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Automatic saline level monitoring and switching system

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Abstract -In past few years, technology is advancing very rapidly within the field of sensors, controllers and lots of other devices. This advancement in technology are often utilized in the sector of health care, in order that patient health are often monitored more sophisticatedly and safely. These innovative methods are often wont to monitor patient health without or less human intervention. Theessential treatment given to the patient is to feed the saline to enhance patient health by treating dehydration. In current systems, whenever saline is fed to the patient, his/her health must be monitored continuously by a caretaker or nurse. Most of the days, altogether hospitals, and nursehave got to monitor many numbers of patients simultaneously. Sometimes due to heavy work load or lack of sufficient skills, patients are often harmed within the hospitals. So this technique is proposed to watch drip rate and saline level within the bottle. When saline level goes below predefined threshold, the flow of saline stopped automatically. Also this technique can switch the saline bottles automatically, in case more than one saline bottle got to be fed to the patient.

Key Words:Arduino, GSM, IR sensor, Load cell, T-connector, Auto-switcher.

1.INTRODUCTION

With increasing population, need for health care also increased. So it's necessary for everybody to require excellent care of themselves. Also in hospitals, taking patients care is that the topmost priority, but due to heavy work load on nurses, sometimes it's difficult for them to manage each and each patient continuously. Again in some emergency situations, like natural disasters it's really tough for hospital staff to manage all the patients. So this technique can help to scale back their load.

The basic treatment in such situation is to feed saline to the patients, which require to be continuously monitored. Sometimes thanks to negligence, busy schedule and more number of patients, the nurse may forget to modify the saline bottle when it's totally consumed. As saline bottle becomes completely empty, blood starts to flow back to the saline bottle thanks to high of vital sign than the pressure inside the empty saline bottle. This might reduce hemoglobin level of patients and should also cause shortage of red blood cells (RBCs) within the patient's blood causing tiredness. Hence there's a requirement to develop a saline level monitoring and saline switching system which can reduce dependency of patients on the nurses to some extent.

So here we proposed a way to watch saline level automatically. Currently many methods are proposed for saline monitoring and notifying nurse when saline level is low. In case, if patient needs two or more saline bottles, then nurse has got to come and alter bottles manually. So here we also proposed automatic saline switching system, which may switch saline bottles automatically and also notify approximate time when saline level goes to zero. The aim of this method is to completely automate the saline monitoring and switching process with very less or almost no supervision externally. This may help to scale back human errors and can also provide a really reliable and price efficient method without compromising performance. This may help hospitals to watch each and each patient with proper time management and care.

2.Literature Survey

In this paper, flow of liquid through saline is automatically controlled. This is often done by measuring the extent of liquid inside saline bottle then it's compared with intensity. When liquid level reaches threshold, level, saline flow is automatically stopped. These methods are often used for the overcoming of the careless mistakes done by the operators. [1]

The main objective of system proposed in this paper is to supply reliable, convenient, and effortless and price effective system for saline level monitoring. The saline is injected into blood by considering certain parameters like pulse, vital sign, blood heat, and pulse and weight of patient. Because the saline goes below the critical level, it is necessary to vary the saline bottle. The main objective of advanced proposed system is to provide effortless system for saline level monitoring, movement of patient and emergency alarm regarding patient. [2]

This paper proposes the system which automatically monitors the saline flow by using microcontroller. The thought proposed here is cost effective, reliable and automatic saline flow monitoring system, which can be helpful for hospitals. Due to the use of microcontroller ATMEGA 328, wireless module CC2500, Bluetooth module and IR sensors, the system are often made available at very low cost. An equivalent circuit is often reused for an additional saline bottle giving just one time investment. It can wirelessly send the info to nurse's or doctor's computer and display the leads to the shape of saline droplet rate, number of droplets coming from saline bottle, saline given to the patient. It's mainly advantageous within the

dark timing as there's no need for nurses to travel to patient's bed to see the extent of saline in the bottle. [3][4]

Almost altogether hospitals, nurse are liable for monitoring the IV fluid level of patient continuously. Sometime, due to heavy work load or negligence, nurse may forget to vary the saline bottle at correct time. This might results in the backflow of blood. To beat this critical situation, a coffee cost RF based automatic alerting and indicating device is proposed during this paper. IR sensor is employed to sense liquid level inside saline bottle. IR sensor output voltage changes when IV level is below predefined limit. A comparator is employed to continuously compare the IR output with predefined threshold. When the transceiver output is negative, Arduino controller identifies that the fluid level is below threshold and it alerts the observer by buzzer and LCD at the room indicating the space number of the patient. [5]

Afratasneem R. Sayyad proposed a saline monitoring system using load cell, where the liquid level is monitored using load cell. Updates of the saline level as ¼, ½, ¾ and full are measured and sent to the doctor using GSM modem.[6]

Arulious Jora proposed IV fluid level indicator using LDR. LED and LDR are placed on two sides of bottle at the bottom. When, fluid level inside bottle goes below predefined threshold, the conductivity of the sensor increases. This change is sensed by arduino controller and switches on the buzzer placed at doctor's cabin. [7]

Khushboo Vaishnav proposed IoT based saline level indicator system. Here, IR pair is used to sense the level of the saline, and using arduino the message is sent to the doctor using IoT platform.[8]

3. Proposed System

3.1 System requirements:

3.1.1 LOAD CELL:

Fig 1: load cell

A load cell may be a sort of transducer, specifically a force transducer. It converts a force like tension, compression, pressure, or torque into an electrical signal which will be measured and standardized.

As the weight applied to the load cell increases, the output of load cell changes proportionally. So here it can be used to measure weight of the saline bottle. Depend on the weight of bottle, the saline level is calculated.

3.1.2 Load Cell Amlfier:

Fig 2: load cell amplifier

Load cell provide accurate measurement of a load and convert tension or force into a proportional electrical signal. Once the load cell measures the load or force, a load cell amplifier is then used for signal conditioning so that signal can be amplified and converted into an output value. Without a load cell amplifier, the signal from the load cell could also be too weak to read. The amplifier simply "amplifies" the signal so it are often read and used wherever and however needed.

.3.1.3 Arduino and ESP8266:

Arduino Uno is a microcontroller board supported the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

It contains everything needed to support the microcontroller; within the 14 digital pin. Pin 0 and 1 are used for transmitter and receiver. Pin 2-5 are used for LCD data configuration. Pin 6-8 are the high for parameter component this is acted as Vcc of 5v.pin 10 and 11 are used for AD8232 lead off (LO-) and lead on (LO+).

Analog pin A0 is employed for input from the AD8232 output pin. Vcc and ground pin are connected correspondingly. Every analog pin gets the input from the sensors output.

3.1.4 GSM modem:

The GSM modem is used to send the SMS to the nurse as well as doctor. The sms contains details such as patient ward number, patient name, time when saline is attached, time when saline level goes to zero.

Features of GSM Modem: Quad Band GSM/GPRS 850/900/1800/1900 MHz, GPRS multi-slot class 10/8, GPRS Mobile station class B, Compliant to GSM Phase 2/2+, Class 4,(2W@850/900Mhz), Class 1(1W@1800/1900Mhz), Control via AT commands, Operation Temperature(-20 deg C to +55 deg.

3.1.5 Auto-switching mechanism:

In this mechanism, two saline tubes are connected together using T shaped connector and saline tube. Initially only one saline is active and other saline tube is blocked using spring and clamp arrangement. When first saline bottle is completely consumed, it is necessary to stop liquid flow. The control signal is sent to the clamp and spring arrangement, this will block the saline and stop flow of liquid.

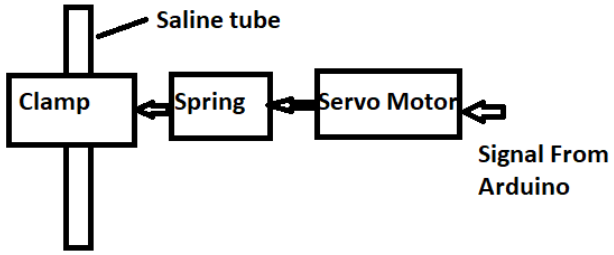

Fig 3: auto switching mechanism

In case, a patient needs another saline bottle, the control signal will be sent to the second clamp, which will unblock the second saline tube and start flow of liquid.

3.2 System Working:

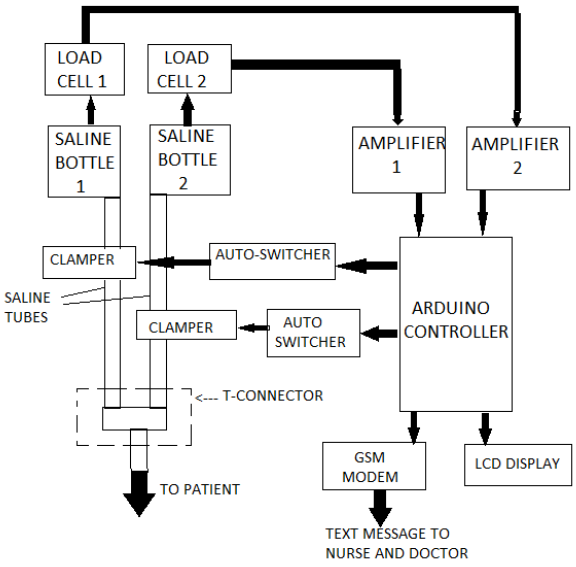

Fig 4: System architecture

The system will work in three stages:

3.2.1 Stage I:

Load cells are used to measure the flow of liquid inside saline bottle. Initially, weight of completely filled and completely empty bottle is measured and from that weight of 50% filled saline bottle is calculated as follows:

Let a=weight of completely filled bottle

b=weight of completely empty bottle and

c=weight of 50% filled bottle then

$$c=(b-a)*0.5+b \quad (1)$$

When the liquid in the saline bottle goes to 50%, the time required to reach 50% is note down. From that, time required to empty the saline bottle is calculated.

T1: time when saline is attached

T2: time when saline bottle is 50% filled

T=time required to completely empty saline bottle

$$T=T1-T2 \quad (2)$$

For the safer side, Two IR pairs can also be placed on the bottle, one at 20% and at the lower end of saline bottle. When IR pass through liquid, voltage received at receiver is less as compared to IR through empty bottle. When liquid reaches 20%, then IR sensor senses the change in the received voltage and this change is sent to the arduino. Arduino then records this time and calculates time required to completely empty the saline bottle. Then it sends the message to the nurse and doctor with following information: Patient's name, ward number, number of saline bottles required, current saline level, time required to completely empty saline bottle.

If nurse attends the patient in time, she will reset the system. But if she fails to do that, system goes to next stage.

3.2.2 Stage II:

In this, if the nurse fails to attend the patient within the specified time limit, system will try to stop the reverse flow of the blood into the saline bottle.

For this, we made a spring and servo motor arrangement. The clamp will be attached to spring. The clamp will move in forward and backward direction by compression and stretching of spring.

When IR sensor at the bottom of the bottle sense that the saline is completely consumed, arduino will send control signal to the servo motor and as per servo motor's action, the spring will be stretched and clamp will move in forward direction to pinch intravenous tube and stop the reverse flow of the blood back in the saline bottle.

After this, arduino sends one message to the nurse and doctor that saline flow has been stopped.

3.2.3 Stage III:

In case, any patient needs more than one saline bottle, we proposed an auto switching mechanism for the saline replacement. In this mechanism, one T-connector is used to connect two saline tubes. If nurse attends the patient after consumption of first saline bottle, she can manually change the saline bottle. But if she fails, arduino sends control signal to the first servo motor and stops the saline flow. Also it sends the control signal to the second servo motor and compresses the second spring, so that the clamp will move in backward direction and starts flow of second saline bottle.

5. Conclusion

In hospitals, it is necessary to monitor status of saline bottle fed to every patient. But practically, it is impossible to take care of each patient on each bed as there is lack of medical staff in hospital. Again in hazardous situations, the patient count is much large. By considering such situations, we developed low cost automatic saline monitoring as well as saline switching system.

When the level of the saline reaches 50%, text message is sent to the nurse or caretaker with the details like patient number, name, ward number and time required to completely empty the saline bottle. Again when saline reaches predefined critical volume, another text message is sent with the same information. If that staff attends the patient then he/she can reset the system, but if he/she fails to attend, then our system automatically stops the saline flow to prevent back flow of blood.

The system proposed here will definitely help hospitals to manage their work load effectively. This system will be much helpful in the natural disasters or hazardous situations.

6. Future Scope

This project considers only fixed capacity saline bottle. Depending on the capacity of saline bottles, at the input, switches can be placed to select capacity of saline bottle, accordingly conditions can be given in program, so that same project can work for different saline bottles.

Again patient's health parameters like heart rate, body temperature etc can also be monitored by connecting appropriate sensors and sent to the doctor or nurse. More advanced controllers can be used to manage number patients from single controller.

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