PERISTALTIC PUMP DISPENSER DOSAGE CONTROL AND MONITORING VIA IOT

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DECLARATION

I declare that this report entitled “Peristaltic Pump Dispenser Dosage Control and Monitoring via IoT” is the result of my own work except for quotes as cited in the references.

Signature :

Author : Arvind Sivashankar

Date : 25 June 2021

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature	:	
Supervisor Name	:	Mr.Mazran bin Esro
Date	:	25 June 2021

DEDICATION

To my beloved parents, family members, and fellow friends.

ABSTRACT

The peristaltic dosing pump is one of the popular choices of equipment in liquid dispensing system for accurate volume dosing. Peristaltic pump is widely used in chemical dosing in laboratories, beverage industries, laundry machines and many more. In such industries, manual dosing of liquids and chemicals consumes more energy with less efficiency and produces more waste. The project is intended to integrate an eco-friendly peristaltic pump dosing system for precise liquid and chemical dispensing based on controllable pumping parameters and monitor the operation using Internet of Things (IoT). The liquid dispenser is integrated with motor drive, peristaltic pump, signal conditioning circuit and microcontroller connected to the IoT dashboard. The system employs Blynk mobile application to function as a tool to monitor the pump and machines' status. A signal conditioning circuit is designed to amplify small signal from machine hall sensor and feed into microcontroller digital input. The project also focusses on the analysis to find the optimum point based on several parameters including varying motor speed, duty cycle and pumping time to the output volume dispensed. The system is designed with alert notification features to inform the user on the status of the machine.

ABSTRAK

Pam dos peristaltik adalah salah satu pilihan peralatan yang popular dalam sistem pengeluaran cecair untuk dos isipadu yang tepat. Pam peristaltik banyak digunakan dalam dos kimia di makmal, industri minuman, mesin basuh dan banyak lagi. Dalam industri sedemikian, dos cecair dan bahan kimia secara manual menggunakan lebih banyak tenaga dengan kecekapan yang kurang dan menghasilkan lebihan sisa. Projek ini bertujuan untuk menyatukan sistem dos pam peristaltik yang mesra alam untuk pengeluaran cecair dan kimia yang tepat berdasarkan parameter pam yang dapat dikawal dan memantau operasi menggunakan Internet of Things (IoT). Dispenser cecair disatukan dengan pemacu motor, pam peristaltik, litar isyarat penyuai dan pengawal mikro yang disambungkan ke papan pemuka IoT. Sistem ini menggunakan aplikasi mudah alih Blynk yang berfungsi sebagai alat untuk memantau status pam dan mesin. Litar isyarat penyuai direka untuk menguatkan isyarat kecil dari penderia Hall keluaran dari mesin dan masukkan digital pengawal mikro. Projek ini juga memfokuskan pada analisa untuk mendapatkan titik optimum berdasarkan beberapa parameter termasuk kelajuan motor, kitar tugas dan waktu pam yang berbeza bagi sejumlah keluaran. Sistem ini direka dengan ciri notifikasi amaran untuk memaklumkan pengguna mengenai status mesin.

ACKNOWLEDGEMENTS

I would like to express my appreciation to my supervisor, Senior Lecturer Mr. Mazran Bin Esro for his guidance, motivation, and knowledge throughout my journey in conducting this project. Without his constant moral support and concern, this thesis would not be presented here.

My appreciation also directs to my friends for supporting this project. I am also grateful to all my family members. Finally, I would like to extend my gratitude to everyone who has involved in this project directly and indirectly.

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LIST OF SYMBOLS AND ABBREVIATIONS

3D	:	Three Dimensional
DC	:	Direct Current
FSI	:	Fluid Structure Interaction
IDE	:	Integrated Development Environment
IEEE	:	Institute of Electrical and Electronics Engineering
IoT	:	Internet of Things
MQTT	:	Message Queuing Telemetry Transport
NodeMCU	:	Node Microcontroller
PID	:	Proportional Integral Derivative
SMF	:	Securities Master File
VoIP	:	Voice over Internet Protocol
WiFi	:	Wireless Fidelity

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CHAPTER 1

INTRODUCTION

This chapter covers the project outline, the project background, purpose behind the case study that reciprocate with the rational identified problem and possible work scopes.

1.1 Background of Project

Every revolutionary technology has advantages and disadvantages [1] [2]. Self-laundry and dry-cleaning system allow users to do their laundry anytime they want, including the use of detergent and softener expand exponentially as the number of self–service laundries and dry-cleaning facilities has developed. Laundry detergents are harmful to the atmosphere and are not biodegradable. Highly toxic metals such as cadmium and arsenic are polluting our water sources, waterways, and oceans as a consequence of detergent.

To prevent this dangerous emission, the precaution measure will reduce the detergents and use it precisely as required. Designing an integrated system to control and monitor the usage will be an adequate way to confront [3-5]. Hence, developing a peristaltic pump dispenser for the detergent would be way more precise with using the detergent and other substances used [6]. This will benefit the owner by allowing the detergent to run in the desired volume and avoiding waste or overuse of the substances [7] [8]. Furthermore, an IoT-based monitoring device can assist the user in determining the updates whether the machine is running or stopped. This will save their time, and the other user would access the service without having to wait for an extended period [9].

The NodeMCU is selected as the microcontroller for this project because it is easy to configure, and its compact size allows it to be mounted more conveniently on the framework. This microcontroller can be connected to the internet without the need for extra modules or boards to be wired or integrated into the device. A significant benefit of this microcontroller is that it is less complicated because the programming platform is the Arduino, which is the Arduino IDE. It is also less challenging to troubleshoot the dispute in processing the data. In this project, the liquid dispensing is controlled by the NodeMCU, which gives the green light to dispense.

The device pulse is taken and used as an indicator for the occurring phase. The transducer takes the pulse to maintain a steady pulse waveform to be transmitted to the microcontroller. Using this steady pulse waveform, the microcontroller can count the cycles required to dispense the liquid and identify the optimal time to dispense the liquid for the washing phase by analyzing the pulse waveform period. The microcontroller will be coded with the cycle count and dispensing specifications. In this project, the peristaltic pump dispenses the liquid due to the vast transitions in the chemical, biological, and food beverages field for a long time.

The term peristaltic pump derives its meaning from the hydraulic theory. A lightweight hose, rotor with rollers, shoes or wipers, and a pump casing are all components. The fluid inside the tube squeezes and relieves, causing the fluid to flow internally and externally [10-13]. Rollers connected to the rotor, shoe, and wipers are attached to the outside of the tube to induce pressure and stimulation. When the rotor starts, an under-compression tube part closes, forcing the liquid to flow through. The tube is then reshaped to the initial state with a cam, and fluid flow is induced back to the pump; this is known as restitution.

1.2 Problem statement

Self-service laundry has caught attention for many years, and it is being implemented in many places around the country. It is well known for the user-friendly service and hustle-free job done. This culture has inspired by the western side, such as the United States. This self-service laundry is also implemented on some new building to increase the revenue. Some of the laundry owners also provide free detergents and softener as it benefits both parties of the process. The liquid substances are dispensed manually, operated either automated to setting the value but not precise enough. These lead to the problem whereby using the detergent extra than the needed level or lesser than the needed level [1] [5].

Convenient is mainly focused on all of the sectors nowadays. This is a significant aspect that all the customers are seeking. The new generation or the new evolving community is seeking to make things by saving time and having updates from time to time when needed [7]. When it comes to laundry, the time of the machine is overlooked and misestimated which creates a delay in collecting the laundry. This results in a delay where another user has been affecting.

1.3 Objectives

i. To design a peristaltic pump control system to produce a precise volume of liquid based on controllable pumping parameters.

ii. To analyze the proper volume of liquid based on the pumping speed and pumping time for liquid with different viscosity.

iii. To create an IoT based monitoring system for the laundry machine.

1.4 Scope of Work

In this proposed project, the scope of the project is primarily focused on use of peristaltic pump in the laundry sector to avoid excessive detergent and to integrate with IoT. This limits from using a high powered and pressured peristaltic pump usage since an ordinary powered pump is adequate for the desired level of detergent pumping, which performs more precisely [14] [15]. A typical pressured pump is sufficient as the pumping liquids are in light concentration but different viscosity levels among the liquids. The peristaltic pump is used because it has a vast range of use, and it is quick to be maintained, which becomes user-friendly and sustainable for an extended period [16] [17].

In addition, the IoT-based framework is designed only to monitor the machine, as the prospect is to identify the status of the machine in the laundry to ease the user experiences. Peristaltic pumps embedded with IoT systems are used because of their flexibility in various applications, easy maintenance, and handy monitoring access to the users.

1.5 Methodology

Hardware and software are needed for implementation in this project. The procedures deduce from transforming washing machine pulses to the integration of the embedded system with IoT connection. The machine's liquid dispensing period is observed, and the pulses are converted to dc signal using an electrical circuit for system adaption. Then, the dc signal is installed to the NodeMCU and embedded with controlling commands to approach the operational state with accuracy. Besides, the customers' notification of the machine status can be observed using the QR code generated by the developer in the Blynk app.

1.6 Thesis outline

This thesis outline is organized into five chapters to cover the research work that is related to dispensing using peristaltic pump and integrate with IoT. The outlines of the thesis are described as follows:

1. Chapter 1

   This chapter is about the introduction part. In this chapter, usually will talk about the background of Peristaltic pump. Furthermore, the content of problems statement, objectives, the scope of project and the report structure of the project for an overview of the whole chapter will clearly explain in this chapter.

2. Chapter 2

   This chapter representing the literature review of Peristaltic pump, NodeMCU, motor driver, and Internet of Things. In this chapter, all the information about peristaltic pump and IoT will be explained.

3. Chapter 3

   This chapter is the research methodology of the hardware and software. This part will describe the project management including the overall of flowchart and the planning throughout the project. In this chapter, all the methods used obtain the data to develop a prototype will be explained.

4. Chapter 4

   This chapter is mainly focused in the analysis and discussion on the result of dispensing system. In this chapter, we can see the analysis data that used to set the parameters of dispensing liquid and the result of the IoT system.

5. Chapter 5

   This chapter provides an overall conclusion of the project and future work of this project. So, in this chapter, we can conclude what we get and what we want in the future.

CHAPTER 2

BACKGROUND STUDY

The background studies discover the reviews of the intellects on proposing a peristaltic pump system for the dispensing aid with established IoT platform to be monitored.

2.1 Introduction

Peristaltic pumping is the compression and decompression mechanism mounted onto the pump's rotor, which pushes the substance through the channel in and out to the laundry industries. The futuristic element and development for the wireless monitoring with electronic components at its respect to the degree of the project. This chapter reviews the concept of fluid pumping by the peristaltic pump. The IoT embellishment with advanced connection configuration of the continuity of the project

[18-20]. Additionally, the research of the method and development of the pumping system has included.

2.2 Peristaltic Pump

A peristaltic pump is a positive displacement mechanism of fluid regardless of viscosity and thermal conditions. The peristaltic pump is also known for easy and inexpensive maintenance since it does not have seals, valves, and glands. Its vast usage of the pump primarily pumps liquids with different concentrations and textures. These pumps are commonly known as roller pumps. These pumps are generally known as roller pumps for the flowing principle, which is carried by an elastic tube set to the pump. The liquid pressured to be travel throughout the tube when the rotor rotates and relatively compresses the tube [1] [4]. Peristaltic pump like fluid carriers or suppliers had the inlet, and outlet channel comes with compromising tubes and opens susceptible flow path, giving high resistance to abrasion. The forward movement of a fluid column is achieved due to the sequent congestion of the tubing along with the rotor pump working scheme.

Furthermore, peristalsis is described as the tube's opening to its initial state, allowing the liquid to be induced into the pump. This example is based on biological processes such as the gastrointestinal tract; hold and obstruct the tube, trapping a pool of liquid between them. The peristaltic pump operating scheme interconnects on channelling a liquid material throughout a hose by reducing and inducing the flow. The liquid is pushed around the pump by the pump shoes. The phase corresponds to internal human mechanisms such as oxygen and blood flow. The peristaltic pump will separate a substance from the environment as well as the atmosphere from the liquid.

As a result, these pumps can be used in an infinite number of industrial field executions.

The linear peristaltic pump consists of multiple actuators that work in tandem to stress out the tubing through coordinated orthogonal trumping, resulting in a sine wave. The number of cycles, the number of relocated valves, the actuator weights, the pre-compression of the tubing, and the flexibility of the tubing all have a significant effect on the volume of the liquid. In the linear peristaltic fill mode, the filling system can also be operated in a time-pressure mode. In this mode, two piezo actuators in the filling system act as a valve, and the fill volume is controlled comparable to a standard TPS.

Advantages of Peristaltic Pump

- There is no pollution since it is easy to clean the interior of the pump.
- They can function in viscous, slurred fluids.
- The pump's configuration prevents backflow without the use of valves.
- These pumps can be regulated using various mechanisms, including a lever, a foot pedal, or a control screen.

Disadvantages of Peristaltic Pump

- Flexible tubes are prone to deterioration over time and will need replacement regularly.
- The liquid flow would be pulsed, primarily at low rotational speeds.

2.3 NodeMCU

NodeMCU is Microcontroller Unit that provides an open-source software and hardware development platform built using economical System-on-a-Chip. The ESP8266 is a NodeMCU designed and manufactured by Espressif Systems, contains the critical components of a computer: the central processing unit, memory unit, networking by Wi-Fi module, and a modern operating system. Thus, it becomes a suitable fit for IoT-based projects [17].

It needs pre-soldering with the appropriate analogue voltage to its pins. Moreover, to integrate it in low-level machine commands that the chip hardware can interpret.

2.4 Transducer

A transducer is an electronic device that commutes energy from one form to another. The products signified are microphones, loudspeakers, thermometers, position and pressure sensors, and antenna. It is very unmanageable task to determine the magnitude of the physical forces like temperature and pressure. The physical force is converted into an electrical signal with the help of a meter.

Performance is an essential factor of any transducer since it is equivalent to the output and input power. Its efficiency is determined by the ratio of the targeted power output to the total power input. If P denotes total power input and Q denote power output in the desired form, then the efficiency E expressed as a ratio between 0 and 1, is given by:

$$E = Q/P$$

If E% represents the efficiency as a percentage, then:

$$E\% = 100Q/P$$

There is no situation as 100 percent efficient due to the losses in the conversion process.

2.5 Motor Drive

The DC motor drive is a type of amplification that connects the controller to a direct current motor. It transforms the small power into a high current for the engine. The DC motor drive also has high current torque. DC motor drives have diverse uses, including rolling mills, paper mills, mine winders, hoists, machine arms, excavators, and cranes. Non-regenerative DC drive is one type the DC motor drives. The single quadrant drive is determined as it is only rotating in one direction [13]. It does not come with inherent braking capability; thus, the only way to terminate the motor is by eliminating the supply. In contrast, the regenerative drive regulates the speed, direction, and torque as it is a four-quadrant drive.

The regulation of the speed drive is for process control and energy conservation. As opposed to a fixed speed mode of operation, an adjustable speed drive will also have a smoother operation. When variable speed drives are used, the pumps run at a faster speed all the time as the wet well level increases. This corresponds to the average inflow, resulting in a smoother process.

2.6 Internet of Things

The idea of IoT dates back to 1982 when a tweaked Coca-Cola machine is connected to the internet and can report the contents of the machine and whether the beverages were cold or not [9]. Some authors tried to define IoT according to its functions and roles. According to the author [14], the internet is a global infrastructure of the interconnected computer system that utilizes the internet protocol suite (TCP/IP) to connect millions of users worldwide. A thorough analysis of IoT confirmed that there is no single concept of the internet of relevant things to the global group of users. Furthermore, Shankar and Dhakshayini [19] suggested that the internet of things can be thought of as a global structure that provides contact between humans, things, things, things, or something in the universe assigning a unique identity to every individual. Regarding IoT technologies and impacts, research analytics estimated that over 46 percent of the world's population currently access social. It has had a transformative influence on society and industry, well with the rise of relatively close communication through electronic mail, texting, and voice over internet protocol (VoIP), telephone calls, two-way immersive video calls, and online shopping pages.

2.7 Review of the recent research

The study focuses on the literature review about the current envision regarding this project by the researchers. This area covers observations, analysis, and the relative result of the project with the excellent agreement of the discussed and proposed ideology. The range of collectives and background of articles are based on the peristaltic pump handling and utilization in a system, IoT embedded, and supportive design components.

The online research platforms such as IEEE Xplore, Sci-hub, and Google Scholars are the searching tool for the technical paper and journals that have thoroughly studied the project. The research gap is chosen between five years to understand the technological developments on building an efficient peristaltic pump system with monitoring capacitance.

A peristaltic pump is used as a crucial material in the transportation of fluid systems since most research appeals to propose a peristaltic pump in their studies. The study is discovered on overviewing the working scheme of the peristaltic pumps and their advantages and disadvantages in technological installations such as in chemical transportation for viscous processing products and vegetable oils. The article also discusses laboratory setup with peristaltic pumps for hydration of crude vegetable oils in figure 2.1. A variety of techniques have been used to calibrate and monitor the dosing of the two-component mixture. It is often used to reduce the overall number of pumps in the installation by re-directing the part flows.

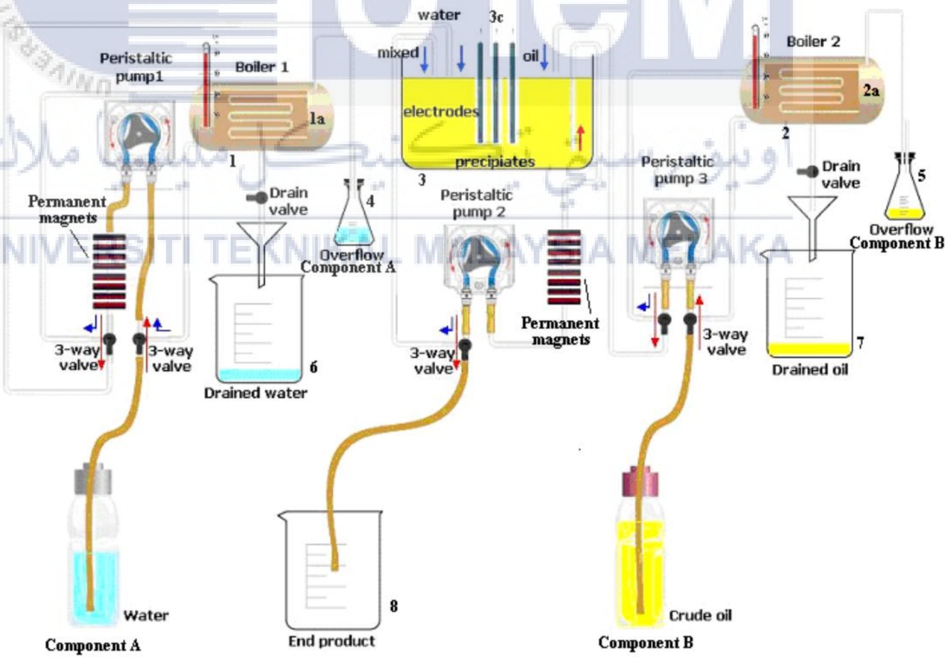

Figure 2.1: Technological scheme for an installation with peristaltic pumps for crude vegetable oil hydration [1]

Another peristaltic pump-based system developed for the hemodialysis treatment implications using Arduino controller. It is to develop one electronics pump system using an Arduino controller for transferring liquid from a tank to another tank. The liquid flow rate is measured using a flow sensor located at the input and output part. Intelligent Input Part and Peristaltic Pump Control System consider measuring the system efficiency as shown in figure 2.2 and 2.3.

If the peristaltic pump is attached to the hemodialysis unit, it can be modified to operate as a controlling device. As a result, tubing with a diameter of 10mm is supplemented with a tube similar to that used in surgical assemblies since tube scales affect the system's flow rate. Thus, the average efficiency of the machine has improved, and it now meets the optimal performance.

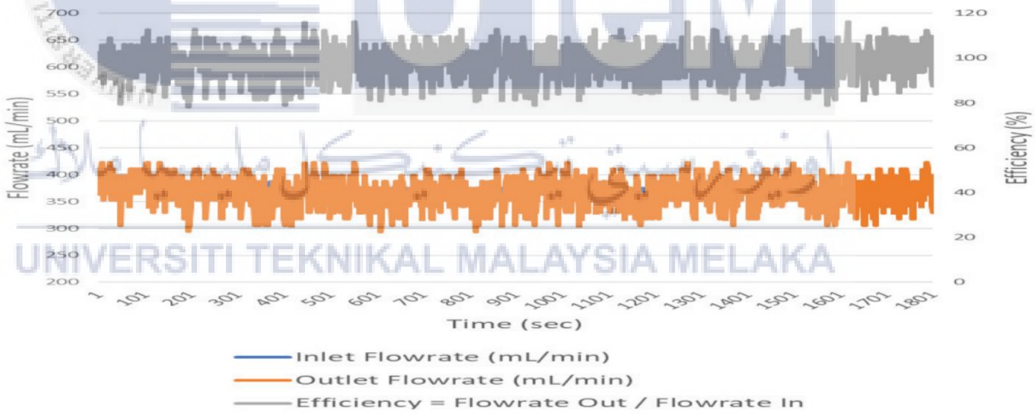

Figure 2.2: Outlet flow rate and Inlet flow rate relationship for speed 30 [2]

Blood Pressure Category	Speed (30-255)	Efficiency, (%)
Normal	30	97.96
Pre-hypertension	50	100.15
Hypertension Stage 1	130	99.54
Hypertension Stage 2	200	99.87

Figure 2.3: The efficiency according to the speed [2]

In a further study, fluid-structure interaction (FSI) modelling is composed of one metallic crimper and a hyperplastic tube pumping a viscous Newtonian fluid to predict the flow in the pump. Because of the roller and tube interface, the peristaltic pump produced high pressure and flow throb [5]. The pulsatile action of the liquid is achieved by gripping and releasing the tube during the operative process. The effects of numerical model data equated to one cycle pressure measurements obtained from pump test loop data in figure 2.4, and the overall variance between actual and configured data is less than 5%.

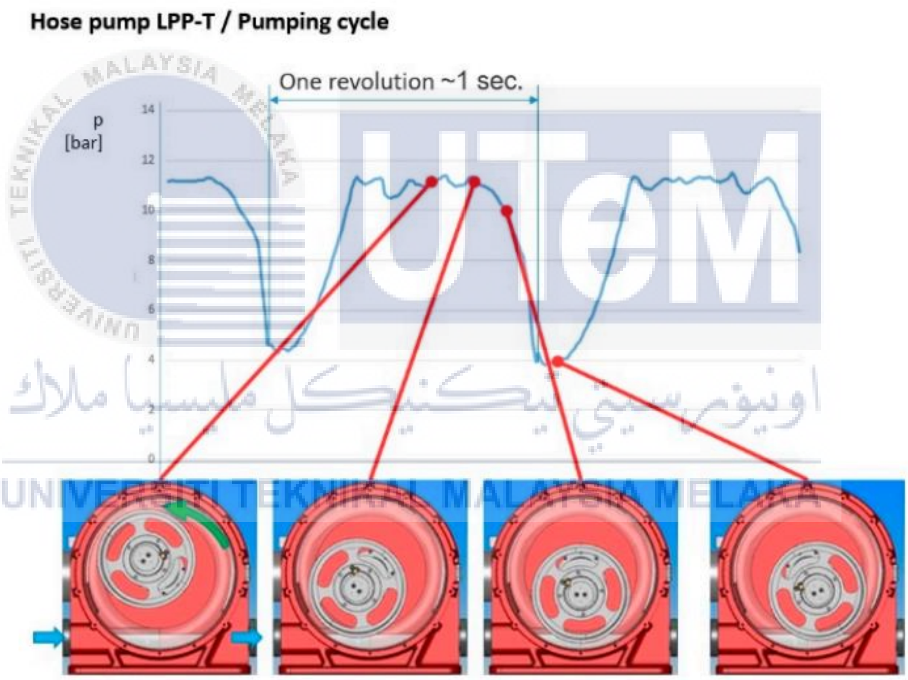

Figure 2.4 Pumping cycle in pump moment [3]

Moreover, blood flow measurement via a tapered porous channel is provided in this analytical report. The peristaltic pumping is responsible for the blood supply. The effects of thermal radiation were also considered. In this formulation, the convective and slip boundary conditions were also used. The wave speed in the tapered porous is constant but offers varying amplitudes and phases. Some approximations were obtained, such as the suggested mathematical modelling equations and analytical solutions for stream function, and volumetric concentration profiles were obtained using non-dimensional analysis. With the aid of computational findings, different emerging parameters on thermal characteristics and nanoparticle concentration were investigated.

Flow Injection Analysis methods can conduct an automated scientific study with small quantities of reagents and samples. They are widely used in pharmaceutical, quality inspection, and manufacturing laboratories and the range of analytic technologists [2-5]. The FIA machinery is built-in series of installed modules in the simplest sequential configuration, as shown in figure 2.5, so that a flow channel leads from a carrier reservoir. This design creates a pulsed flow, which can be reduced by inserting any tubing or a column with a large diameter after the pump to serve as a pulsation damper.

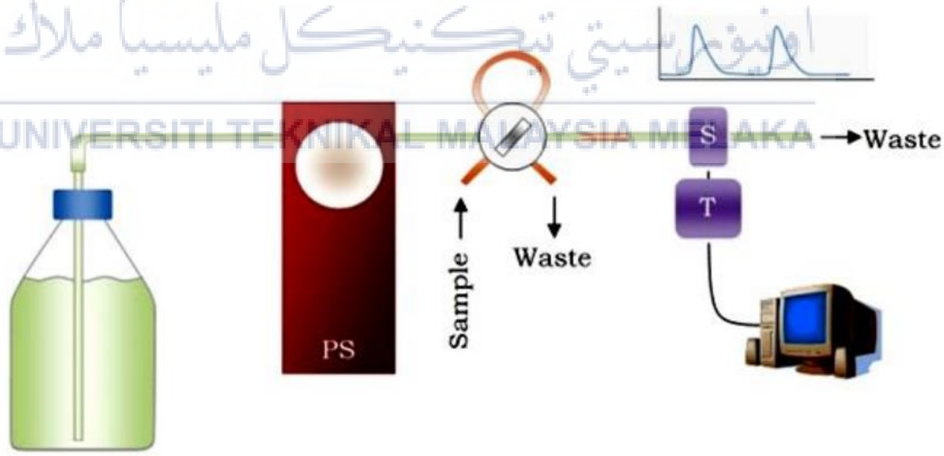

Figure 2.5: The FIA setup. PS: pumping system; S: sensor; T: transducer [5]

Another research presents a new peristaltic pump that stimulates the tube by a circulating eccentric oscillation that reflects the psychological environment's flow condition. The pump properties are radically different from traditional roller pumps since they incorporate constant flow with swappable flow pulsation. In an open loop, a non-occlusive pump can minimize flow pulsation by approximately 85% compared to a traditional roller pump. According to the configuration shown in figure 2.6, programmable flow pulsation is done by adjusting the oscillation amplitude, which allows the generation of given volume flow pulses.

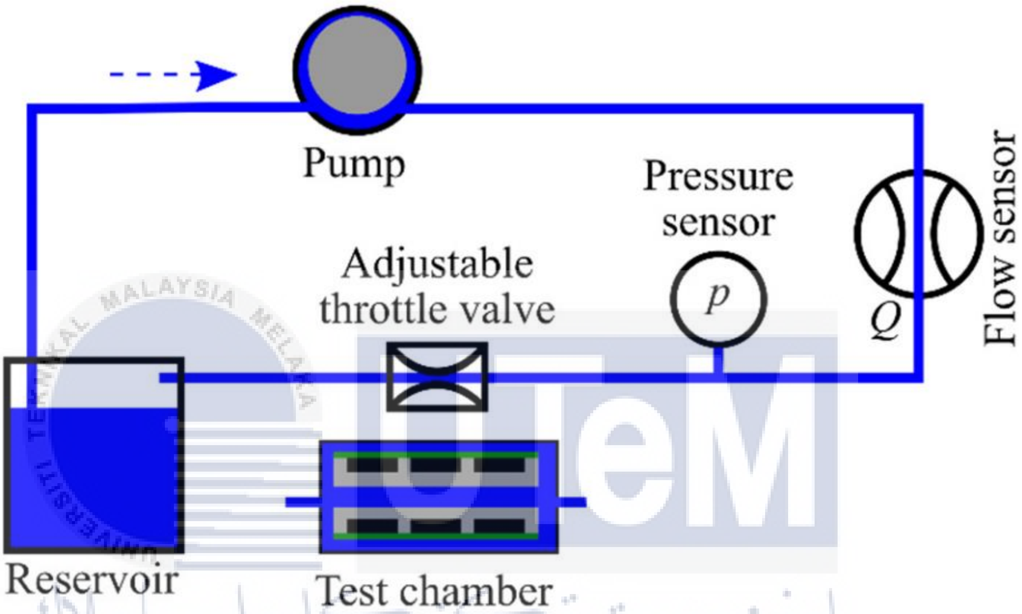

Figure 2.6: Schematic illustration of the test circuit [6]

The development of a competent, flexible liquid transport system based on high-accuracy peristaltic pumps is described. The proposed system's program and hardware architecture are considered [7]. The liquid supply machine-usable in public catering such as pubs and at home to prepare blended and layered cocktails. Because of the system's simplicity and scalability, it can be used in a variety of human activities where fine dosing of liquids is desired, as seen in figure 2.7.

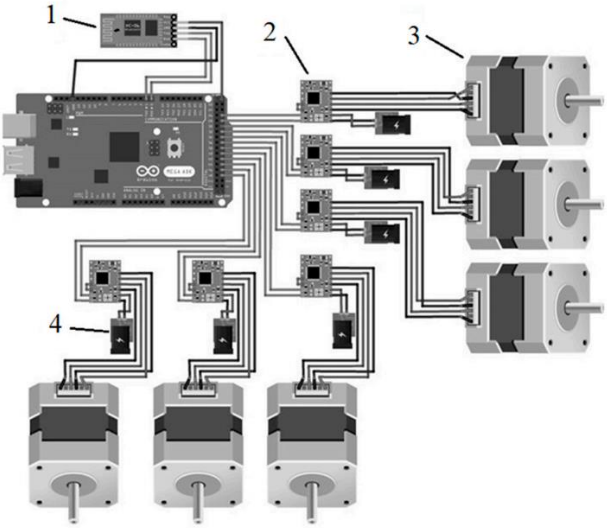

Figure 2.7: Circuit system (1: Bluetooth module; 2: Stepper motor; 3: peristaltic pump; 4: Power supply 24V) [7]

Infusion pumps, also known as micro-dosing pumps, act as a heart in extraction systems. Peristaltic pumps are one of the systems for injecting micro amounts of fluids that provide high accuracy and maintain fluid properties. The constant release activity of modern peristaltic pumps is not favorable in real-world drug delivery applications. As a result, an inquiry is conducted into the intermittent output of two peristaltic pump designs based on four and five rollers.

Pump efficiency is recorded for a variety of rotation speeds and lag times between infusions. The proposed pumps illustrated a vital volumetric accuracy without any dependency on rotation speed and lagged time, as shown in figure 2.8. For the initial moment, small-scale rotary peristaltic pumps were used in a non-continuous manner instead of traditional peristaltic pumps that function continuously. Based on available space and necessary output volume, the peristaltic pump can be conveniently scaled to six or more rollers.

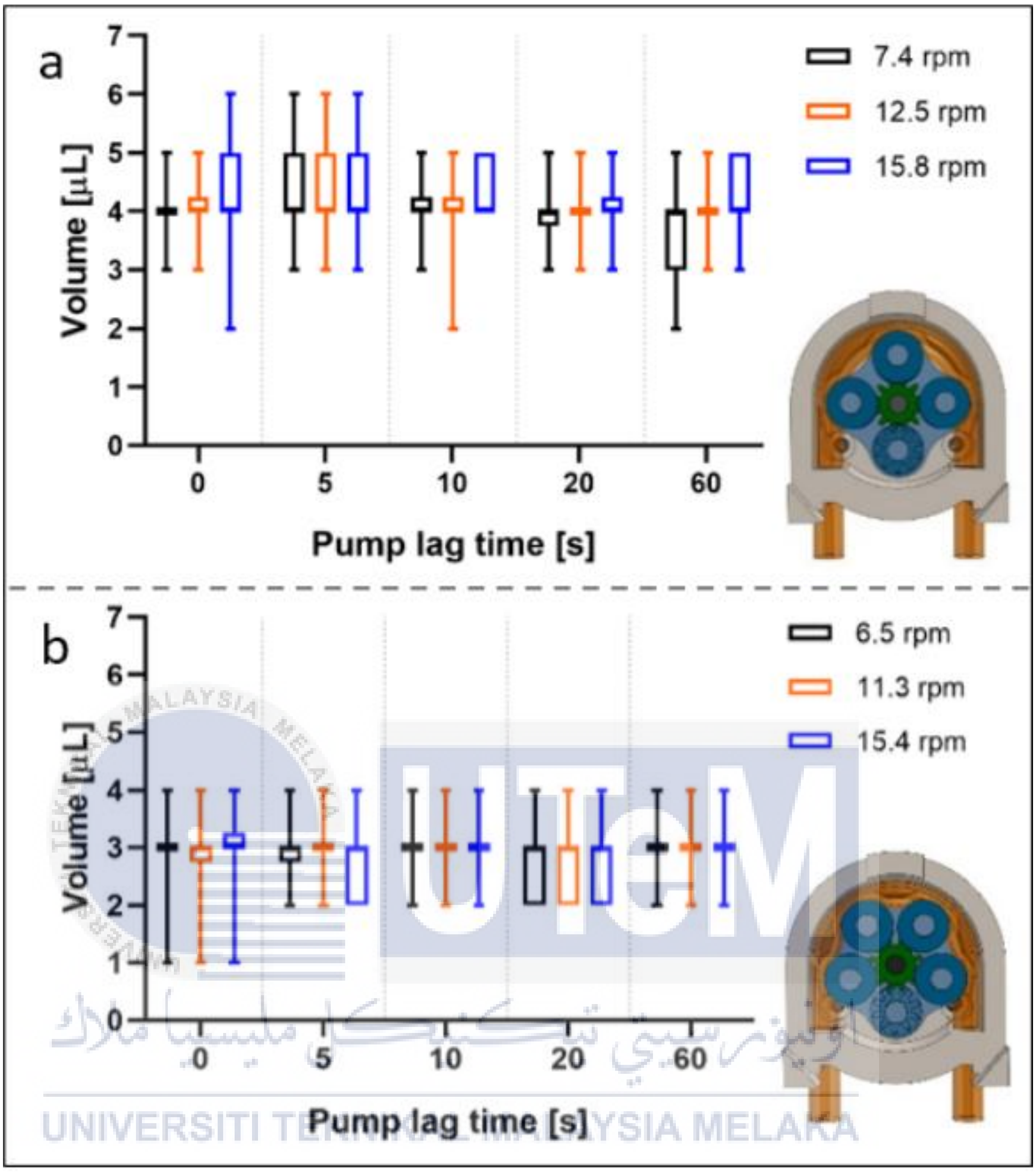

Figure 2.8: Peristaltic rotary pump a) four roller and b) five roller pumps [8]

The equilibrium between speed, precision, and, or length, the mass of moving elements is a severe hurdle for most 3D printing platforms. A peristaltic pump into a bioprinter implementation is developed to solve these problems, allowing the most critical criteria to be combined: high accuracy, a large material reservoir, and biological material protection [9] [10]. A thoroughly heated throttle and a cooled print bed were created to preserve the optimum hydrogel temperature and crosslinking speed. The improvements to the bioprinter design enhanced the mechanical properties and precision of the printouts while retaining the maximum cell survival rate and increasing the capability of the bioink reservoir. The flow rate over time and pressure stimulation during pump operation were checked to ensure the efficiency of the produced peristaltic pump design. Examinations of the pump activity allowed regulated dosing of the bioink due to a relative rise in the quantity of hydrogel pumped with an increase in the operating speed of the peristaltic pump, as seen in figure 2.9.

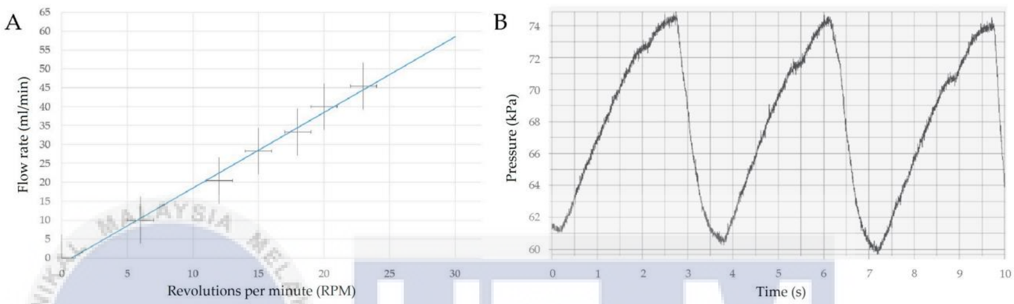

Figure 2.9: Constructed peristaltic pump. (A: Speed; B: Pressure) [10]

The efficiency of a continuous oil or water separation apparatus combined with a peristaltic pump is examined for the persistent separation of widespread oil or organic solvent contaminants from aqueous solutions. As seen in Figure 2.10, an SMF filter is inserted into the pipe and then attached to a peristaltic pump to continuously extract oils from water. The oil removal efficiency of the SMF may be exclusive of its original adsorption capability with the aid of a peristaltic pump, avoiding the time-consuming filtration while reducing the volume demand of adsorbent materials. Hence, these findings showed the probable efficiency of SMF in primary oil leakage collection in an emergency.

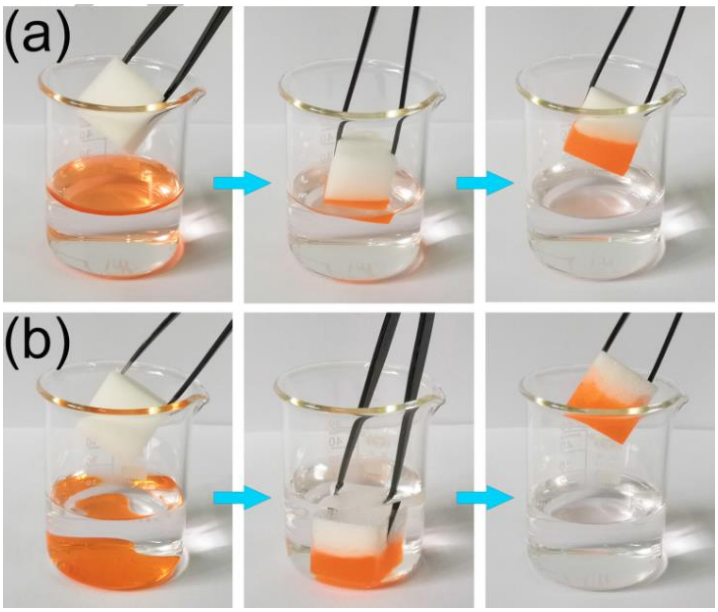

Figure 2.10: Absorption of (a) light oil and (b) heavy oil [11]

A peristaltic pump fabricated in most research laboratories using 3D printing and readily available off-the-shelf parts is a developed alternative for many valuable purposes. The pump can be designed and assembled using a 3D printer and is powered by a stepper motor that connects directly to a device [10]. This device can be transformative in environments such as drug screening and, lab-on-a-chip applications, and cell cultivation, where it dramatically decreases hardware expenditures and permits the installation of sophisticated fluidic systems. The Fast Pump is a small-scale peristaltic pump with several free-spinning rollers on a central shaft that works on the same basis as many industrial pumps. It is a horizontal, self-contained pump with six all-metal rollers [12].

The main pump body insists on three lid versions, and the central shaft is all part of the specification. It also includes the jig used for roller assembly. Based on open-source and availability, all pieces can be 3D-printed and assembled with a limited set of equipment, as seen in Figure 2.11.

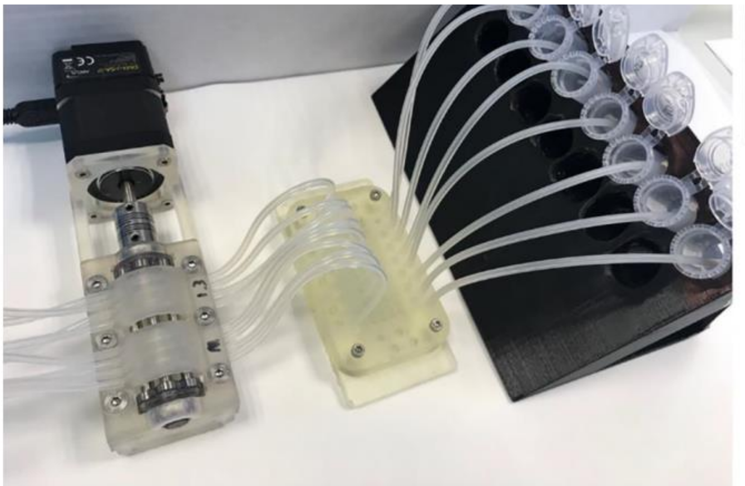

Figure 2.11: Complete fluidic system with Fast pump and inlet reservoirs [12]

A system is developed for modelling and regulating pressure at the inlet of a microfluidic lab-on-a-chip computer using a peristaltic pump [16]. The basic concept is to change the voltage supplied to a DC peristaltic pump depending on the pressure measured at the microfluidic device's inlet. The design offered a simple, low-cost alternative to conventional microfluidic flow control instrumentation, as seen in figure 2.12. The model represents different resistance and intermittent peristaltic oscillations of the piston, taking into account the fluid's variable viscosity. A model concerning pressure and flow at the inlet of the microfluidic system is constructed using the expanded Bernoulli equation and peristaltic pump geometry.

A proportional-integral-derivative (PID) control scheme has been introduced [13]. The suggested model achieves excellent alignment between experimental findings and simulation results. In the operation of a microfluidic lab-on-a-Chip, this pressure model can be used to determine different pump and fluid properties. Viscosity compared to water is recognized via the transitory open-loop reaction and parameters for non-linear system relations by a set of phases.

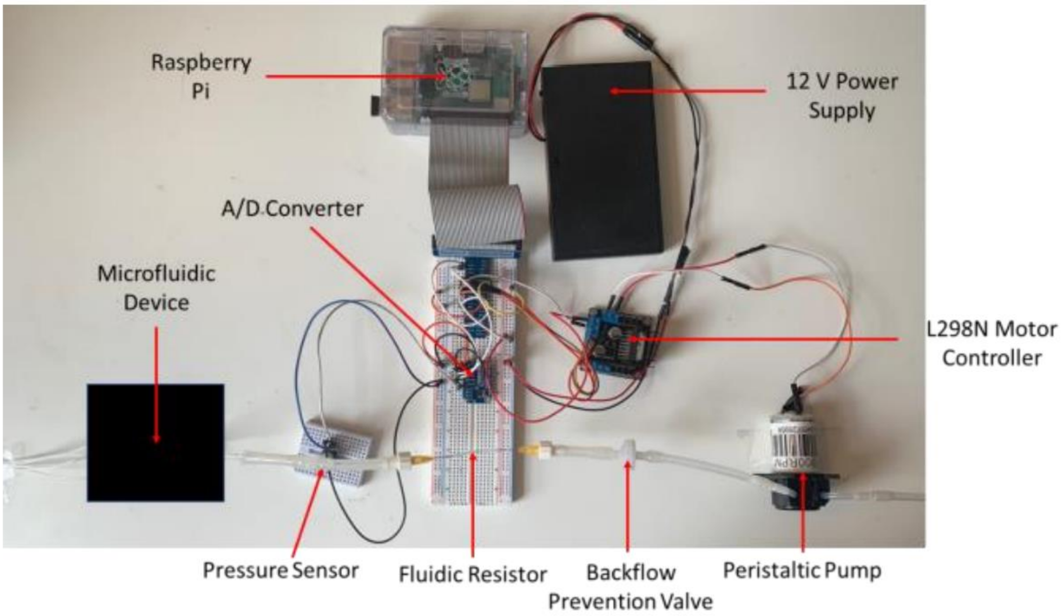

Figure 2.12: Experimental setup for microfluidic flow control [13]

More studies have been conducted; magnetorheological elastomer peristaltic pump is one of the recent researches. It can transmit both Newtonian and Non-Newtonian fluids bi-directionally with an accurate net pumped volume and desired viscosity forms. The essential feature is very brief and consists only of a magnetic elastomer tube and an electromagnet.

A magnetorheological elastomer peristaltic pump consists of two essential elements in a sequence. The maximum pumped volume can be obtained using the maximum lag between voltage parameters gap1 and gap2 [14]. To monitor the net pumped volume accurately over a steady operating period, the Nelder–Mead optimization approach is used. The viscosity of fluids can also be calibrated for a given net pumped volume by modulating the driving voltage parameters using the Nelder-Mead optimizing procedure. The relative result is shown in figure 2.13.

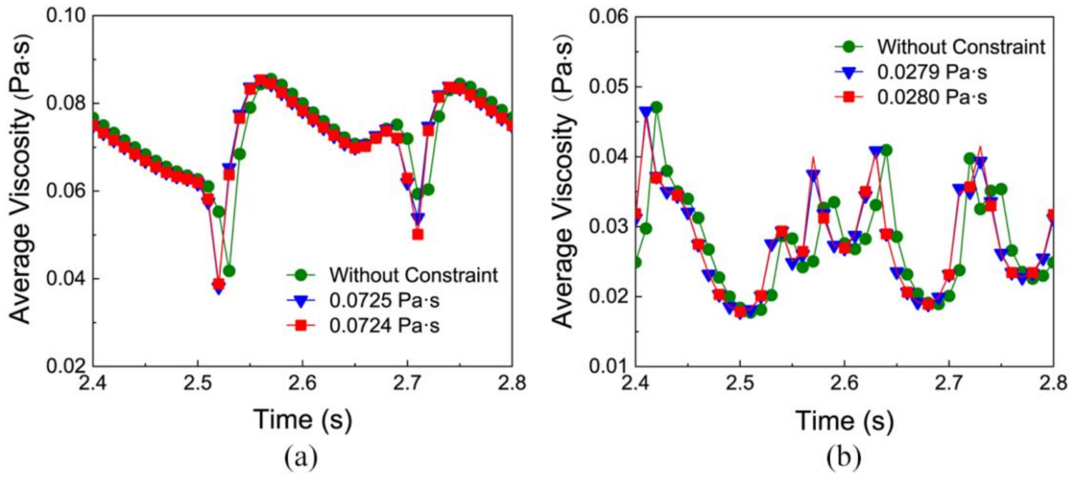

Figure 2. 13: Viscosity of the (a) shear thickening and (b) thinning fluids [14]

A futuristic investigation has carried for the applicability of a linear peristaltic pump, as a novel and innovative filling system for the low-volume filling of parenteral, compared with the state-of-the-art filling systems currently used during pharmaceutical production [4] [15]. The working principle of the pump and evaluated its accuracy for a target fill volume of 50 µL. The results demonstrated that the linear peristaltic pump could be used for fill volumes ranging from 12–420 µL.

A deeper investigation is performed with the fill volume of 50 µL because it represents a typical clinical dose of an intravitreal application. According to figure 2.14, the filling accuracy is stable over an 8-hour operation time, with a standard deviation of +/- 4.4%. The linear peristaltic pump could represent a valid alternative to the state-of-heart filling systems currently used by covering the full range of fill volumes required for a typical injectable.

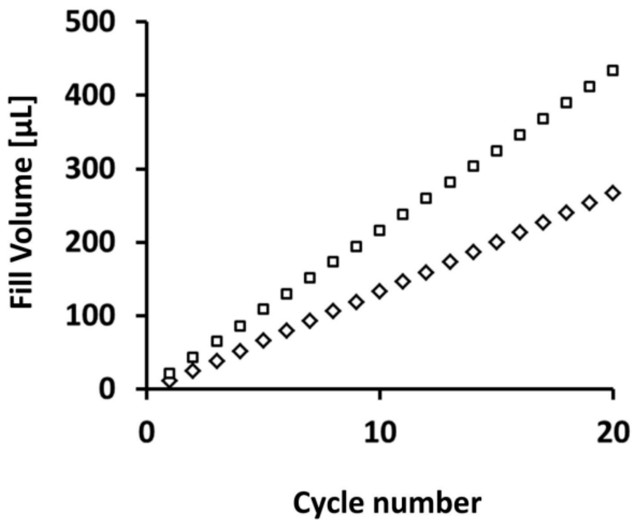

Figure 2.14: Fill volume in 20 cycles [15]

A new replaceable peristaltic micropump, which permits accurate dosing of volumes in the Nano litre scale, has been produced. The tube is merged into a single cartridge with several advantages. High pressure is produced, while a limited internal volume allows costly or rare fluids to be handled. Its small size enables biochips or microfluidic systems to be implemented. Semi-flexible cylinders or tubes may be linked to the standalone solution. The fluidic characteristics of the pump and the overall load have been determined. The fatigue resistance of the cartridge has been verified. Figure 2.15 pictures a simple structure as it offers the potential for mass production.

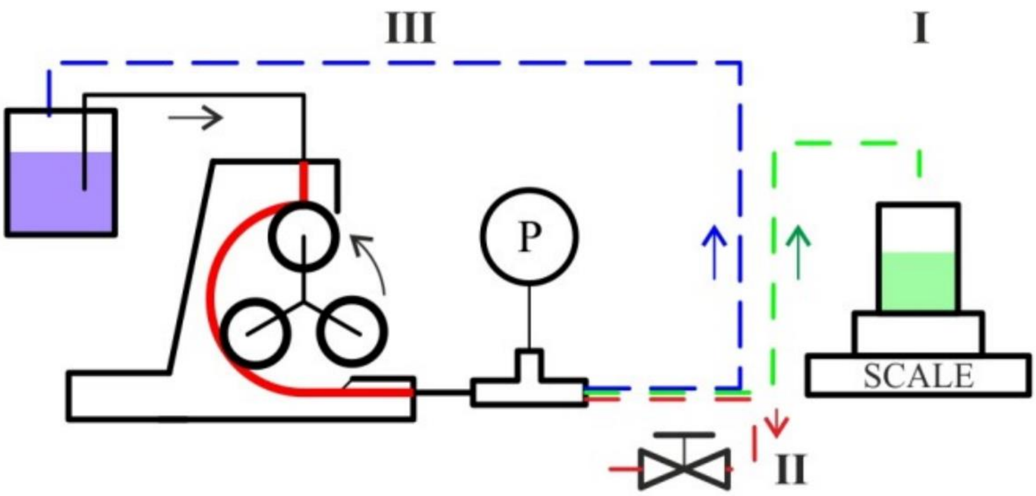

Figure 2.15: Measurement setup I) volume II) pressure III) fatigue [16]

Peristaltic dosing system with two liquids of volume can be mixed using one Arduino Uno board developed as illustrated in figure 2.16. The speed of the motor can be controlled by varying the input voltage of the pump. On the other hand, the volume of water taken from both beaker 1 and beaker 2 can be changed by further programming into the Arduino [18]. The graph between the varying input voltage of the peristaltic pump and the time taken by the pump to completely transfer a certain amount of water from one beaker to another is shown in figure 2.17.

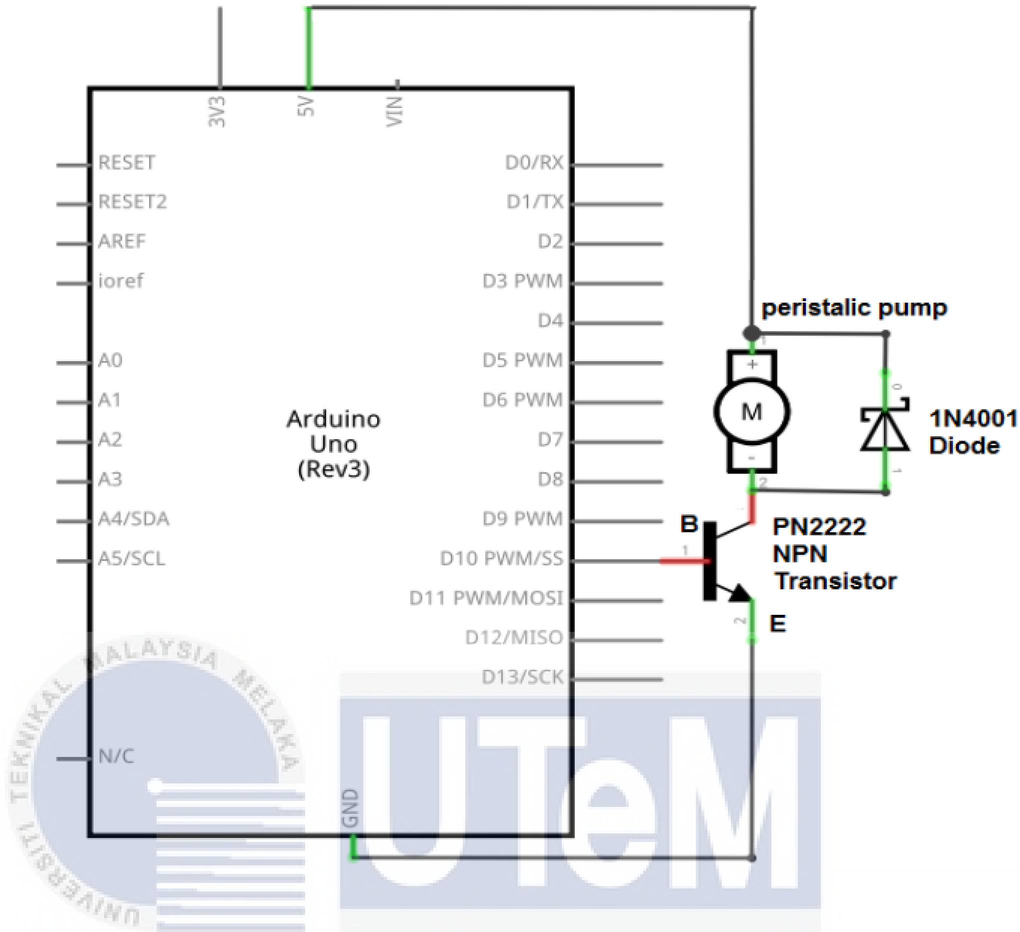

Figure 2.16: Connection of the pump with Arduino [9]

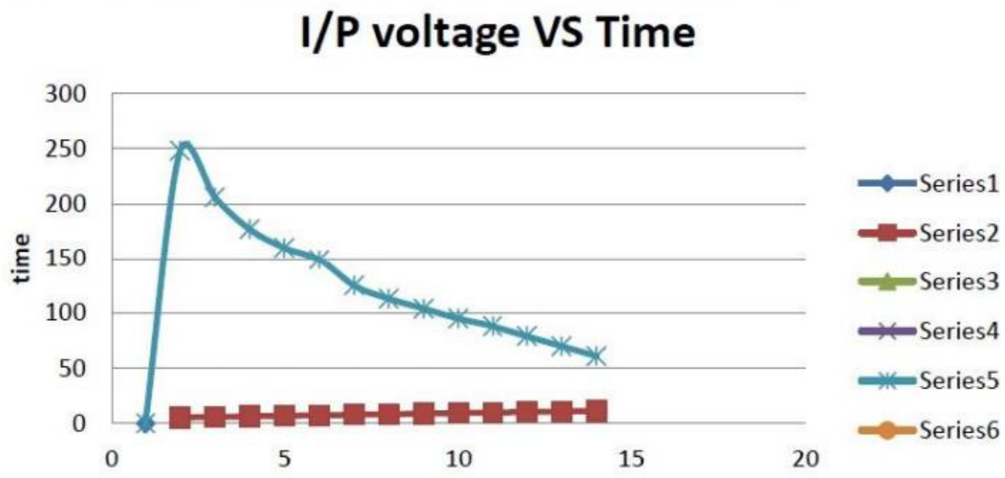

Figure 2.17: Comparison between I/P voltage and time [9]

Another perspective on this research study is discovering technology development where wireless connectivity and advanced components have become vital and irreplaceable. It has been determined that all of the devices in the home are possibly connected to the same network. This boosts the home's comfort, energy consumption, indoor safety, and efficiencies. A description of a lightweight Message Queuing Telemetry Transport (MQTT) protocol experimented on the ESP8266, a Wi-Fi-based development board. Sensor nodes are linked to the ESP8266, and an MQTT broker based on Mosquito is set up for telemetry systems [17] [18].

The sensor readings can be viewed by any MQTT client that is subscribed to this subject. By publishing relevant control commands on appropriate subjects, LED and buzzer install to ESP8266 can be switched on and off. The MQTT client application connected via Wi-Fi is built on ESP8266, a standard home gateway used to track and manage the sensors and actuators remotely. Thus, the current technology will be used to improve and smarten home appliances. This implementation establishes a home automation device that is logical, convenient, and environmentally sustainable. It also makes it possible for the elderly and people with disabilities to monitor the equipment in their homes.

Home automation necessitates the interoperability of a vast range of IoT applications. With the significant increase in the number of devices on cloud systems, firmware must be updated regularly. It entails removing installed gadgets, making appropriate modifications to the firmware and the program codes. To address these questions, information processing should be performed elsewhere. Node-RED is a graphical wiring tool that aids in the easy interaction of devices, resulting in quick and easy connectivity configurations. Gadgets are connected to an ESP8266 and a

Mosquito-based MQTT broker via Node-RED, and a connection for remote monitoring and control is established, as shown in Figure 2.18.

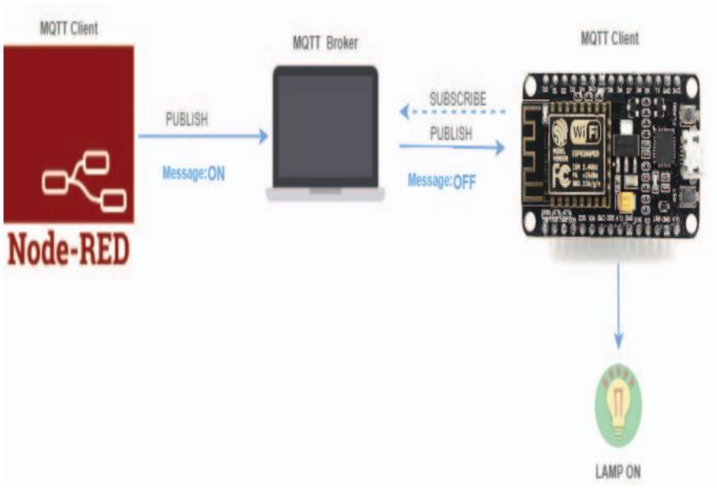

Figure 2.18: Network setup Node-Red connection with ESP8266 [19]

In the ordinary, the method of filling the water container without any wastage, the Internet of Things conception applicable to sort the issue [19] [20]. As seen in Figure 2.19, the solution employs an ESP8266 controller capable of controlling the depth of the water bottle. The controller will automatically open and shut the pump or valve to prevent water from overflowing and wasting, as detected by an ultrasonic sensor. The Blynk IoT service used PHP web programming to provide water level tracking and control, and the device is tested on a 64 cm water container.

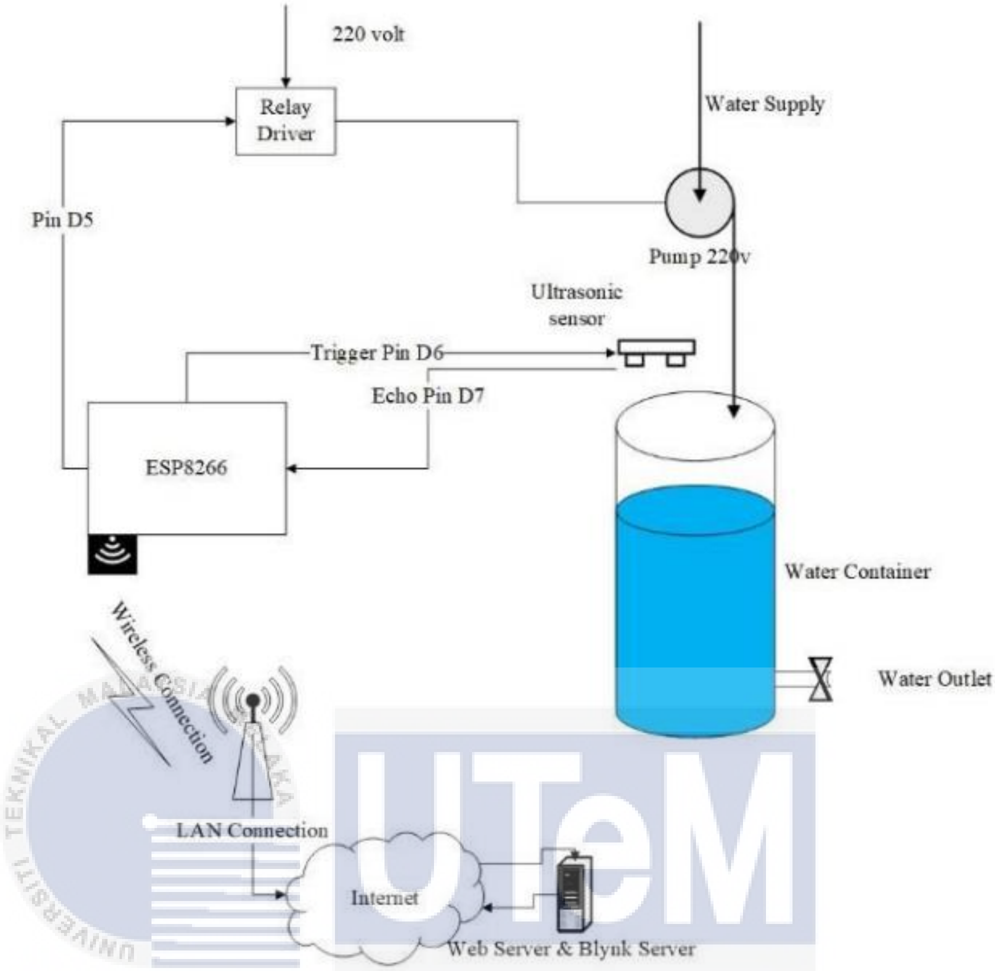

Figure 2.19: Design setup of the system [20]

CHAPTER 3

METHODOLOGY

The process and procedures to carrying out this project have finely analyzed for their adaptability. The roles of the steps and how it enhances the project building easily is depicted in this chapter.

3.1 Introduction

The methodology is the systematic, theoretical analysis of the methods applied to a field of study. Hardware and software are needed for implementation in this project. Firstly, a discussion with a supervisor is held to get the title for the project and how it operates. Then, different related works and literature reviews are reviewed. As the following process, the designing of circuits and dispensing system is to be developed. In the end, the dispensing system will be integrated with IoT. The machine pulse will be converted as a stable waveform and transferred to NodeMCU to start.

3.2 Description of the Project Flow Chart

The flow chart in Figure 3.1 describes the Peristaltic Pump Dispenser Dosage Control and Monitoring via IoT, which is the integration and designation of the components discovered by literature reviews such as peristaltic pump L298N motor driver, 4N25 optocoupler, B547 transistor, and NodeMCU microcontroller. Then, a circuit with a peristaltic pump is constructed to analyze the dispensing time for different liquids such as detergent and water with different speeds by using the NodeMCU microcontroller.

After the analysis, the pulse is obtained from the laundry machine, and a circuit is designed using Proteus to confirm the output voltage. When the desired pulse or output is obtained, the programming phase begins to program the NodeMCU to work with the output of the circuit by using the Arduino IDE platform, and the serial monitor is observed. Consequently, an IoT monitoring system is built by using the Blynk platform, a simple app available in the app store of mobile devices. The procedure proceeds with the IoT system to the PCB designing phase using Proteus, where the schematic layout is carried forward to the fabrication process.

The fabrication process has several steps: the UV printing process, etching process, drying method, drilling process, and finally, soldering process. After the fabrication process testing method is done to ensure all the components and the circuit are built entirely, avoid the short circuit and lose connections between the components. Furthermore, a casing is built to safeguard the circuit and components and to store all the circuit, microcontroller, motor driver, and the peristaltic pump in a safe package together. Finally, moving to the testing phase to ensure all the parameters are set correctly and everything works well together, and the prototype is ready to use in the real world. The result is collected to analyze the performances according to all the parameter settings.

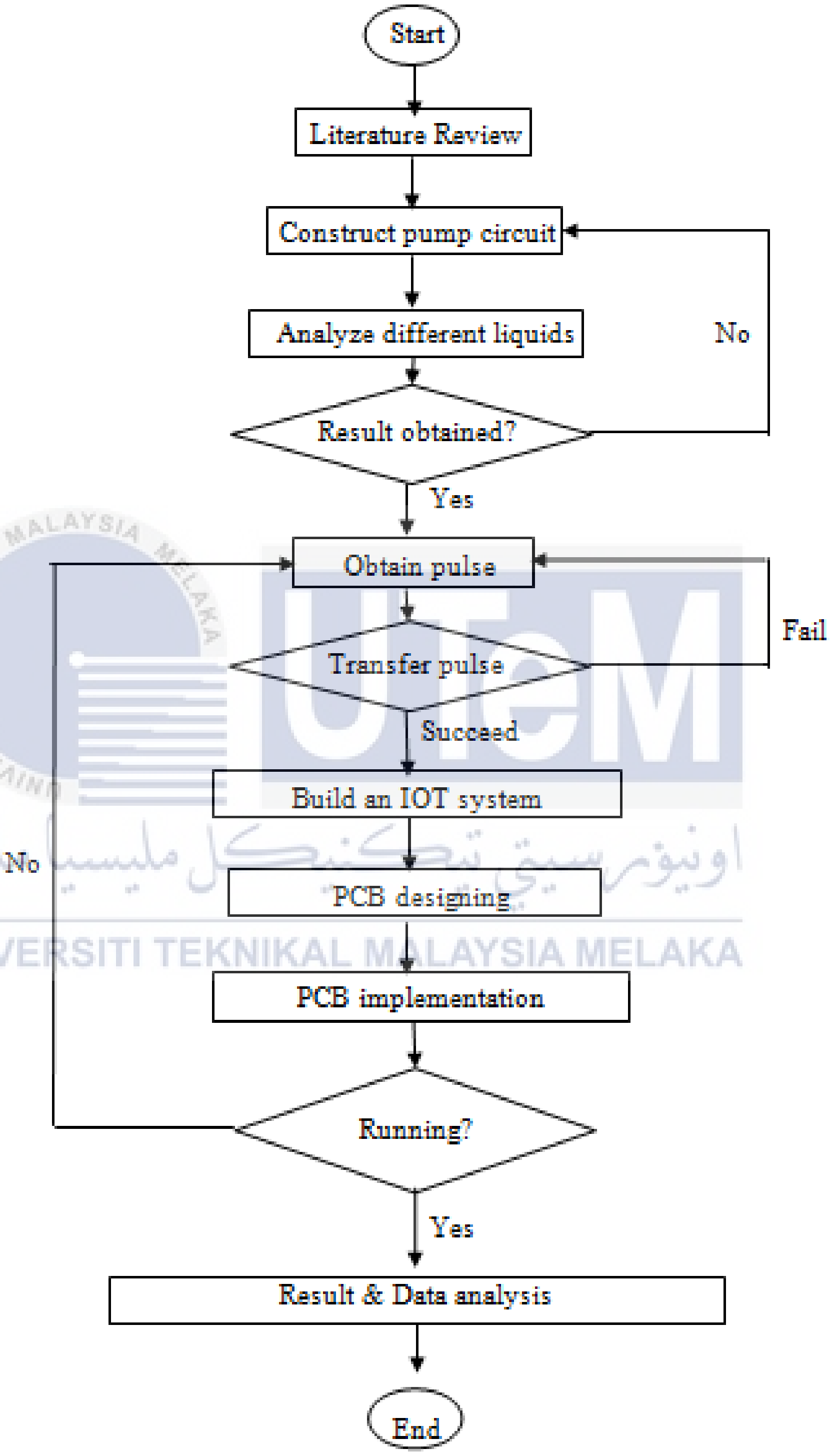

Figure 3.1: Project Flow chart

3.3 Hardware

The hardware emphasis the components of this project. NodeMCU ESP8266 is open-source firmware and development kit that is used for prototyping or building IoT products. It is different from Arduino, whereby it can connect to WiFi without having an extra extension board and has an analog pin for receiving analog signal, as shown in figure 3.2. NodeMCU is a microcontroller that is compatible with Arduino IDE as it is easy to program and test the input it receives in Arduino IDE. It is used in this project to send and store the data of sensors into the Blynk application.

Figure 3.2: NodeMCU ESP8266

Additionally, there is a voltage regulator embedded in the L298N motor driver module itself. The voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, the internal circuitry will be powered by the voltage regulator, and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is more remarkable than 12V, and separate 5V should be given through the 5V terminal to power the internal circuitry. ENA & ENB pins are speed control pins for Motor A and Motor B, while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B, as shown in figure 3.3.

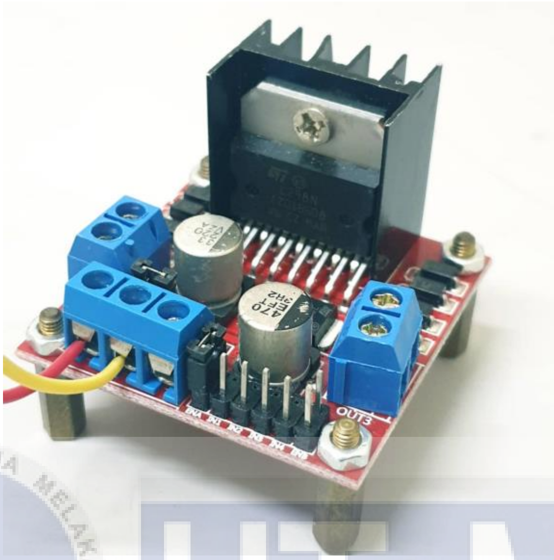

Figure 3.3: L298N Motor Driver Module

Peristaltic pumps are a type of positive displacement pump used for pumping a variety of fluids. The fluid is contained within a flexible hose or tube fitted inside the pump casing. The actual pumping principle, called peristalsis, is based on alternating compression and relaxation of the hose or tube, drawing content in and propelling product away from the pump.

As in figure 3.4, a rotating shoe or roller passes along the length of the hose or tube, creating a temporary seal between the suction and discharge sides of the pump. As the pump’s rotor turns, this sealing pressure moves along the tube or hose, forcing the product to move away from the pump and into the discharge line where the pressure has been released. The hose or tube recovers, creating a vacuum, which draws the product into the suction side of the pump, the priming mechanism.

Figure 3.4: Peristaltic Pump

The NodeMCU expansion board in Figure 3.5 is a board that can support up to 5V to 12V and power up the NodeMCU with the voltage received by using the voltage modulator built in the board. This board also has a supply of Vin which will supply the same voltage that the board receives. This board also has several voltage outputs, the Vin and 5V and 3V, as this is a significant advantage when building a circuit as the supply can be used for the circuit only with one input source being plugged in.

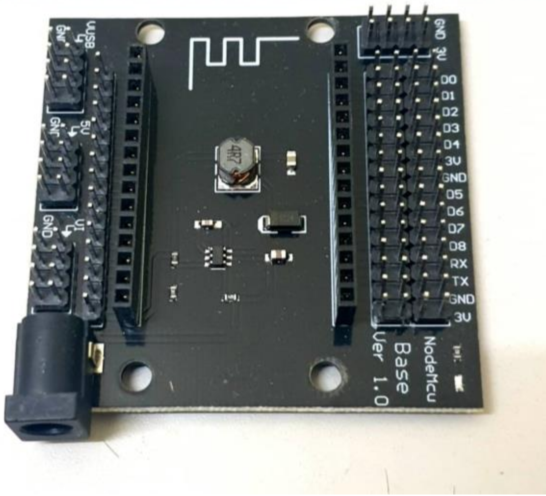

Figure 3.5: NodeMCU expansion board

Optocoupler 4N25 is an IC that can replicate the input signal and can be used to isolate the load circuit from the control circuit and is illustrated in figure 3.6. When the input signal is connected to the positive of the IR diode, it is turned on and emits infrared rays internally, and when these rays strike the phototransistor in it, the transistor turns on. When the transistor is turned on, current flows through the load circuit and the voltage across the other side is seen.

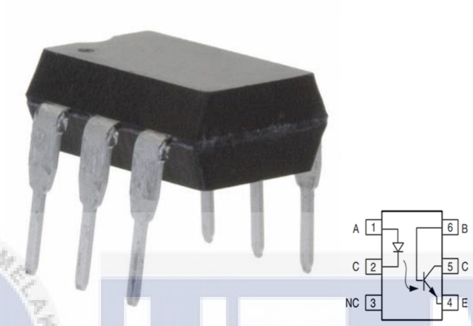

Figure 3.6: Optocoupler 4N25

3.4 Software

Arduino IDE is an open-source software used in this project to write and compile the code into the Arduino Uno and NodeMCU ESP8266 board. The main code, also known as a sketch, created on the IDE platform. Figure 3.7 will ultimately generate a Hex File, then transferred and uploaded to the board's controller. It supports both C and C++ languages.

Figure 3.7: Arduino IDE Platform

Blynk, as shown in 3.8, is a platform whereby it is available in the apps store of iOS and Android devices and can be used for IoT purposes. This platform can control and monitor several microcontrollers such as Arduino, NodeMCU, ESP32 and Raspberry Pi over the internet. The data retrieved from the sensor or the prototype can be stored in a cloud database of its own.

Figure 3.8: Blynk IoT Platform

The Proteus 8 Professional program is used to create the circuit ahead. It may also be tested to assure it is acceptable to achieve the desired outcome using simulation before conducting the actual circuit. This application provides a range of components and equipment to enable optimal circuit operation, as in figure 3.9.

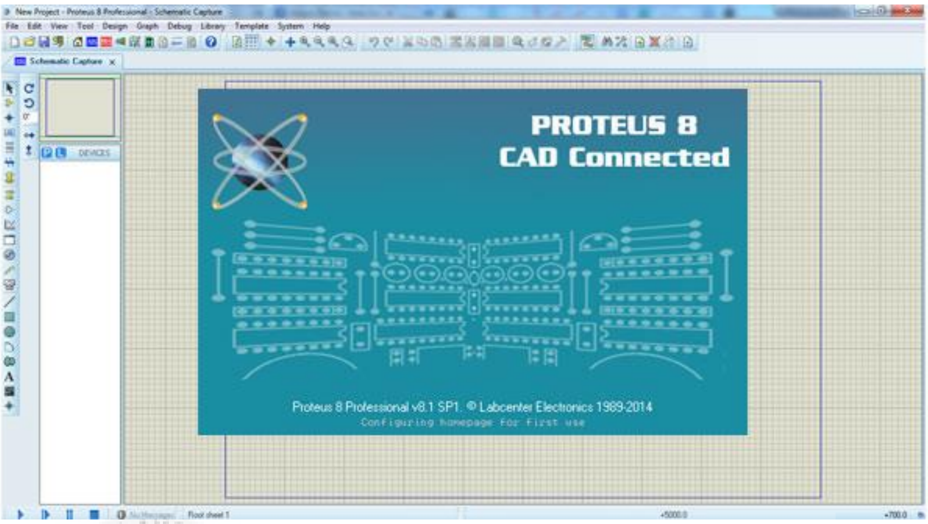

Figure 3.9: Proteus 8 Professional Platform

3.5 Block Diagram and Process Flow

Figure 3.10 shows the block diagram of the project that concise the section of the whole process.

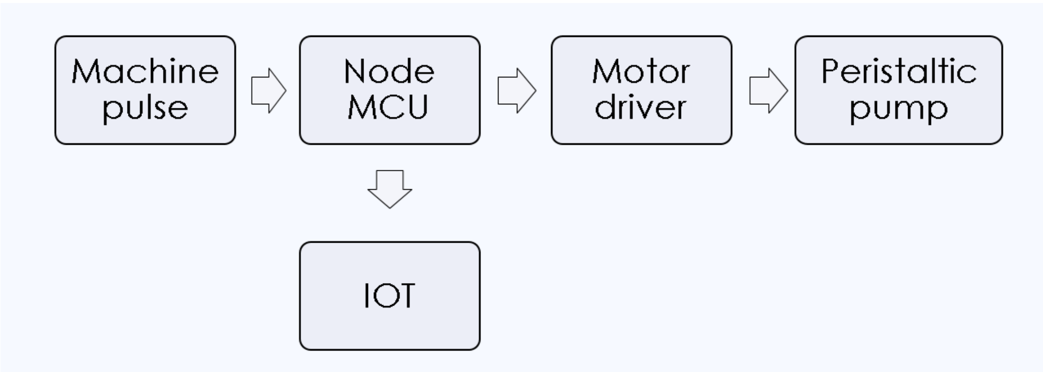

Figure 3.10: Block Diagram and the Process Flow

I. The system's brain, the microcontroller NodeMCU is attached to the expansion board specially made for NodeMCU and has several varieties of output voltage in the expansion board. The board also can support up to 5V to 12V supply without harming the NodeMCU because it has a built-in voltage regulator that will supply the 3V to the microcontroller; nevertheless, the voltage is 5V or 12V. There is also output pin Vin, which will dissipate the input voltage, so by connecting the 12V supply, the same supply can be used with 4 output Vin pins.

II. As the NodeMCU connected with the extension board and the 12V supply is feed, the 12V supply from Vin pins are used to connect with the two inputs in the circuit designed to replicate the signal of the machine output and another 12V supply is connected to the L298N motor driver and the peristaltic pump motor is connected to the L298N motor driver to function with the desired output.

III. Using the NodeMCU, the input for L298N motor driver is sent to control the speed and time to dispense the liquid. The fabricated circuit output is connected to the NodeMCU analog pin, and the input of the circuit is connected to the output of the machine pulse.

IV. When the dispensing circuit is completely connected with the machine and the peristaltic pump together, it is ready to dispense the liquid as the value being programmed once the machine triggers the NodeMCU.

V. The flow will be machine pulse will be fed into the fabricated circuit and be replicated and turned into a signal that is compatible with NodeMCU and DC components. Once the triggering point reaches the NodeMCU will send instruction to start the process of detergent flowing as per the programmed parameter. A message will be sent to the user that the machine is started to phone by using the Blynk platform via IoT.

VI. Once the detergent flows to the programmed level, which is 100ml equivalent to 1 cup of detergent used for single washing, the flow stops and starts to wait for the end time of the machine. When the machine stopped washing, and simultaneously the delay counting of the microcontroller comes to an end, it will send a notification alert to the mobile phone using the Blynk platform via IoT that the machine has ended. The user can go back to the laundry to collect the laundry.

3.6 Developing process

In this developing process, the work that has been done to develop this project into a prototype is shown and explained. The developing process includes several processes such as programming, designing, fabrication, and the prototype assembly at the end. All of this process is explained in detail. Programming is the first part of this process, the programming language used in this project is C++ in the Arduino IDE platform, figure 3.10 to code it into the microcontroller.

Firstly, various peristaltic pumping speeds coding is done to fix the best speed to be confirmed. The speed of the peristaltic pump is decided to 100%, 80%, and 60% to analyze the dispensing time and dispensing liquid. Then, the data is collected and analyzed. The coding for IoT is being continued after sending data to the IoT monitoring system and connecting to the internet. Finally, the coding for the microcontroller to react with the input of the circuit as it enters and starts up the peristaltic pump to dispense.

Figure 3.11: Programming platform

Proteus 8 Professional is the platform of this designing part. Designing part is about designing the circuit. Figure 3.12 makes the signal from the machine to the microcontroller. In this part, the circuit design is made in the Proteus 8 Professional to ensure that the connection and the output are all aligned and connected correctly with all the components. Then, a PCB layout, figure 3.13, is generated to place the components without the connection is being interfered with and carried over to the fabrication of the circuit.

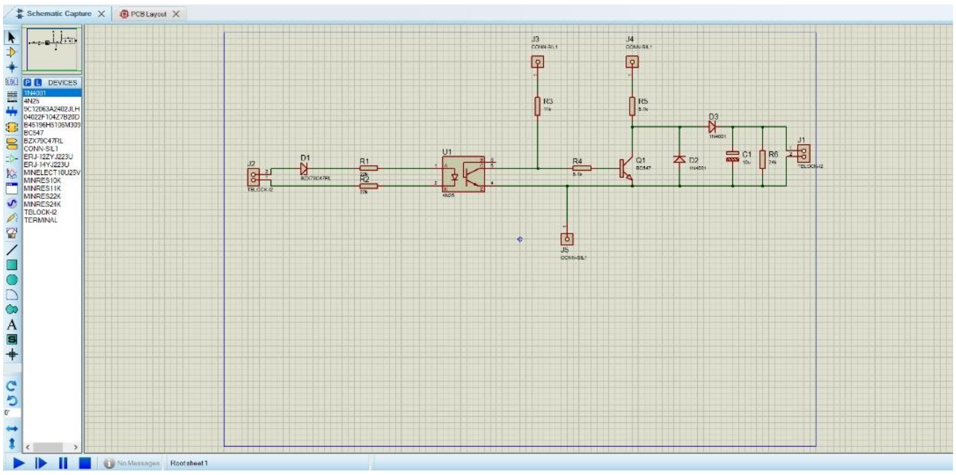

Figure 3.12: Circuit Construction

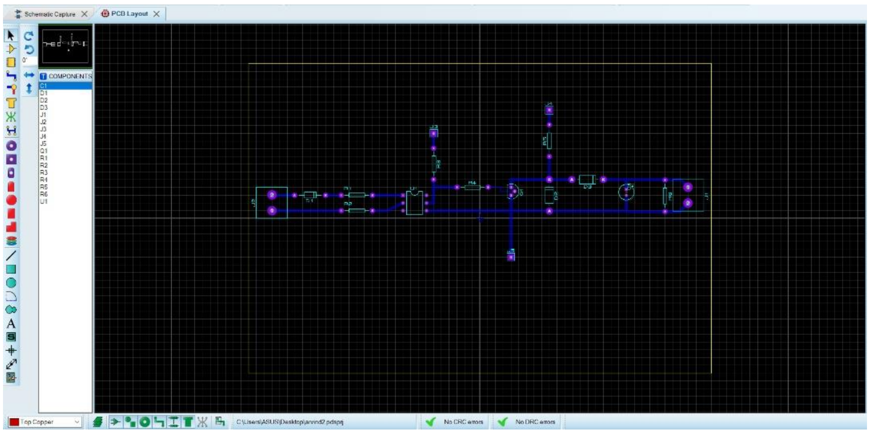

Figure 3.13: PCB Layout of the circuit

The fabrication process has several steps to ultimately produce a functioning circuit: UV printing, etching, drilling, soldering, and troubleshooting. The first process is UV printing which will use the PCB layout of the circuit finalized in the designing process and printed on a plastic sheet for the UV process. This plastic printed circuit will be placed on top of the PCB board once the plastic of the copper side has peeled and placed the board on the UV printer as in shown figure 3.14 to begin the UV printing.

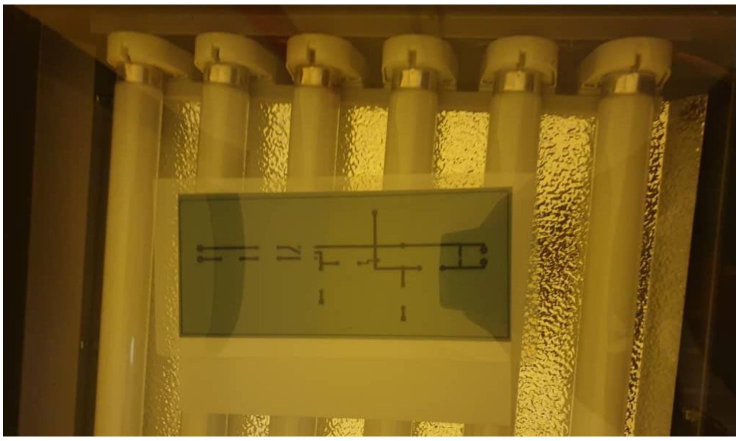

Figure 3.14: UV printer

UV printer lid has to be closed without troubling the printed plastic on the board. After the lid is closed, the buttons of the UV printer are pressed from right to left in order and wait for 10 seconds as it warms up and prepares for the UV printing, as in figure 3.15. When the UV printer is prepared for printing, it can be started and wait for 15 seconds as the printing process goes off. Once the printing process is over, the board is ready for the next step, which is etching.

Figure 3.15: UV printing process

Etching is a step in dealing with chemicals, so personal protective equipment is essential when carrying out this step. Personal protective equipment is protective equipment such as an apron, gloves, shoes, and mask, as in figure 3.16. This personal protective equipment is used to protect if there are any chemical split out happens and to avoid injuries or infections. First, need to immerse the printed board in the chemical solution to etch away the unwanted copper on the board left after the printing process, as in figure 3.17.

Figure 3.16: Personal protective equipment

Figure 3.17: Etching process

The solution will remove the unwanted copper layer on top of the board and rinse it. This step is repeated approximately three times to completely dissolve the copper layer in the chemical solution as it is immersed in the chemical and rinse back, as in figure 3.18.

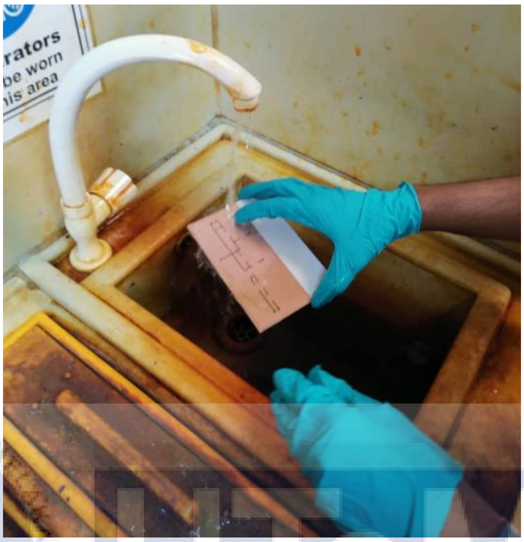

Figure 3.18: Copper removal

Following that, the PCB board was given an acid bath to guarantee that any copper residues were removed; the board was then put on a conveyor belt and passed through the acid bath three times, as in figure 3.19.

Figure 3.19: Acid application

Then, immerse the PCB board that has been cleaned of copper residue in Acetone solution in Figure 3.20, eliminating the ink track on the PCB board. This will make the copper track of the circuit printed visible on top of the PCB board, as in figure 3.21.

Figure 3.20: Acetone Solution Application

Figure 3.21: Circuit on the PCB board

Consequently, the board is rinsed thoroughly to remove the Acetone solution and other chemicals on it. Then dry the board with the dryer to remove the water on the board and ensure that the board is water-free in figure 3.22. To begin with, the next following step is drilling.

Figure 3.22: Drying process

Drilling is the following process that will be carried out after the etching process, which drills the holes on the board to fix the components safely on the board and based on the position of the design in the software as in figure 3.23. There are also different drill bit used to drill bigger holes as the terminals required bigger holes than the standard components used.

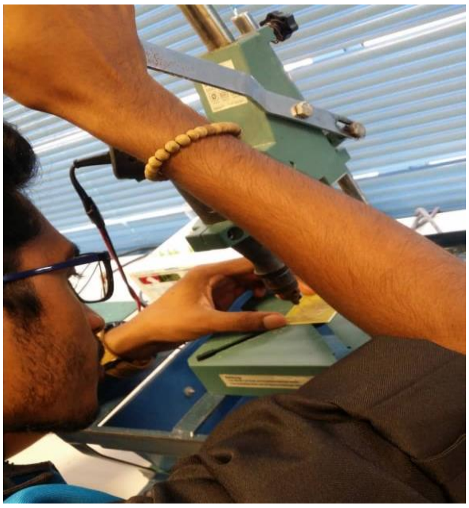

Figure 3.23: Drilling Process

Soldering is the next step that will occur, which is components are placed on the board as designed and soldered with the copper track with the help of a soldering tool and wick to ensure that the components are secured in the proper place. Then the extra legs of the components are being cut to make them neat and easy to be placed in the prototype, as shown in figure 3.24.

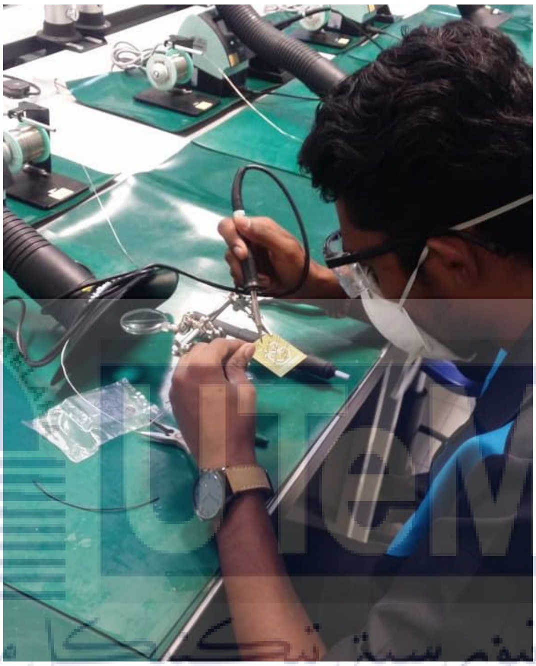

Figure 3.24: Soldering components to the board

The final step of this fabrication process is troubleshooting. The troubleshooting process in figure 3.25 is whereby the board is tested for any defective connections or even unintended soldering connections during this phase. This is one of the main steps which has to be done to avoid any short circuits or damage to the circuit and components when all the components are assembled.

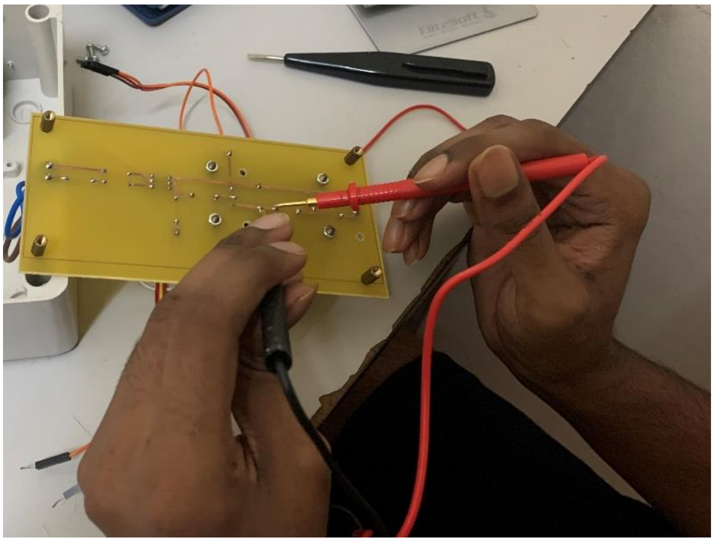

Figure 3.25: Troubleshooting process

The assembly process involves merging the casing, fabricated circuit, peristaltic pump, and the boards altogether. First of all, this process starts with setting up the casing in figure 3.26 to insert all the components inside the casing and place them without interfering with each other, as shown in figure 3.27. Drilling is done to fix all the components inside and screw them to stick in on place. Small holes are drilled for the power input to be fixed and remove easily.

Figure 3.26: Casing for the system

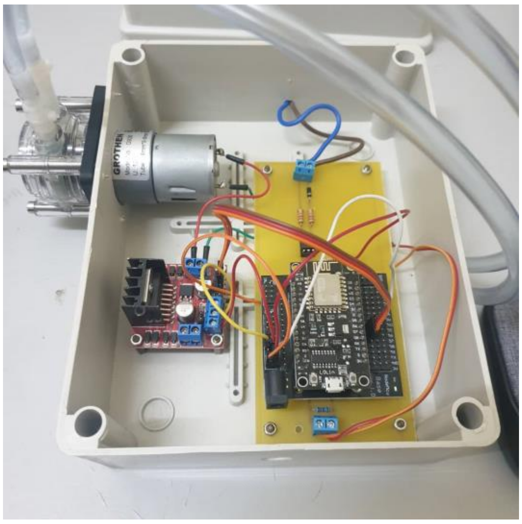

Figure 3.27: Component placement

3.7 Obtaining result

This part is referred to how to obtain the result and what kind of result is being focused on. First of all, a small setup using NodeMCU, peristaltic pump, and the motor driver is created to analyze the liquid dispensed with varying speed which has been decided whereby 100%, 80%, and 60%. This result is used to analyze which speed of the peristaltic pump and how long it is needed to have the desired volume of liquid dispensed using a speed controlling circuit as shown in Figure 3.28.

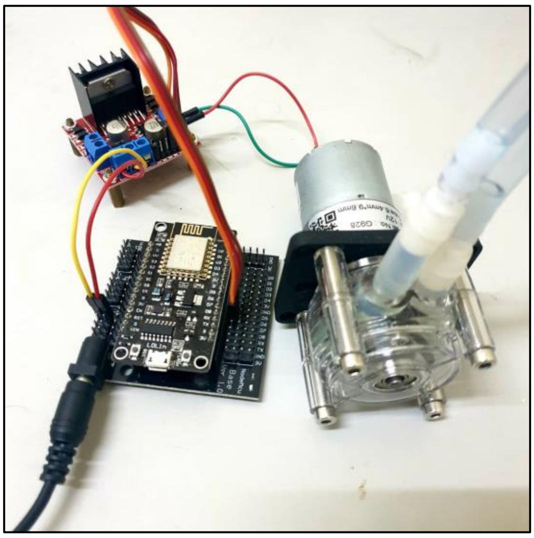

Figure 3.28: Speed controlling circuit

A circuit is needed to be created as the machine output, as shown in figure 3.29, is not stable and not compatible with the DC components, which can damage the components, so a circuit is specially created. The result is obtained as the desired voltage output is received, and it could replicate the same as the machine output as shown in figure 3.30.

Figure 3.29: Machine output

Figure 3.30: Circuit for signal replication

CHAPTER 4

RESULTS AND DISCUSSION

The result and discussion exhibit the outcome of the investigated material and the analysis of the project summed into tables and waveform.

4.1 Introduction

This chapter will discuss the methods used to attain the project's goal and provide a deeper look at how the project was completed. Each accomplishment and decision made during the project's implementation will be explained in-depth for each state until the project is completed.

4.2 Dispensing volume data analysis

Initially, the 12V dc motor is run by connecting straight to the power supply; without any control, it will run at full speed, 100% speed of the dc motor. A dispensing test with different liquids, water, and detergent is being carried out to analyze the difference and the time taken for each liquid to be dispensed for a particular volume. Then, the testing is being carried out with a different speed t the dc motor is capable of because when the speed is reduced to less than 50%, the dc motor stopped its rotation and some noise in the interior is a harmful dc motor. After that, the dc motor is tested with other speed such as 60% and 80%, which works fine, and these values being used for the analysis as this would be better varies parameters. Data analysis for 80% and 60% speed of dc motor, NodeMCU, expansion NodeMCU board, and the motor driver are added to the circuit to control the speed. There must be a PWM pin and a motor diver that will receive the PWM's output and set the dc motor to the desired speed.

The volume for dispense in 100% speed in figure 4.1 is 1 litre as the changes could be recorded and the changes in time taken to be visible. The volume for dispense in 80% speed and 60% speed is 500ml as the changes are visible earlier, as shown in figure 4.2 and 4.3. The data of the different liquids dispensed and the time taken for the liquids to be dispensed obtained and recorded.

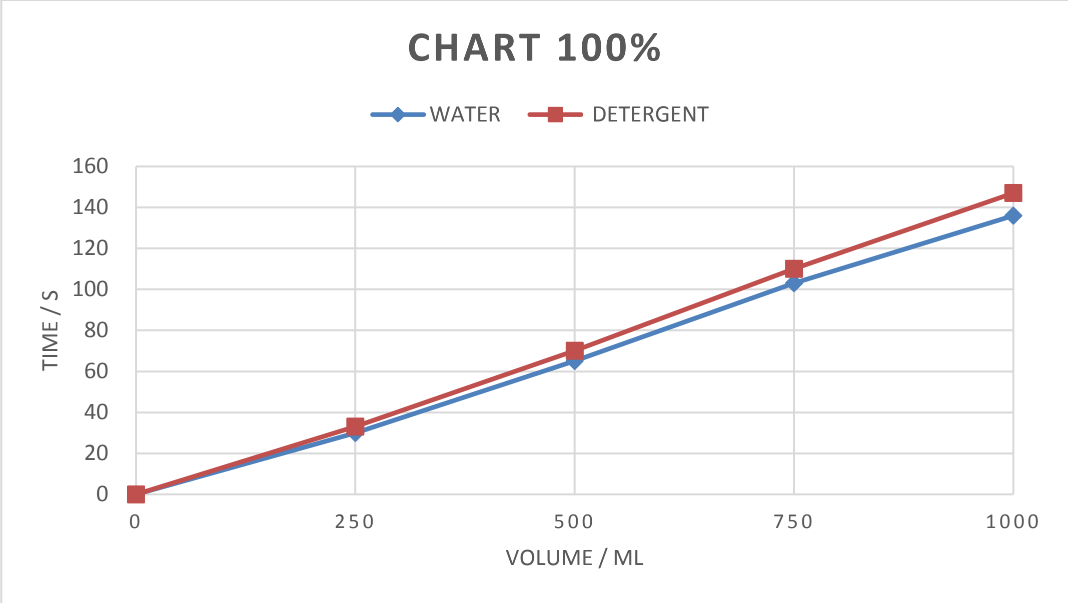

Figure 4.1: Graph of time taken to dispense liquid comparison between water and detergent with 100% speed of dc motor.

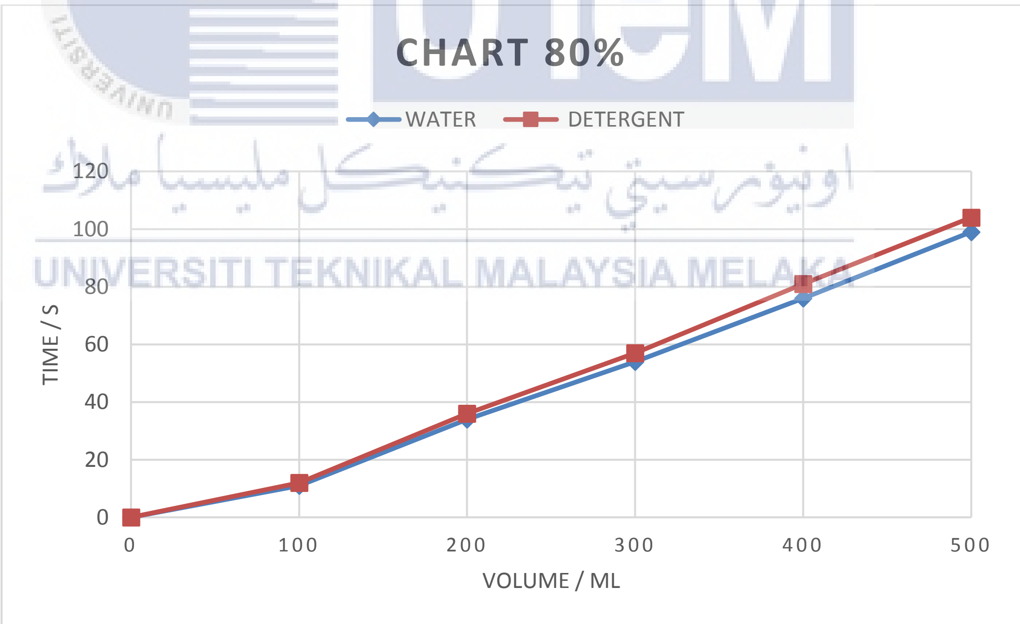

Figure 4.2: Graph of time taken to dispense liquid comparison between water and detergent with 80% speed of dc motor.

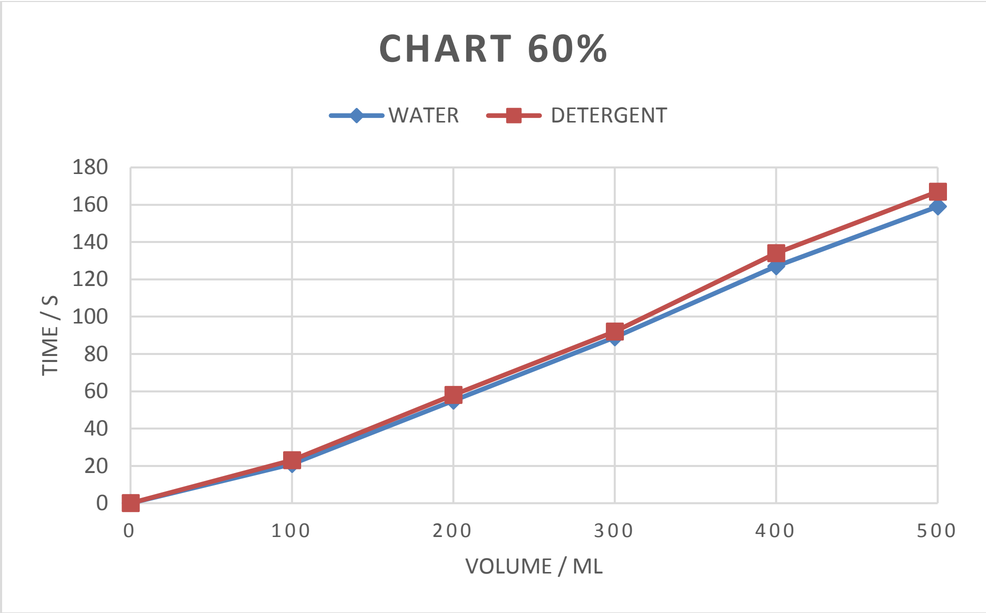

Figure 4.3: Graph of time taken to dispense liquid comparison between water and detergent with 60% speed of dc motor.

Based on the graphs, both liquids were dispensed for 1 litre in 100% speed of dc motor and 500ml in 80% and 60% dc motor speed.

4.3 Machine output compatible circuit.

Generally, a laundry machine operates in an AC supply directly from the plug point built on. As the current which driving through in the machine is AC, this makes it difficult to be compatible with the DC components as it could damage the components when being connected but without connection to the laundry machine directly, the pulse or the triggering time to dispense the detergent cannot be obtained. To overcome this issue, a circuit is designed to replicate the triggering pulse from the laundry machine without affecting the DC components that work in the other part of the prototype. The machine pulse is obtained from the wires coming out from the laundry machine and goes to a controlling unit, as in figure 4.4. Several wires combined and were tested with an oscilloscope and tabulated for different voltage output range, as shown in figure 4.5 – 4.8.

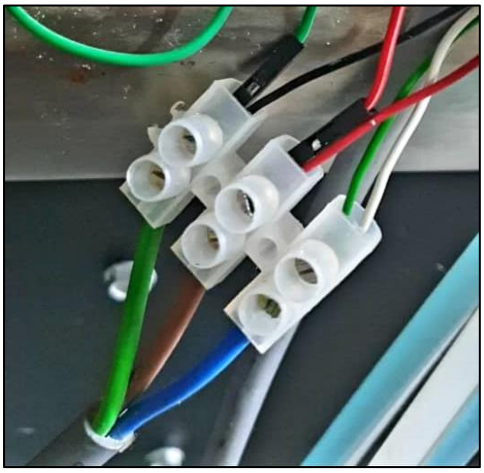

Figure 4.4: Wires from the laundry machine.

Based on figure 4.5, the output is a combination of positive terminal in brown wire and the negative terminal on the blue wire which results a output voltage range of 0mV to 2.2mV. Thus, this output voltage is very low whereby it is nearly to zero voltage and hard to configure by using this output waveform signal.

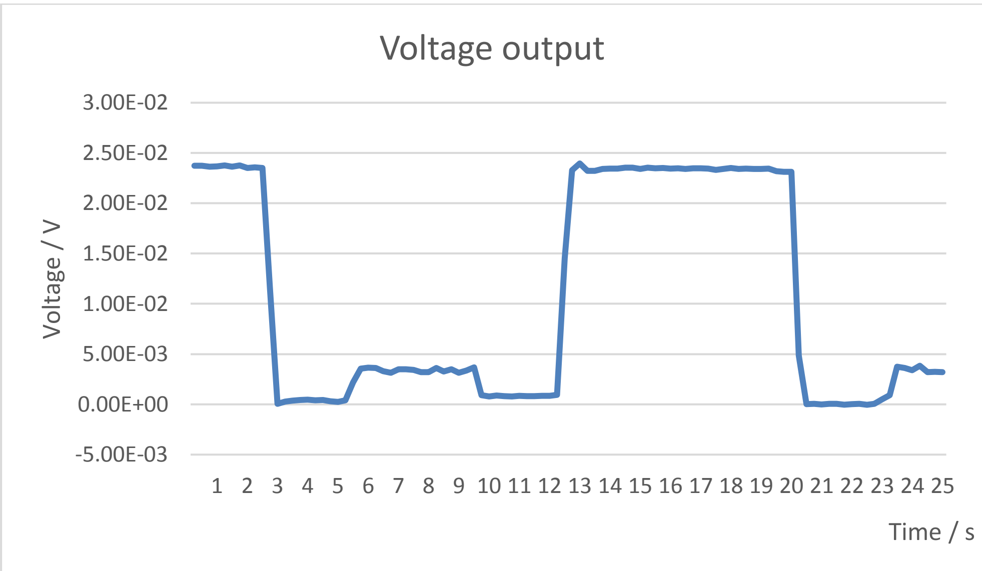

Figure 4.5: Oscilloscope reading of the voltage output range 0mV-2.2mV.

Referring to figure 4.6, the output is a combination of positive terminal in green wire and the negative terminal on the blue wire which results a output voltage range of 3mV-4mV. Thus, this output voltage is very low whereby it is nearly to zero voltage and hard to configure by using this output waveform signal.

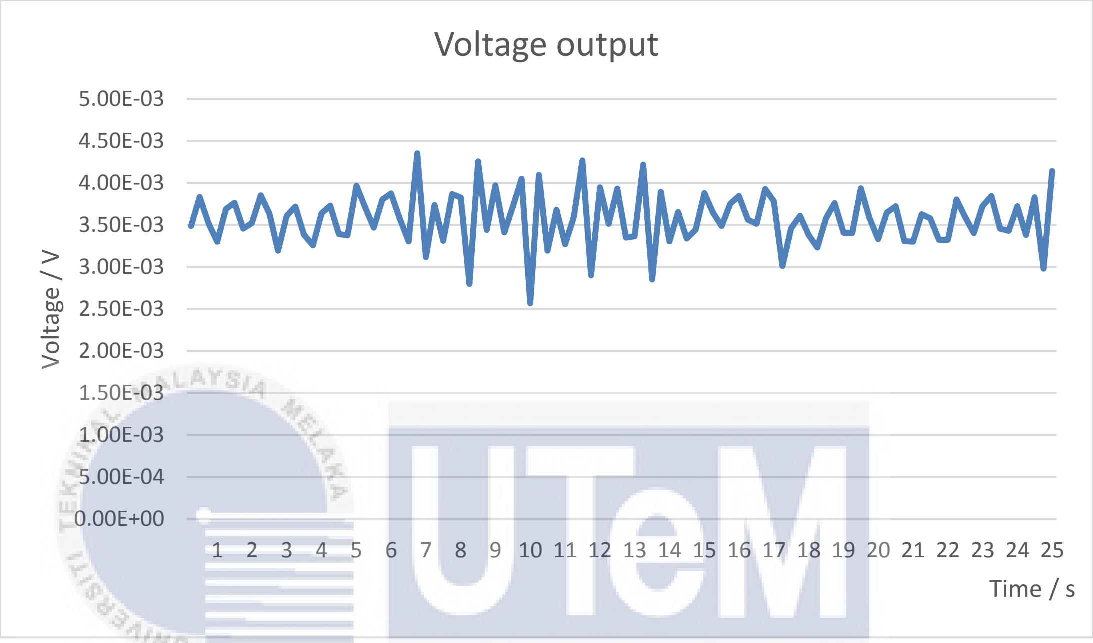

Figure 4.6: Oscilloscope reading of the voltage output range 3mV-4mV.

Referring to figure 4.7, the output is a combination of positive terminal in brown wire and the negative terminal on the green wire which results a output voltage range of 0.37V-0.52V. Therefore, this output voltage is very suitable to use whereby it is a low voltage and has a range that is suitable for the triggering application and has a waveform with a triggering point which will be very suitable for activate the dispensing of detergent into the machine.

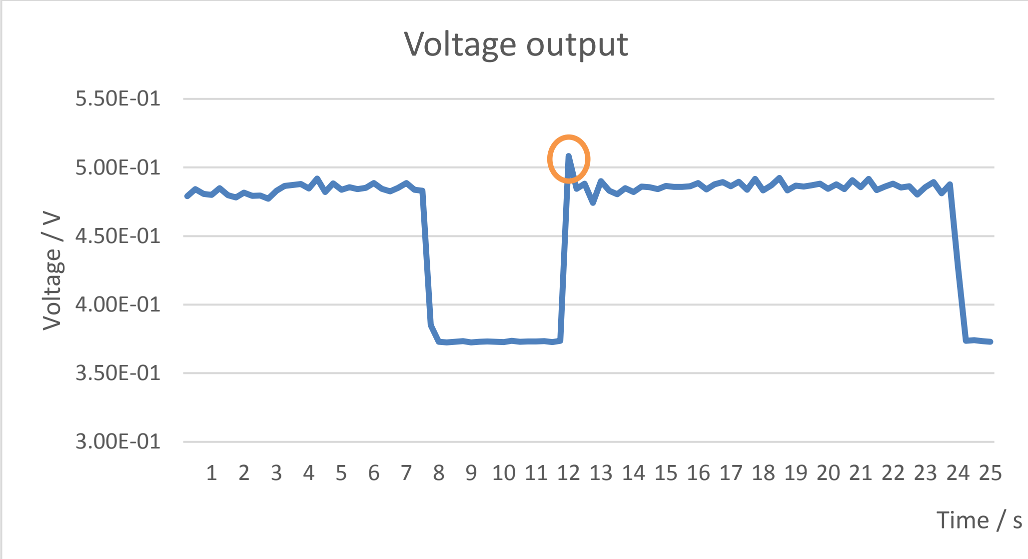

Figure 4.7: Oscilloscope reading of the voltage output range 0.37V-0.52V.

Based on figure 4.8, the output is a combination of positive terminal in green wire and the negative terminal on the brown wire which results a output voltage range of 2mV-1.1mV. Thus, this output voltage is very low whereby it is nearly to zero voltage and hard to configure by using this output waveform signal.

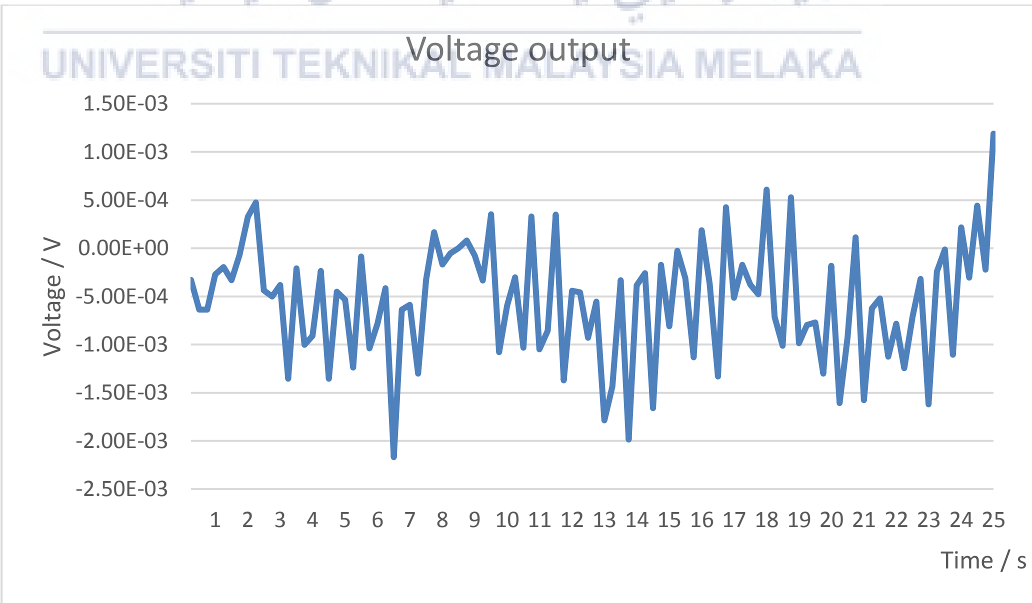

Figure 4.8: Oscilloscope reading of the voltage output range -2mV-1.1mV.

Table 4.1: Experiment test results in between different wires.

Positive terminal (colour of wires)	Negative terminal (colour of wires)	Voltage output / V
Brown / red	Blue / white and green	0mV – 2.2mV
Green / black	Blue / white and green	3mV – 4mV
Brown / red	Green / black	0.37V – 0.52V
Green / black	Brown / red	-2mV – 1.1mV

Table 4.1 the result obtained is recorded and can be used for the dispensing trigger time with more precise observation. The laundry machine's voltage output, mainly in millivolt, cannot be used as it is a very low voltage output and nearly zero voltage. The combination of brown/red in the positive terminal and green/black in the negative terminal has an output range of 0.37V – 0.52V, which is good voltage output that can be used as a triggering pulse for the NodeMCU to be work on and the marked point in figure 4.7 is the exact point which will be used to trigger the microcontroller. A circuit with a 4N25 optocoupler in figure 4.9 is developed to replicate the triggering time of the machine output and separate the load circuit and the control circuit. The circuit contains dc supply to supply the triggering time and activate the pump dispensing. The result of the circuit is shown in figure 4.10 with different readings.

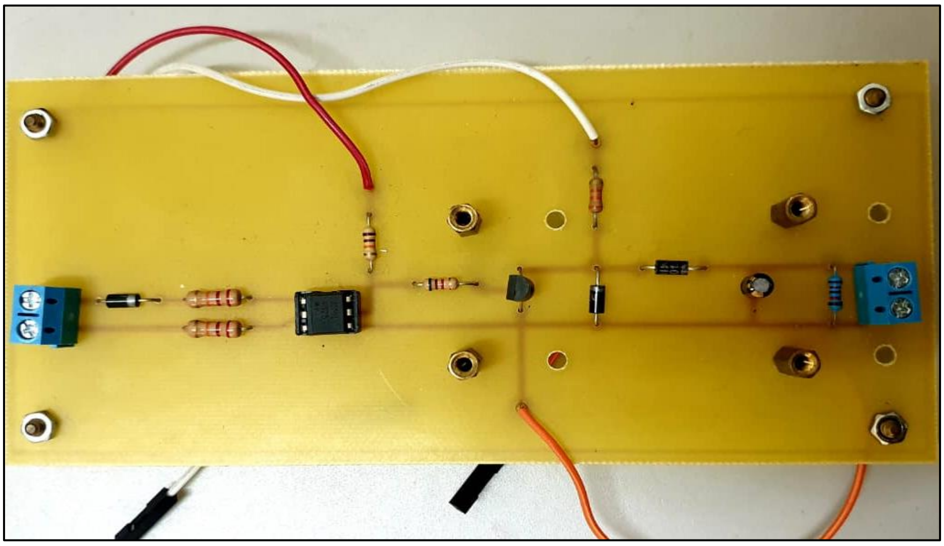

Figure 4.9: Circuit to connect machine with the prototype.

Figure 4.10: Result obtain from the circuit.

Referring to figure 4.11, the output of the circuit does not exceed 3.3V, which is the main precaution that had to be followed as the NodeMCU microcontroller pin A0 limit is 3.3V. If there is any voltage above 3.3V, it may damage the board. The output of the circuit replicates the machine output triggering time exactly and trigger the prototype accordingly. The same point marked in figure 4.7 is also marked in figure 4.11, which is the replication of the input triggering voltage.

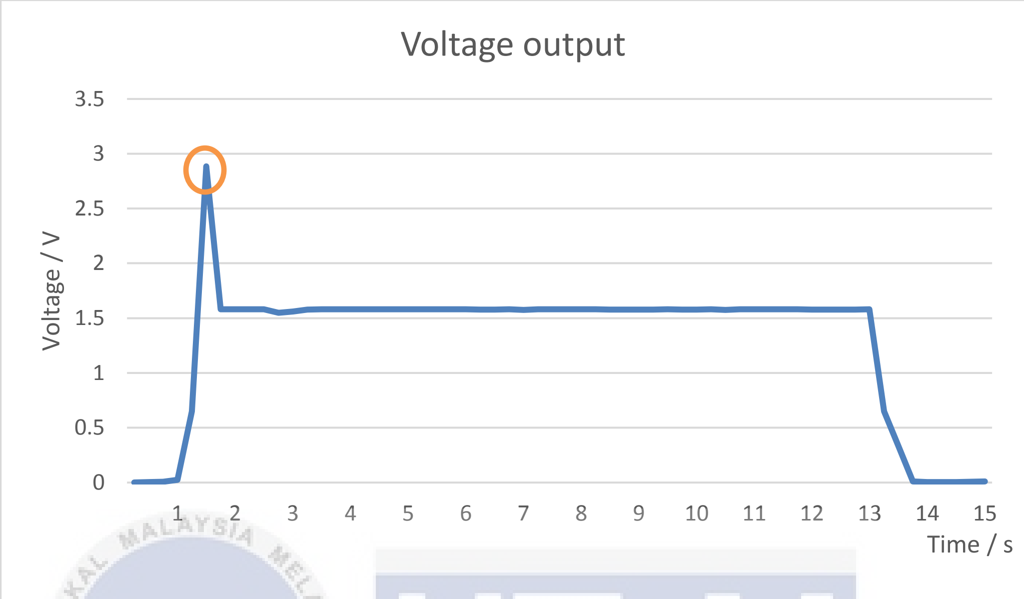

Figure 4.11: Graph of circuit output.

4.4 Prototype outcome

This is the result of the developed system in cooperation with the hardware and the software designed. This Peristaltic pump dispensing system contains NodeMCU, NodeMCU expansion board, fabricated circuit, motor driver, and a peristaltic pump, as shown in figure 4.12 and 4.13. The main controlling element is performed by the NodeMCU, which is programmed in the Arduino IDE platform and associated with the Blynk platform for the IoT monitoring system.

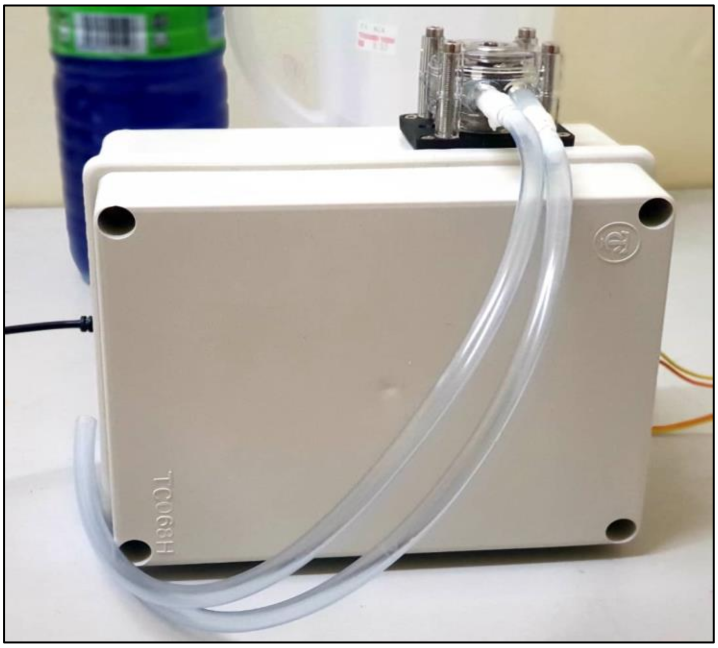

Figure 4.12: Prototype

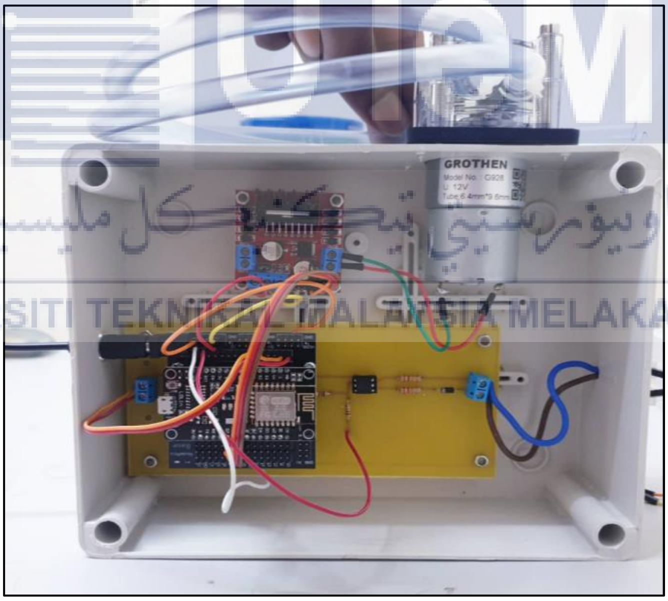

Figure 4.13: Internal view of the prototype

The outcome of this prototype is by dispensing the precise amount of liquid and sending notification to the Blynk platform. The Blynk interface is shared by generating a QR code for the users and sending notification once the washing begins and the washing ended. Users will also receive the notification once the laundry machine ends the washing and repeat when the laundry machine starts again, as shown in figure 4.14.

Figure 4.14: Blynk result

4.5 Enviroment and Sustainability

The impact of this prototype for the environment is that this prototype contributes for the Sustainable Development Goal(SDG)14 as this project reduce the excess use of the detergent which is non-biodegradable and damages the environment. This project will also make a step forward for the technology and the environment under the laundry sector. Prototype without vision is a creation without and intention to last long, it needs to be sustained in the market or being sustainable for development in future and this prototype has fulfilled it completely as this is a moving forward technology and will be room for more upgrades in the future.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

This chapter concludes the results obtained and the finding hypothesis the reflection between the project accomplishments, objectives, and scope. Future studies are proposed for continued development in the expansion of the project research up to the potentials.

5.1 Conclusion

In this technical study, a dispensing dosage control for social life application, especially laundry system, is intended using a peristaltic pump as a foremost product. The dispensing dosage is integrated with electronic components for controlling and connected via IoT for monitoring purposes. The dosage system variety, methods and expansion prospect are thoroughly investigated for the controlling and monitoring applications. With the aid of project budget, scale and scope, curation has been made for the project's suitability in terms of components and reasonable procedures.

A microcontroller manages the peristaltic pumping, NodeMCU, to initiate the input machine signal. The composition of the controlling element is by the programming commands and the connectivity between the components. The input signals for the system is the machine pulse that indicates the dispensing phase, operation initiative. The microcontroller is installed in and out with a motor drive, circuit, pump and online interface via IoT.

The design is made using circuit construction platform Proteus for DC signal replication that involves optocoupler, transistor, resistors and diodes. The pumping period, speed and volume of the different liquids are evaluated, and the project output implies the project's objectives.

5.2 Future Work

There are several accomplishments to the field of research for future progress and advancements. This integrated system has the potential for improvements and adaptation in this technologically advanced world. Therefore, some recommendations would like to be proposed as a part of future work. First and foremost, the peristaltic pump properties can be modified according to the usage, speed, and volume application preferences, such as rollers.

The engagement of the many dispensing systems to one convenient monitoring panel for business development. Further expansion in digital sensing for the dosing system and more informative interface development to the customers.

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APPENDIX A

Programming Command

```
#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#define BLYNK_PRINT Serial


BlynkTimer timer;



char auth[] = "Yo8gyvvt-30ipc_9z-tAqZaAaDGiSAgs";

char ssid[] = "A";

char pass[] = "aaaaabbb";



int IN1 = D6;
```

```
int INAc = A0;
int data = 0;
int IN2 = D7;
int ENA = D5;
int FALSE = D8;
void setup() {
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  pinMode(INAc, INPUT);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(ENA, OUTPUT);
  pinMode(FALSE, OUTPUT);
  Serial.println("STABLIZED INPUT VOLTAGE FROM THE MACHINE");
  Serial.println("THE VOLTAGE HAS BEEN OPTIMISED FOR THE NODEMCU TO READ");
  Serial.println("Readings:");
```

```
  timer.setInterval(1000L, sensorDataSend);

  delay(2000);

}

void loop() {

 timer.run();

 Blynk.run();

 }

void sensorDataSend(){

  int INV = analogRead(INAc);

  INV = INV * 0.003222656;

  data = analogRead(INAc);

  Blynk.virtualWrite(V2, INV);

  Serial.print("VOLTAGE: ");

  Serial.print(INV);

  Serial.print("V");



  analogWrite(FALSE, 1000);
```

```
if (INV > 2.5) {

  Blynk.notify("MACHINE STARTED");

  Serial.println("STARTED");

  digitalWrite (IN1, HIGH) ;//send tone

  digitalWrite(IN2, LOW);

  analogWrite(ENA, 1000);

  Serial.println("DETERGENT FLOWING");

  delay(12000);

{

  Serial.println("MACHINE WAITING");

  digitalWrite (IN1, LOW) ;

  digitalWrite(IN2, LOW);

  analogWrite(ENA, 0);

  delay(8000);

  Blynk.notify("MACHINE ENDED");

}
```

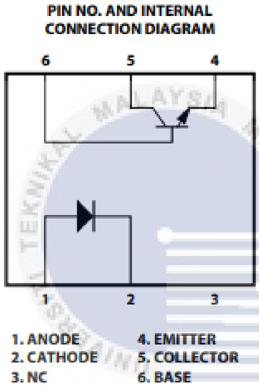
```
 }

else
 {
   Serial.println("MACHINE ENDED");
   digitalWrite (IN1, LOW) ;
   digitalWrite(IN2, LOW);
   analogWrite(ENA, 0);
   Serial.println("DETERGENT NOT FLOWING");
 }
delay(1000);
}
```

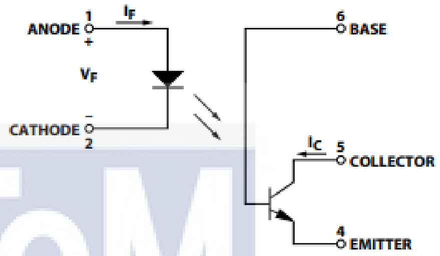
APPENDIX B

Datasheet of 4N25 Optocoupler

Functional Diagram



Schematic



ELECTRICAL CHARACTERISTICS (1)

PARAMETER	TEST CONDITION	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
INPUT							
Forward voltage (2)	I_F = 50 mA		V_F		1.3	1.5	V
Reverse current (2)	V_R = 3 V		I_R		0.1	100	μA
Capacitance	V_R = 0 V		C_O		25		pF
OUTPUT							
Collector base breakdown voltage (2)	I_C = 100 μA		BV_{CBO}	70			V
Collector emitter breakdown voltage (2)	I_C = 1 mA		BV_{CEO}	30			V
Emitter collector breakdown voltage (2)	I_E = 100 μA		BV_{ECO}	7			V
I_{CEO}(dark) (2)	V_{CE} = 10 V, (base open)	4N25			5	50	nA
		4N26			5	50	nA
		4N27			5	50	nA
		4N28			10	100	nA
I_{CBO}(dark) (2)	V_{CB} = 10 V, (emitter open)				2	20	nA
Collector emitter capacitance	V_{CE} = 0		C_{CE}		6		pF
COUPLER							
Isolation test voltage (2)	Peak, 60 Hz		V_{IO}	5000			V
Saturation voltage, collector emitter	I_{CE} = 2 mA, I_F = 50 mA		$V_{CE(sat)}$			0.5	V
Resistance, input output (2)	V_{IO} = 500 V		R_{IO}	100			GΩ
Capacitance, input output	f = 1 MHz		C_{IO}		0.6		pF