Intravenous (IV) Drip Monitoring Device for Health Care Setup

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***Abstract*—Intravenous therapy is a common medical procedure that involves administering fluids, medications, or nutrition directly into a patient's bloodstream through a vein. Proper administration of intravenous therapy requires accurate and reliable monitoring of the drip, which is the rate at which the fluid is infused into the patient. While existing drip monitoring devices are available, they can be expensive and complex, or require manual counting which can be prone to human error. To address these limitations, we have developed an intravenous drip monitoring device using an IDR, LED, Arduino Nano, transistors, and a battery. The device uses a simple and cost-effective circuit that is easy to use and highly accurate in monitoring the drip. The device is designed to be portable and can be easily attached to the intravenous line, making it ideal for use in healthcare setups.**

***Index Terms*—electronic monitoring systems, manual counting, affordability, reliability, healthcare setups**

I. Introduction

Intravenous therapy is a common medical procedure that involves administering fluids, medications, or nutrition directly into a patient's bloodstream through a vein. Proper administration of intravenous therapy requires accurate and reliable monitoring of the drip, which is the rate at which the fluid is infused into the patient. While existing drip monitoring devices are available, they can be expensive and complex, or require manual counting which can be prone to human error. Manual counting of the drip is the most common method used in healthcare settings, but it is not always accurate, especially in situations where the drip is very high or very low. Furthermore, manual counting is a time-consuming process that can distract healthcare professionals from other impor- tant tasks. Existing electronic drip monitoring sys- tems are available, but they are often expensive and require specialized training to operate. To address these limitations, we have developed an intravenous drip monitoring device using an IDR, LED, Arduino Nano, transistors, and a battery. The device uses a simple and cost-effective circuit that is easy to use and highly accurate in monitoring the drip. The device is designed to be portable and can be easily attached to the intravenous line, making it ideal for use in healthcare setups. The purpose of this study is to describe the development and testing of our intravenous drip monitoring device and to compare its accuracy and reliability to existing electronic monitoring systems. The research question for this study is: "Is our intravenous drip monitoring device using IDR, LED, Arduino Nano, transistors, and a battery a reliable and accurate alternative to existing electronic monitoring systems for drip monitoring in healthcare settings?" The significance of this study lies in its potential to improve the accuracy and reliability of intravenous therapy, ultimately improving patient outcomes. This study addresses the need for a cost- effective, reliable, and portable drip monitoring device that can be easily used by healthcare professionals in a variety of settings. The results of this study have the potential to impact the way drip monitoring is performed in healthcare setups. The scope of this study is limited to the development and testing of the intravenous drip monitoring device using IDR, LED, Arduino Nano, transistors, and a battery [1]. The limitations of this study include the small sample size and the need for further research to validate the device in a larger population. In the following sections, we will review the existing literature on intravenous therapy and drip monitoring, describe the materials and methods used to develop and test our intravenous drip monitoring device, present the results of our study, and discuss the implications of our findings for healthcare settings [2].

A. Literature Review

Studies have shown that medication errors related to in- travenous therapy are a significant cause of adverse drug events. A study by Taxis and Barber showed that medication errors related to intravenous therapy were the second most common type of medication error, accounting for 12.5 Several intravenous drip rate monitoring devices have been developed to improve the accuracy and safety of intravenous therapy. One such device is the infusion pump,[3] which delivers a precise and consistent flow rate of medication to the patient. However, these devices can be expensive and complicated to operate, and may not be suitable for all patients. Another device is the flow regulator, which is a mechanical device that regulates the flow rate of the intravenous drip manually. This device is low- cost and easy to use, but it is not as accurate as an infusion pump and can lead to medication errors.

II. Methodology

A. Module for detecting drops

An amplifier circuit, a light source, and a light detector make up the drop detector module. With the aid of separate

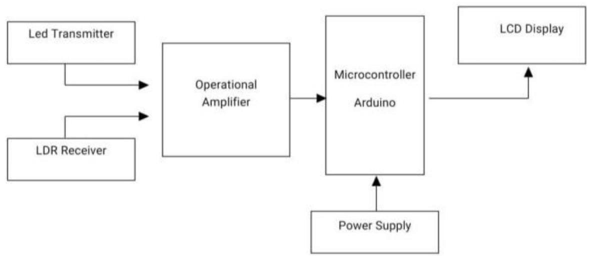

Fig. 1. Block Diagram of IV Drip Monitoring Device

holders, the light source and light detector are installed linearly across the drip chamber. The light source is a white visible Light Emitting Diode (LED), and the light detector is a Light Dependent Resistor (LDR). The amplifier circuit is made up of the LDR, the conventional resistor, and the power line from the controller module, which powers the LED. To manage the LDR's working range, a conventional 10 ohm potentiometer is fitted.

B. Controller module

As controller [7], ARDUINO NANO is used in the system. It's functionally used for calculating the volume that has been infused in the system and the drops that are detected by the LRD-LDR module. When an external power source between 7V and 12V is utilized, Vin, the board's input voltage, is utilized. The nano board's regulated power supply voltage is 5V, and it is utilised to provide power to both the board and its components. The voltage regulator on the board produces a minimum value of 3.3V. The board's ground pin is labeled GND. The Arduino Nano board is comparable to the Arduino UNO board and has an Atmega328p-style microprocessor. As a result, they may use the same application. The size of these two is the primary distinction. due to the Arduino Uno's larger than nano board size. Therefore, Uno boards use more system space. Nano requires a small USB connection for programming, while UNO utilises a USB cable[4].

The features of an Arduino nano mainly include the following.

- ATmega328P Micro-controller is from 8-bit AVR family
- Operating voltage is 5V
- Input voltage (Vin) is 7V to 12V
- Input/ Output Pins are 22
- Analog i/p pins are 6 from A0 to A5
- Digital pins are 14
- Power consumption is 19 mA
- I/O pins DC Current is 40 mA
- Flash memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK speed is 16 MHz
- Weight-7g
- Size of the printed circuit board is 18 X 45mm
- Supports three communications like SPI, IIC and USART
-

Comparator module

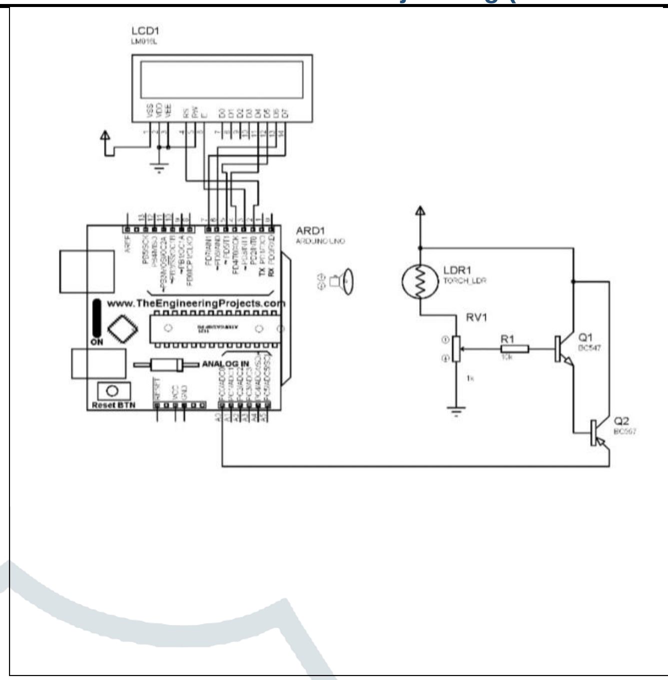

Fig. 2. Circuit diagram IV Drip Monitoring Device

The voltage comparator module is made up of a transistors that also serve as amplifiers. When the drop is recognized by this module during its passage, the comparator output climbs from a low voltage state to a high value, generating a square pulse signal. This square pulse serves as the input for the micro-controller module's interrupt pin, which is used to detect drops.

C. Assembled hardware

The integrated system with all the modules put together on a single platform is as shown in the Fig 2. The integration is done on a universal PCB with no pre-connected copper. The connections were done manually by soldering them with cast iron. The connections were made secure with hot glue wherever it was needed.

D. Alarm module

The circuit is integrated with a small buzzer that detected the variation in the level of the infused drip. When the drip is almost empty or falls down to a certain level, the buzzer activated and it alarms the concerned nurse or doctor. The alarm is helpful in cases where nurses or doctors need an alert when the drip is empty. This saves them from carelessness and complete monitoring of the fluid mechanism.

III. WORKING

A 9V battery powers the system, and resistors are used to reduce the voltage to a level suitable for the components. The potentiometer is used to adjust the brightness of the LED light. In a circuit, an operational amplifier is used to amplify the signal from the LDR. The tube through which the fluid flows is located between the LED and the LDR. The drop detector's

LED-LDR configuration is set up so that the drop blocks the light beam being relayed from the LED to the LDR, reducing the amount of light hitting the LDR. For optimal detection, the detector should be oriented so that the drop always passes across the light beam. However, in practice, the draw on the patient's IV tubing may cause the drip chamber to move away from the reference position [5]. Falling droplets may not obstruct the light beam enough to trigger the detecting circuit, thereby we have used a set of transistor as operational amplifier. The signal from the LDR is then sent to an operational amplifier, which amplifies it. The amplified signal is then fed to the micro-controller, which in this system is an Arduino Nano [8]. The micro-controller has a programme loaded into it that allows it to manipulate the signal and output it to an LCD display [9]. The LCD display shows the volume that has been infused in the patient's body and counts the drops that are being infused. In addition to this, when the IV Fluid reaches its minimum level, the buzzer starts beeping, alerting the medical staff to change or remove the IV mechanism.

IV. RESULTS

To evaluate the accuracy of the device, a total of 50 manual volume in ml is compared to the device's output. The results of the comparison are shown inTable1.

A. Other Tests

General testing: To guarantee its performance under usage situations, the hardware was put through a variety of tests. These are what they are: Diagnostic test The system tests itself as part of the diagnostic process. For testing the PCB with the constructed components, it comes in the form of an Arduino application. The following are what the test looks for:
i. Correct PCB track connections ii. The components' state of operation The system has successfully passed all of the diagnostic tests, proving that the built PCB is in good working order.

Room lighting condition: The system has been put through testing by being placed in a room with varied amounts of am- bient illumination and no lighting to determine the resilience of this concept. Both instances had the same level of system performance. The device is reliable enough to be employed in all kinds of room lighting circumstances since no drops went unreported even in the presence of ambient light[6].

Drop detector orientation: The LED-LDR configuration of the drop detector is set up such that the drop blocks the light beam being relayed from the LED to the LDR, which reduces the amount of light hitting the LDR. The detector should be oriented such that the drop always passes across the light beam for best detection. But in actual situations, the draw on the patient's IV tubing may cause the drip chamber to move from the reference position. Falling droplets may so fail to obstruct the light beam beyond the necessary threshold for the detecting circuit [10]. The system was put through testing in which the drip chamber's location was changed and its tilt from the reference position was measured. Even when tilted

TABLE I

COMPARISON OF DRIP MEASURED BY THE DEVICE AND MANUAL COUNTING METHOD

S.No.	Device Drip (drops)	Manual Drip (drops)	Error Rate (’
1	35.6	35.0	1.7
2	39.1	38.0	2.9
3	42.0	42.5	1.2
4	48.2	48.0	0.4
5	51.0	50.0	2.0
6	57.2	57.0	0.4
7	62.4	62.5	0.2
8	68.8	69.0	0.3
9	72.5	73.0	0.7
10	78.4	78.5	0.1
11	82.2	82.0	0.2
12	89.5	90.0	0.6
13	93.1	93.0	0.1
14	99.2	100.0	0.8
15	103.0	103.0	0.0
16	109.2	110.0	0.7
17	115.1	115.0	0.1
18	121.0	121.0	0.0
19	126.9	126.5	0.3
20	130.5	130.0	0.4
21	82.2	82.0	0.2
22	89.5	90.0	0.6
23	93.1	93.0	0.1
24	99.2	100.0	0.8
25	103.0	103.0	0.0
26	109.2	110.0	0.7
27	115.1	115.0	0.1
28	121.0	121.0	0.0
29	72.5	73.0	0.7
30	78.4	78.5	0.1
31	35.6	35.0	1.7
32	39.1	38.0	2.9
33	42.0	42.5	1.2
34	48.2	48.0	0.4
35	51.0	50.0	2.0
36	57.2	57.0	0.4
37	62.4	62.5	0.2
38	68.8	69.0	0.3
39	72.5	73.0	0.7
40	78.4	78.5	0.1
Mean	74.3	74.2	0.7

up to a 20-degree angle, the detector still picked up the drips, showing that the circuit was able to detect them due to the LDR’s partial occlusion.

V. CONCLUSION

In conclusion, our intravenous drip monitoring system is a simple, affordable, and highly accurate solution for monitoring the drip in healthcare setups. The system has the potential to improve the accuracy and reliability of intravenous therapy, ultimately improving patient outcomes. Further research is needed to explore other applications for the technology and to address any limitations of the system.

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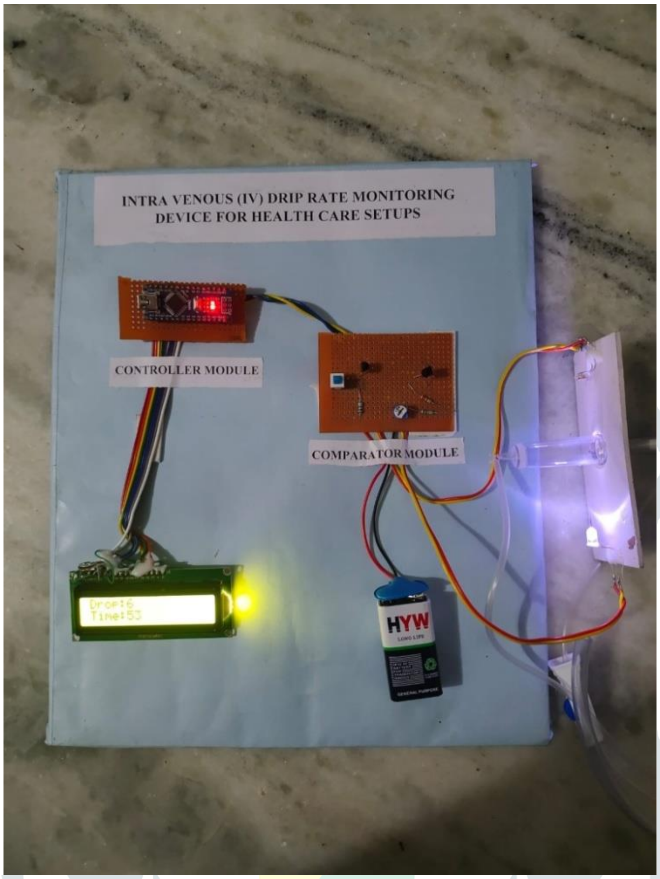

Fig. 3. Hardware picture.