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Intravenous Fluid Monitoring and Alert System

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Abstract: The Iot-based Iv-bag Monitoring System Automates The Monitoring Of IV Fluid Levels And Vital Signs To Enhance Patient Care. It Uses Arduino, Load Cell, Heartbeat And Temperature Sensors, Dc Motor For Bed Control, Bluetooth For Voice Commands, And Node Mcu For Emergency Alerts. This System Reduces The Need For Constant Manual Supervision And Supports Timely Intervention By Caregivers.

Keywords: Smart Healthcare,Patient Safety System,Fluid Level Detection

I. INTRODUCTION

The IoT-Based IV-Bag Monitoring System is designed to enhance patient care by automating the monitoring and control of intravenous (IV) fluid levels and vital signs, alongside providing emergency alerts. Built around an Arduino microcontroller, this system integrates a load cell to continuously monitor the weight of the IV bag, ensuring timely replenishment. Additionally, heartbeat and temperature sensors are incorporated to track critical patient vitals, providing comprehensive health monitoring. The system also features a DC motor to control bed movements, offering adjustable comfort for patients, which can be operated through voice commands enabled by a Bluetooth module. This makes it highly accessible and user-friendly, especially for patients with limited mobility. For seamless communication and emergency response, the NodeMCU module is programmed to send notifications to caregivers via Telegram when the IV bag weight falls below a set threshold or if abnormal vital signs are detected. This integrated approach in monitoring, alerting, and control reduces the need for constant manual supervision, thereby supporting healthcare providers in delivering timely and effective care.

An Intravenous Fluid Monitoring and Alert System addresses these challenges by incorporating technology to automate and enhance the monitoring process. These systems use sensors to continuously track fluid levels, flow rates, and other parameters, sending alerts to healthcare professionals when abnormalities or critical levels are detected. By reducing reliance on manual observation, such systems improve efficiency, minimize human error, and ensure timely interventions.

II. LITERATURE REVIEW

In [1] paper**,** The current state of the art of intravenous (IV) fluid administration systems lacks remote monitoring and control capabilities. This study presents an intelligent infusion pump system for automatic and remote management and monitoring of IV drips. This work used Arduino based microcontroller for controlling drop counter, detecting tube blockage and monitoring the emptying of drip bag. This system used low power laser diodes and optical sensors for the aforementioned monitoring tasks. The flow rate (in drop per minute) and infusion-interruption problems were monitored remotely via transmission of data wirelessly to users' smartphones using Blynk mobile application and computerbased applications. This study found no difference between the manual and automatic counting reading. In addition, the system is able to notify its users of empty bottle and line blockage. This work concluded that the developed prototype may be further enhanced (in its design and features) and tested for its effectiveness and consistencies in real clinical settings.

In [2] paper, Recently, with the development of technology in the medical and industrial fields, which contributed to the arrival of this technology to smart homes and life-saving hospitals for people to stay in their homes in a comfortable place where the normal situation for their lives, independence and freedom, and maintaining their security and health,. Message Sheet offers a specially designed medical care bed for patients in homes, nursing homes, hospitals or other people who need some special treatment and any form of health care by voice command. To control the smart bed system with the use of sensors capable of transmitting voice-activated signals, Numerous settings and capabilities are accessible via voice commands, including changeable height for the full bed, head and foot, and customizable temperature.

Medical beds for patients and the elderly are now available. If the patient has a disorder that makes it impossible for them to live independently at home, this device allows them to be self-sufficient and does not require the assistance of others as in the past. It's all part of keeping up with research and development by incorporating smart technology into hospital beds to improve comfortability and limit the frequency of preventable diseases like pressure ulcers, which can occur when people stay in bed for lengthy periods of time. It is a network of electronic, mechanical, and digital components that are all working together.

In [3] paper, Continuous patient monitoring during hospitalization is necessary to identify patterns of indicative risks or pathogens, whose early diagnosis and treatment is likely to lead to a reduction in morbidity and mortality and, consequently, a reduction in both the duration and cost of hospitalization. On the other hand, a patient falling from bed can cause serious damage to his health state, while the effect of pressure ulcers can be avoided by timely and accurate mapping of pressure points that inhibit tissue perfusion resulting in death. Recent technological advances and scientific achievements have introduced new and improved medical devices using highly-developed embedded control functions and interactivity. Current hospital beds include new forms of functionality, while still serving the same purpose. All of them are designed to fulfil a predefined purpose, whether that is to monitor the patient's vital signs continuously, in a non-obtrusive manner, or prevent a patient from falling off their bed or prevent the development of pressure ulcers. Over the last decades, this hospital bed evolution has brought a big change in both their standards and the overall patient care. In this work, we conduct a review of existing smart bed systems for patient monitoring, fall and pressure ulcer prevention from the state-of-the-art, focusing on evaluating smart bed systems that include any kind of smart features, like sensors and sensor mats, or exploiting Machine Learning (ML) algorithms and Wireless technology.

In [4] paper, Many industries depend on the technological development of the world. Technological developments in smart homes and life-saving hospitals allow people to stay indoors in a comfortable, secure and independent way where they want to be. This paper presents a Medical Care Bed with Internet of Things Solutions a bed designed specifically for patients in hospitals or other people who need some forms of health care that can be used with button, voice commands and phone applications. for control the Smart Bed System using sensors, to voice-controlled application, we are continuously trying to find a better way to control electrical and electronic devices to ease our daily life. Common features include adjustable height for the entire bed, head and feet, adjustable, adjustable, temperature, pressure, voice command and application to run both family using sensors and monitoring patient's body temperature, Measuring the proportion of oxygen in the blood and heart beat using arduino board. This family features are special features for both the ease and comfort of the patient and the comfort of health care workers.

In [5] paper, In today's world, the problem of taking care of elderly people in their old age is just important and tedious as of taking care of a child, but the time and requirements are not available for everyone. The proposed project is developed in such a way that all the required monitoring is done automatically and the data reports and required suggestions are sent to the caretakers. The aim of the proposed IoT based smart bed system is to assist caretakers in helping elderly people who feel difficulty in taking care of themselves. Different sensors are used to measure the heart rate, temperature, blood pressure, and wetness. Raspberry Pi is used to interface with all the sensors. Raspberry Pi collects all the sensor data. These sensor data are given to the recommender system. Based on these sensors' data, the recommender system produces the output. For example, if the heart rate is high and blood pressure is low, the system tells that body needs oxygen, and this output is sent to the server, and an alert is sent to the caretakers to take further actions. The total setup of the hardware is so compact that it provides the elderly people as if a normal bed and also additional monitors can be set up for enabling an easy view of the sensor readings. The prototype of the bed is developed and the readings are viewed using a web server.

In [6] paper, In recent years, technological innovations have considerably improved patient care and accelerated the healing process. Effective hydration and electrolyte management are two of the most important parts of hospital care. Intravenous(IV) treatment is critical, especially for patients in intensive care units (ICUs). However, the difficulties of overloaded hospitals frequently impede the seamless administration of this critical care. Currently, manual monitoring of IV drip levels is the responsibility of nurses and hospital employees. Unfortunately, their hectic schedules might lead to mistakes and omissions. Acknowledging the significance of tackling this core problem, the suggestion involves the creation of an independent, self-regulating drip monitoring system utilizing Internet of Things (IoT) technology. This entails the incorporation of ultrasonic and LDR sensors with the ESP8266, all programmed using Arduino UNO language. This novel technology intends to revolutionize drip monitoring by overcoming obstacles such as bubble formation in IV drips and removing the need for sophisticated alarm systems. This suggested system has far-reaching implications. Nurses and hospital personnel will be freed of the burden of manual monitoring by automating the procedure, freeing up their time and attention to focus on other vital patient care activities. The capacity of the device to identify air bubbles will help to avoid potential difficulties and adverse outcomes caused by inappropriate infusion.

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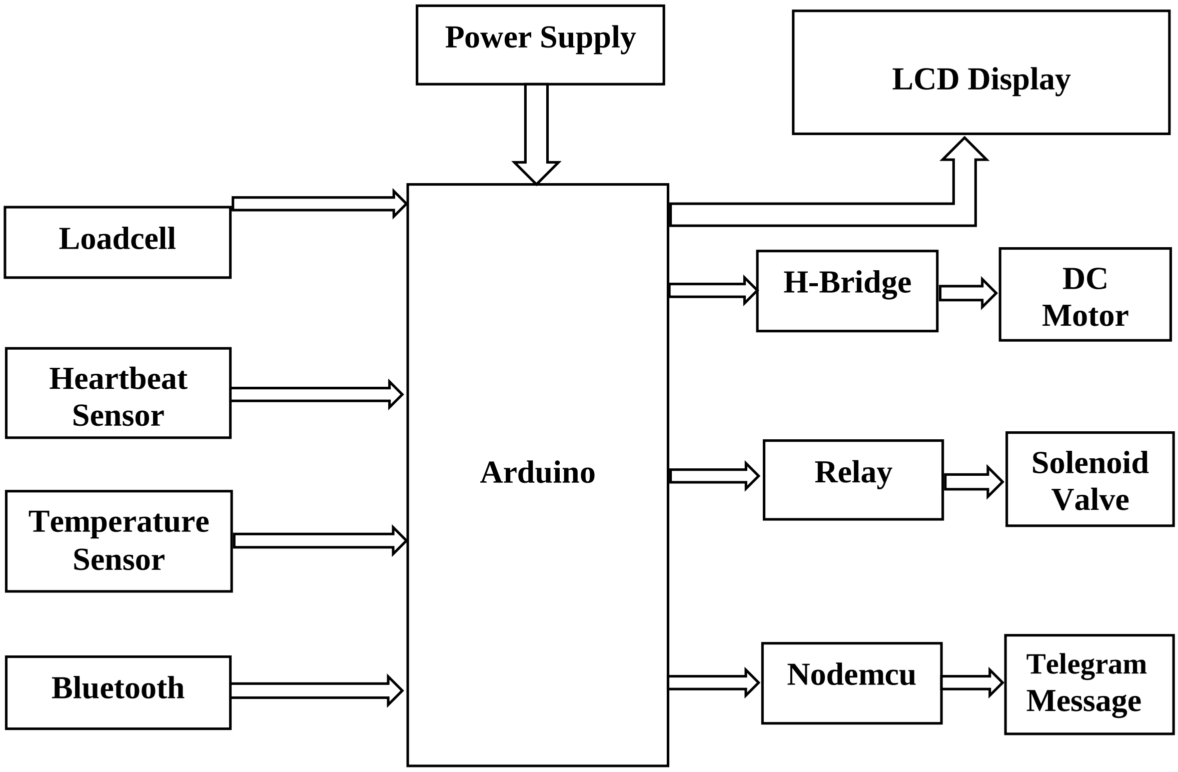
Furthermore, IoT technology allows for real-time data transfer and remote monitoring, allowing healthcare practitioners to receive precise and up-to-date information about fluid levels and any abnormalities from any place. We can usher in a new era of efficient and dependable IV fluid management by embracing technological innovations in healthcare, improving patient outcomes, and promoting a safer healthcare environment.

III. METHODOLOGY



The block diagram of the IV Bag Monitoring and Alert System consists of a Power Supply Unit to provide energy to the components, a Sensor Module (weight or pressure sensors) to monitor fluid levels, and a Microcontroller Unit to process sensor data and make decisions. The system includes an Alert System for local (visual and audible alerts) and remote (SMS, email, or app notifications) notifications, a Communication Module (Wi-Fi, Bluetooth, or GSM) for data transmission, and a User Interface to display real-time status locally or on a mobile app/web dashboard. Optionally, a Cloud/Server Module can store and analyze data, enabling integration with hospital systems. Finally, a Feedback Loop ensures accuracy and system reliability.The iot-based IV-Bag Monitoring System is designed to automatically track IV fluid levels, monitor patient vitals, and provide emergency alerts to caregivers. The system uses various sensors and modules integrated with Arduino and nodemcu to ensure real-time data acquisition and communication.

Working Principle:

The methodology represented in this diagram can be described as follows:

- If the system includes a communication module, a notification is sent to a central monitoring system, nurse's station, or mobile device.
- Flow Rate Monitoring: A flow sensor can be integrated to ensure the IV fluid is delivered at the correct rate.
- Automated Flow Control: In advanced systems, motorized flow regulators can adjust the IV drip rate automatically based on real-time requirements.The IV bag is placed on the load cell, and the system is calibrated to account for the bag's initial weight The load cell continuously measures the weight of the IV bag.
- The microcontroller calculates the remaining fluid based on the difference between the initial weight and the current weight.
- A buzzer or LED is activated to alert nearby medical staff.

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IV. HARDWARE AND SOFTWARE DESCRIPTIONS

Arduino ESP 32:

ESP 32/Genuine Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of ESP 32 Software (IDE) 1.0. The Uno board and version 1.0 of ESP 32 Software (IDE) were the reference versions of ESP 32, now evolved to newer releases. The Uno board is the first in a series of USB ESP 32 boards, and the reference model for the ESP 32 platform; for an extensive list of current, past or outdated boards see the ESP 32 index of boards.

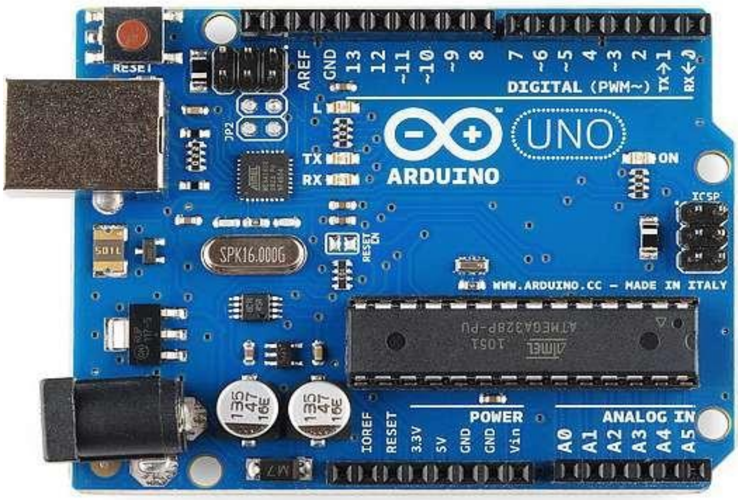

Figure: Arduino ESP 32

LCD Display

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock.

Solenoid Valve

A solenoid valve is an electromechanical device that controls the flow of fluids or gases by using an electric current to create a magnetic field in a solenoid coil, which then moves a plunger or armature to open or close the valve. These valves are commonly found in industrial automation, HVAC systems, pneumatic systems, and water treatment applications, where they regulate fluid or gas flow with high precision.

Load Cell

The fig shows a Load sensor is a device which measures the weight of objects such as vehicles. If the weight of a vehicle is beyond the threshold value (here 1.5kg), the gate is closed. Thus preventing the entry of heavy vehicles into the bridge.

SOFTWARE REQUIREMENTS

The Arduino software (Arduino IDE) is an open-source platform that allows users to write, compile, and upload code to Arduino microcontroller boards. It is widely used for projects involving embedded systems and IoT devices, like an IV bag monitoring system.

Embedded C is one of the most popular and most commonly used Programming Languages in the development of Embedded Systems. Embedded C is a specialized version of the C programming language designed for developing software for embedded systems, which are compact computing devices integrated into hardware.

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V. RESULT

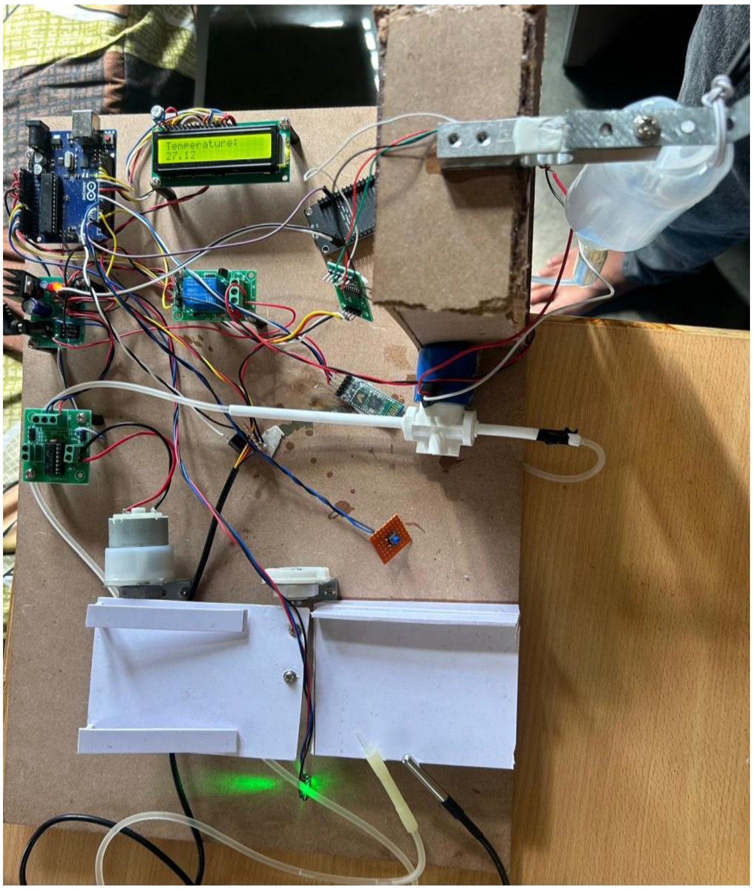

Figure: Complete Model

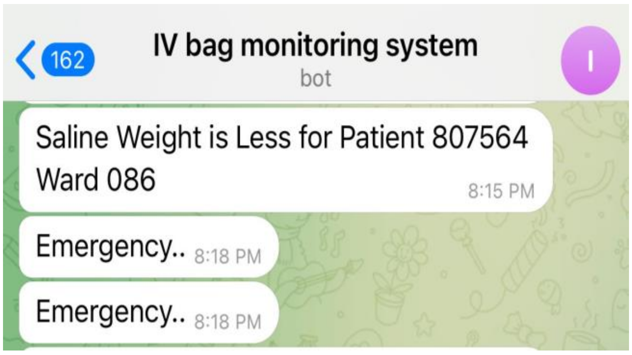

Figure: emergency alert

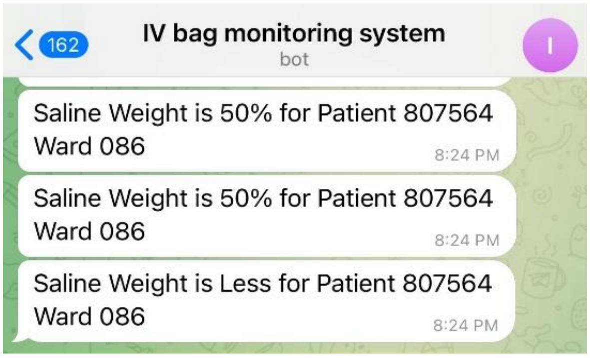

Figure:Message Received on Telegram

VI. CONCLUSION

The IoT-Based IV-Bag Monitoring System provides an innovative solution to address key challenges in patient care, specifically in monitoring IV fluid levels and vital signs. By automating these tasks and integrating real-time alerts, this system significantly reduces the need for manual supervision, allowing healthcare providers to focus on other critical responsibilities. The use of a load cell for IV bag monitoring ensures timely alerts for fluid replenishment, while heartbeat and temperature sensors offer continuous insights into the patient’s health status.The inclusion of voice-controlled bed movement enhances patient comfort, especially for those with limited mobility, making the system highly adaptable for both hospital and home healthcare settings.

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Furthermore, the integration of NodeMCU for Telegram-based emergency alerts enables immediate caregiver response in critical situations, improving overall patient safety and treatment outcomes. This project demonstrates how IoT technologies can be effectively applied in healthcare to create smart, automated systems that support caregivers and enhance patient well-being. Future enhancements could include cloud data storage for long-term health data analysis, AI integration for predictive health alerts, and expanded functionalities to cater to a broader range of medical needs. Overall, this system offers a scalable and efficient approach to modern healthcare monitoring.

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