"Intravenous Fluid Tracker Using Embedded Systems"

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***Abstract*— The paper report an improvement and modification in an intravenous fluid tracker focusing on better and more simplified fluid therapy management. The designed for embedded system, real time system continuing to monitor fluid volume, flow rate, and air in the IV bag. The system is made out of multiple sensors connected to an Arduino microcontroller. Meanwhile, the microcontroller is connected to the wireless network of the hospital and the monitoring system. For each alert in the monitoring system, the microcontroller sends an SMS, an App and it includes a notification for the hospital?s nurse call system. The increase of medical response in real time system minimizes the IV complication, reduces the monitoring manual work and makes the process safer and more efficient for the patient and the clinic.**

Index Terms—Embedded systems, fluid monitoring, clinical safety, flow rate detection, automated alerting.

I. INTRODUCTION

The aim of this project is to increase the accuracy, dependability, and safety of IV administration in healthcare facilities using an embedded system designed to track the sensors for temperature, volume, and flow rate of the IV fluid in the IV bag. During every few seconds interval, the flow control unit of the IV is programmed to track the data and assess it for the supplied rate of fluid to determine if the IV is functioning.

The embedded system is programmed to monitor temperature change, flow rate, and volume to stay in a safe range and to provide an alert to staff when the systems is functioning outside of the defined control parameters. Immediate staff alerts are intended to mitigate said complications.

The system is designed to provide medical staff data to identify patterns in IV administration over time to improve systems and workflows, increase efficiency, and provide a basis for decision-making.

The negative impacts of error on IV fluid administration can be severe. An embedded system designed to monitor and provide alerts based on the parameters of flow rate, temperature, and volume of IV bags and the control systems built to notify staff based on parameters are unique and innovative.

II. LITRATURE SURVEY

Innovation in IoT technology and embedded systems continues to grow and is effecting automation in health care where monitoring IV therapy is concerned. Over the years, different academics have explored resolving difficulties with manual IV tracking, patient safety, and staff workload in hospitals.

A smart IV infusion monitoring system was devised by

Park and Kim [1], where sensors monitor the IV bag's fluid levels. Their investigation proved the value of simple automation in avoiding detection of fluid backflow or unintended emptying of the IV bag during busy hospital shifts. Another system focuses monitoring patient vital signs, where Kumar and Patel [2], designed an IoT system that monitors temperature and heart rate and sends emergency warnings when there is an abnormal change.

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Furthermore, Ahmed and Chan [5] proposed An Efficient System for IV Fluid Level and Patient Condition Monitoring, integrating both IV monitoring and vital sign tracking. In order to improve patient outcomes and enable prompt medical treatment, their 2024 IEEE work uses Wi-Fi-based alert mechanisms to send real-time notifications to caregivers.
From the evaluation of these studies, it is obvious that IoT and embedded systems play a vital role in enhancing healthcare automation, notably in IV therapy monitoring. Nevertheless, the majority of current systems concentrate on either patient vital monitoring or IV level detection separately. By offering a uniform, dependable, and affordable solution that guarantees ongoing monitoring, automatic alerts, and improved clinical safety, the suggested Intravenous Fluid Tracker using Embedded Systems seeks to close this gap.

III. PROBLEM STATEMENT

Intravenous (IV) therapy is a normal and necessary operation in hospitals, when fluids, drugs, and nutrients are administered directly into a patient's bloodstream. Despite its importance, most hospitals still rely on manual monitoring of IV fluid levels. Nurses must manually check each IV bag at regular intervals to ensure it does not empty or run too fast. This manual approach is time-consuming, prone to human error, and can lead to major dangers, such as air entering the IV line, fluid overload, or delays in treatment.

Continuous manual monitoring becomes even more difficult due to a growing patient load and a shortage of medical personnel. Consequently, the demand for a dependable, automated system that tracks
IV fluid levels in real time and alerts healthcare staff before any critical situation occurs.
An embedded-system-based Intravenous Fluid Tracker can address these issues by providing continuous measurement of fluid levels, detecting abnormalities in flow rate, and sending timely notifications. Such a system would improve patient safety, reduce nurse workload, and enhance overall efficiency in healthcare settings.
This paper aims to design and develop an embedded solution that accurately monitors IV fluid levels and provides real-time alerts, helping to prevent complications caused by IV fluid mismanagement.

IV. SYSTEM DESIGN

The suggested Intravenous Fluid Monitoring System is built as a multi-sensor integrated architecture intended for the continuous acquisition, processing, and wireless transmission of IV therapy information. The system includes numerous sensing modules interfaced with an Arduino UNO microprocessor, providing precise monitoring of fluid level, flow rate, and patient physiology. The technology guarantees enhanced clinical safety, decreased manual supervision, and automated IV regulation through real-time data evaluation and warning production.

- The primary hardware components utilized in the design include:

  1.Load Cell: Measures the IV bag's weight and indicates fluid-level depletion.

  2.Flow Sensor: Identifies saline flow rate, obstructions, and leak conditions.

  3.Temperature, ECG, and pulse sensors: Constantly gather vital signs from patients.

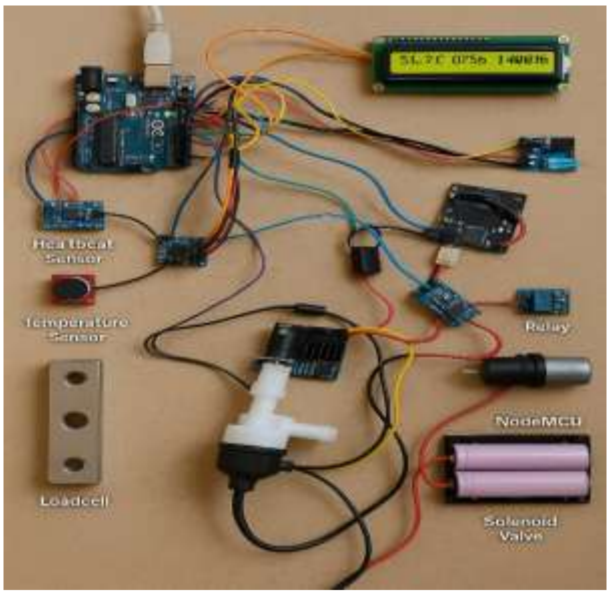
  4.LCD Module: Displays real-time system values for local supervision.

  5.GSM Module & Android App: Enable remote monitoring and wireless alert alerts.

  6.Solenoid/Controlled Valve: Regulates the infusion rate using remote Android-based control.

4.1 Hardware Architecture

Each sensor functions as a separate measuring unit while contributing to a single monitoring environment thanks to the hardware architecture's modular sensing framework. The Arduino UNO works as the central processing element, gathering sensor data, doing calibration, and issuing warnings.



The load cell, which is placed underneath the IV fluid bag, continuously tracks changes in weight that correspond to fluid loss. In order to identify anomalies like zero flow, reverse flow, or excessive flow rate, the flow sensor, which is integrated into the drip line, detects instantaneous saline displacement.

Biomedical sensors such as ECG, pulse rate, and temperature modules capture patient physiological activity, ensuring synchronized monitoring of both fluid administration and patient status. Sensor outputs are processed and displayed on an LCD interface, while parallel wireless transmission is carried out through a GSM module for timely warning.

While the solenoid-controlled valve enables closed-loop flow-rate adjustment based on system feedback, the Android application enables nurses and clinicians to remotely observe patient status, fluid levels, and flow conditions.

4.2 Architecture of Data Flow

The system's operational workflow follows an organized, multi-stage processing pipeline:

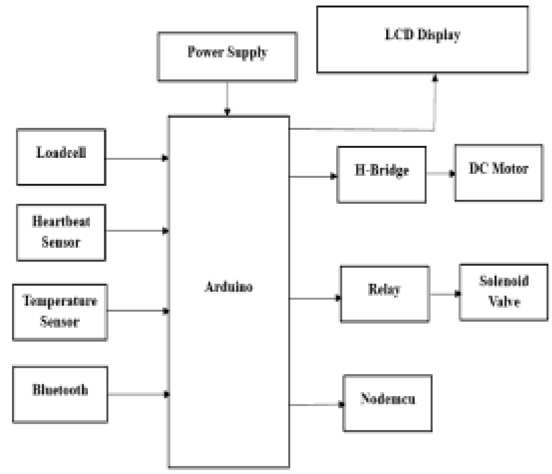


Fig 3.1 The block diagram of the proposed system

1. Continuous Sensing-
All sensors—load cell, flow sensor, ECG, pulse, and temperature—acquire real-time data at regular sampling intervals.
2. Signal Conditioning & Processing-
For every sensing parameter, the Arduino UNO performs threshold comparison, noise filtering, and calibration.
3. Identification of Abnormalities and Alert Triggering-
If the fluid level dips below a pre-set threshold, flow abnormalities occur, or vital indicators deviate from typical ranges, the system activates quick SMS/Android warnings.
4. Wireless Data Transmission -Feedback-Based Actuation
When required, the Android app operates the solenoid valve, allowing remote adjustment of the IV flow rate.
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When required, the Android app operates the solenoid valve, allowing remote adjustment of the IV flow rate.

IV. FINAL OBSERVATION

The Intravenous Fluid Monitoring System worked properly and reliably during testing, successfully monitoring fluid level through the load cell and detecting flow variations with the flow sensor. Every time the fluid level was low, the flow was obstructed, or the patient's vital signs displayed abnormal values, the system instantly generated notifications via the GSM and Android application. Every

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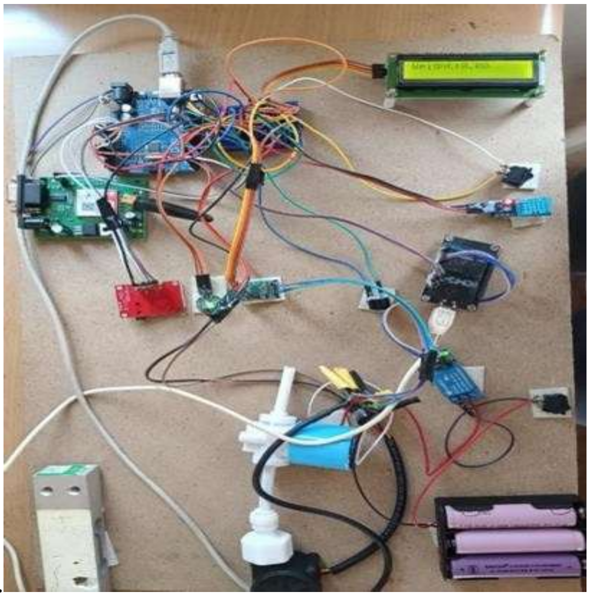
sensor had a constant response, and the information showed on the mobile app and LCD was understandable and clear. All things considered, the system was successful in increasing patient safety, decreasing manual monitoring, and guaranteeing ongoing, automated IV therapy supervision.



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V. CONCLUSION

In this study, an embedded-system–based Intravenous (IV) Fluid Monitoring System was created and deployed to enable real-time supervision of fluid level, flow rate, and patient vitals during IV therapy. The system includes numerous sensing modules—such as a load cell, flow sensor, and biological sensors—interfaced with an Arduino microcontroller to continually track infusion parameters under varying clinical settings. Experimental observations indicated that fluid-level changes and flow-rate fluctuations were accurately identified, validating the system's capability to identify key events such as low fluid levels, blockages, leaks, and irregular infusion patterns. The alarm mechanism, activated using GSM and an Android application, ensured timely notice to medical professionals, considerably lowering the need on human monitoring.

The association between sensor outputs and actual infusion conditions revealed good linearity and repeatability, indicating reliable system performance throughout prolonged operation. The advantages of embedded monitoring solutions—high responsiveness, low power consumption, ease of integration, and suitability for continuous clinical use—over conventional manual IV supervision techniques are highlighted by the combination of wireless communication, real-time sensing, and automated notifications.

The technology also provides a strong basis for upcoming improvements, such as automated flow control with sophisticated feedback mechanisms, cloud-based data logging, and predictive analytics for infusion trends. All things considered, the suggested IV Fluid Monitoring System offers a scalable, precise, and effective method for enhancing patient safety, facilitating the early identification of infusion-related problems, and assisting predictive healthcare practices in clinics, hospitals, and remote-care settings.

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