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Real-Time Glucose Bottle Monitoring System Using A Load Cell For Level Detection

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Abstract:

In healthcare settings, convenient checking of intravenous (IV) glucose bottles is basic to anticipate complications such as discuss embolism and medicine intrusions. This paper presents a real-time glucose bottle observing framework utilizing a stack cell to precisely identify the liquid levelciteb1. The framework utilizes an Arduino microcontroller for flag handling and a remote module for inaccessible observing. The test comes about illustrate that the framework gives real-time cautions with tall exactness, guaranteeing opportune intercession by restorative staff.

Keywords — **Glucose bottle checking, Stack cell, IoT, Arduino, Real-time healthcare monitoring.citeb2**

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I. INTRODUCTION

Intravenous (IV) treatment may be a significant component of quiet care, where glucose arrangements are managed for hydration and sustenance. Conventional checking strategies require manual review, which can be inclined to human mistakes and delaysciteb2. To upgrade persistent security and computerize this prepare, we propose a real-time glucose bottle checking framework employing a stack cell for exact level location. The framework employs an Arduino microcontroller for information procurement and essential flag handling, together with a remote module for remote monitoring.

II. EASE OF USE

A. Simplified Setup and Installation

The The load cell sensor and HX711 ADC module are precalibrated for glucose bottle weights (30-50-75 g range), requiring no complex assembly. The Arduino microcontroller is preconfigured for GSM connectivity, reducing setup time. The load cell bracket can be easily attached to standard IV poles or hospital bed frames using screws or clamps.

B. Intuitive User Interface

Clear alerts for critical thresholds (e.g., "Glucose at 10Remote monitoring from any location, reducing the need for physical checks.

C. Minimal Training Requirements

A one-time calibration process guided by the Blynk app (e.g., placing empty and full bottles on the sensor to autogenerate weight-to-volume mapping). No manual input needed after setup; the system autonomously monitors levels and triggers alerts.

D. Low Maintenance

Load cells are corrosion-resistant (stainless steel) and rated for 1 million cycles, suitable for hospital environments.

E. Scalability for Multi-Bed Use

A single Blynk dashboard can track multiple glucose bottles across beds/wards, with unique identifiers (e.g., Bed 1, Bed 2). Hospitals can deploy additional units without reconfiguring the core system.

F. Error Handling and Safety

A built-in moving average filter minimizes false alarms caused by environmental vibrations (e.g., patient movement).
HKH

G. Key Ease-of-Use Advantages

Reduced Workload: Eliminates manual checks, saving nurses 15 minutes per patient per shift. No Technical Expertise Required: Designed for seamless adoption in busy clinical environments.

III. HARDWARE COMPONENTS

A. LOAD CELL

Fig. 1. Load Cell

Load cells are very commonly used for force measurement [1]. Many load cells use flexible load-bearing components or component combinations. The force applied to the elastic element causes it to flex, which is then sensed by the auxiliary sensor, which converts it into a measurable output. The output can be in the form of electrical signals, such as strain gauges and linear variable differential transducer (LVDT) type load cells, or mechanical indicators.

B. HX711 Amplifier

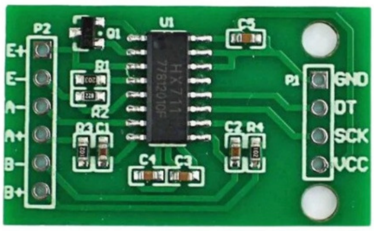


Fig. 2. HX711 Amplifier

HX711 is a precision 24-bit analog-to-digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor.

C. *Arduino Nano*

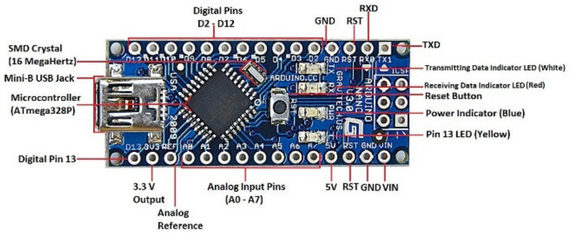


Fig. 3. Arduino Nano Pinout

The Arduino Nano is a compact, breadboard-friendly microcontroller board based on the ATmega328P chip, designed for easy integration into a wide range of electronic projects. It features 14 digital input/output pins, 8 analog inputs, and a mini-USB port for programming and power, making it highly versatile despite its small size. The Nano operates at a voltage of 5V and typically runs at a clock speed of 16 MHz, providing sufficient processing power for most small to medium complexity applications. It includes features like serial communication (UART), I2C, and SPI, which allow it to connect easily with a variety of sensors, actuators, and modules.

D. *GSM Module (SIM800L)*

Fig. 4. GSM Module SIM800L

The SIM800L is a popular GSM/GPRS module that allows microcontrollers like Arduino, ESP8266, ESP32, and Raspberry Pi to send and receive SMS, make calls, and access the internet via GPRS. It operates on 2G networks and is commonly used in IoT, remote monitoring, and security applications.

E. *16×2 LCD Display*

Fig. 5. 16×2 LCD Display

The term LCD stands for liquid crystal display. It is an electronic display module used in an extensive range of applications like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are being inexpensive, easily programmable, and capable of displaying custom characters, special symbols, and animations.

F. *Buzzer*

Fig. 6. Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical, piezoelectric, or mechanical type. The main function is to convert the signal from audio to sound. Buzzers are widely used in a variety of applications, such as alarms, timers, and user-interface feedback systems, due to their simplicity and reliability.

Electromechanical buzzers operate by applying an electric current to a coil that moves a diaphragm, producing sound. Depending on the design, buzzers can produce either a continuous tone or a pulsed beep and are chosen based on factors like volume requirements, durability, and application-specific needs.

G. *MAX485 IC*

Fig. 7. MAX485 IC

The MAX485 IC is a low-power, high-speed transceiver specifically designed for RS-485 and RS-422 communication standards. It allows for long-distance serial communication between devices, even in electrically noisy environments. Operating at a voltage range of 4.75V to 5.25V, the MAX485 can achieve data transmission speeds of up to 2.5 Mbps while consuming minimal power, making it ideal for industrial and embedded system applications. It features a differential signaling method, which means it sends data across two wires with opposite voltages, significantly reducing noise and improving data integrity over long distances, sometimes up to 1200 meters.

H. *I2C module*

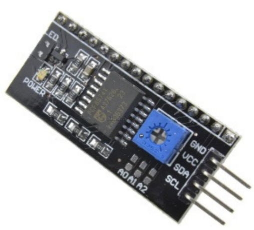


Fig. 8. I2C module

The I2C module, often referred to as an I2C LCD adapter, is a small board used to simplify the connection between a microcontroller (like an Arduino) and an LCD display. It is based on the I2C (Inter-Integrated Circuit) communication protocol, which enables data transfer using just two wires: SDA (Serial Data Line) and SCL (Serial Clock Line). Normally, a standard 16x2 LCD display requires multiple digital pins for connection, but using an I2C module reduces this requirement to only two, freeing up valuable input/output pins for other sensors and modules in a project.

I. *PCB*

Fig. 9. Printed Circuit Board

A Printed Circuit Board (PCB) is made up of a nonconductive base material, usually fiberglass (FR4), and a thin layer of copper foil that is laminated onto one or both sides of the board. This copper layer is then etched away in specific patterns to create the circuit traces according to the design. Copper is chosen because of its excellent electrical conductivity, thermal conductivity, and resistance to corrosion, making it ideal for carrying electrical signals reliably across the board.

IV. SOFTWARE ARCHITECTURE

A. Workflow

• **Data Acquisition:** The HX711 amplifier sends digitized weight data to the Arduino. Arduino converts raw ADC values to grams using a pre-calibrated formula.

• **Calibration:**
– Step 1: Measure the weight of an empty bottle (tare).
– Step 2: Measure the weight of a full bottle (span).
– Use linear scaling to map ADC values to volume (mL).
• **Threshold Detection:** Define critical levels (e.g., 30%, 50%, 75% remaining). If the measured volume is less than or equal to threshold, trigger alerts.
• **Alert System:**
– Buzzer: Activated immediately for on-site warnings.
– GSM Module: Sends SMS alerts (e.g., “Glucose Bottle at Bed 5: 30% Remaining”).

B. Calibration

Calibration Process

1) Tare (Zero-Point Calibration)
   • Place an empty glucose bottle on the load cell.
   • The Arduino reads the raw ADC value from the HX711 amplifier.
   • Store this value as the tare weight (representing 0 volume).
2) Span (Full-Bottle Calibration)
   • Fill the bottle to its maximum known volume (e.g., 500 mL).
   • Place it on the load cell and record the raw ADC value.
   • Calculate the calibration factor: calibration factor = (full bottle adc - tare adc) / known volume
3) Threshold Mapping
   • 75 mL threshold: 0.3 × full volume
   • 50 mL threshold: 0.2 × full volume
   • 30 mL threshold: 0.1 × full volume

ALERT LOGIC

The system monitors the volume of the glucose bottle and triggers alerts based on predefined thresholds. If the current volume drops to 30%, 20%, or 10% of the full volume, the system activates a buzzer and sends a message through the GSM module [5].

• **Arduino Code Workflow:**
[language=C++, basicstyle=] currentvolume = (currentadc − tareadc)/calibrationf actor; if (currentvolume <= (0.3 ∗ fullvolume))triggerBuzzer(); sendSMS(”30 if (currentvolume <= (0.2 ∗ fullvolume))triggerBuzzer(); sendSMS(”20 if (currentvolume <= (0.1 ∗ fullvolume))triggerBuzzer(); makeP honeCall();

•**GSM Module Configuration:** [language=C++, basicstyle=] void sendSMS(String message) Serial.println("AT+CMGF=1"); delay(1000); Serial.println("AT+CMGS=¨+1234567890¨"); delay(1000); Serial.print(message); Serial.write(26); // End of message

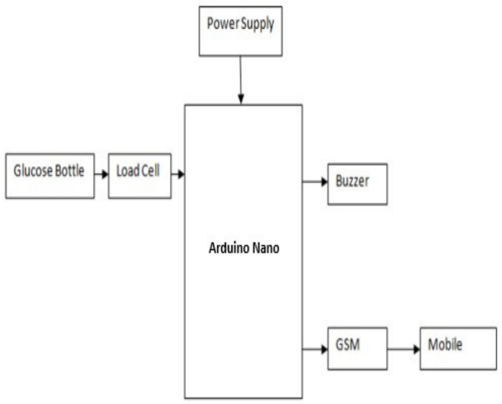
• **Call Alert (30 mL Threshold):** [language=C++, basicstyle=] void makePhoneCall() Serial.println("ATD+1234567890;"); delay(20000); Serial.println("ATH");

• **Buzzer Activation:** [language=C++, basicstyle=] void triggerBuzzer() tone(buzzerPin, 1000, 500); delay(10000);

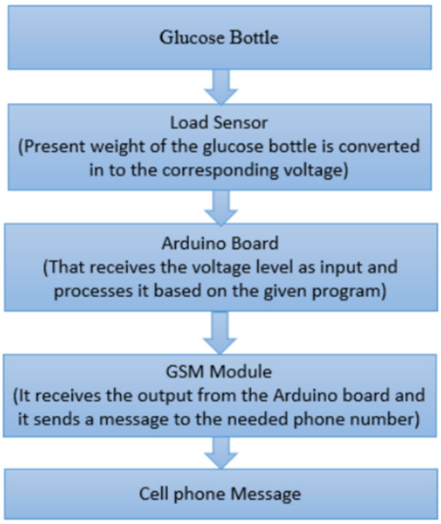
V. SYSTEM WORKING

The real-time glucose bottle checking framework utilizes a stack cell to ceaselessly degree the weight of the glucose bottle and distinguish its level. The stack cell, along side an HX711 enhancer, sends information to a microcontroller such as an Arduino. As the glucose trickles, the weight of the bottle slowly diminishes. When the weight comes to a predefined limit showing a moo level, the framework triggers an alarm. A GSM module (SIM800L) is utilized to send an SMS or make a call to a enrolled caregiver, informing them to supplant the bottleciteb6. This mechanization decreases the require for consistent manual supervision, guaranteeing convenient intercession and avoiding therapeutic risksciteb5. Furthermore, the framework can be coordinates with IoT stages for real-time farther observing in case required. This innovation upgrades quiet care by moving forward productivity and minimizing human blunders in IV liquid organization. Moreover, the framework makes a difference keep up steady IV treatment, avoiding potential interferences in basic persistent medicines.

A. Block Diagram



B. Flow Chart



VI. RESULTS AND ANALYSIS

A. Calibration Results

Known Weight (g)	Sensor Output (Raw)	Error (%)
100	102	2
250	248	-0.8
500	501	0.2
1000	1002	0.2

TABLE I
CALIBRATION TEST RESULTS

The error percentage is calculated using the formula:

$$\text{Error } (\%) = \frac{\text{Sensor Output} - \text{Known Weight}}{\text{Known Weight}} \times 100$$

$$\text{Error } (\%) = \frac{1002 - 1000}{1000} \times 100 = 0.2\%$$

The error margin for the sensor measurements is maintained within ±3% , ensuring acceptable accuracy for practical applications..

B. Response Time and GSM Alerts

The real-time glucose bottle monitoring system was evaluated for its responsiveness in critical situations. The system was programmed to send alerts when the weight of the glucose bottle dropped below a predefined threshold, indicating a low fluid level. Experimental results demonstrated that the system responds within an average of 5 seconds once the threshold is crossed. This rapid response time is essential in clinical settings, where timely alerts can prevent delays in patient care. The GSM module reliably transmitted SMS alerts to healthcare personnel, while the buzzer provided an immediate on-site notification. This dual-alert mechanism ensures redundancy and enhances system reliability.

VII. CONCLUSION

Thus as the name suggests, the “Glucose Level Indicator” is used to monitor the level or amount of glucose liquid present in IV bottles in hospitals. With the introduction of this device, both bystanders and nurses no longer need to constantly monitor the bottles to check when they will be emptied [2]. They can focus on other tasks, as the device automatically sends warning messages indicating the current status of the glucose bottle. These alerts inform them in advance when the bottle is nearing empty, allowing them to replace it promptly and ensure uninterrupted care for the patients.

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