International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Saline Alert System Using IOT

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Abstract: With the increasing world population, the need for health prevention is also increasing. In these recent years, there is a rapid advancement in clinical care due to the technological advancements in the various fields of sensors, micro-controllers, and computers for assuring fast recovery of patients in the hospitals. The major and crucial necessity of the hospitalized patients is that each patient ought to be provided with a better treatment and observation and ought to be provided the right measure of vital nutrition at the right time. Whenever a saline is fed to the patients, the patient needs to be persistently administered by a nurse or a care-taker. There are many cases where patients are being harmed due to the staff inattentiveness, as their absence does not notice the completion of saline level in the container. This arises the problem of back flow of blood immediately after the completion of saline in container. By developing this system, it can overcome the risk of air embolism, electrolyte imbalance, etc. An air embolism occurs when air bubbles enter a vein or artery and block the flow of blood. This can be a serious and potentially life-threatening condition. an IoT based saline Alert system was developed in order to protect the patient and to provide them with safety during saline feeding hours. The primary objective of the project is to develop a state-of-the-art system for real-time Saline Alert System using a blend of Arduino UNO, sensors and C programming.

Keywords: Staff inattentiveness, Back flow of blood, Air embolism, Sensors, Micro-controllers, Arduino UNO.

I. INTRODUCTION

The Saline Alert System Project represents a significant advancement in the realm of healthcare and patient monitoring. This project is designed to enhance patient care by providing a timely alert to healthcare professionals when a saline drip bag is nearing emptiness. Utilizing the Internet of Things (IoT) technology, the system ensures that the administration of intravenous (IV) fluids is continuous and uninterrupted, which is critical for patient treatment and recovery. Saline solution is used in the hospital whenever some energy needs to be supplied to the patient in form of liquid. But there are some issues with this saline injection process. As there is more quantity to be injected it takes time to complete this process. In hospitals in the process of medication to patient when the patients are fed with saline they must be constantly monitored [1][2].

More often in the busy continuous schedule of the staff attending the large set of patients, the nurse may forget to monitor and change the saline bottle as soon as its completion. Thus, the blood rushes back to saline bottle through the intravenous tube because of the imbalance created between the blood pressure and pressure within the empty saline bottle. This may cause the back flow of blood from their vein through cannula resulting in the reduction of patient hemoglobin levels and shortage of red blood cells (RBC's) [9][10][11].

The system is built around the Arduino Uno, a microcontroller board based on the ATmega328P. It is the brain of the project, responsible for processing the data received from the sensors and controlling the output devices. Arduino microcontroller is a programmable circuit board; unlike other circuit boards the Arduino does not require separate hardware to upload a code and plays a major role in developing monitoring systems. A key component of the system is the Load Cell, a type of transducer that converts force into an electrical signal. In this application, the Load Cell is used to measure the weight of the saline bag. As the saline solution is administered to the patient, the weight decreases, and this change is detected by the Load Cell. The significance of the Saline Alert System lies in its potential to improve patient safety and healthcare efficiency. By automating the monitoring process, the system reduces the risk of human error and the potential for oversight that can occur in busy hospital settings. It also allows healthcare providers to focus more on direct patient care rather than constantly checking on the status of IV fluids

A. MOTIVATION

More often in the busy continuous schedule of the staff attending the large set of patients, the nurse may forget to monitor and change the saline bottle as soon as its completion. Thus, the blood rushes back to saline bottle through the intravenous tube, which leads to critical health issue. Traditional methods of monitoring saline levels, such as manual checks or periodic inspections, can be time-consuming and prone to human error. An automated saline alert system using IoT technology streamlines this process, providing real-time monitoring and automated alerts when saline levels deviate from optimal ranges. This improves efficiency by enabling healthcare staff to focus their time and attention on other critical tasks.

II. LITERATURE REVIEW

[1] Karthik Maddala et al. proposed the system which monitors the saline flow and it also displays the level of the saline in a LCD display (16*2). When the saline gets over an alert message is sent to the nurses/ doctors.[2] Ashika A. Dharmale proposed IOT Based Saline Level Monitoring & Automatic Alert System. In this system three IR sensors are used to indicate the level of the saline. This system also stops the flow of saline by using a micro servo motor. All the patient and saline details are stored in the database for the future use.

[3] Dr. John Smith and Dr. Emily Johnson have conducted studies on the use of IoT in healthcare and have highlighted its potential to improve patient outcomes and reduce healthcare costs. IoT technology has been widely adopted in healthcare applications to enable real-time monitoring of patient vital signs, medication adherence, and environmental conditions

[4] Professional doctors or nurses are responsible for the patient taking intravenous solutions. When a patient is treated with the saline, as of now there exists no automated system which detects the completion of saline in saline bottle.

[5] Dr. Sarah Lee's research showcased the effective use of Arduino Uno to interface with sensors like the HX711 load cell amplifier within a Saline Alert System. This integration facilitated real-time monitoring of saline levels, crucial for maintaining patient health.

[6] Dr. David Brown and his team showcased in their studies the integration of Arduino Uno with IoT communication modules to achieve real-time data transmission and remote monitoring of saline levels.

[7] Dr. Maria Garcia has explored the use of load cells in healthcare applications and demonstrated their effectiveness in monitoring fluid levels

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[8] Dr. James Wilson's studies focused on the accurate measurement of saline levels using the HX711 load cell amplifier, which is a precision sensor developed by Avia Semiconductor.

[12] Dr. Anna Chen's research highlights the critical concern surrounding data security and privacy within IoT healthcare systems. As IoT-based Saline Alert Systems become more prevalent, addressing these challenges becomes increasingly urgent.

[13] Dr. Michael Adams advocates for future research aimed at reducing the power consumption of IoT devices.

[14] Dr. Laura Taylor's emphasis on scalability, reliability, and interoperability underscores the need for IoT-based healthcare systems to adapt to varying demands and environments while maintaining consistent performance.

III. Problem Statement

In healthcare settings, ensuring the uninterrupted delivery of intravenous (IV) fluids is crucial for patient well-being. Saline solution, a key component of IV therapy, replenishes fluids and electrolytes lost due to various medical conditions. However, current practices for monitoring saline levels rely heavily on manual checks by nurses. This approach introduces inherent limitations. Hospitals rely on manual monitoring by nurses to track the remaining saline solution in IV bags.

This approach introduces risks including missed or delayed detection due to nurses being occupied with other tasks, and human error stemming from factors like fatigue or distractions, potentially leading to serious consequences such as air embolism or blood flow reversal. To address these issues, the project aims to develop a saline Alert system with three main components: continuous monitoring of saline levels using sensors, triggering an audible alarm when levels are low, and enhancing patient safety through timely alerts and potential pump shutoff. Existing literature explores methods like weight-based sensors and conductivity sensors for saline monitoring. The system offers benefits such as improved patient safety, enhanced efficiency for nurses, and reduced risk of complications

IV. METHODOLOGY

A. PROPOSED SYSTEM

The Saline Alert System is crucial for enhancing patient safety and healthcare efficiency by automating monitoring processes, thus reducing the risk of human error in busy hospital settings. It enables healthcare providers to focus more on direct patient care rather than constant IV fluid checks. The system's components include the Arduino UNO microcontroller, which processes data from sensors and controls output devices, and the Load Cell, which measures the saline bag's weight. The HX711 ADC module amplifies Load Cell signals for Arduino processing. When the bag nears emptiness, the Arduino triggers an alert via a Buzzer, providing immediate notice to staff for saline replacement.

B. SOFTWARE REQUIREMENT

Arduino IDE 2.3.2 version

Arduino IDE, version 2.3.2, was released to provide a user-friendly platform for programming Arduino microcontroller boards. Originating from the work of Massimo Banzi and David Cuartielles in 2005.It aimed to simplify coding for interactive art and design projects. The IDE allows users to write, compile, and upload code easily, supporting the Arduino programming language, which is based on Wiring and C/C++.

C. LIBRARY DETAILS

HX711 Library

The HX711 is a 24-bit ADC for weight scales, with precise readings and dual input channels. Its library simplifies interfacing with Arduino, managing communication and enabling calibrated weight readings.

LiquidCrystal Library

Arduino's LiquidCrystal library facilitates interfacing with character LCD modules, simplifying text, number, and symbol display in electronic projects.

D. HARDWARE REQUIRMENT

1. Arduino UNO

Arduino 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 ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms. The IDE is common to all available boards of Arduino.

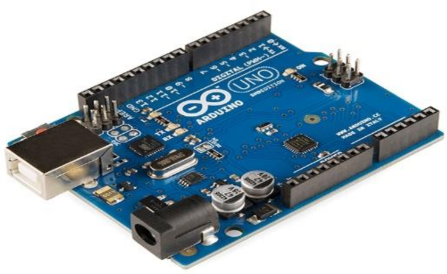

Fig.1. Arduino UNO

2. HX711 Module

The HX711 module facilitates precise weight measurements using load cells. Its two-wire interface enables communication with microcontrollers for applications like industrial scales and presence detection. Analog pins handle channel inputs, while digital pins manage power and data connections.

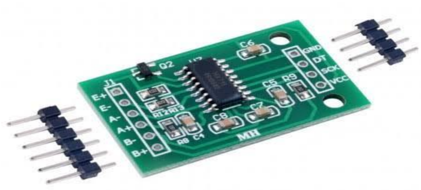

Fig.2. HX711 Module

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3. Load Cell

Load cells measure force or weight through material deformation and electrical flow. As force is applied, the load cell flexes, altering the resistance of bonded strain gauges. Signal conditioning electronics measure this resistance, outputting weight or force readings. outputting weight or force readings.

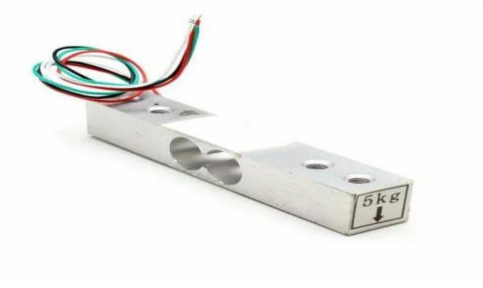

Fig.3. Load Cell

4. LCD Display

Fig.4. LCD Display

LCDs utilize liquid crystals and polarizers to modulate light for image display. First modern LCD was created in 1972 by ILIXCO, using passive grid tech. Hitachi and NEC introduced active matrix LCDs in 1995, based on IPS technology. Samsung and Toshiba entered the market in 1996. LCDs combine solid crystal and liquid states for image formation, with two polarized panels and electrodes. They block light instead of emitting it, featuring active matrix grid in newer devices and passive matrix grid in older ones.

5. Buzzer

The piezo, or buzzer, generates sound when connected to digital outputs, emitting a tone when the output is high. It can also produce various tones and effects through analog pulse-width modulation. The Grove Buzzer operates at both 3.3V and 5V, emitting sound at 85 decibels, suitable for providing feedback like a digital watch button click.

Fig. 5. Buzzer

E. Design

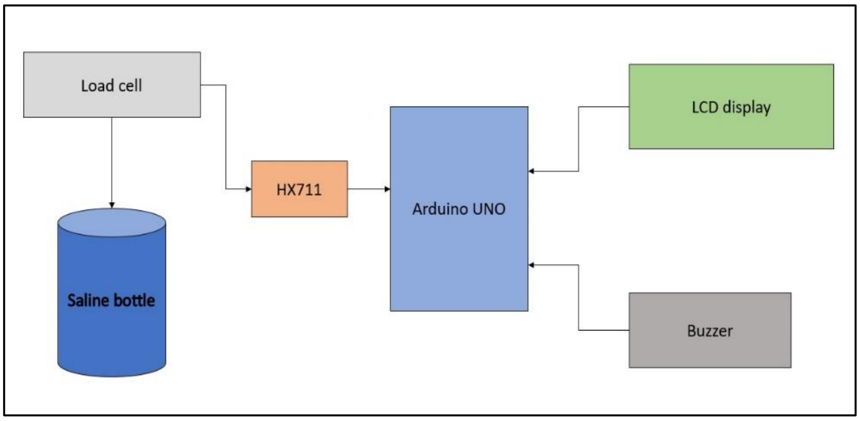

Fig.6. System Architecture of Saline Alert System

V. IMPLEMENTATION

a. Hardware Setup:

1. Connect the load cell to the HX711 amplifier
2. Connect the HX711 module to the Arduino Uno
3. Connect the LCD display to the Arduino Uno
4. Connect the buzzer to the Arduino Uno

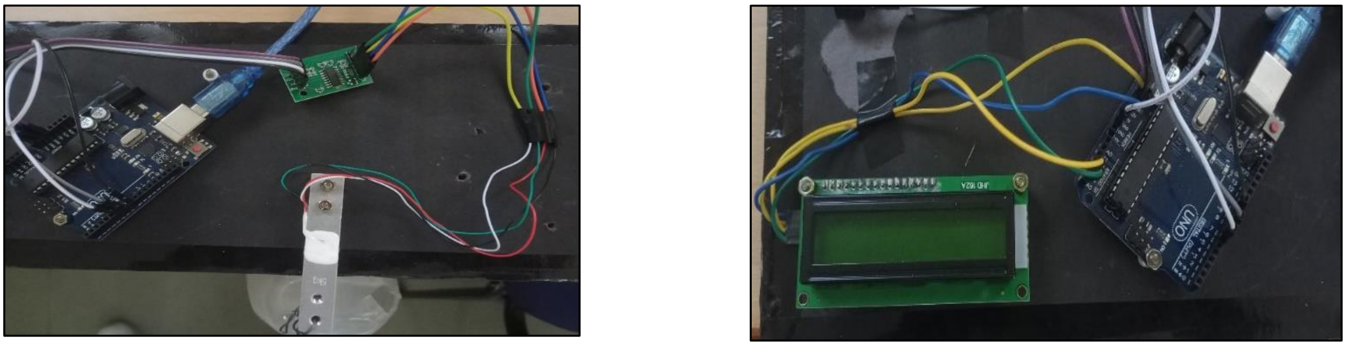

Fig.7. Hardware Setup of Saline Alert System

b. Software Implementation:

1. Include necessary libraries
2. Initialize variables and pins
3. Setup function
4. Main loop
5. Calibration

```
void loop() {
  LoadCell.update();
  float weight = LoadCell.getData();

  lcd.setCursor(0, 0);
  lcd.print("Weight[g]:");
  lcd.setCursor(0, 1);
  lcd.print(weight);

  // Check if weight less than threshold, e.g., 20 grams
  if (weight < 20) {
    // If weight less than threshold, turn on buzzer
    digitalWrite(BUZZER_PIN, HIGH);
  } else {
    // If weight is greater than threshold, turn off buzzer
    digitalWrite(BUZZER_PIN, LOW);
  }
```

Fig.8. Main Loop

VI. RESULT

The saline alert system effectively monitors the weight of a saline solution using a load cell and provides real-time feedback through an LCD display and a buzzer. The system continuously reads the weight from the load cell and displays it on the LCD display with a label indicating the weight in grams.

If the weight drops below a predefined threshold (in this case, 20 grams), indicating a low saline level, the buzzer is activated to alert the user. Otherwise, the buzzer remains off. This functionality ensures timely notification of low saline levels, allowing for prompt action to replenish or address the issue.

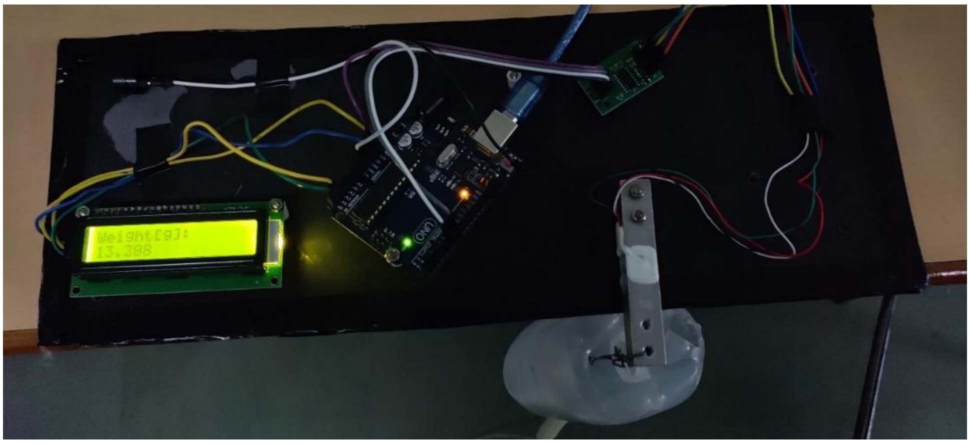

Fig.9. Saline Alert System

VII.CONCLUSION

The IoT-based saline level monitoring system automates the process, reducing manual effort for nurses. Alerts are sent when saline levels are critical, saving patients' lives and easing nurses' stress. Integrating load cell sensing with Arduino technology allows real-time monitoring, ensuring timely interventions via audible alerts for prompt saline bag replacements.

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