International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

The Novel Intravenous Fluid Level Indicator for Smart IV Systems

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Abstract - *The intravenous therapy is used to correct electrolyte imbalances and to deliver medicines. In this scenario, hospitals like high speciality hospital have infusion pump in dripping system. In any case if there is any failure in infusion pump, we cannot monitor the patient correctly. With the help of the device developed in this project the checking of the level of fluid given to the patient and the flow can control automatically. When the fluid reaches a predefined threshold level, device will give an alarm to the nurse and to the bystander. The main aim of the project is to relieve human effort by automatically controlling the dripping system of the patient in a hospital. In this device a flow meter is used to find out the fluid level in the tube and a NODEMCU module is used to processes the information to control the flow and to communicate the information to activate the indicator at the premises of duty nurse and bystander. An external actuator, which is enabled by the signal from the Raspberry-Pi module is used to block the flow of fluid to the patient body. By using this device, we can reduce the number of patients' death by entering bubbles with blood through vein and also reduces the stress of nurse.*

Key Words: actuator, dripping system, intravenous therapy, NODEMCU, threshold.

1. INTRODUCTION

The human era shows value to patient safety, in which people's healthcare is been considered as a valuable one. We come with many automatic healthcare facilities which provide safety to patient health. This automatic healthcare mainly reduces the stress on hospital duty nurse and also the bystander who accompanies the patient. There are many drastic changes taking place in the field of medicine but IV fluid is still a challenging issue [1]. Intravenous fluid regulation is the control of the amount of fluid you receive intravenously (within vein), or through your bloodstream. The fluid is given from a bag connected to an intravenous line. This is a thin tube, often called an IV, that's inserted into one of your veins.

The present technology takes us to the method of using infusion pumps which is more complex. Infusion Pumps are now commonly used in all hospitals. The major disadvantage of Infusion pumps is bigger in size and also the pump is expensive [2]. This infusion pump cost about Rs. 25,000. The proposed method Is Smart Intravenous Fluid Indicator. This method uses Raspberry Pi and NODEMCU for transmitting and receiving signals [3]. The cost of this is much lesser than Infusion pump system and also affordable.

The remaining part of the article is organized as: Section II is discussing the literature survey for leading the proposed works. Section III describe the proposed smart IV system and section IV give the list of components required for the proposed work. The experimental analysis are shown in section V and the article conclude in the section VI.

2. LITERATURE SURVEY

In the literature we can see that through several process we can control the level of fluid in a dripping system. The methods all includes using level sensor, GSM module etc.

The intravenous fluid level indicator is a system, that is designed such that if the Intravenous fluid reaches a critical level, it is sensed by the LED and LDR set up and an alarm is sounded at the nurse's room indicating the room number [4]. The saline level indicator such that saline is a key ingredient as a part of intravenous solution that delivers water to patients in hospitals and clinics. And also helps in controlling the reverse flow of blood into the saline and is not restricted to just informing the care takers of the critical level [5].

The embedded patient monitoring system that inform the doctor about the ICU patient condition through wireless [6]. This project provides a device which will continuously monitor the vital parameters to be monitored for a patient and do data logging continuously. If any critical situation arises in a patient, this unit also raises an alarm and also communicates to the concerned doctor by means of an SMS to the doctor.

The drip control automation system for hospitals that using an RF transmitter and receiver which is basically used for the wireless communication purpose [7]. In this, an alert message will be sent to the concern doctor even can control the drip system as the drip reaches a particular level by using GSM module. The PIC16F876A microcontroller is used to

processes the information for all the instructions given to each component. A load cell is used to measure the weight of the drip interfaced with IC hx711 that provide the level information to microcontroller [8]. An external actuator is used just next to the drip which is an electromagnetic valve that blocks the flow of liquid to the patient body as the drip reaches the particular level and also starts the drip system by receiving of the message from the concerned doctor.

From the above-mentioned ones, there are many disadvantages that makes this ineffective. Using of GSM module makes the system more complex. And installation is difficult for a level sensor.

3. THE PROPOSED IV SYSTEM

This idea is proposed to develop an effective health monitoring system which alerts the doctor or nurse when the fluid level of the saline bottle is below the threshold limit. This requires the use of the devices given below:

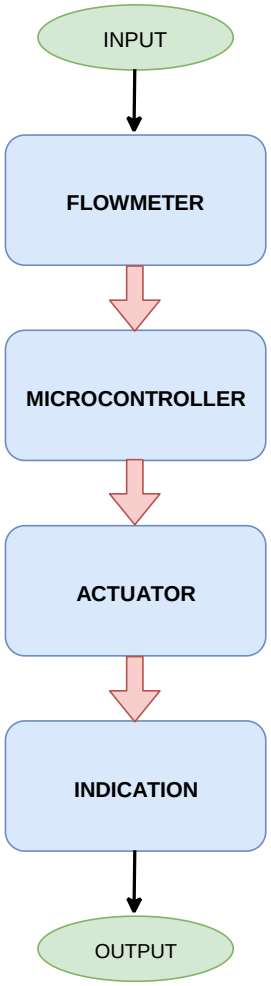

Fig. 1. The operational flow of smart IV system

Intravenous therapy is a medical procedure in which the liquid substances (medications) are directly entered into the vein through an IV tube and needle is inserted into the patient's vein. A sealed device called drip chamber controls the entire process so That the substance slowly passes into the vein, and it also blocks the air to enter into the blood stream. The project includes the development of a Smart Intravenous Fluid Level Controller, for effective health monitoring. The device developed will alert the nurse when the fluid level of the drip bottle is beyond a threshold limit and to block the flow of fluid automatically.

The proposed device comprises of a flow meter, microcontroller, actuator, Wi-Fi module, and buzzer. Initially, the

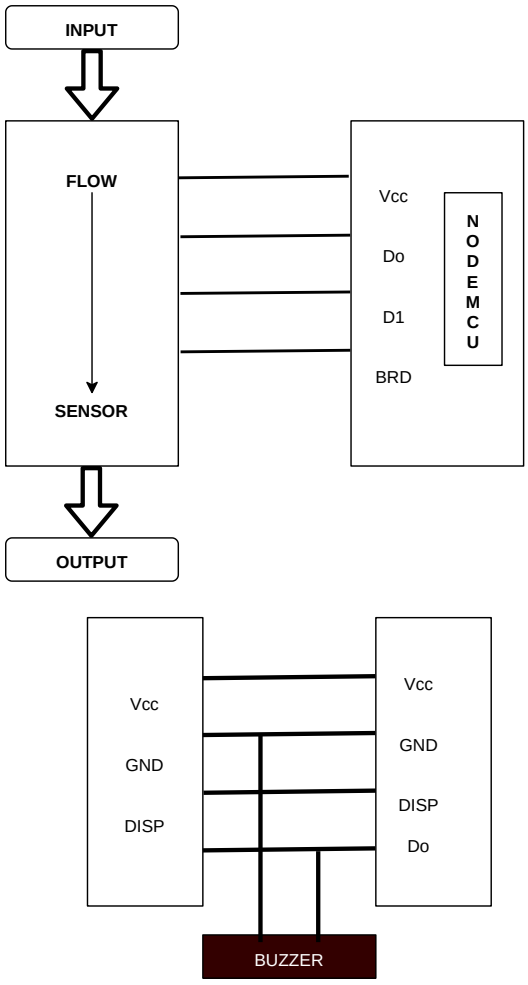

Fig. 2. The circuit diagram of smart IV System

flow meter continuously checks the fluid level inside the tube and whenever it crosses the threshold it will send an alert signal to the bystander and nursing station through NODEMCU board and Wi-Fi. At the same time, it energizes an actuator t stop the flow. The micro-controller in the nursing station detects the signal and it correspondingly shows the bed number of the patient by LED indication.

4. COMPONENT REQUIRED

The main components used in this project are:

A. NODEMCU

The NodeMCU is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit, modify, build. NodeMCU Development board consist of ESP8266 Wi-Fi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Express if Systems with TCP/IP protocol.

B. FLOWMETER

The SLF3S-1300F liquid flow sensor is based on Sensirions proven CMOSens Technology and optimizes costs by simplifying the design without sacrificing the easy fluidic, electrical and mechanical connections. The straight and unobstructed flow channel has no moving parts; inert wetted materials provide outstanding chemical resistance and excellent media compatibility. In measuring flow rates up to 40 ml/min bidirectionally, the sensor allows monitoring the entire system operation and detecting common failure modes.

C. BUZZER

A buzzer or beeper is an audio signalling device, which may be mechanical, electro mechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

D. LED DISPLAY BOARD

It doesn't need to do wiring. Its simple plug and play device. The programming interface method used is Wi-Fi. The popular brands are XPS/G-Energy. There are many display abilities such as scrolling text, random text, Numeric date and time.
The applications are outdoors/indoor brightness-Auto/Manual.

E. RASPBERRY PI

The Raspberry Pi is a series of small single-board computers. The organisation behind the Raspberry Pi consists of two arms. The first two models were developed by the Raspberry Pi Foundation. After the Pi Model B was released, the Foundation set up Raspberry Pi Trading, to develop the third model, the B+. Raspberry Pi Trading is responsible for developing the technology while the Foundation is an educational charity to promote the teaching of basic computer science in schools and in developing countries.

5. EXPERIMENTAL ANALYSIS

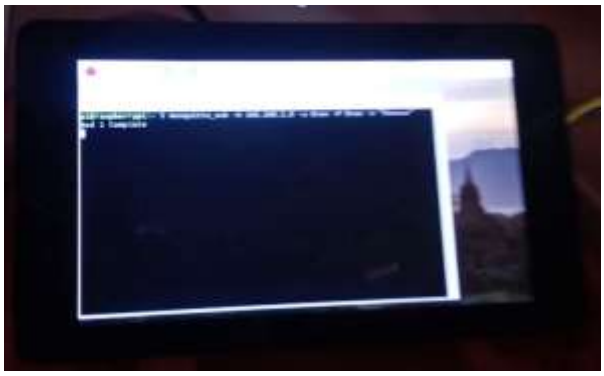

Fig. 3. The prototype Raspberry pi setup

The simplest experiment was done to verify the performance of the proposed device. Let us consider rooms in hospital. Initially sensors are fixed at the bottom of saline bottles in all rooms. If the liquid is present in the travelling path then output voltage measured is high and that can be viewed in the viewer software. Here we give the totalizer as the amount of fluid Level at which the drip gets off. As we change the value of the totalizer the fluid level also changes effectively. The buzzer is used to produce alarm until observer change the saline bottle.

Fig. 4. The viewer software setup

Fig. 5. The flow sensor setup

It consists of both Hardware and software parts. The Hardware parts includes Sensirion SLF3S Flow sensor, NODEMCU, RASPBERRYPI, Display. The software parts include Arduino IDE, Sensirion viewer software, Raspberry Pi.

6. CONCLUSION

This system is more advanced than the existing dripping system. We know that in the existing system the level sensor is used to check the fluid level of IV system the sensed level of the fluid is converted into electric signal and send it to the micro-controller. If the set point is crossed, the buzzer alerts the patient then the nurse reaches the ward and stopped from the patient's vein. To overcome this situation, our proposed system to develop the IV fluid monitoring system automatically sends a message to the nurse through GSM technology and automatically turned off the flow of a liquid from the IV system by using the solenoid valves. Our smart intravenous drip system removes the hassle of continuous monitoring of patient by automating the task and notifying medical officials in case of emergency. This system significantly improves the efficiency and prevents reverse flow of blood into the IV bags. The control system can be the better in time consumption, the system can easily control the hardware by use the micro controller. This project provides the advantages for nurse or assists in health care system and control of notice board generally.

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