BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 416 (January 2023)

Microprocessor And Embedded System Laboratory

Final Project Report

Section: B2 Group: 03

Iot Based Automatic Saline Flow Control

Course Instructors:

Bijoy Sikdar
Mrinmoy Kundu

Signature of Instructor: ______________________________

Academic Honesty Statement:

"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."

Signature: [illegible] **Full Name:** Jaiyan Sadid Ifty **Student ID:** 1806109	**Signature:** [illegible] **Full Name:** Md Imrose Hossain **Student ID:** 1806118
Signature: Jobayer **Full Name:** Jobayer Ahammed **Student ID:** 1806115	**Signature:** Soumik **Full Name:** Soumik Shanto **Student ID:** 1806102

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. <u>Type the student ID and name, and put your signature</u>. ***You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.***

Tale of Contents

1 Abstract

Our project revolves around the automation and manual control of saline flow rates. We achieve this control by using a stepper motor to regulate the drop rate of the saline solution. To ensure precise control, we incorporate a feedback mechanism based on Photoplethysmography (PPG) signals. Doctors can make real-time adjustments to the flow rate remotely, even from outside the hospital, by analyzing the PPG signal feedback. We provide this feedback by uploading the data to a server. We achieved this through NodeMCU.

Introduction

In a world where automation plays a significant role in various aspects of our lives, leveraging IoT-based monitoring to administer precise treatment to patients is essential. Traditionally, patients undergoing saline therapy require manual monitoring, and adjustments to the saline flow rate are made by nurses. However, this manual process carries inherent risks. Rather it would be more convenient to observe saline flow rate and patient's condition remotely and make any change without physically checking frequently. Moreover, one can observe multiple patients at the same time by this process. With the use of accurate sensors, this whole process can be automated by which is sometimes more convenient.

2 Design

2.1 Problem Formulation

Saline solution is administered to numerous patients on a daily basis within hospitals. It is a very tiring process to constantly monitor these many patients' conditions and attend to all of them. This requires more manpower which may not be available in a hospital. This is a pressing problem which we attempted to address in our endeavor.

2.1.1 Identification of Scope

A potential solution is to manually control the saline giving process remotely. This way, a person can monitor and attend to multiple patients at the same time. Another solution can be to automate the whole process but this requires very accurate and fast responding sensors as the premise is very sensitive.

2.1.2 Literature Review

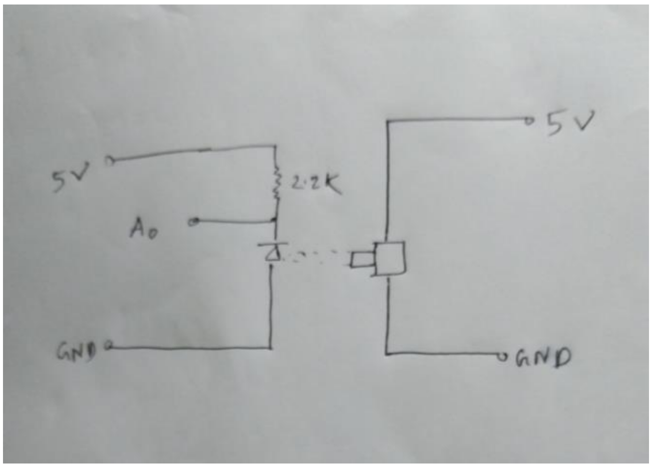
The latest available literatures dive into our stated problem but fail to reach precise control of the flow rate. Moreover, no literature was found regarding measurement of drop rate. They mainly focus on turning on and off the flow and measuring the saline level.[1-2]

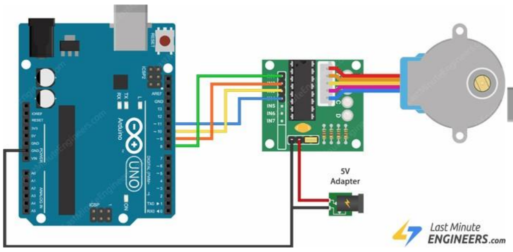
2.2Design Method

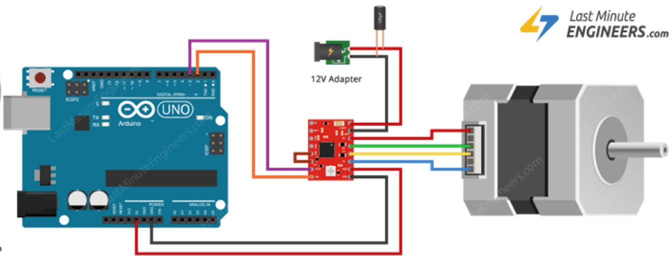
To tackle the problem of drop rate, we have come up with a unique solution. We have designed a transmitter-receiver system where the saline drops act as interference. Our transmitter is a Laser Module, we have tried with LED, IR LED but Laser Module is the best fit for our project. The receiver is a Photodiode. We tried to design it with LDR, IR Receiver but Photodiode is the best available solution. However, using phototransistor should result in more accurate result as it has faster response to light. Whenever a saline drop falls, it interrupts the light received by the photodiode, resulting in lower output values of the sensor. By choosing an optimized threshold value, we can count the drop rate. For connection with server, we have used NodeMcu where drop rate and vitals will continuously update. Using duplex Serial communication, we can also receive data from server to control the stepper motor. To extract blood pressure values from ppg signal, we used Serial communication to send data from Arduino to Python and also receive data once the values are extracted. We designed a cam and a holder for 28BYJ-48 stepper motor. The cam is specially designed to apply pressure on the saline tube. According to the pressure's intensity, the drop rate changes. Unfortunately, 28BYJ-48 motor cannot provide sufficient torque so, we tried it with Nema 17 stepper motor. However, this motor requires a metallic hardware holder which can suppress its strong vibrations. Due to out time limit, we have chosen the easier solution which is to use the 28BYJ-48 motor. To drive this motor we have used ULN driver which uses the Darlington array.

2.3 Circuit Diagram

The following figure is a simplified circuit for our sender-receiver system.





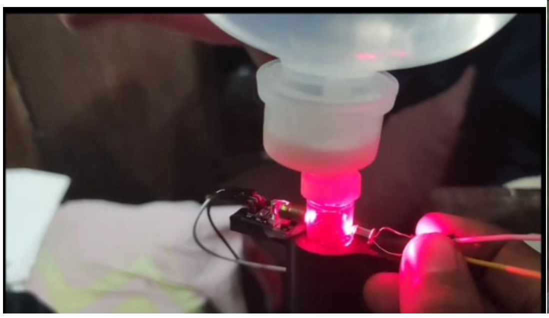


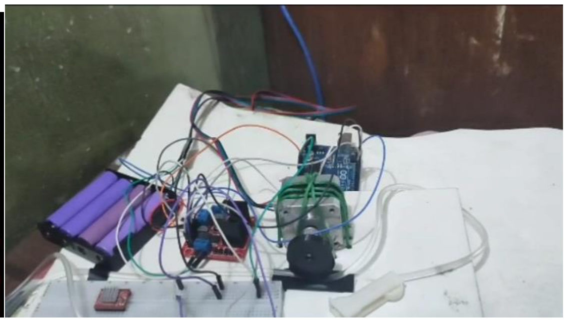
The above diagrams show the connection of 28BYJ-48 Stepper motor and Nema 17 stepper motor. The connection of NodeMcu and pulse sensor is not shown as their connections are quite straight-forward.

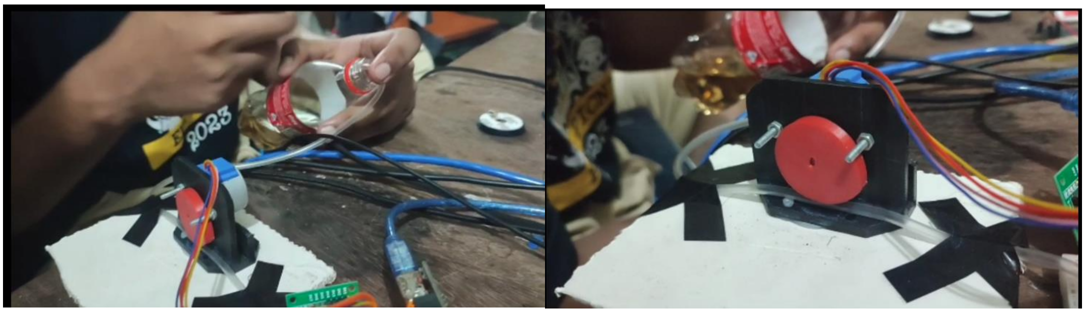
3 Implementation

3.1 Description

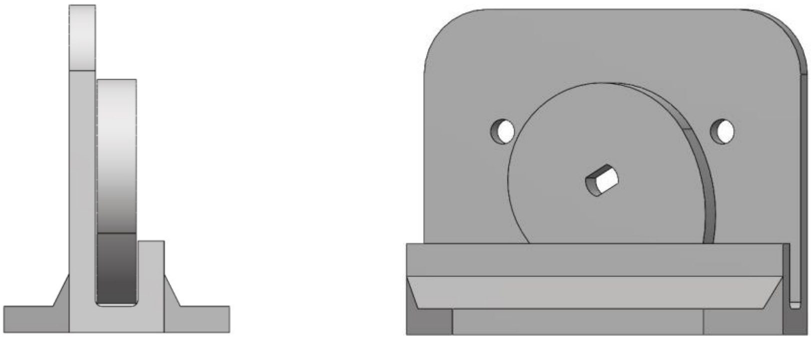
We have implemented the sender-receiver system using Laser and Photodiode. We have designed a holder in Solidworks to keep the sender and receiver perfectly aligned. This is done so that the photodiode can receive the maximum intensity at all time. Nodemcu communicates with the server through wifi while Arduino communicates with NodeMcu and Python using Serial communication. 28BYJ-48 is connected using ULN driver.





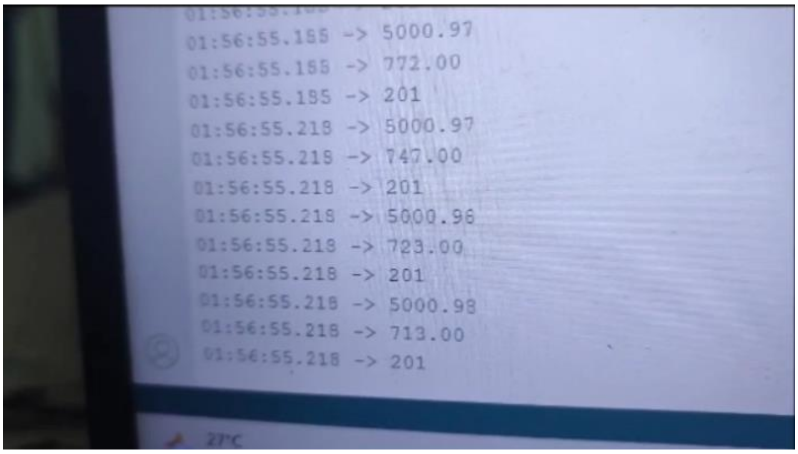


3.2 CAD/Hardwire Design



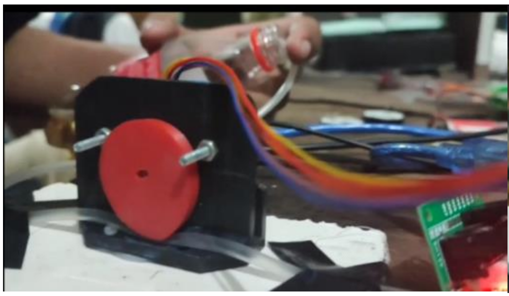
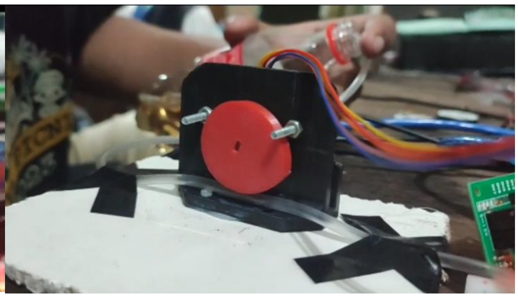
These are solidworks design for our cam and holder. This design is specifically for 28BYJ-48 stepper.

3.3 Results



The above figure shows the drop rate, 200 offset is added as many serial communications are taking place at the same time. So, if the drop rate is 1, the result in serial monitor is 201. The following graph shows the drop rate sent to the server. The first field is the output drop rate while the second field is the input drop rate, i.e. the rate one wants to manually select.

The changes in the position of the motor according to the input are given below.

First figure corresponds to the OFF position while the second one refers to the ON position. However, using Nema 17 will give us much more flexibility and freedom in precisely controlling the drop rate.

4 Design Analysis and Evaluation

4.1 Novelty

1. Utilizing a Laser and Photo Diode to Calculate Drop Rate based on the notion of fluctuating refractive light intensity.
2. Low-cost method for detection and monitoring of vital signs (blood pressure, oxygen saturation level, and heart rate).
3. ABP plot generation utilizing a customized deep neural network using ppg data.
4. Both Manual and Automatic mode of control
5. Stepper motor Control design

4.2 Design Considerations

- There is no issue or public safety in our project but if there is any irregularity its control such as delay may damage the health of a patient. Using laser on saline liquid could have some unforeseen consequences

- There will no bad effect to the environment

- There will no bad effect to cultural needs but can affect the job sector of nurses

4.3 Limitations of Tools

- The available sensors in the market give inaccurate data which results in randomized i.e. unexpected data.

- Phototransistors are not available in market.

- Nema 17 requires carefully designed mechanical setup.

4.4 Sustainability of our project

- As there are currently no devices available for remotely controlling saline flow, this project has the potential to be a groundbreaking innovation in this field

- Nothing bad in terms of societal affect can be seen

- It may have a minimal or negligible environmental impact in terms of pollution or waste generation.

5 Reflection on Individual and Teamwork:

The project can be divided into three main segments: hardware collection and testing, Arduino and sensor management and configuration, and the implementation of a deep learning model. Imrose (1806118) and Ifty (1806109) were responsible for handling Arduino and sensor management, including the design of an adjustable cam for flow control (drop rate). Shoumik (1806102) took the lead in developing the deep learning model to extract blood pressure information from PPG signals, while Jobayer(1806115) focused on the design and integration of the stepper motor and other hardware components.

6 Communication

6.1 Executive Summary

In this project we mainly designed a predefined bandgap reference circuit. To meet the required specification conventional CMOS bandgap reference circuit is not enough. We had to modify our circuit to do so. We used Cadence virtuoso software and tsmc18 nm process for our project. We tuned the resister values and the slope of PTAT and CTAT for our design. There are certain limitaions in our project. These are:

- To gain low TC(Temperature Coefficient) .

- To keep fixed reference voltage at low TC .

- Low TC maintaining causes increment of reference voltage.

- Fixed reference voltage causes higher TC.

6.2 User Manual

- Connect the Arduino
- Connect NodeMCU
- For manual control use the following command in your cmd

  curl -X POST "https://api.thingspeak.com/update.json" -d "api_key=QOCFFA8U8PR3EB0H&field1=**YOUR_DESIRED_SPEED**"

7 Project Management and Cost Analysis

Arduino	800
Laser	150
Photo diode	150
Saline	300
Nema 17(Stepper Motor)	1300
A4988 (Motor driver), L298N	200+ 100
Node MCU	200
Other(Non-technical)	200

So, these are the main components of our project and cost around 3200 taka

8 Future Work

Photo-transistor for prompt & accurate response and Nema-17 with proper design for Cam placement and holder may give better response which is to be done as our future endeavor.

9 References

1. Rothfuss MA, Franconi NG, Unadkat JV, Gimbel ML, Star A, Mickle MH, Sejdic E. A System for Simple Real-Time Anastomotic Failure Detection and Wireless Blood Flow Monitoring in the Lower Limbs. IEEE J Transl Eng Health Med. 2016 Aug 25;4:4100114. doi: 10.1109/JTEHM.2016.2588504. PMID: 27730016; PMCID: PMC5052026.

2. KritiOjha, JatinParihar, GouriBrahmankar, "IoT based saline level moni-toring system", Journal of Science and Technology, Vol. 06, issue no. 01, pp.: 2456-5660, 2021