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Intravenous Drip Monitoring System

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Abstract: In this paper, a system which displays the real time drip rate of an Intravenous (IV) infusion fluid and provides an estimated time by which the IV bottle empties is proposed. In the proposed system, a light emitting diode (LED) and light dependent resistor (LDR), linearly assembled are used, which is more accurate than an infrared sensor - emitter assembly and economically feasible than computer vision techniques. The existing system doesn't display the time left until the IV bottle empties, so in this proposed system, volume/weight detection technique using load cell is used to provide real time data regarding the time left.

***Index Terms*: Drip rate monitoring, load cell, LDR**

I. INTRODUCTION

Intravenous drip infusion is one of the most primary and prominent treatments given to all types of patients in hospitals. Doctors and nurses use their experience and an eye test to predict when the intravenous (IV) bottle will empty. This is subject to human error and the drip rate varies with the temperature of veins and the gravitational force of the bottle. Automating this process makes the treatment more reliable [1]. Over infusion of the fluid can cause major health problems including blood loss and fluid backflow which is hazardous to the patient's health

FLUID ORDERS									
	Name:	*Saloma Ishmael*			Registration Number		*604321*		
METHOD AND SITE		METHOD			SITE				
		Intravenous Infusion			*Peripheral vein left hand*				
	FLUID TYPE	Amount (ml)	Addition	Duration (hrs / min)	From		To		Rate ml/hr
					Date,	Time	Date	Time	
1	*Normal saline in Dextrose 5 %*	*500*	*1 gm KCl*	*5 hrs*	*09/07/17*	*8.00 a.m.*	*09/07/17*	*1.00 p.m.*	*100*
2	*Dextrose 5 %*	*500*	*Nil*	*5 hrs*	*09/07/17*	*1.00 pm*	*09/07/17*	*6.00 p.m.*	*100*
3	*Normal saline in Dextrose 5 %*	*500*	*1 gm KCl*	*5 hrs*	*09/07/17*	*6.00 p.m.*	*09/07/17*	*11.00 p.m.*	*100*
4	*Dextrose 5 %*	*500*	*Nil*	*5 hrs*	*09/07/17*	*11.00 p.m.*	*10/07/17*	*4.00 a.m.*	*100*
5	*Dextrose 5 %*	*500*	*1 gm KCl*	*4 hrs*	*10/07/17*	*4.00 a.m.*	*10/07/17*	*8.00 a.m.*	*125*
	TOTAL	*2500*	*3gm KCl*	*24 hrs*					

Fig. 2. Treatment data [1]

Within this duration, the designated health personnel have to repeatedly check on the patient to see if the drip rate is non zero and the treatment is proceeding seamlessly. With the use of the proposed device, these repeated checkups can be minimized.

In the proposed system, the drip rate is calculated with the help of a LED –LDR assembly [2], the relative change is resistance is then translated to an estimated drip rate which is displayed on an OLED screen placed on the board. At the same time, the current weight of the IV bottle, which is calculated using a load cell, is translated to an estimate of the time left until the IV bottle empties. A buzzer alarm is triggered in case the drip rate becomes zero as well as the weight of the IV drip bottle goes below a reference threshold value which is preset, hence notifying the desired health personnel about the completion of the dose..

II. DESIGN APPROACH

This system is prepared using minimum number of electronic components. A load cell, HX711 which is an amplifying module, LED, LDR, OLED display and Arduino Uno R3 board, which has the microcontroller ATmega328p, are all used for this system. The whole circuit is connected using jumper wires while soldering minimal number of components. The system is designed to work regardless of tubes having limited optical transmissivity. The device can be propped up to the IV drip treatment stand and the drip tube can be passed through the passage between the LED and the LDR.

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III. METHODOLOGY

When the Intravenous drip bottle is attached to the proposed assembly, the drip tube should lie between the LED and LDR. The drip rate can only be measured if the LED, drip tube and the LDR are collinear.

The circuit is powered and the LED is turned on. In this state, all of the LED's light is falling on the LDR and hence, the output resistance value is constant at this stage. When the drip chamber is placed between the LED and LDR and subsequent drops start falling through, this disrupts the amount of light falling on the LDR and hence, the resistance value fluctuates with every subsequent drop falling through the drip chamber. This fluctuation in resistance is translated into voltage values which are read by the microcontroller, ATmega328p. This is further translated to the drip rate which is ultimately displayed on the attached OLED display.

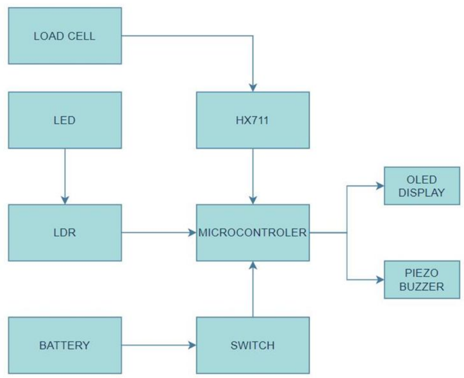

Fig. 2 Flow diagram

The IV bottle is hanged to the load cell which calculates the relative weight or gravitational force of the attached body. The load cell's output is passed through a HX711 module which is an amplification module. This amplified value of the weight of the attached IV bottle is given to the microcontroller which uses the drip rate value and the real-time weight of the body to provide an estimate of the time left until the bottle empties or the drip rate becomes zero.

When the drip rate becomes zero and the load cell output regarding the weight crosses a threshold value, the piezo buzzer is triggered and the designated personnel is/are notified.

IV. INSTRUMENT DESIGN

The components used in the circuit are as follows:

1) 1kg load cell: It is used to measure the weight of the attached IV bottle.
2) HX711 module: It is the amplifying module for the load cell.
3) OLED display: 0.96 sq. inch display is used to display all the relevant data.
4) Arduino Uno R3: It is an Arduino board consisting of the ATmega328p microcontroller.
5) LED: A simple light emitting diode is used for drip rate detection.
6) LDR: A light dependent resistor is used to calculate the drip rate coupled with the LED.

This intravenous drip monitoring system is assembled using the minimum amount of circuit components in an economically efficient way. The detailed circuit layout is as follows.

The LED is connected to pin 13 of the digital output end of the Arduino Uno R3 board. The cathode of the LED is connected to the ground of the board. The LDR is connected to pin A0 of the analog input end of the board. A load cell is used to measure weight of the attached body which it can convert into an electrical signal, and the HX711 module is a 24-bit analog to digital converter (ADC). The red and black wires of the load cell are connected to the Excitation + (E+) and Excitation – (E-) --) ends of the HX711 load cell amplifying module. Here, the red wire can be thought of as the Vcc or power supply, and the black wire can be thought of as the ground or negative voltage supply. This simply connects the load cell to the amplifying module.

Then, the HX711 module is connected to the Arduino Uno R3 board by connecting the Data IO connection (DT) pin and the Serial Clock Input (SCK) pin to the digital pin numbers 2 and 3 respectively. Furthermore, the Vcc and ground pins of the module are connected to the respective power pins of the Arduino board. This ultimately establishes a connection between the load cell and the microcontroller, ATmega328p.

The Serial Data (SDA) pin of the OLED display, which is being used as a status display, is connected to digital pin 4. Similarly, the Serial Clock Line (SCL) pin is connected to digital pin 5. These two pins are present because OLED displays work on I2C communication protocol, which roughly means it works on two-way communication.

The above mentioned digital pin numbers are interchangeable. We have taken them in serial order for simplicity in understanding the circuit. Furthermore, the circuit has been implemented for prototyping purposes.

V. CONCLUSION

The main novelty in this system over the existing systems is that real-time feedback about the total time left until the drip bottle empties is provided. With the help of the proposed system, the health personnel can avoid unfruitful checkups of the patient, hence saving their valuable time.

The complexity of our project is really simple and this can be considered as a disadvantage as further modifications to the system cannot be made without a complete overhaul of the design. Due to its prototypical structure, the durability of the proposed system is questionable.

The future scope of the system is optimistic with potentially every hospital finding this system useful. Even domestic clinics can use this system in the treatment of their patients. IoT technology can be integrated within this so that the drip rates and times until completion for each patient can be viewed through a website or an application.

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