IoT-Based Smart Intravenous Drip Monitoring System

Muskan Jindal, Nidhi Gajjar, and Nehal Patel

Abstract Health care being the most important aspect in heading toward a contented life also plays an essential role in India's progress. These days, automating the health monitoring devices leads to a drastic change in medical sphere as it ensures the safety of the patients and even helps in reducing the stress of doctors and nurses. In this field, intravenous remedy plays an important role as it is the system wherein the liquid substances are directly inserted into the patient's vein via an IV tube but it could also worsen the situations if not taken proper care. Thus, this paper emphasizes on the necessity to overcome such a consequence by introducing a solution to it. Hereby an automatic intravenous drip monitoring system is developed which directly sends an alert message to the assigned nurse when the fluid level of the bottle reaches a certain limit. This system measures the weight of the saline bottle with the help of a load cell and then using an automatic alerting and indicating device namely GSM sends the alert signal. This system would be a significant serve to build a different approach toward the intravenous therapy.

Keywords Load cell · HX711 sensor · Arduino microcontroller · GSM modem · Health care · IoT

1 Introduction

The Internet of things (IoT) and cloud technology play a dynamic role in the expansion of civilization as a brand novel tactical trade, and the modern technologies have

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a profound influence on the contemporary education organization [1–3]. With the increasing population around the globe, the demand of the healthcare [4, 5] units also increases. Also, it becomes the responsibility of the healthcare industry to provide best possible treatments to the patients at lower costs and maintaining their safety. Automation in health care is the step toward providing best services to patients in a cost efficient way. One of the challenges faced by the healthcare units is ensuring the safety of the patients during IV infusions. Intravenous infusions [6, 7] (commonly known as drips) are the process of infusing fluid substances directly into patients' vein. It is a typical method of treatment used for fluid volume replacement, to correct electrolyte imbalances in body, to send medicines, and for transfusion of blood or fluid injection. The task of keeping a constant watch on the level of the fluid in the fluid bottle is tedious and time consuming and restricts the efficiency of the hospital staff to do other tasks. Thus, this system helps in eliminating the constant manual task of keeping a regular watch on the level of fluid in the bottle.

In this paper, Section 2 defines background study of IoT-related sensors and health care. The proposed system is elucidated in Sec. 3. Section 4 indicates implementation and discussion of proposed system. Section 5 shows the result of the system. Finally, the last section shows summaries and future direction.

2 Existing System

Keerthi et al. [8] suggested that the system comprises of IR sensor which acts as a level sensor for monitoring saline level in the bottle and whenever the saline level reaches the predefined dangerous level of liquid alert message is sent through the internet to nurse. Along with that, buzzer alarm also starts ringing.

Anand [6] has proposed system, in which sending the message regarding the patients' health to the nurse is through GSM technology. The system automatically turns of the flow of liquid from intravenous bag using solenoid valve and also measures the pulse rate and blood pressure of the patient and display it on the LCD.

Bhavasaar et al. [7] developed a system where the level of the IV bag is monitored and checks if the level is dropped beyond the set level and senses the air bubbles or embolisms appearing in tube before it enters the patient's vein. The nurse station is also alerted about the same with help of alarm system so suitable action can be taken on time.

Arulious et al. [9] used the level of liquid light-dependent resistors (LDR) to address. The LDR and LED are fixed opposite to each other and once the level of liquid becomes low the conductivity of LDR sensor increases. The microcontroller is programmed in such a way that once the conductivity is increased it buzzes the buzzer in nurse's room and alerts the nurses.

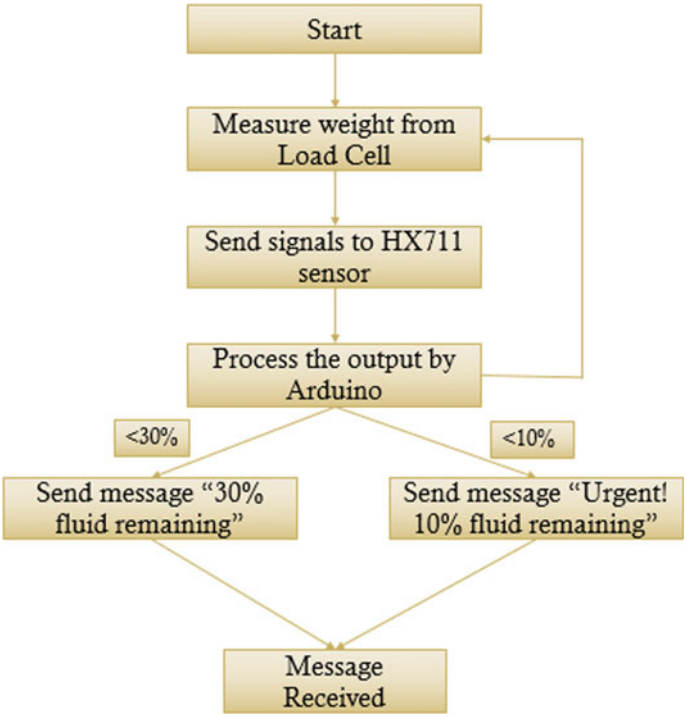

Fig. 1 Flow of entire system

3 Proposed System

This system aims at automating intravenous fluid monitoring system using the Arduino microcontroller. This project proposes GSM-based automatic alerting system where weight sensor is used as level sensor. Here, the intimation is given when the fluid reaches the certain fixed level, so that the nurse gets enough time to reach the room and replace the bottle. Figure 1 shows flowchart of how the system works. The load cell measures the weight and once the weight is less than the specified amount the GSM is used to send the message to the specified phone number.

4 Implementation

A. Connection of Load Cell and HX711 Sensor
A load cell is a sensor that detects changes in a physical stimulus (force, weight, or pressure) and then produces an output proportional to the physical stimulus. Load cell is basically used to sense the weight of the bottle and supply an electrical analog voltage to the HX711 load amplifier module. The HX711 is a

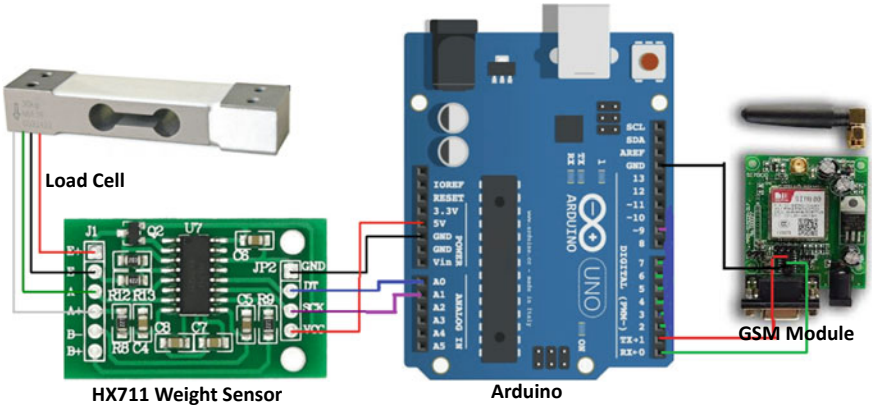

Fig. 2 Connections

load cell amplifier which is used to generate measurable data out from the load cell and strain gauge. The amplifier attached with the load cell helps in finding the actual weight of the saline bottle. Thus, by using the measured weight, the level of liquid present in the bottle can be calculated and is further passed onto the arduino.

B. Connection of HX711 Weight Sensor and Arduino
In this proposed system, an open-source electronics platform based on easy-to-use hardware and software is used namely Arduino. The HX711 load cell amplifier is connected to the Arduino and thus the software Arduino IDE is used to monitor the measured weight of the glucose bottle as predicted by the load cell and amplifier. It involves the task of calibrating the system for measuring correct weight. After calibration, weight measurement is done normally.

C. Sending Alert Message
Global system for mobile communications (GSM) is a mobile communication modem. A GSM module or a GPRS module is a chip or circuit that will be used to launch communication between a mobile device or a computing machine and a GSM or GPRS system [10]. After the Arduino receives the weight of the bottle in the form of voltage signals, it processes the signals and checks if the weight of the fluid is less than the specified amount. If the weight is less, then the GSM module through the serial communication sends the alert message to the nurse. Figures 2 and 3 indicates the working of entire system.

5 Results and Discussion

This automation system with Arduino and GSM is developed for the healthcare system of the human beings. This project provides the advantages for nurse and

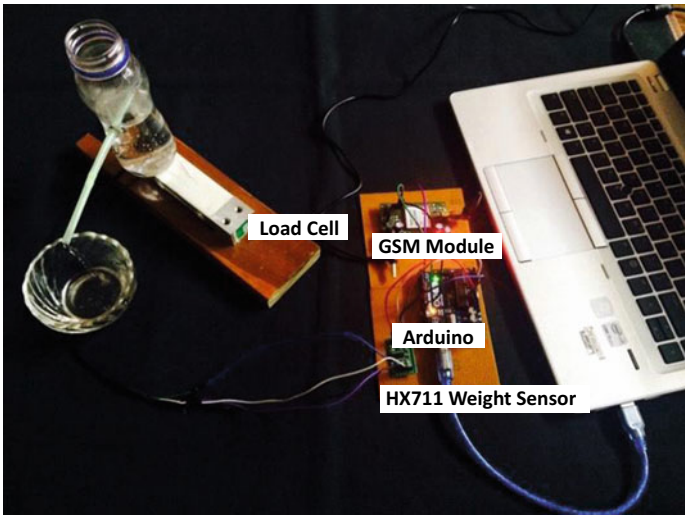

Fig. 3 Actual setup

assistants in healthcare system as it helps in eliminating the task of constantly monitoring the level of liquid in a bottle manually. The varying weight can be viewed on the serial monitor of the Arduino IDE. Following is the observed output of the load cell.

In Fig. 4, the alert is generated when the level has dropped below a certain limit. The alert message would be received in the form of a SMS on the registered phone number as shown in Fig. 5.

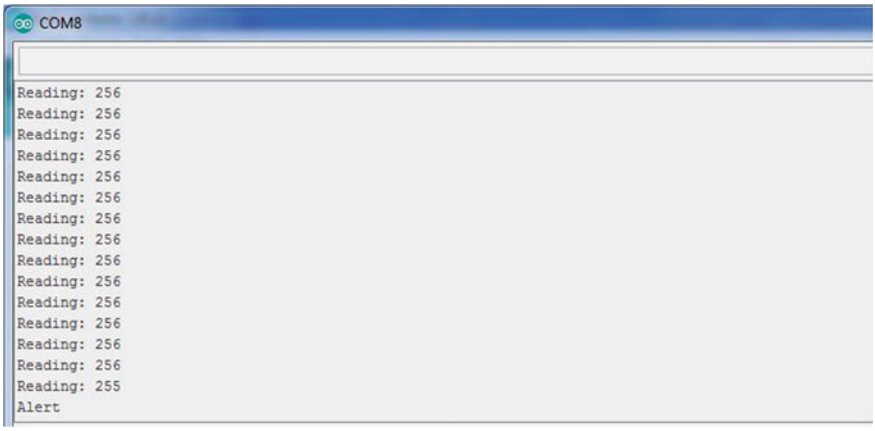

Fig. 4 Output on serial monitor

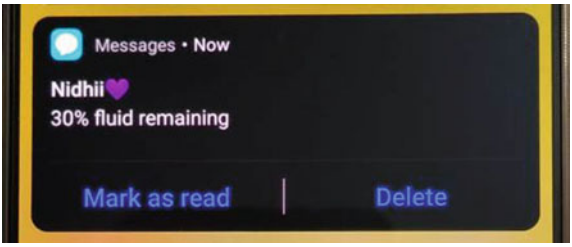

Fig. 5 SMS alert message received

6 Conclusion and Future Direction

To recapitulate, the constant task of manually monitoring the intravenous drip is eliminated. This system would be more beneficial at the nighttime to the hospital staff and patients. Also, implementing this system avoids a major risk of air bubbles entering the patient's bloodstream, which if happens can be fatal. This system can further be extended by including a call alert in it when the level of fluid is critical. Also, the system can be enhanced where along with the fluid-level message, the patient's body temperature, blood pressure level, and pulse rate are measured and sent to the hospital staff at regular intervals.

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