Smart Fluid Level Indicator

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Abstract: Most of the times, in hospitals, to improve the body's hydration, Intravenous Therapy (IV) is given. The bottle's saline level needs to be monitored continuously because when the bottle is emptied and if the needle is not removed from the vein then the blood flows reverse into the bottle. This can cause serious casualty and may lead to death. To overcome this problem in all the hospitals an efficient and reliable IoT based system is proposed which can monitor the fluid level and alert the nurse or Doctor when the bottle is about to empty. The system monitors fluid level in real-time and a notification is sent on the mobile through Wi-Fi when the fluid level drops below certain threshold. Thus, the proposed system will prove to be a reliable solution to the mentioned problem and can be implemented in hospitals and homes to stop and accidental casualty.

Keywords —Arduino, IoT, Load Cell, NodeMCU, Saline level monitoring

I. INTRODUCTION

The Internet of Things (IoT) refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention. The advancements in the field of IoT has given birth to a loT of wireless controlled and small devices that can work independently to help humans. IoT has its applications in almost all fields but also plays a huge role in the healthcare domain and will prove to a life saver to lot of patients [1][2].

One such application is monitoring the fluid level of saline bottle. Saline, one of the most popular intravenous (IV) therapy plays a major role in the management of patients who are Critically ill. The saline bottle needs continuous monitoring and needs to be replaced on time. Usually, a doctor or a nurse is responsible for monitoring the fluid level of the bottle. Carelessness or negligence in refilling the saline bottle can prove to be dangerous as reverse flow of blood takes place. This reverse flow can cause serious casualty and may lead to death. Thus, to overcome this problem a system is proposed to remotely monitor the fluid level and notify the doctor or nurse to refill the bottle on time [4]. It uses a Load cell to continuously monitor the weight of bottle. When the weight drops below certain threshold a notification is sent on the app to alert the nurse indicating that the bottle is about to empty and needs refilling [3]. The system sends data over WiFi to the mobile application is a lot efficient and reliable. Implementing this system in hospitals and home can prove to be vital in case of accidental casualty. This system will ensure that the saline bottle is refilled on time and the patients will not suffer [5].

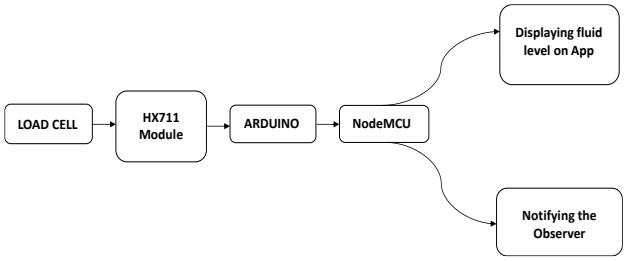

Figure 1. Proposed Block Diagram

II. SYSTEM OVERVIEW

The proposed system block schematic is shown in figure 1. The system is built using 4 major components. Arduino uno(microcontroller), Load cell, HX711, NodeMCU (Wi-Fi development board). The load cell is used to sense the current weight of bottle and its analog output is converted to digital using the HX711 ADC module. Then the controller reads this weight and it is converted to appropriate measuring unit. Then this value is sent to NodeMCU through serial communication for further processing.

The NodeMCU sends the current weight of the bottle to the server and that value is retrieved in the app. Along with that a notification is also sent on the app when the bottle is about to empty.

A. Hardware Architecture

Load cell is the most important component of this system. It is used to sense the weight of saline bottle. Load cell is a sensor that converts a load or force acting on it into an electronic signal. It works on the principle of piezo resistivity. When a load/force/stress is applied to the sensor, it changes its resistance. This change in resistance leads to a change in output voltage when an input voltage is applied.

This load cell is connected to HX711 module which 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. The HX711 module converts the analog voltage into digital voltage which is read by the digital I/O pins of Arduino board. Two digital pins are configured in input mode to read the digital voltage value and then calibration process is done to get the exact weight in grams.

This calibrated weight is then transferred to the NodeMCU Wi-Fi development board which has ESP8266 Wi-Fi microchip. The communication between Arduino and NodeMCU board is done through serial communication and SoftwareSerial.h library is used for the same. The ESP8266 chip is further programmed to send this weight value to mobile application over the internet.

B. Software Architecture

The main aim of the system is to alert the nurse/attendant about the level of saline remaining in the bottle, and this is achieved with the help of a mobile application. For prototyping of the system an open-source platform (Blynk) was used. Blynk is a platform for development of smartphone applications which work with a wide range of microcontroller. It allows the user to build graphic interface for IOT projects. It can control hardware remotely and display sensor data. Figure 6 shows the app that was built to display the bottle weight using the Blynk IoT platform.

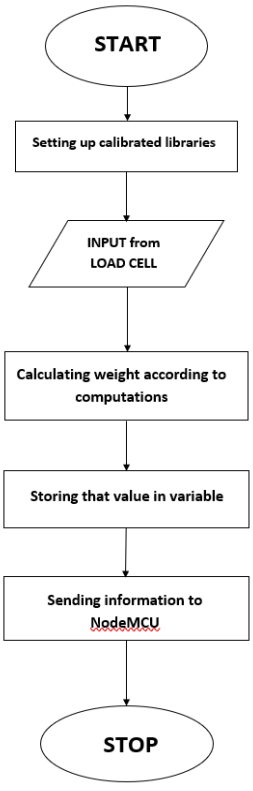

Figure 2. Algorithm for Arduino

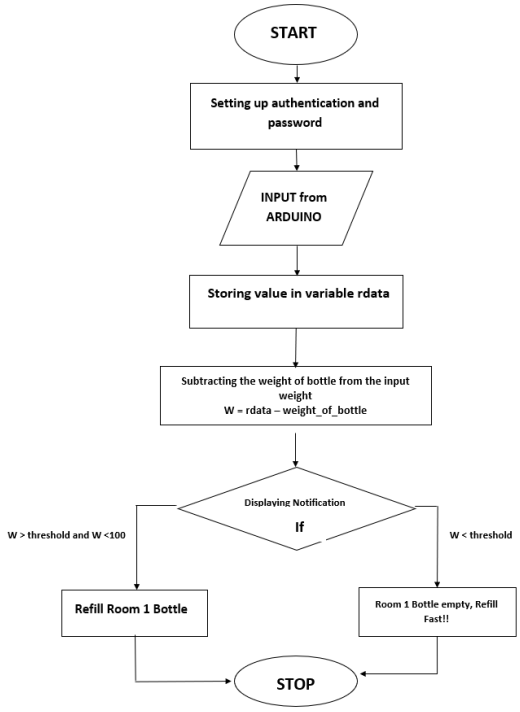

Figure 3. Algorithm for NodeMCU

Figure 2 and Figure 3 represents the algorithm of the system.

III. SYSTEM SPECIFICATION

1) **Load Cell**: A 5kg Load cell sensor is used for sensing the weight of the bottle. The load sensor works on the principle that on applying a mechanical load, the piezoelectric material of strain gauge in the load cell deforms that leads to change in resistance and thereby the output voltage will change. So, a load cell acts as a transducer that measures force, and outputs this force as an electrical signal.
2) **HX711 Module:** HX711 is a precision 24-bit analog to-digital converter (ADC)chip with preamplifier included. The chip is specifically designed for weight scales applications. The load cells which usually measure weight provide voltage outputs in millivolts. These outputs are difficult to handle directly by controllers, so we can use HX711 IC which takes these voltage signals and provide standard digital values which can be used by a microcontroller. The chip has integrated preamplifier specifically to handle these low voltages. This module handles the Conversion of sensor data and amplifies it for further use in the system.
3) **NodeMCU:** NodeMCU is an open source Lua based firmware for the ESP8266 WiFi SOC from Espressif and uses an on-module flash-based SPIFFS file system. This is one of the main components of the system as it is responsible for sending the data to the mobile application over cloud.

IV. System Implementation

The load cell has four different colored wires representing four different resistances. These wires are Red, Black, White, and Green respectively. The HX711 module has four slots to take input from the Load cell. The four wires are connected to their respective slots on the HX711 module.

The VCC and Ground pins of HX711 module are connected to the VCC and Ground pins of Arduino UNO board. The clock and Data pins of HX711 are further connected to digital pins 2 and 3 of the Arduino board.

The Serial communication pins of NodeMCU are connected to the Serial Communication pins(Digital pin 0 and 1) of Arduino UNO.

Figure 4 shows the circuit diagram of the system and figure 5 shows the prototype of implemented system.

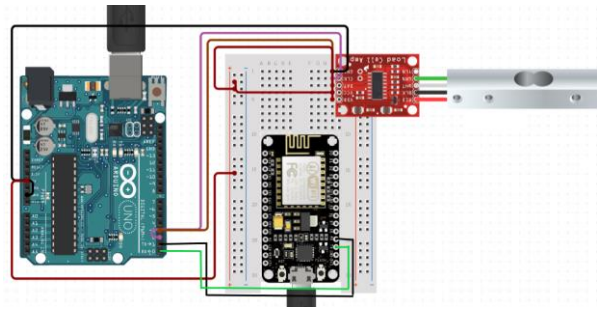

Figure 4. Circuit Diagram

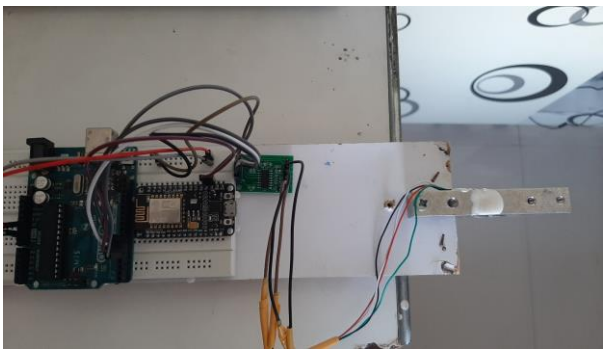

Figure 5. Actual Circuit

V. Results

After Designing and implementing the system it was observed that the system monitors the fluid level. Along with that real-time tracking of the weight of bottle is done and it is displayed on the app. Finally, a notification was sent on the mobile app when the fluid level dropped below threshold level indicating the nurse/attendant to refill it.

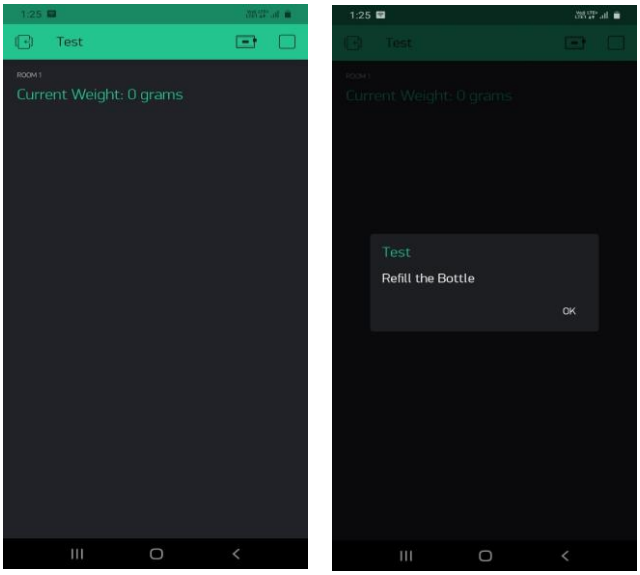

Figure 6. Mobile Application

VI. Conclusion

This paper discussed a smart fluid tracker system for monitoring the saline level in the bottle which would notify the nurse on their mobile to refill the bottle. This system will save the time of hospital staff and will avoid the fatal risk of air bubbles entering the patient's bloodstream, which is a serious threat as air bubbles in blood can cause immediate death. Implementing this system in hospitals will decrease the chances of patients hazards and increase the accuracy of health care.

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