents a major advancement over traditional manual monitoring methods used in healthcare settings. In the present system, healthcare professionals are tasked with manually checking IV fluid levels, a process that is prone to human error and delays. This project automates the entire monitoring process, reducing these risks and improving the accuracy of fluid level tracking. By using a combination of components like the ESP8266 microcontroller, load cells, and HX711 amplifier, the system continuously measures the weight of the IV bag, ensuring that healthcare providers are alerted when fluid levels fall below a predefined threshold.

The integration of real-time data transmission via the Internet of Things (IoT) enables immediate notifications to be sent to healthcare professionals through a mobile app (such as Blynk). This allows healthcare workers to respond quickly, even if they are not in the immediate vicinity of the patient. Additionally, the system displays fluid levels on a 16x2 LCD screen for easy monitoring and includes visual indicators like LEDs to further alert the staff.

By offering automated, continuous, and accurate monitoring, this system enhances patient safety by preventing issues like fluid overload, dehydration, or air embolism. Furthermore, the real-time notifications improve the workflow efficiency of healthcare providers by enabling them to act promptly, even when they are away from the patient or the monitoring station. In summary, the IoT-based IV Bag Monitoring System not only resolves the inefficiencies of manual monitoring but also introduces a more reliable, timely, and user-friendly solution for healthcare facilities.

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