IoT-Based Automated Saline Monitoring and Alert System Using NodeMCU

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Abstract— **With the rising global population, the demand for efficient healthcare systems is increasing rapidly. In hospitals, one of the most common and essential treatments administered is intravenous (IV) saline therapy. However, manually monitoring saline levels is time-consuming and often leads to human errors, such as allowing the saline bottle to empty completely, which can cause serious complications including backflow of blood. To address this issue, this paper presents an IoT-based automatic saline level monitoring and alert system using NodeMCU Wi-Fi technology.**

The system employs an ultrasonic sensor to continuously monitor the fluid level in the saline bottle. When the fluid level reaches a predefined low threshold, the system triggers an alert using LEDs and also sends a real-time notification to medical staff via Wi-Fi. The NodeMCU module ensures seamless communication and cloud connectivity, enabling remote monitoring and reducing the dependency on continuous human supervision. The system employs an ultrasonic sensor to continuously monitor the fluid level in the saline bottle in real- time.

This solution is cost-effective, scalable, and enhances patient safety by minimizing risk due to delayed response. The integration of IoT technologies in such critical monitoring applications marks a significant step forward in the development of smart healthcare systems.

Index Terms— **Internet of Things (IoT), NodeMCU, Saline Level Monitoring, Ultrasonic Sensor, Healthcare Automation, Alert System, Wi-Fi Communication**

I. INTRODUCTION

In recent years, the integration of technology in the healthcare sector has seen remarkable growth, particularly through the adoption of Internet of Things (IoT)-based systems. These advancements have led to the development of intelligent, automated healthcare solutions aimed at improving patient care, reducing the burden on healthcare workers, and minimizing the potential for human error. One such area of concern is the continuous monitoring of intravenous (IV) fluid levels in hospitals and home- care setups.

Saline infusion therapy is one of the most commonly administered treatments in clinical environments. It is vital for hydrating patients, delivering medications, and maintaining electrolyte balance. However, the conventional method of manually checking saline levels is inefficient and error-prone. Medical staff may overlook an empty saline bottle due to busy schedules or high patient loads, which can result in serious complications such as air embolism, blood backflow, or vein collapse.

To address these issues, this paper proposes an IoT- based solution for real-time saline level monitoring and alert generation. The system is built using NodeMCU, an ESP8266-based microcontroller with built-in Wi-Fi capabilities, and an ultrasonic sensor that detects the liquid level in the saline bottle. The system sends an alert to medical staff when the saline level drops below a defined threshold, either through LEDs, buzzers, or via wireless notifications such as SMS or app alerts.

This approach not only ensures timely intervention but also enhances patient safety and operational efficiency. The design is low-cost, easy to implement, and suitable for deployment in various medical scenarios, including hospitals, ambulances, and home healthcare. By combining embedded systems with IoT, the proposed solution serves as a step toward smarter, automated healthcare services.

II. METHODOLOGY

The proposed system aims to monitor the saline level in real time and alert medical staff before the bottle runs empty. The methodology involves both hardware and

software components that work together to collect, process, and transmit data. The core components include the NodeMCU (ESP8266), an ultrasonic sensor, a buzzer, LEDs, and a power supply system. Below is a detailed breakdown of the system design and operation:

A. System Architecture

The system consists of the following components:

- **NodeMCU (ESP8266):** Acts as the central microcontroller. It reads data from the ultrasonic sensor and handles Wi-Fi communication for sending alerts.
- **Ultrasonic Sensor (HC-SR04):** Placed above or beside the saline bottle to continuously measure the distance between the sensor and the fluid surface. This measurement determines the remaining volume of saline.
- **Buzzer and LEDs:** Used for local alerts. When the saline level falls below a safe limit, the buzzer sounds and the LED turns red.
- **Wi-Fi Module:** Built into the NodeMCU, used to send notifications (e.g., via cloud service or mobile app) to the hospital staff.
- **Power Supply:** A 5V supply or battery pack powers the entire setup.

B. Working Principle

The working principle of the system is based on the time-of-flight method used by the ultrasonic sensor. The HC-SR04 sensor emits ultrasonic pulses that travel through the air, reflect off the saline fluid surface, and return to the sensor. The time taken for the echo to return is used to calculate the distance from the sensor to the fluid surface using the formula:

$$Distance = (Speed\ of\ Sound * Time) / 2$$

This distance is then subtracted from the known height of the saline bottle to determine the current fluid level. If the fluid level is above the threshold, the system remains idle. However, once the level falls below the critical mark, the system enters an alert state.

In the alert condition, the NodeMCU activates a buzzer and switches an LED from green to red to visually and audibly signal the low saline level. Simultaneously, using its built-in Wi-Fi capability, the NodeMCU connects to a network and sends a notification to the designated personnel. This can be done using platforms like Blynk, ThingSpeak, or a custom mobile application connected via MQTT or

HTTP.

This real-time communication ensures that hospital staff are immediately informed about the saline depletion and can take necessary action before any harm is caused to the patient. After refilling, the system automatically resets and resumes monitoring without any manual intervention.

The continuous feedback loop provided by the system enables reliable and autonomous saline level tracking, thereby enhancing patient safety and reducing the monitoring burden on healthcare staff.

C. Software Flow

- The NodeMCU is programmed using Arduino IDE.
- Sensor readings are processed using conditional statements to determine saline level.
- If the level is critical, a digital Write () command activates buzzer and LED.
- Wi Fi Client or similar libraries are used to send alerts via HTTP requests or MQTT protocol to a mobile or cloud interface.

D. Sensor Integration and Placement

The ultrasonic sensor (HC-SR04) is mounted above the saline bottle, aimed directly at the fluid surface. It is chosen for its high accuracy, low cost, and easy interface with microcontrollers. The sensor's Trigger and Echo pins are connected to the digital I/O pins of the NodeMCU. It periodically sends out sound pulses and calculates the distance based on the time it takes for the echo to return.

The calculated distance is used to infer the volume of fluid remaining. For better accuracy, the sensor is calibrated according to the height and shape of the saline bottle. Any unusual fluctuation is filtered using a basic averaging technique to avoid false alarms due to small fluid movements or sensor noise.

E. Software Logic and Threshold Detection

The entire control logic is written in Arduino IDE using C/C++. The NodeMCU is programmed to:

- Continuously read sensor values at fixed time intervals.
- Convert the distance into fluid height.
- Compare the current height with a predefined threshold value.
- Trigger alert mechanisms when the level is critically low.

A simple control structure using if conditions is used to

differentiate between safe and unsafe levels. Debouncing logic is added to ensure the system doesn't send repeated alerts in case the level fluctuates near the threshold.

III. IMPLEMENTATION AND RESULT

A. Implementation

The system was developed and tested using the following hardware components:

- NodeMCU ESP8266 microcontroller (for processing and Wi-Fi connectivity)
- Ultrasonic Sensor (HC-SR04) for saline level detection
- LED indicators (Green for safe, Red for low level)
- Buzzer for audio alerts
- Power supply (via USB or 5V adapter)
- Breadboard and jumper wires for circuit connections

The ultrasonic sensor was fixed at the top of the saline bottle stand, aligned to detect the fluid level inside. The NodeMCU was programmed using the Arduino IDE with ESP8266 libraries. When the fluid level dropped below a pre-defined threshold (e.g., less than 15–20% of the total bottle height), the system performed the following actions:

- Turned on the red LED and deactivated the green LED
- Activated the buzzer to give an audible alert
- Sent a notification via Wi-Fi using the Blynk app to a registered smartphone

The notification message clearly displayed the patient's bed number and that the saline level was low. The Blynk app dashboard also displayed the current level in percentage. After the saline bottle was refilled or replaced, the system automatically reset to the idle (green LED) state.

B. Result Analysis

The prototype system was successfully implemented and tested under various conditions to evaluate its performance and reliability. When the saline bottle was full, the ultrasonic sensor accurately measured the fluid level, and the system remained in its default state—displaying a green LED and no alerts were triggered. As the saline level gradually decreased to around 50%, the system continued to function normally, indicating that the fluid was within a safe range.

However, once the saline level dropped below the defined critical threshold (around 20% of the bottle height), the system promptly activated the buzzer and switched the LED from green to red. Simultaneously, a real-time notification was sent via the Blynk mobile application to the registered smartphone, clearly stating that the saline level was low and immediate attention was required. This notification included identification details like the patient's bed number or system ID for clarity.

The system was also tested for its reset behavior. After the saline bottle was refilled or replaced, the ultrasonic sensor detected the increased level, and the alert system automatically deactivated. The red LED turned off, the buzzer stopped, and the green LED resumed—indicating that the system had returned to a safe state without the need for manual intervention.

Another important observation was the system's reliability during internet disconnection. Even without Wi-Fi, the local alert components (LED and buzzer) remained fully functional, ensuring that the patient's safety was not compromised due to connectivity issues. This offline fallback feature is particularly useful in settings where network stability is inconsistent.

Overall, the system demonstrated high responsiveness, accurate detection, and consistent alerting performance, making it a reliable and low- cost solution for hospital and home-care environments.

C. Observations

- The system worked reliably under various lighting and room conditions.
- Wi-Fi-based notifications allowed timely action by nurses or attendants.
- Offline fallback (LED and buzzer) ensured the patient's safety even without internet.
- The system can be expanded easily to monitor multiple saline bottles simultaneously.

IV. CONCLUSION

This paper presents the design and implementation of an IoT-based automated saline level monitoring and alert system using NodeMCU and ultrasonic sensing technology. The proposed system effectively addresses a critical need in hospitals and home-care setups—ensuring timely detection of low saline levels to prevent backflow and associated health risks for patients.

By integrating an ultrasonic sensor with the NodeMCU microcontroller, the system is capable of

continuously measuring the saline level and providing real-time alerts through visual indicators (LED), audio signals (buzzer), and wireless notifications via Wi-Fi. The system proved to be low-cost, scalable, and easy to deploy in clinical environments. Importantly, it reduces dependency on manual monitoring, thereby improving efficiency for healthcare workers and enhancing patient safety.

Through testing and analysis, the system showed consistent performance, accurate detection, and reliable alert delivery. Even during network outages, the local alert mechanisms ensured uninterrupted functionality. Overall, the system demonstrates how IoT can be effectively leveraged to create smart healthcare solutions that are both affordable and life-saving.

REFERENCES

[1]. Naik, G. R., & Rajput, A. P. (2019). *IoT Based Real-Time Monitoring and Alert System for Intravenous Therapy*. International Journal of Innovative Research in Computer and Communication Engineering, 7(6), 3200–3205.

[2]. Priyadharshini, G., & Vidhya, R. (2021). *Smart IV Drip Monitoring System Using IoT*. International Journal of Engineering Research & Technology (IJERT), 10(6), 204–207.

[3]. Yadav, N., & Joshi, R. (2022). *IoT Based Healthcare Monitoring System*. Journal of Emerging Technologies and Innovative Research (JETIR), 9(1), 51–57.

[4]. Bhargava, K., & Ranjan, A. (2018). *Real-Time Monitoring and Alert System for IV Fluid Using Wireless Communication*. In Proceedings of the 4th International Conference on Communication and Electronics Systems (ICCES), pp. 476–480.

[5]. Nirala, R., & Paliwal, M. (2021). *Smart IV Bottle Monitoring System Using IoT*. International Journal of Research in Engineering, Science and Management, 4(9), 88–93.

[6]. Dey, S., & Ghosh, S. (2021). *IoT Based Medical Monitoring System Using Arduino and NodeMCU*. International Research Journal of Engineering and Technology (IRJET), 8(3), 1884–1889.

[7]. Reddy, V. V., & Varma, P. K. (2019). *Wireless Intravenous Fluid Monitoring System Using IoT*. International Journal of Scientific & Technology Research, 8(11), 2146–2150.

[8]. Kumar, N., & Mehta, A. (2020). *Smart Saline Monitoring and Alert System Using Arduino and GSM*. International Journal for Research in Applied Science and Engineering Technology, 8(6), 367–372.

[9]. Verma, R., & Tyagi, R. (2020). *Design of an IoT Based Remote Health Monitoring System Using NodeMCU*. International Journal of Advanced Science and Technology, 29(6), 4205–4212.

[10]. Shah, A., & Patel, S. (2021). *Saline Level Detector with Alert Notification Using IoT*. In Proceedings of the International Conference on Smart Systems and Inventive Technology, pp. 445–450.

[11]. Patil, S., & Ingle, A. (2020). *Automated Intravenous Drip Monitoring and Alert System Using IoT*. International Journal of Engineering Research & Technology (IJERT), 9(7), 678–682.

[12]. Rajan, R. A., & Sreelekshmi, S. (2019). *IoT Based Intravenous Fluid Monitoring and Alert System*. International Conference on Communication and Signal Processing (ICCSP), pp. 1231–1235.

[13]. Sharma, A., & Mishra, D. (2019). *IoT Based Intelligent Health Monitoring System Using Arduino and Blynk App*. Journal of Network Communications and Emerging Technologies, 9(5), 15–20.

[14]. Sujan, M., & Bhowmik, R. (2021). *Design and Development of IoT Based IV Fluid Monitoring System Using NodeMCU*. International Journal of Engineering and Management Research, 11(2), 19–24.

[15]. Raut, V., & Pawar, S. (2020). *Patient Saline Monitoring Using NodeMCU*. In International Conference on IoT, pp. 201–205.

[16]. Ajith, J. B., Manimegalai, R., & Ilayaraja, V. (2020). *An IoT Based Smart Water Quality*

Monitoring System using Cloud. In 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), pp. 1–7. IEEE. https://doi.org/10.1109/ic-ETITE47903.2020.122

[17]. Alahi, M. E. E., Mukhopadhyay, S. C., Burkitt, L., & Eisenbarth, D. (2018). *IoT Sensor Node for the Monitoring of Saline Solution Bags in Hospitals*. IEEE Internet of Things Journal, 5(6), 5129–5136. https://doi.org/10.1109/JIOT.2018.2859966

[18]. Dhumane, R., & Kadam, P. (2020). *IoT Based Smart Drip Infusion Monitoring System*. In 2020 International Conference on Communication and Electronics Systems (ICCES), pp. 123–128. https://doi.org/10.1109/ICCES48766.2020.9137870

[19]. Nasralla, M. M., & Jasim, M. M. (2021). *IoT Based Saline Monitoring System Using NodeMCU*. International Journal of Scientific Research in Engineering and Management (IJSREM), 5(4), 15–21. https://ijsrem.com/download/IoT-Based-Saline-Monitoring-System-Using-NodeMCU.pdf

[20]. Dubey, A., & Agrawal, S. (2020). *IoT Based Intravenous Fluid Level Monitoring System*. International Journal of Computer Sciences and Engineering (IJCSE), 8(10), 180–185. https://www.ijcseonline.org/full_paper_view.php?paper_id=5672