SMART IV FLUID CONTROL SYSTEM USING IOT

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Introduction:

Industrial pipeline and sewage inspections pose significant risks to human safety. To address this, IoT-based solutions are increasingly being adopted to monitor and control critical conditions in real time, reducing the need for human intervention in hazardous environments. Similarly, in hospitals and clinics, intravenous (IV) fluid administration is a common and critical procedure. However, manually monitoring fluid levels in IV bottles can lead to human errors such as neglecting empty bottles, resulting in the entry of air into veins and causing serious complications or even fatality. With the rise of IoT (Internet of Things) in healthcare, automation of such monitoring processes can greatly enhance patient safety and reduce the workload of medical staff. This project aims to develop a smart IV fluid control system using IoT that can continuously monitor the fluid level in the IV bottle and alert medical staff when the fluid level drops below a critical level.

This system leverages sensors and a microcontroller, combined with wireless communication modules, to send real-time updates and warnings to a mobile or central monitoring system.

Objectives:

- Design an IoT-based monitoring system for IV fluid levels.
- Automate real-time alerts to medical staff for low IV fluid.
- Minimize human errors during fluid administration.
- Enhance patient safety in hospitals and clinics.
- Reduce workload for medical personnel through automation.

Methodology:

The smart IV fluid control system using IoT is an advanced healthcare solution aimed at ensuring safe, efficient, and automated intravenous fluid administration. At its core, the ESP32 micro-controller serves as the central control unit, interfacing with multiple sensors and modules to collect and process real-time data. A 10kg load cell, connected via the HX711 amplifier, continuously monitors the weight of the IV fluid bag to determine the remaining volume with high precision. The MAX30102 sensor tracks vital signs like heart rate and SpO2 levels of the patient, ensuring that the infusion aligns with the patient's condition. Temperature monitoring is carried out by the DS18B20 sensor to detect any unusual thermal changes that may affect the system or the patient. Additionally, the TCS3200 color sensor checks the fluid's color to detect contamination or identify the type of fluid being used.

An OLED display is used to show critical data such as fluid level, patient vitals, and system status, making it easy for medical staff to monitor the setup. Buttons are provided for manual control and to acknowledge alerts. Audio feedback is given through a DF Player Mini and speaker, playing voice alerts stored on a memory card to notify staff in case of emergencies like low fluid levels or abnormal vitals. A solenoid valve, controlled via a 5V relay and level converter, is used to automatically regulate the flow of IV fluid based on sensor data. Furthermore, the system is IoT enabled through the ESP32's Wi-Fi module, allowing data transmission to a cloud server or remote monitoring interface. This enhances the system's capability by allowing real-time alerts and data access from anywhere, ensuring timely medical intervention and improving patient safety

Result and Conclusion:

In conclusion, The Smart IV Fluid Control System using IoT was developed using a temperature sensor, SpO2 sensor, blood detector, and load cell to enhance patient monitoring and safety. The temperature sensor effectively tracked the patient's body temperature in real-time, while the SpO2 sensor provided accurate readings of oxygen saturation, enabling timely detection of any decline in patient condition. The blood detector played a crucial role in identifying the presence of blood in the IV line, helping to prevent reverse blood flow and associated complications. The load cell accurately measured the IV fluid weight, allowing continuous monitoring of the fluid level and generating alerts when the fluid was about to finish. Additionally, using the ESP32 dual-core system, critical information such as the IV fluid level and blood detection status was automatically sent to a registered email, ensuring prompt notification to medical staff even from a remote location. Overall, the integration of these sensors with IoT technology enabled remote and automated monitoring, reducing the need for manual supervision. This system enhances the reliability, safety, and efficiency of IV fluid administration in clinical settings.

Future Scope:

The future scope of this project includes:

Integration with Hospital Management Systems: Automate patient record updates and streamline workflow for medical staff.

Mobile App Integration: Provide real-time alerts and remote access for doctors and caregivers.

Support for Multiple IV Lines: Extend the system to manage multiple IV lines, catering to more complex treatments.

Additional Vitals Monitoring: Expand the system to include monitoring of other vitals such as heart rate and ECG for comprehensive patient care.

Application in Rural and Emergency Care Settings: Use the system to provide remote health monitoring in rural areas or emergency situations, improving accessibility to healthcare.