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The Future of Iv Therapy: Smart Saline Bottle Using Iot Solutions

Mrs. M. Mohanapriya[1]
Department of Computer Science and Engineering
SRM Valliammai Engineering College
Chennai, India

Abilash K[2]
Department of Computer Science and Engineering,
SRM Valliammai Engineering College
Chennai, India

Harish N[3]
Department of Computer Science and Engineering
SRM Valliammai Engineering College
Chennai, India

Dhushiv S[4]
Department of Computer Science and Engineering
SRM Valliammai Engineering College
Chennai, India

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Abstract: intravenous (IV) therapy is a critical component of modern healthcare, ensuring efficient delivery of fluids, medications, and nutrients. However, traditional IV systems rely on manual monitoring, leading to potential issues such as delayed response to depletion, air embolism risks, and inaccurate flow rate adjustments. This paper presents an IoT-enabled Smart Saline Bottle designed to enhance patient safety and healthcare efficiency.

The proposed system integrates sensors, microcontrollers, and wireless communication to continuously monitor saline levels, flow rates, and patient-specific requirements. Real-time data is transmitted to medical staff via a cloud-based platform or mobile application, enabling automated alerts for timely intervention. Additionally, AI-driven analytics can optimize IV therapy, predicting depletion times and adjusting flow rates dynamically.

By leveraging Internet of Things (IoT) technologies, the smart saline bottle minimizes human error, improves resource management in hospitals, and enhances patient care. This innovation represents a significant step toward intelligent, automated healthcare systems, reducing workload for medical professionals and improving treatment outcomes.

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I. INTRODUCTION

With the rapid advancements in internet of things (iot) technology, there is a growing opportunity to revolutionize conventional iv therapy through automation, real-time monitoring, and smart alert systems. the integration of iot-enabled smart saline bottles into healthcare infrastructure can address key challenges by providing continuous fluid level monitoring, remote supervision, automated alerts for timely intervention, and ai-driven analytics for predictive maintenance.

this paper explores the development and implementation of a smart saline bottle that utilizes iot sensors, wireless communication, and cloud-based data processing to enhance iv therapy safety and efficiency. the proposed system aims to minimize human errors, prevent iv-related complications, optimize resource management in hospitals, and improve overall patient outcomes. by leveraging smart healthcare solutions, this innovation represents a significant step toward intelligent, automated medical systems, ensuring a more efficient, reliable, and patient-centric approach to iv therapy.

Despite its importance, traditional IV systems rely heavily on manual monitoring by nurses and healthcare professionals, leading to inefficiencies, delays in response, and potential risks such as fluid depletion, air embolism, or improper flow rate adjustments. These limitations can result in critical health complications, increased workload for medical staff, and suboptimal patient car

II. LITERATURE REVIEW

A Neonatal Intravenous Monitor Prototype Authors: J. Silva, E. Jeong, C. Lam, G. C. Valentine, D. M. Wilson The paper discusses the development of an intravenous (IV) infusion monitoring system prototype, H2neO, designed for low drip rates (25–400 drops/hr) with a macrodrip infusion set. The system, utilizing an infrared emitter, detector, and Arduino-based microcontroller, is aimed at low-resource settings for neonates. Through signal preprocessing and a k-means approach to drop classification, the system achieves a detection error of +/- 0.5%, outperforming commercially available monitors and demonstrating its potential for use in neonatal care.

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Low-cost BLE based Intravenous Monitoring and Control Infusion System Authors: S. Abdullah, K. Kanwal, A. Hafid, S. Difallah This paper presents a wireless intravenous drip monitoring system using Bluetooth Low Energy (BLE) technology. The system integrates an infraredbased drop counting system, digital servo motor for flow control, and a microcontroller, providing remote monitoring through a LabView GUI. The system achieves an accuracy of 96%, ensuring precise calculation of the drip rate and fluid level, thus enhancing intravenous therapy administration.

Patient Monitoring System on Intravenous Fluid Authors: V. Arunvikas, S. Pravesh, J. Shafni, V. Sumitra This system integrates a DHT11 temperature sensor, heart rate sensor, and ultrasonic sensor for real-time monitoring of intravenous fluid administration. The system provides automatic alerts if the drip rate deviates, and an emergency stop mechanism halts monitoring when necessary. Data is transmitted to an 7 Android app via an ESP8266 microcontroller for remote monitoring, aiming to improve the efficiency and safety of intravenous fluid management.

Automatic Intravenous Drip Drop Counter and Controller Authors: R. T. Abbasi, A. Zahoor, L. Junaid, F. Amin, Z. U. Rehman This paper discusses the development of an automated IV drip monitoring system that uses sensors to detect and count drops passing through the IV chamber. It compares the system's measured drip rate to manual calculations, providing more accurate infusion volume and flow rate data. The goal is to reduce complications related to intravenous infusion by automating the monitoring and control process.

Intelligent Intravenous Fluid Monitoring System for Health Surveillance Applications Authors: MradulKumar Jain,Prof. Brij Mohan Singh,Dr. Mridula Singh This paper presents an IV bag monitoring system designed to ensure accurate dosage and reduce complications in intravenous therapy. It includes specialized sensors to measure flow rate, pressure, and remaining volume in the IV bag, providing real-time updates to healthcare professionals. The system integrates alarms for irregularities, reducing the risk of medication errors and ensuring patient safety during IV administration Methodological Approach.

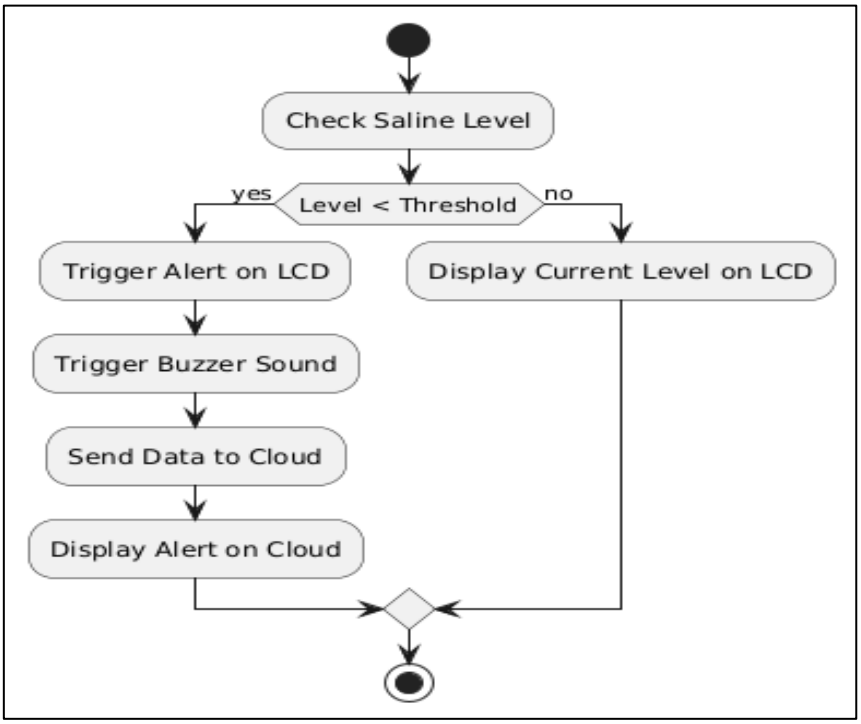

Fig 1 Data Flow Model

The data flow model of the IoT-enabled Smart Saline Bottle describes the systematic process through which data is generated, transmitted, processed, and utilized to ensure real-time monitoring and automation of IV therapy. This model is structured into six major stages: data collection, processing, transmission, storage, user interface interaction, and decision-making. Each stage plays a crucial role in improving patient safety and optimizing hospital resource management.

The IoT-enabled Smart Saline Bottle revolutionizes IV therapy by introducing an automated, data-driven monitoring system. Through real-time data collection, cloud-based analytics, and AI-driven decision-making, the system enhances patient safety, reduces medical errors, and improves hospital efficiency. By integrating IoT with healthcare, this innovation paves the way for smart, automated medical systems, ultimately leading to better patient outcomes and a more efficient healthcare ecosystem.

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III. ARCHITECTURAL FRAMEWORK

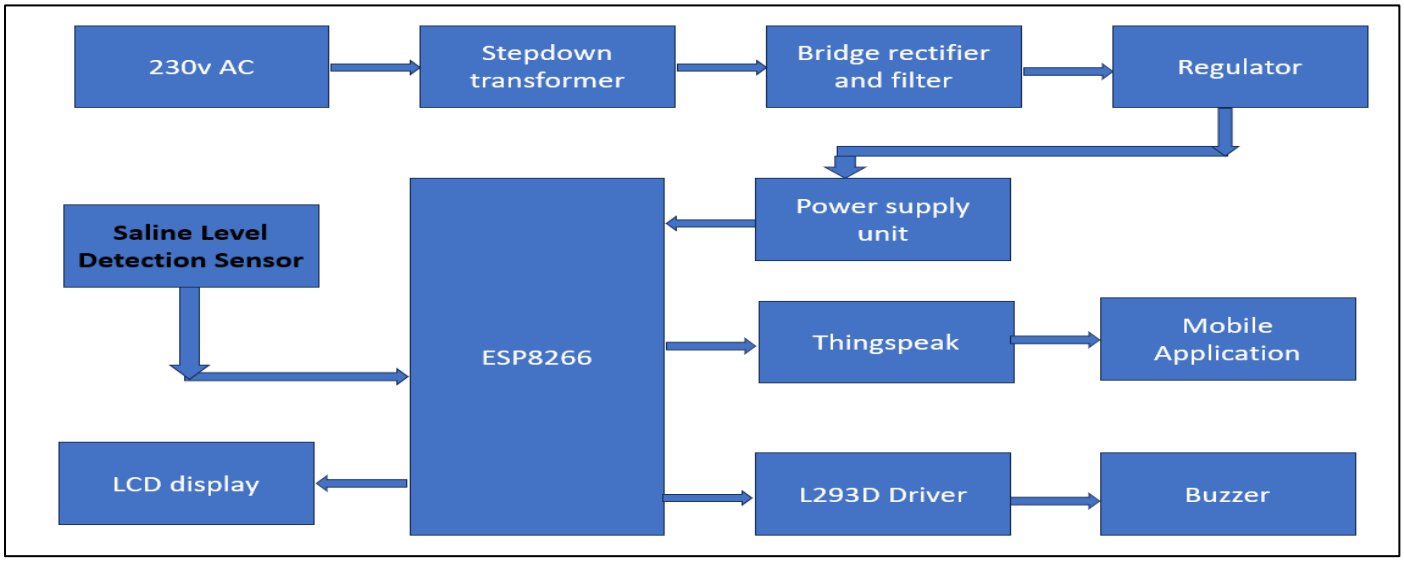

Fig 2 System Architecture

A. *Saline Level Detection Sensor*

This sensor continuously measures the saline level inside the IV bottle.Weight-based sensors (measuring weight reduction as fluid is used).Capacitive sensors (detecting liquid levels through capacitance changes).Ultrasonic sensors (measuring the distance of liquid inside the bottle). When the saline level reaches a critical low threshold, the sensor sends a signal to the ESP8266 microcontroller.

B. *Esp8266 Microcontroller*

- Wi-Fi Connectivity – Built-In 2.4 Ghz Wi-Fi for Wireless Communication.
- Low Power Consumption – Suitable for Battery-Operated iot Devices.
- Compact & Affordable – Small Size with High Processing Power at A Low Cost.
- GPIO Pins – General Purpose Input/Output Pins to Connect Sensors and Actuators.
- Supports Multiple Interfaces – UART, SPI, I2C for Connecting Various Components.
- Programmable Via Arduino IDE – Can Be Programmed Using C/C++, Micropython, And Other Languages.

C. *Thingspeak*

Innovative Smart Saline Bottle Monitoring System redefines IV therapy via IoT. It also incorporates automation and real-time alerts. The system, by utilizing ESP8266, ThingSpeak, and mobile notifications, guarantees that IV fluid replacement will be carried out in a timely manner, which contributes to improving the safety of the patient and hospital efficiency.This project is a large step to smart healthcare, which minimizes human labor and makes hospitals interconnected, automated and intelligent.

L293D driver L293D Motor Driver is an important part of the system that monitors the IoT saline bottle. It allows for the bottle to be replaced automatically or for the flow of the saline to be controlled through an IV. The component serves as a connector between the ESP8266 microcontroller and the motors. It is an intermediary that allows the system to control the motorized mechanisms. Saline bottle substitution for automated system with a clamp for cutting Saline flow. The L293D is a dual H-Bridge motor driver. It can control 2 DC motors and 1 stepper motor switching between moving forward and backward.E. Mobile application

Mobile application for Smart Saline Bottle Monitoring System in IoT improves efficiency and safety of hospital. It facilitates real-time monitoring of saline level which lets nurses and doctors check the level of IV fluid remotely. The app will show live saline level data taken from sensors and processed by ThingSpeak cloud platform. One of the main features of the application is sending instant alerts and notifications when the saline level is critically low to avoid air embolism risks or treatment delays.

Moreover, the program includes a straightforward interface dashboard. It enables the demonstration of saline level graphs, connectivity of the device, and usage history.This provides hospital employees with the ability to check the usage data of the liquid and optimize the management of resources. Also, if direct exchange of the saline bottles is available, the program can activate mechanical function with an L293D motor driver, which will reduce human intervention.

D. *Final outcome*

This is a unique system of monitoring "Smart saline bottle" the "Internet of Things". It enhances the automation, efficiency and safety of infusion therapy. Integration of technologies such as the Internet of Things, cloud computing and automation ensures real-time monitoring of saline levels without the need for nursing. The project proves that smart

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healthcare application is effective and increases the hospital efficiency and patient satisfaction.

One key result of this model is sensing the saline level in real-time using sensors. The ESP8266 microcontroller reads the saline level sensor data and is transmitted to the ThingSpeak IoT cloud platform. Through the mobile app, hospital staff can view the saline level remotely, which saves the need for a physical check. When the saline level reaches the critical stage, the system triggers an instant alert by buzzer alarms, LED indicators, and push notifications on mobile devices. In this way, timely replacement of saline bottles will avoid risks such as air embolism or IV therapy interruptions Moreover system can use L293D motor drivers to realize automatic bottle replacement or saline flow regulation. Such an automation will allow nurses to relax, increase the speed of response to patients, and improve the efficiency of the hospital. The power supply unit must be stable to ensure continuous operation and to prevent performance problems associated with power surges or drops.

A mobile application is important for the remote viewing of the saline levels. It provides a nice and easy dashboard for doctors and nurses to view live saline levels, historical trends, and system alerts. This app also provides multi-device connectivity, allowing monitoring of multiple IV bottles at the same time. This could be particularly useful for large hospitals and ICUs with a massive number of patients.

The end result of the project is a cost-effective scalable, efficient system that brings automation and intelligent monitoring to IV therapy. It reduces human intervention, minimizes errors, increases patient safety, and improves the utilization of hospital resources. Further improvements in the future, such as AI-based prediction, the integration of voice assistant, and the realization of 5G connectivity, will make these IV therapy smarter, and active.

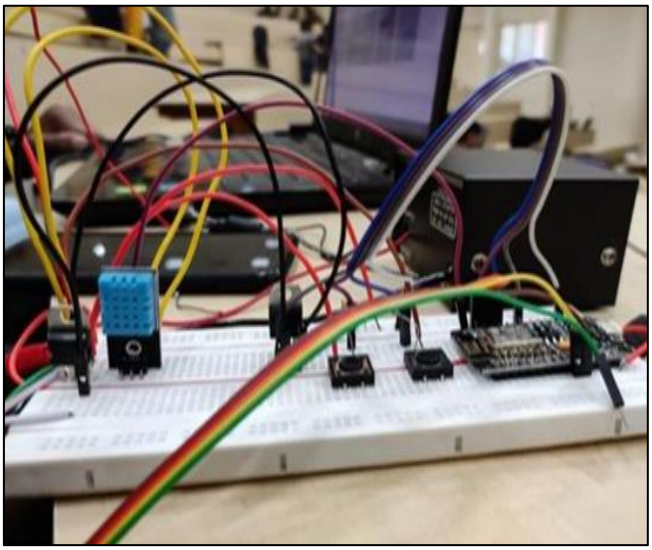

Fig 3 Smart Bottles with Iot Capabilities

IoT-based Smart Saline Bottle Monitoring System is a revolutionary invention in the healthcare sector. It improves the efficiency and automation of IV therapy. The system contains saline level sensors to monitor the level of fluid in the IV bottle. The ESP8266 microcontroller is used to collect and process the data ensuring real time monitoring that is then sent to the ThingSpeak cloud platform for remote access. The ThingSpeak cloud platform. Nurses and doctors can now monitor the level of the saline from any location, thereby demising the need for regular manual checks and increasing efficiency in the hospital.

An automatic alarm system is one of the main features of the system.When the saline level goes below a particular level, the system will indicate it in the form of buzzer alarms, LED lights, and mobile alerts through a designated mobile application. This ensures on-time saline replenishment, avoiding such life-threatening situations as air embolism and IV stoppage. The system warns instantly which helps to reduce the delays in saline replacement, ensuring that the patient receives continuous treatment.

Integration of IoT cloud connection further improves system operations. The ThingSpeak platform gives the ability to remotely check real-time saline level data, historical trends, and system status.

Fig 4 Saline Bottles

Breadboard circuit design indicates the project is at the prototyping level, where testing and optimization of sensor precision and data transmission rate are facilitated. Embedding IoT technology allows hospital personnel to remotely monitor several saline bottles through cloud-based software, thereby minimizing manual effort and enhancing hospital workflow productivity. Additional enhancements can be incorporated in the shape of motorized saline refilling through an L293D motor driver, AI predictive insights, and voice assistant integration for voice control.

Overall, this prototype presents an intelligent and efficient healthcare solution that can significantly enhance IV therapy management. Using IoT, automation, and real-time monitoring, the system promises improved patient safety,

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reduced workload for the hospital staff, and improved medical efficiency

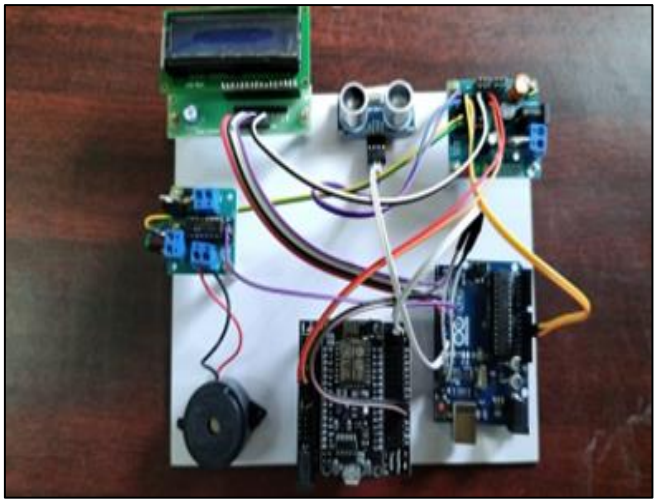

Fig 5 Saline Monitoring System

IV. DIRECTIONS FOR FUTURE RESEARCH AND CONCLUSION

The Smart Saline Bottle Monitoring System based on IoT is a major breakthrough in IV therapy automation, but more research can make it more accurate, scalable, and efficient. Future research can be directed towards enhancing sensor precision by using advanced fluid level sensing technologies like ultrasonic or infrared sensors for accurate readings. Moreover, AI-driven predictive analytics can be used to study fluid intake patterns to provide early warnings before the saline runs out. Additional research can also investigate computerized IV fluid replacement processes with robotic arms or servo motors driven by AI. This would make human intervention unnecessary for IV fluid management. Another likely enhancement is voice assistant integration in real-time to allow hands-free monitoring through Alexa, Google Assistant, or hospital communication systems. In addition, 5G and Edge Computing technologies can be used to support higher speed and more reliable data transmission to allow flawless remote monitoring in hospitals

To enhance usability and deployment, more research would focus on developing an entirely portable, battery-operated version of the system, thus making it directly usable in remote healthcare facilities, home patient care, and ambulatory care. Integration of the system into electronic health record (EHR) systems could allow computerized documentation of IV fluid administration, enhancing hospital efficiency.

Smart Saline Bottle Monitoring System is a revolutionary healthcare technology that employs IoT, real-time monitoring, and automation to enhance IV therapy management. Through eliminating the need for manual checks of saline levels, offering real-time notifications, and remote monitoring, the system lowers the workload of humans massively, enhances patient safety, and maximizes hospital resources.The use of ESP8266, ThingSpeak cloud, and mobile applications enables medical staff to monitor multiple patients at once effectively.

Smooth completion of this project is towards smarter healthcare solutions with improved automation of workflow, safety of the patients, and efficacy of treatments. Although today's system stands to gain a great deal, coming developments in the areas of AI, robots, and forecasting through predictive analytics will keep enhancing the automation of IV therapy further. Through on-going research and development, it's possible to deploy the technology for smart hospitals, home-based care, and pre-hospital care, with a smarter, more responsive, and safer health delivery system.

REFERENCES

[1]. J. Silva, E. Jeong, C. Lam, G. C. Valentine and D. M. Wilson, "A Neonatal Intravenous Monitor Prototype," in IEEE Sensors Letters, vol. 6, no. 11, pp. 1-4, Nov. 2022, Art no. 6004004, doi: 10.1109/LSENS .2022.3218770.

[2]. S. Abdullah, K. Kanwal, A. Hafid and S. Difallah, "Low-cost BLE based intravenous monitoring and control infusion system," in 2023 International Conference on Advances in Electronics, Control and Communication Systems (ICAECCS), Blida, Algeria, 2023, pp. 1-5, doi: 10.1109/ICAECC S56710.2023.10104683.

[3]. V. Arunvikas, S. Pravesh, J. Shafni and V. Sumitra, "Patient Monitoring System on Intravenous Fluid," in 2024 10th International Conference on Communication and Signal Processing (ICCSP), Melmaruvathur, India, 2024, pp. 1561-1565, doi: 10.1109/ICCSP6087 0.2024.10543827.

[4]. R. T. Abbasi, A. Zahoor, L. Junaid, F. Amin and Z. U. Rehman, "Automatic Intravenous Drip Drop Counter and Controller," in 2023 3rd International Conference on Digital Futures and Transformative Technologies (ICoDT2), Islamabad, Pakistan, 2023, pp. 1-5, doi: 10.1109/ICoDT259378.2023.10325753.

[5]. V. S, A. T, V. L, A. K. M, H. P. N and J. A. K, "Intelligent Intravenous Fluid Monitoring System For Health Surveillance Applications," in 2023 9th International Conference on Smart Structures and Systems (ICSSS), Chennai, India, 2023, pp. 1-5, doi: 10.1109/ICSSS58085.2023.10407101.

[6]. S. E, K. R, A. K, D. S. D and A. A, "Intravenous Fluid TelemetrySystem," in 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2023, pp. 1401-1406, doi: 10.1109/ICACCS57 279.2023.10112675.