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Smart Intravenous Fluid Monitoring System

[1]Dr.K.Sangeetha, [2]**Dr.P.Vishnuraja, [3]Mrs. K. Vijaya**,**[4]Dinesh S**,**[5]Gokul Anandh V S**, **[6]Hariprakash K**

[1,2]Associate Professor, Computer Science and Engineering, Kongu Engineering College, Perundurai, India
[3]Assistant Professor(Sl.Gr), Computer Science and Engineering, Velalar College of Engineering and Technology, Thindal, Erode, India
[4]Student, Computer Science and Engineering, Kongu Engineering College, Perundurai, India
[5]Student, Computer Science and Engineering, Kongu Engineering College, Perundurai, India
[6]Student, Computer Science and Engineering, Kongu Engineering College, Perundurai, India

ABSTRACT: Simple electrolyte bottles are used in hospital without any proper indication.This creates a trouble to patient as the blood will start flowing in reverse flow from body towards bottle. To overcome this critical situation, an IoT based automatic alerting and indicating device is proposed where sensor is used to monitor the level. For monitoring the level, the capacity of the bottle is needed so a mobile application which gets the capacity as input from the hospital staff. When intravenous fluid level is less than fixed threshold value, it alerts the nurse through the LCD display,mobile application, webpage and buzzer. In a situation that the staffs are not available to change the bottle, solenoid valve will shut the flow of fluid automatically.The departments of hospital require similar kind of automatic monitoring and indication system. Health care industries can also be one of the users.Thisarrangement can be helpful in small, medium and large size of hospitals and also it valuable during home care. This supervising system will decrease the chances of patients risk and boosts the accuracy of health care in hospital. The regular need to check physically the level of bottles is avoided. This project is very useful to monitor the patients during night times. The serious risk of air bubbles entering the patient's bloodstream is avoided which is a serious threat as air bubbles in blood can cause immediate death. This application setup will generate assurance of safe situation to patients.

Keywords: Intravenous fluid, flow sensor, air bubble, buzzer,IoT, solenoid valve

I. INTRODUCTION

In existing framework, observing of patients is done by manual procedure which may results to switch stream of blood during trickles process. At the point when bottle get unfilled and if health care faculties don't know about it, it might end up in reverse blood stream.To observe the patients in late night is troublesome and communication among specialist and patient is less. The solution for the previously mentioned issue is, a flow sensor which reads the amount of discharge of water and the status is displayed in the LCD display. The same values are updated in the database also. Central monitor and a mobile application will display the status of the patient's fluid bottle. Mobile application gets the capacity of the fluid

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bottle initially, as there are different capacities of intravenous fluid bottles are available. Through that staffs are able to know the level of the fluid in the bottle. If the amount of fluid in the bottle reaches the fixed threshold value it will alert the staff and then the staff came to know that the bottle will get empty soon so they can change the bottle before it gets empty. If the staffs are unavailable at that time, the system will automatically shut the flow. This will prevent the reverse flow of blood stream and so it will eliminate the serious problems of patients.

II. LITERATURE REVIEW

DraganaOros& et al (2021) worked in Intravenous Infusion Dosing System by detection, signaling and monitoring of liquid in an IV bottle at a remote location. This system alerts the medical staff to continue and timely changes of IV bottles which can have positive effects on increasing the success of IV therapy.

Anagha R & et al (2020) focused in automation of level monitoring using ultrasonic sensor which is placed at the top of the fluid bottle. They aimed to make patients comfortable with their system. They also worked for fan automation for patients ease of use. They place the flex sensor under the finger, when the patients need/no need of fan they can turn on/off by bending the finger. They also automated the stoppage of fluid using solenoid valve.

Elizabeth Liza Mathew & et al(2020) worked on The Novel Intravenous Fluid Level Indicator for Smart IV Systems by checking the level of the fluid given to the patient and controlling the flow of the fluid automatically by using sensors.

Timothy Adam Walsh& et al worked in using various integrated sensor to measure the flow of the fluid and alerting the staff nurse when the fluid level reaches certain percentage.

Ms.Sincy Joseph & et al(2019)worked in reducing the workload of staffs and overcome the critical situation in the area of an Intravenous drip monitoring system using Automated Intravenous Drip Monitoring System.

Matthew Ruggeri Novak (2019) worked in IV pump remote alarm system includes a modular unit detachably connected to a stationary unit, which is associated with the IV pump from which the nursing station can be alarmed when the status is critical.

Sampath Kumar K & et al (2018) worked with the fluid monitoring system with the help of infrared sensor. With the Infrared sensor they calculated the height by fixing the infrared sensor at certain level. When the bottle is filled with fluid infrared receiver will not sense any signal as the signal gets refracted. If the bottle is with low amount of fluid that is lesser than the height of the infrared sensor it alerts. They displayed the result in the web page.

AruliousJora A & et al (2018) worked in completely different way. They used LDR sensor to sense the light intensity through the liquid. When the fluid is at higher level light spreads so the intensity will be minimum, resistance will be maximum and when it is at lower rate the intensity with be high, resistance will be minimum. Then it alerts the nurse with radio

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frequency transmitter which transmits the data wirelessly to the nurse’s room. The signal is received by radio frequency receiver which is connected with the buzzer.

MonishaK.Bhavasaar& et al (2016) worked in automated intravenous fluid monitoring and alerting system by using load cell and heartbeat sensors and monitor the status of the patients and alert the staffs accordingly.

KanchiRaghavendra Rao& et al (2020)worked by adopting IoT cloud with wireless sensor networks that is beneficial, especially when administering the condition of a greater number of patients and their resulting data storage are taken into account. Liquid level sensor, Ultrasonic sensor and Temperature sensor are used.

III. METHODOLOGY

Intravenous Fluid Monitoring System consists of raspberry pi 3,flow sensor, LED lights, buzzer LCD display and solenoid valve. The mobile application gets the capacity from the hospital staff and it is updated in the database. The flow sensor calculates the remaining amount of fluid from the bottle by taking the difference between the capacity of the bottle and the total discharge from the bottle. It calculates the rate of flow of fluid continuously. These values calculated by the raspberry are displayed in the LCD display and also the values are updated in the firebase. The web page and mobile application will retrieve the values from the firebase and display the values. LED lights and buzzer are to alert the hospital staffs. When the level of fluid in the bottle is lesser than the threshold level then it alerts the staffs. This system consists of three states NONE which is the initial state before the start of the system, SAFE which indicates that the intravenous fluid bottle is not in critical state and the other state is CRITICAL, in this state the level of the bottle is lesser than the threshold level. In the safe state the green LED light will glow, buzzer will not alert and in the critical state the red LED light will glow and at the same time buzzer will also alert. The status will be displayed in the LCD display, the mobile application and the web page also so the staffs came to know about the patient’s IV fluid level and status. If the staffs are unable to change the bottle, the solenoid valve will shut the flow when the level of bottle is lesser than the fixed shutdown value.

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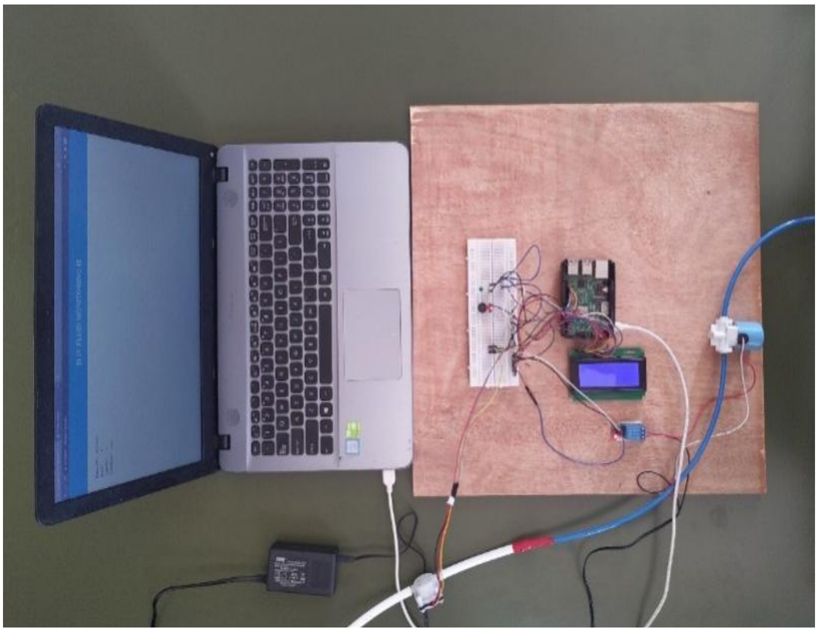

Fig. 2.1 .System Setup

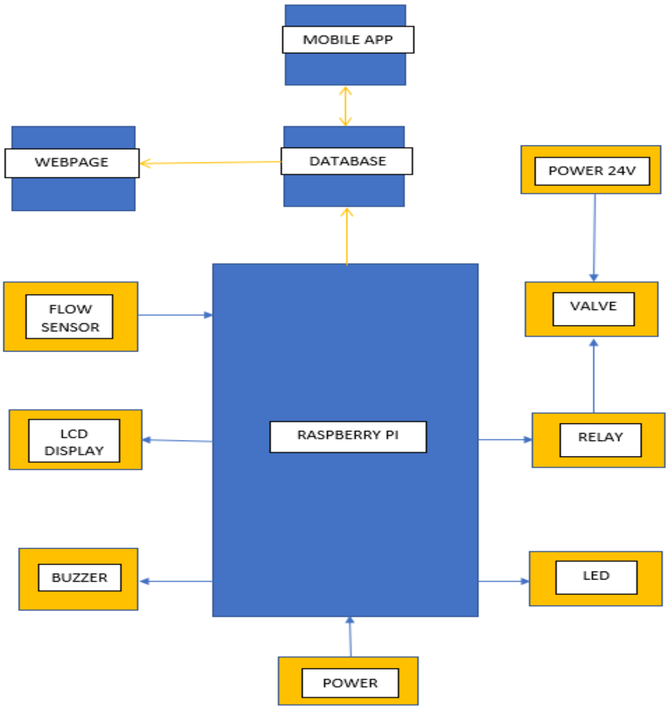

Fig. 2.3. Architectural Diagram

IV. COMPONENTS USED

A. Raspberry Pi 3 Model-B

Raspberry Pi 3 Model B is single-board computer with wireless LAN and Bluetooth connectivity. It requires USB power cable to give power supply to the Raspberry Pi and micro SD card with Raspberry Pi OS. In order to use Raspberry Pi as a Desktop computer it needs monitor, HDMI cable, Keyboard and Mouse. The flow sensor, LCD display, LED lights and buzzer are connected with the raspberry pi. This processes the data from the flow

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sensor and gives the values and status in the LCD display and updates the value in the firebase.

Fig. 3.1. Raspberry Pi

B. Flow sensor

1/8 inch Water flow sensor YF-S401 consists of a plastic valve body, a water rotor, and a Hall Effect sensor. When water flows through the sensor, the internal rotator will alter its speed with various rate of flow and Hall Effect sensor outputs the equivalent pulse signal. Flow sensor has three wires namely Power-in (Red), Ground (Black) and Output (Yellow). This is fixed in between the fluid pipe to monitor whether the fluid is flowing through the sensor.

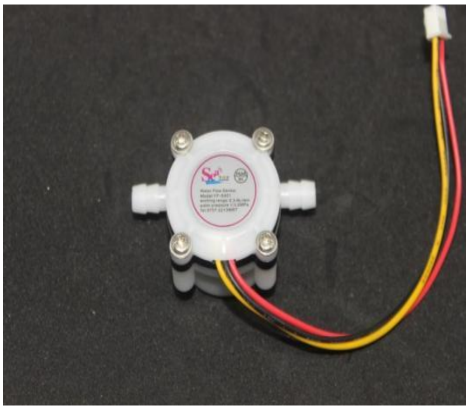

Fig. 3.2. Flow Sensor YF-S401

C. Solenoid Valve

A solenoid valve is an electromechanically-operated valve. Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high-reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

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Fig. 3.3.Solenoid Valve

D. Relay

The Relay has Electromagnetic Coil turned around a metal piece this will reacts as magnet when coil gets energized. Movable Armature attached with spring exactly placed above the electromagnet setup and makes contact between common terminal and Normally closed contact (N/C), with out any supply or zero input supply, this condition may be termed as normally open relay. When the coil get energized movable armature attracted by electromagnet and N/O contact becomes closed and N/C becomes open.

Fig. 3.4.1 Channel Relay

E. LCD Display 20x4

A liquid-crystal display (LCD) is a flat-panel display uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. In LCD Display 20x4, 20 represents number of characters per row and 4 represents the number of rows. This uses blue backlight to view the letters. This gets the value from the raspberry pi and displays the values and status in the screen.

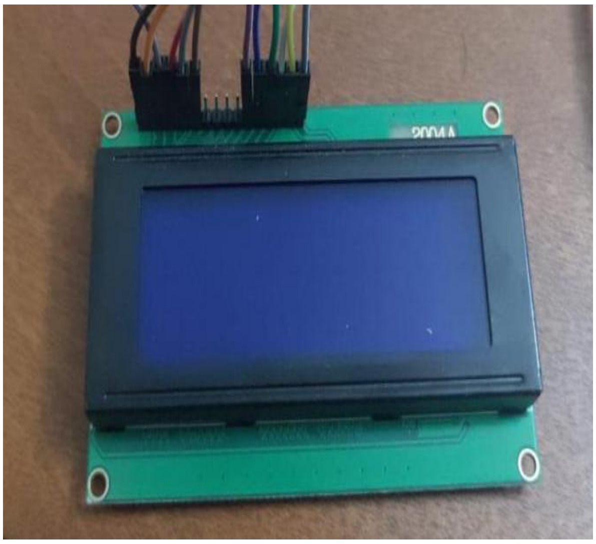

Fig. 3.5. LCD Display 20x4

F. LED Lights

A light-emitting diode (LED) is a semiconductor mild supply that emits light when current flows through it. Electrons within the semiconductor recombine with electron holes, releasing energy inside the shape of photons. The system consists of two LED lights green and red for safe and critical state of the fluid bottle respectively. According to the level of the fluid bottle LED light will glow.

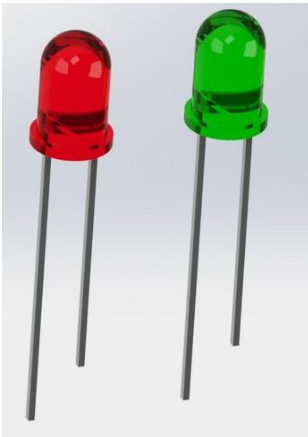

Fig. 3.6. LED Lights

G. Buzzer

The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices. This will alert the hospital staff when the level reaches the threshold point.

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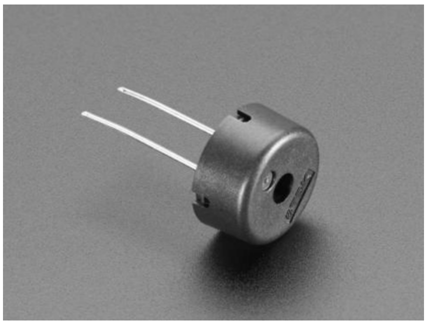

Fig. 3.7.Buzzer

V. EXPERIMENTAL RESULTS

A. Bottle Capacity setup with the mobile application

The capacity is used to calculate the remaining amount of fluid in the bottle. The difference between the capacity and the total discharge will give the remaining amount of fluid in the bottle.

After giving the capacity, the value is updated in the database. The system will retrieve the capacity of the bottle initially and then it calculates the remaining amount of fluid. Then click the activate button in the mobile application to activate the patient.

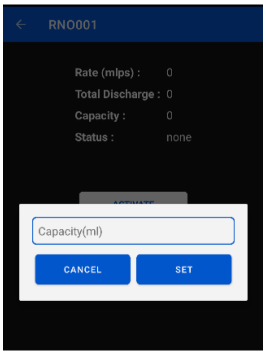

Fig 5.1. Bottle Capacity Setup

B. Status displayed in the LCD display as per the data given by the raspberry pi

Fig 5.2. LCD Status Display

LCD display shows the condition of the bottle, amount of fluid flows per second, total discharge of fluid from the bottle and the remaining amount of fluid in the bottle.

C. Data updated in the firebase

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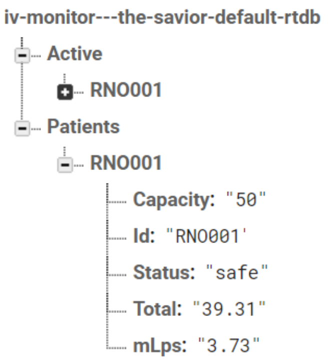

Fig 5.3a.Firebase Safe State

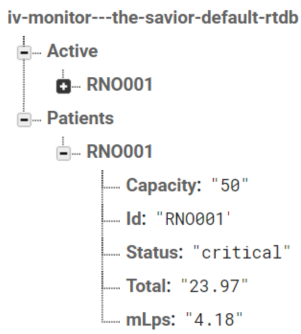

Fig 5.3b. Firebase Critical State

If the total discharge is lesser than the threshold value then the condition is safe, the same will be updated in the database together with the total discharge and the rate of flow of fluid per second. If the total discharge is greater than the threshold value then the condition is critical and it is updated in the database with the values of total discharge and the rate of flow of fluid from bottle.

D. Data retrieved from the firebase

The web page shows the condition, total discharge of fluid and the rate of flow of fluid. According to three different conditions none, safe and critical, the data is displayed with three different colors.

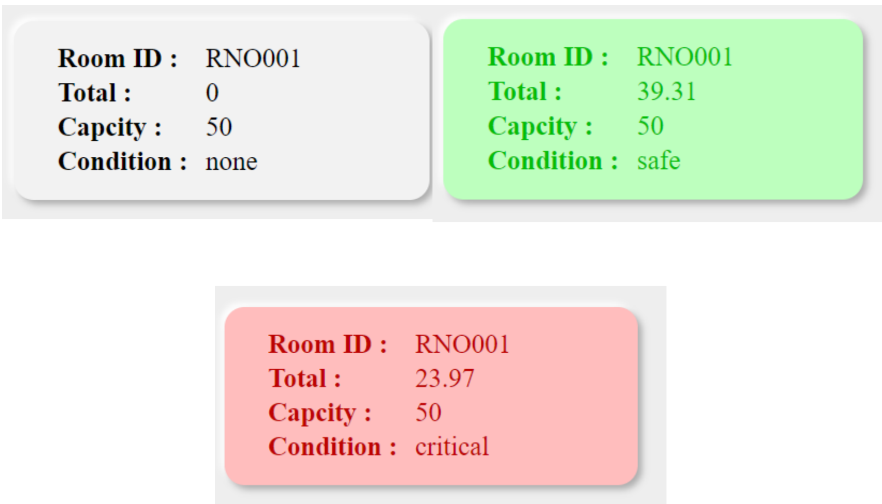

Fig 5.4.Web Page Status

E. Fluid Flow automation

In the critical state, if the staffs are not available to change the bottle and the flow of fluid continues, it will be a series problem to the patient's life. In such condition before the bottle gets empty, the flow of fluid has to be stopped. The flow of fluid can be stopped with the help of the solenoid valve. The valve is open at the time of safe state and critical state. When the remaining amount of fluid reaches the shutdown point then the solenoid valve closes and stops the flow of fluid from IV bottle to the patient's blood stream.

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F. Patient Data reset

After the system has successfully done its work, the data of the patient has to be reset. With the help of mobile application, the user/staff can reset the data. Without the reset of data, we can't use the system for another patient because the last update values are already in the database. Those data have to be reset.

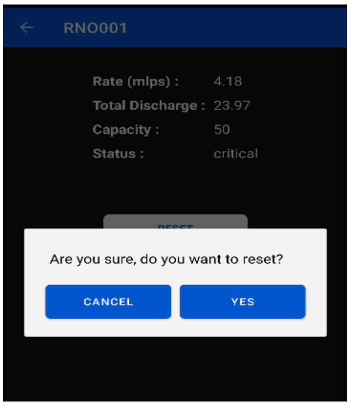

Fig 5.5. Data Reset

V. FUTURE SCOPE OF IMPROVEMENT

A. Body Temperature Monitoring

During infusion of room temperature IV fluids, some patientsexperience shivering, chills and discomfort. So the patient's body temperature should also be monitored.

B. Mobile Alert for Critical Condition

With the help of buzzer alert alone, the staffs would not be aware of patient condition. They also can't view the mobile application and web page constantly. So the mobile alert will help the staff to know that the patient is in critical condition

VI. CONCLUSION

This project overcomes the consequences that occurs due to negligence of monitoring the IV fluid flow. Using proposed monitoring, one can monitor the level of bottle from a distant position which will aid in building smart health care system. Affordable, precise and efficient system that works in a smooth manner is developed. Flow sensor will give data flow of fluid so that the discharge of water is monitored. This will be helpful especially at night times. Anyone can view the LCD display and report it to the staff if they didn't see the monitor. Solenoid valve will stop the flow of fluid when the situation is more critical. This will eliminate the serious problems of patients.

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