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IOT BASED SMART SALINE BOTTLE USING LONG RANGE COMMUNICATION

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ABSTRACT

Medical services in the current modern era had improved gigantically and there are more than one lakh devices categorized under 10,000 types of medical devices. In contrast, to the advancement in the medical sector there are still short falls in practicing quality patient care. One such simple aspect but critical in terms of patient care is to treat the patients with saline for dehydration and for other medical ailments to improve the health condition of the patients. The need for attentiveness is still high even with an infusion pump that uses monitoring and control. Generally, in hospitals tracking the saline level of multiple patients at a time is a tedious task. To address this problem, an IoT based smart saline detection system can be introduced which uses the load cell to measure the weight of the IV bottle, and IR sensor to acquire data on the status of the level of fluid inside the bottle and send an immediate alert to the computer at the nurse station. If the bottle is about to finish it will alert the nurse regarding the IV bottle change via Long Range Communication (LoRa). This technology can be obtained at affordable cost and mainly focuses on providing solutions to the most fundamental aspect to be monitored in the hospital.

Index terms: LoRa, IR Sensor, Load cell, IV bottle.

I. INTRODUCTION

India is a nation with a diverse population in South Asia and accounts for one-sixth of the world's population, making it the second most populous country in the world. Healthcare engineering is a rapidly growing field that encompasses all aspects of disease prevention, diagnosis, treatment and management, and the preservation and promotion of physical and mental health and well-being through medical services. The World Health Organization recommends three nurses for every 1000 people in a population, but India currently has only 1.7 nurses per 1000 patients. This means that India needs at least 4.3 million more nurses by 2024 to meet WHO standards, despite an increase in nursing registrations. While there is a lot of talk about the need for more doctors in India, it is important to remember that nurses are the backbone of the healthcare system, especially in hospital-based healthcare delivery. In developing countries like India, there is a high dis- proportionality of nursing staff to patients, which increases the likelihood of medical errors. Due to the high population and the emergence of diseases, there is a high demand for IV monitoring systems, which involve the injection of medication or other substances directly into the bloodstream via a thin tube or catheter inserted into a vein. While IV administration allows for quick medication delivery and accurate dosing, the need for continuous monitoring of the saline flow into the patient's body is crucial, as back- flow of blood into the saline bottle canoccur if the flow is not monitored properly. However, the lack of sufficient nurses to monitor multiple patients simultaneously makes timely monitoring of saline flow difficult.

Continuous monitoring of saline is necessary when the saline is supplied. The saline or any infusion fluid would be given to the patient's veins during therapy for various purposes. The incidence of saline back-flow and blood suction into the IV lines is still a problem with the drug delivery systems. Generally, a saline bottle containing the necessary drugs is hung at a high level above the patient, which creates pressure and is created by gravity and potential energy to overcome the cardiac pressure. Complications of this intravenous therapy may include air embolism, phlebitis, infiltration, and hematoma and extra- vascular drug administration. Another complication rises during the emptying of the Intravenous (IV) bottle. IV bottles are always airtight or they have a vacuum inside them. When the fluid level is about to empty, the patient's blood reverts into the IV bottle.

The Roller Clamp which is an existing technology helps in the control mechanism of the flow of the saline fluid. Internet of things (IoT) based smart saline monitoring system has been introduced for continuous monitoring of saline level inside the bottle and provides an alarm to the nurse station, in case the fluid inside the bottle is aboutto finish. Long Range (LoRa) is a wireless spectrum that offers long-range communication, for Machine to Machine (M2M) communications and IoT applications. Dragino's LoRa Gateway- LG01 is an open-source wireless transmission device that works on low power consumption and can connect through Wi-Fi, Ethernet, 3G, or 4G cellular networks. Patient's saline level is continuously monitored and the data thereby is shared using the common LoRa Gateway for the entire hospital. LoRa also has the advantage of Data security, Low power consumption, and provides greater communication range with lower bandwidths and extended coverage.

II. LITERATURE REVIEW

This includes the views and the method of working insisted on each paper.

This focuses on the usage of Heartbeat sensors and Load cells for automated IV fluid detection systems. The standard weights of IV bags available are 50ml, 100ml, 250ml, and 500ml. The nurse station will be alerted with the help of a buzzer immediately when the saline level is about to empty or crosses the threshold level. The load cell will be continuously monitoring the saline bottle's weight at fixed time period. Beam load cellis used here and this is connected to INA 125P amplifier for amplification of the results. Load cell usage for our proposed work has been acquired from this paper. [1]

Detection of electrolyte levels inside the saline bottle with the help of an IR transmitter and IR receiver are incorporated. The transmitter will transmit an IR ray and it will be received by the IR receiver. The placement of the sensors would be at the bottle's bottom. At present, when the fluid is present inside the IV bottle, a voltage of 4.5 V will be received indicating that the electrolyte is present inside the bottle. But as the fluid goes beyond the IR sensors, the IR receivers will get more rays, and the corresponding voltage measured will be 5V. This part of the usage of IR sensors has been obtained from this paper. [2]

Newer technology for communication has been experimented with Lora that is Long Range. This Long-Range communication system is sensitive to high receiving ability. The Cost- effectiveness of IoT-based projects can be achieved by combining LoRa with Wi-Fi technology. The Lora gateway gets connected with LoRa end devices so that communication can be done between them. A single LoRa gateway will allow connection to 10 end devices. The data communication, obtained using the Wi-Fi module is only 2 meters whereas, with the help of Lora, a maximum coverage area of 200 meters can be obtained. [3]

Controlling drip irrigation systems with the help of Lora WAN technology has also been developed. It focuses on the development of the GUI software that is used for controlling drip irrigation systems. Kivy, a multi-touch GUI application has been used to display the results and to control the device. Using this GUI platform, we will be able to display the results of the IV bottles in different rooms of the hospital. If the fluid in the bottle has been finished, it will indicate a red color on the corresponding room number. This part of developing a GUI has been obtained from this paper.[4]

Internet of Things helps send data in a faster way to nurses and doctors is understood. The database stores information about the patient, such as their name, room number, components and the amount of saline fed directly to the patient. When the salt level reaches a critical point, it gives an alert message to nurses or doctors with data obtained through IOT.They can find out at which room number the saline bottle reaches a critical level. [5]

Android application has also been developed for saline monitoring. An algorithm is developed to calculate the drop rate of saline, this in turn helps to find the total amount of fluid inside the bottle and the remaining time. This information is sent through wireless technology so the concerned nurse and the doctor can view the information through the saline monitoringapplication on the mobile phone. [6]

The importance of the delivery of fluids through an intravenous drip and the working principle of the intravenous drip system is also being addressed. We can analyze and know the distance at which the drip bottle has to be hung. The formula for drip rate is calculated. [7]

III. PROPOSED SYSTEM

In Multi-specialty hospitals tracking the saline level of patients in itself is a tedious task. The proposed solution is to overcome the limitations of currently existing methods, enhance the accuracy of detecting the saline level, and improve the quality of healthcare. The objective is to develop a system that monitors the level of the saline inside the bottle, this system helps in identifying the saline level inside the bottle, and when the saline level in bottle is about to get emptied it gives an immediate alert to the caretaker and nurse regarding the emptying of the fluid. The proposed IoT- based saline monitoring system has two main modules for saline detection.

LEVEL DETECTION USING IR SENSOR

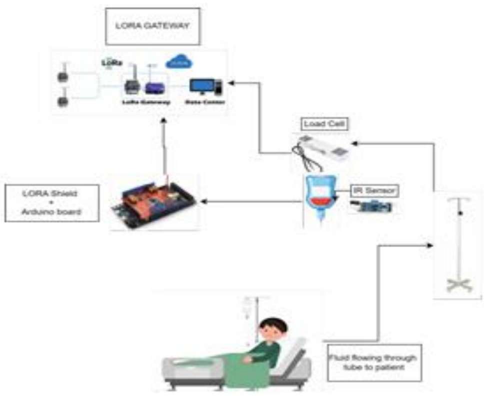
IR SENSOR is used for detecting the presence or absence of saline below threshold level. The transmitter of the IR sensor will be connected to one end and the receiver will be connected on the other end such that both are on opposite sides. The sensor and the Arduino board are connected to read the sensor's data and the results are viewed via the serial monitor of the Arduino. These results are also communicated to the nurse's mobilethrough long-range communication. The patient's history is stored in a database andthe details will also be available in the mobile application of the nurses.

SALINE BOTTLE WEIGHT MEASUREMENTUSING THE LOAD CELL

The load cell is incorporated to measure and analyse the saline bottle's weight. It is a force transducer that is used to convert forces such as torque, compression, and tension into an electrical signal. As the weight of the saline which is hung in the load cell decreases, changes in the electrical signal occur proportionally thereby indicating the reduction of saline level in the bottle. This data from the load cell is also communicated through a wireless technology called LoRa. LoRa works on chirp spread spectrum modulation.

The integration of the IR sensor along withthe load cell is done with the LoRa SHIELD which will communicate with themain LoRa gateway. Every room in the hospital will have an IV bottle working, along with this setup. Each one of the LoRa shields will be connected to LORA Lg-01 GATEWAY. The output of LoRa is viewed in the nurse's mobile application. This mobile application can be downloaded by the nurses with their respective login credentials. This mobile application helps the nurse and caretakers to analyse and keep track of the liquid level (saline) flowing into the patient's body. The alert is sent from time to time regarding the low level of saline in the form of notification and vibration thereby preventing any serious accidents.

IV. BLOCK DIAGRAM



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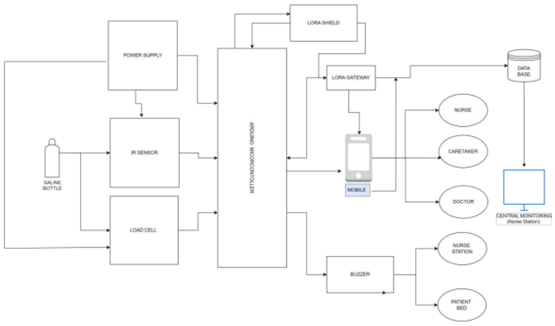

(b)

Fig 3.1: (a)Block diagram of the proposed solution. (b)Simple block diagram of the experimental setup.

V. WORKING PRINCIPLE

IR Transmitter: A unique kind of LED called an infrared light emitting diode (IR LED) generates infrared electromagnetic spectrum photons. The IR rays' emission wavelengths are in the region of 740 to 760 nm. As infrared rays have a longer wavelength than visible light, it is invisible to the human eye.

IR Receiver: An infrared receiver, often known as an IR receiver, is a piece of hardware thatreceives and decodes signals from an infrared remote control or an infrared led to communicate information to another device. To uniquely identify the infrared signal, it receives, the receiver often outputs a code.

LoRa (long-range communication) Shield:

The LoRa transmitter along with the Arduino physical factor and an open- source library called Long range communication (LoRa) Shield. With Arduino Shield, users can communicate data across incredibly great distances at modest data rates. Using the LoRa Shield, users may communicate data across incredibly great distances at modest data rates. With low current consumption, it offers great interference immunity and ultra-long-range spread spectrum communication.

Arduino Uno Board: The Microchip ATmega328P microprocessor and Arduino UNO board is a micro-controller board which is used to program the board's 14 digital pins and 6 analog pins over a type B USB cable.

LoRa Lg-01 Gateway: LG01-N is long range communication Gateway that bridges Wireless network to the IP network by Ethernet, Wi-Fir or 3G/4G cellular data. This technology allows users to transmit data to extremely long range with low data rates and data lag.

Features of LoRa Lg-01 Gateway: The maximum range of LoRa is 5-10km. Itis compatible with Arduino IDE which makes it easy to program. The power consumption of this LoRa Lg-01

Gateway is low: The novelty of this ideation is the use of anS-type load cell and IR sensor along with LoRa technology. Both the sensors, the load cell and IR sensor gives us accurate results by analyzing and measuring the saline bottle' weight along with fluid level present inside the bottle. The Long-range communication-based connection allows at most 120 end devices to be connected to the gateway. Lora allows data to betransferred from the end device to the gateway without internet up to 3km.

This device is mainly intended to beused in hospitals and in small clinics that need the nurses/attendees to change the IV bottle before it gets emptied. This prevents the backflow of the patient's blood into the bottle through the tube. This systematic and innovative setup would make the IV Bottle change much easier and the nurses will be able to look into the status of the bottles for every room from their desktop at the nurse station or with the help of the mobile application. The long-range of data transfer (up to 3km) allows many devices to get connected to one gateway. LoRa tends to have secure communication and the information sent is encrypted. LoRa- based communication is also battery- operated. This setup can be mass- produced for all healthcare centers.

Emergency panic switch: This switch is attached along with the stand for the patients/attenders to manually operate during any sort of discomfort.

Additional Features: The stand will also provide access to the cleaning spirit and bandages which are required for the process of Intravenous infusion therapy.

VI. WORKING PRINCIPLE

Figure 5.1: Experimental setup of the proposed solution.

VII. RESULTS AND DISCUSSION

Saline bottle's weight along with fluid level is given as input to the Lora Transmitter to transmit the data. And thesedata can be received by the receiver end or at the nurse station with the help of the LoRa Receiver gateway. The output can be viewed through the mobile application.

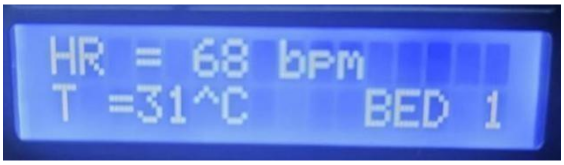

Figure 6.1: Result obtained

VIII. CONCLUSION

This work is to continuously monitor the fluid level inside the saline bottle and to indicate its status to the nurse station. This helps the nurses/attendees in multi-specialty hospitals to keep records of the saline level inside the bottle. Our proposed system prevents reversal of blood back into thepatient's vein.

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