DEVELOPMENT OF SMART GLOVE FOR STROKE REHAB

VINOSHA A/P SIVADEV

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

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THIS REPORT IS SUBMITTED IN PARTIAL FULFILMENT FOR THE REQUIREMENTS FOR DIPLOMA IN MEDICAL ELECTRONICS ENGINEERING

JABATAN KEJURUTERAAN ELEKTRIK

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

1: 2022/2023

ENDORSEMENT

I hereby acknowledge that I have read this report and I found out that its contents meets the requirements in terms of scope and quality for the award of the Diploma in Medical Electronics Engineering.

Signature :

Name : MADAM WEE SOO LEE

Date :

DECLARATION

"I hereby declare that the work in this report is my own except for quotation and summaries which have been duly acknowldeged."

Signature :

Name : VINOSHA A/P SIVADEV

Registration no. : 08DEU20F1024

Date : 5/12/2022

DEDICATION

TO MY FAMILY:

Ts. Dr. Sivadev A/L Nadarajah

Pn. Saraswathy A/P Sundaram Muthi

Prenisha A/P Sivadev

Tavisha A/P Sivadev

For all the love, guidance, patience and care

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Pn. Wee Soo Lee

For the idea, support, motivation and guidance

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For their help and moral support

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ABSTRACT

Everyone's lives depend on their fingertips, as is obvious, whether they are used for holding or gripping an object for identification. This recommendation will focus on how the fingertips are used when grabbing or gripping objects that can cause stroke damage. Stroke is the second-leading cause of death in Malaysia, where it claims the lives of about 40,000 individuals each year. When a stroke occurs, the patient may lose their ability to move their face, arm, or leg or become paralysed. One of the many things that might cause a stroke is a blood clot that develops and blocks the flow of blood and oxygen to the brain. Therefore, rehabilitation is required for stroke victims to better their situation, and this product is the sensible one. In order to solve their problems, stroke sufferers need rehabilitation, which is why this product, a smart glove rehab for stroke patients, was created. A force-sensing resistor electrode is used to record the progress, and the findings are displayed on the LCD display. The creation of the smart glove for stroke rehabilitation is a way to assist stroke victims in regaining their use of their hands and fingers by training them with a glove that has force-sensing resistors connected. Patients can see their progress by looking at the LCD display, which shows HIGH, MID, and LOW. This eliminates the need for patients to travel long distances in order to complete their rehabilitation therapy. Since it is portable and has an intuitive design, patients can use it with little to no supervision and carry it wherever they go to perform their rehabilitation exercises.

ABSTRAK

Kehidupan setiap orang bergantung pada hujung jari mereka, seperti yang jelas, sama ada ia digunakan untuk memegang atau mencengkam objek untuk pengenalan. Cadangan ini akan memberi tumpuan kepada cara hujung jari digunakan apabila mencengkam atau mencengkam objek yang boleh menyebabkan kerosakan strok. Strok adalah punca kematian kedua utama di Malaysia, di mana ia meragut nyawa kira-kira 40,000 individu setiap tahun. Apabila strok berlaku, pesakit mungkin kehilangan keupayaan mereka untuk menggerakkan muka, lengan, atau kaki atau menjadi lumpuh. Salah satu daripada banyak perkara yang mungkin menyebabkan strok ialah bekuan darah yang berkembang dan menghalang aliran darah dan oksigen ke otak. Oleh itu, pemulihan diperlukan untuk mangsa strok untuk memperbaiki keadaan mereka, dan produk ini adalah produk yang masuk akal. Bagi menyelesaikan masalah mereka, penghidap strok memerlukan pemulihan, sebab itu produk ini, pemulihan sarung tangan pintar untuk pesakit strok, dicipta. Elektrod perintang pengesan daya digunakan untuk merekod kemajuan, dan penemuan dipaparkan pada paparan LCD. Penciptaan sarung tangan pintar untuk pemulihan strok adalah satu cara untuk membantu mangsa strok mendapatkan semula penggunaan tangan dan jari mereka dengan melatih mereka menggunakan sarung tangan yang mempunyai perintang pengesan daya yang disambungkan. Pesakit boleh melihat kemajuan mereka dengan melihat paparan LCD, yang menunjukkan HIGH, MID, dan LOW. Ini menghapuskan keperluan untuk pesakit melakukan perjalanan jauh untuk menyelesaikan terapi pemulihan mereka. Memandangkan ia mudah alih dan mempunyai reka bentuk intuitif, pesakit boleh menggunakannya dengan sedikit atau tanpa pengawasan dan membawanya ke mana sahaja mereka pergi untuk melakukan latihan pemulihan mereka.

CONTENT PAGE

INTRODUCTION

1.1 Introduction

In a world that is growing rapidly, we are aware that not only our lives are getting busy, but we are more prone to many diseases due to our hectic lifestyle, these diseases include those which is life-threatening and some even takes lives. In this proposal we will focus on stroke which will affect body parts and, in this proposal, specifically the hands and fingertips. A stroke, sometimes called a brain attack, occurs when something blocks blood supply to part of the brain or when a blood vessel in the brain bursts. In either case, parts of the brain become damaged or die. A stroke can cause lasting brain damage, long-term disability, or even death. Stroke can affect the body parts of the patient and in this proposal, we will focus on the hands or more specifically the fingertips of the patient. A person whose hand function has been affected by a stroke can release an object more quickly when the affected arm is supported on a platform, but the support does not make it easier to grip the object, according to a new study. The study also found that active muscle-stretching exercises improved how quickly the stroke survivor could grip an object but made release of the object more difficult. These findings show how a stroke affects hand function and provide a roadmap for rehabilitation. In this study, we will understand on how stroke affects the hands and gripping of object and how a product can help solve this issue. This device is used to allow patients to train their fingers by gripping and object such a rubber ball or a pen or even by just pressing two fingers together (the thumb and the index or middle finger) and the results will be displayed on the LCD display in the form of HIGH, MED or LOW based on the force of gripping. To detect the gripping force, the force sensing resistor is used which are attached to the glove at the index finger and middle finger region. The reason we used the index finger and middle finger is because both of that finger plays the most important role in gripping an object. When the patients grips the object, the LED lights up, indicating the force of gripping produced, this is connected to the LCD too, when the force is low, the LCD displays the word LOW and the led doesn't light up, when the force is medium, the LCD displays the word MID and the led blinks, when the force is high, the LCD displays the word HIGH and the led lights up (no blinking). There are also 2 different coloured LED for each respective force sensing resistors named A1 and A2.

In a way, the patients can carry out their session at home without the need to visit rehabilitation centers which makes it easier for people who have less access to transportation services or for people who wants to do this simple exercise at home and monitor their progress. As we are aware, the covid-19 pandemic has affected everyone's normal lifestyle in the sense of working or studying. Focusing on the working aspect, everyone was encouraged to reduce going out and working from home was implemented, this means working with technologies more than physical working, or in simple words working with computers or laptops that requires a lot of typing. This in a long term might cause pain in their fingers due to a lot of typing, which might make this project to be more useful in a long term, in the future uses. So, we are aware that this project can bring a lot of benefits to the community in short term and long term process.

1.2 Problem Statement

As we know, stroke is a common disease which occurs to elderly people. Stroke is a disease that affects the arteries leading to and within the brain. It is the No. 5 cause of death and one of the leading causes of disability. A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked by a clot or bursts (or ruptures). When that happens, part of the brain cannot get the blood (and oxygen) it needs, so it and brain cells die and causes paralysis. After the stroke treatment, the patient must go for the rehabilitation to exercise their hands and fingers to make it mobile again and this rehabilitation is often expensive and also faraway from home which makes the patient to skip their rehab appointment or not perform well during their appointment because of not practicing using that equipment for quite a long time. The goal of stroke rehabilitation is to help you relearn skills you lost when a stroke affected part of your brain. Stroke rehabilitation can help you regain independence and improve your quality of life. By inventing this glove, the stroke patients can now do their own rehabilitation at home with a cheap price which can be afforded by elderly people and at their comfort at their own home because they don't have to travel to another place which might be far or no access to transportations.

1.3 Objective

- To enable stroke patients to move their fingers and their hands again
- To make the patients able to do their exercise everyday so that they can have speedy recovery
- To make this product easily affordable for the patients
- To make it facilitate the doctors to observe the patient's recovery virtually

1.4 Scope of Project

-elderly people
-people who are affected by stroke
-people who have finger pain due to typing a lot (work from home)

1.5 Importance of Research

The development of this Smart Glove Rehab Device will train the patients or the people using it to practice hand movements without the need to go to a special places such as the hospitals or physiotherapy centers which makes it easier for those people to do it with a low price without needed to go to these kinds of places. The components needed are gloves, force sensing resistor electrode, LCD display, Arduino UNO R329+, rubber ball, rechargeable lithium-ion battery, resistors, powerbank and the Arduino software. The main component in this project is the Arduino which is easily available in the hardware shops or in online shopping platforms. This Arduino can be programmed to our own needs which is to measure the progress of the patients. This product is also shaped like a glove so it can be easily brought to anywhere and it is also easy to be used and the patients just have to wear the glove and start practicing their hand movements anywhere at their comfort of their home.

LITERATURE REVIEW

2.1 Introduction

In addition to the numerous technologies that have been developed because of global modernization, new diseases are also proliferating as a result of human lifestyles. According to the Borgen Project, stroke is one of Malaysia's most prevalent diseases and the country's second-leading cause of death, claiming 40,000 victims annually. Strokes is caused by High blood pressure, high cholesterol, smoking, obesity, and diabetes. However, certain strokes can be treated with the use of medical procedures and rehabilitation. Due to broken connections between the brain and the hand muscles after a stroke, the hands may become more tense or stiff. This condition is known as spasticity. Strong evidence of progress includes full finger extension without help as hands heal. Exercises for rehabilitation that are straightforward and repetitive repair the lost connections between the brain and muscles, correcting the pathways and preventing spasms. To relax, stretch, and strengthen the hand muscles, a course of therapies is frequently recommended. The grip, strength, and overall function of the hands is often additionally impaired, making it difficult to completely lift, grasp, or release items. This makes daily tasks more difficult and could make it harder to engage in functional activities independently. Other problems include numbness, which can occasionally feel like pins and needles, or swelling spells. Whether the neurological damage occurred on the dominant or non-dominant side of the brain can have an impact on the degree of pain and loss of sensation brought on by the stroke.

In this proposal, we'll concentrate on strokes that affect the hands—more specifically, the fingertips—which are used for holding things and going about a patient's everyday activities. As is well knowledge, a person suffering from a stroke cannot go about their everyday activities normally because a stroke results in the paralysis of some bodily parts. and since it would be difficult to entirely rely on someone else, patients would want to live a regular life and engage in normal activities. Rehabilitation helps address this problem. So, this Smart Glove for Stroke Rehab can help the people who have arm paralysis, and their hands has been affected. This project helps the patient to monitor their progress from the LCD display which is the force of gripping in the form of HIGH, MED and LOW reading. The patient is required to only wear the glove with force sensing resistor connected at the index and middle finger of the glove and practice their gripping with their finger and the reading will be obtained and LED lights up based on the force of gripping, which is no light up, blinking lights and lights up based on the force exerted. This enables the patient to easily monitor their progress without needing to visit certain rehabilitation centers for their appointment. This project also has a low cost which enables people to purchase this product and this product is user-friendly as it doesn’t require a lot of fixing and set up and also requires minimal supervision to conduct the exercise.

2.2 History of Smart Glove for Stroke Rehab from researches

The invention discloses a recovery glove for stroke treatment. The recovery glove comprises a glove body, five sensors, electrodes and a control unit, wherein the five sensors are respectively arranged on the five fingers of the glove body and used for detecting the angle change of the proximal interphalangeal joint of each finger; the electrodes are used for applying electrical stimulation to the finger extensor muscle of a stroke arm; and the control unit is used for receiving the angle changes of the proximal interphalangeal joints of the fingers, outputted by the sensors and controlling the electrodes to output electrical stimulation according to the angle change signals. The recovery glove disclosed by the invention is simple in structure, convenient to use, and applies corresponding electrical stimulation to the finger extensor muscle of the paralysis side arm through detecting the angle change of the proximal interphalangeal joints of the paralysis palm of a paralytic, so as to enable the palm of the paralytic to open and realize the purpose of stroke recovery, and the recovery glove is applicable to households.

Another research states that:

A Korean health tech company, Neofect, has created a smart rehabilitation solution for stroke patients who need to learn how to reuse their hands. The glove is designed to induce neural plasticity in the patient through specific and customized exercises with gamification. According to a 2014 study by the World Heart Federation, approximately five million people globally affected by a stroke annually. The same study also notes that for the next 20 years stroke mortality will triple in Latin America, the Middle East and sub-Saharan Africa. Neofect's product, the Rapael Smart Glove is a wearable rehabilitation glove that will help stroke patients regain movement through repeat hand and arm movements in a virtual reality-type setting. The glove has built in sensors that measure the patient's movements as they do rehabilitation exercises and is all connected via an app. Neofect added gamification elements to keep patients engaged and maintain interest in the repetitive rehabilitation exercises. The gamification elements are designed to motivate the patient throughout the rehab process.

2.3 Why Do Survivors Need Specialized Gloves After Stroke?

It's critical to comprehend how a stroke can initially impact hand movement in order to determine which style of stroke recovery glove is appropriate for the patient. A stroke happens when there is a disruption in the blood flow to the brain, which damages the parts of the brain that were not supplied with oxygen-rich blood. The ability of the brain to send messages instructing your muscles to move is interfered with when a stroke affects the parts of the brain involved in movement, such as the motor cortex. As a result, many stroke survivors struggle with muscle weakness after stroke. While weakness may be experienced throughout the body, approximately 70% of stroke survivors experience upper limb and/or hand weakness. Survivors are encouraged to participate in regular therapy to help improve movement after stroke. When therapy is neglected, conditions such as spasticity (tightness in the affected muscles) can progress into severe complications such as contractures (stiff, tight, often painful joints). In fact, when hand spasticity is left unmanaged, contractures can eventually cause the hand to tighten into a fist. This not only limits the ability to use the hand, but can potentially be quite painful as well. Gloves for stroke patients can help prevent the development of this complication, among others. But before any stroke recovery gloves are involved, it is important to understand the process behind recovering hand functions after stroke.

When a stroke impacts the brain’s ability to send signals to move the hand, the brain can work around the damaged area by rewiring itself. This process is known as neuroplasticity, and it allows the brain to create and strengthen new neural pathways. Neuroplasticity is activated through repetition, or massed practice. When you repeat a task on a repetitive and consistent basis, the brain receives this stimulation and responds by strengthening the neural pathways responsible for that task. Therefore, high repetition of hand therapy exercise is one of the best ways to improve hand function after stroke. This helps stimulate the brain, encourage neuroplasticity, and increase function in the affected hand over time.

2.4 Glove recommendations for patients

When your hand is paralysed, extremely weakened or bloated, or clenched with spasticity after a stroke, hand exercises might be challenging. Gloves for stroke sufferers can be useful in this situation.

Gloves are useful rehabilitation equipment that can aid stroke victims in regaining movement and hand function.

Types of Gloves for Stroke Patients

Static Hand Braces

Figure 2.1: Sensor hand braces

For stroke survivors with clenched or motionless hands, static hand braces are excellent. Static braces hold the fingers and palm in a stretched position while opening them up. By preventing the fingers from curling into a fist, this aids in preventing contractures in the finger joints. Static hand braces won't be able to assist you restore use of your injured hand on their own, though. They are useful in avoiding contractures from developing as a result of hand spasticity, but they don't do much to alleviate the spasticity itself. Repetitive hand treatment exercises are necessary to activate neuroplasticity, which will help to recover hand function and lessen stiffness.

Edema Gloves

Figure 2.2: Edema gloves

Sometimes the arm and/or hand swells following a stroke, often due to a lack of movement. An edema glove is a tight-fitting glove that goes over the hand to reduce and prevent swelling. Edema gloves may cover only part of the fingers and wrist, or may fully cover the hand, fingers, and halfway up the forearm. While these gloves also do not directly reduce spasticity or increase hand movement, they can help with redirecting excess fluid build-up to allow the hand to move more freely.

Assistive Gloves

Figure 2.3: Assistive gloves

There are a few types of assistive gloves, including dynamic braces and assistive robotic gloves. Dynamic braces place the fingers in a stretched position, but unlike static braces, have some flexibility to allow the fingers to be able to bend when needed.

Assistive robotic gloves use technology to power movement of the fingers. Both types of assistive gloves promote hand movements, which allows you to use your hand more easily during activities of daily living. This not only helps protect your joints from contractures, but it also encourages small movements which helps provide some stimulation to the brain.

Hand Therapy Exercise Gloves

Figure 2.4: Hand therapy exercise gloves

These gloves contain sensorized fingertips that track your movement while you perform hand therapy exercises. This helps rewire the brain and allows you to restore as much hand function as possible. It works by tracking your hand movements as you follow along to an engaging, music-based therapy game.

This kind of glove produces immersive rehab experience where users are encouraged to make hundreds of repetitive motions in one half hour session. This helps spark neuroplasticity in ways that are unparalleled in other types of gloves for stroke patients.

2.5 Which Stroke Recovery Gloves Help with Spasticity?

When the brain is unable to properly communicate with the affected hand, spasticity develops. As a result, the hand's muscles tighten up to try to defend themselves.

Spasticity-related contractures can be avoided by stretching tense hands, but this does not address the mind-muscle disconnect. Spasticity can only be treated from the inside out by retraining the brain with repetitive hand therapy exercises.

Use various stroke recovery gloves for various purposes if you want to regain as much hand function as you can.

In order to trigger neuroplasticity and address the underlying cause of hand weakness, you can also set aside 30 minutes to sit down and perform your hand therapy exercises after that.

2.6 Choosing the Best Gloves for Stroke Patients

As you shop for stroke recovery gloves, remember that every stroke is different and every survivor will benefit from different recovery tools. A survivor with a clenched hand will likely benefit from a static hand brace while a survivor with moderate spasticity but some residual hand movement can utilize a hand exercise glove like hand therapy exercise glove.

METHODOLOGY

3.1 Introduction

Hardware Products that I used to complete this project is Arduino UNO, Force Sensitive Resistor, LCD display, connecting wires, connectors, resistors, LED and rechargeable lithium-ion batteries. The software I used to complete this project is the Arduino IDE application, Proteus 8 Professional software and Fritzing.

3.2 Modules Requirement

Force Sensing Resistor (FSR)

Figure 3.1: Force Sensing Resistor

A substance known as a force sensitive resistor (FSR) alters its resistance in response to pressure or force. One such material that resists force is conductive film. In other words, a force sensitive resistor is a sensor that can recognise weight, squeezing, and physical pressure. In this project, we attach this component at the fingertips of the glove to measure the force exerted at the fingers of the patient and to obtain the reading.

Light Emitting Diode (LED)

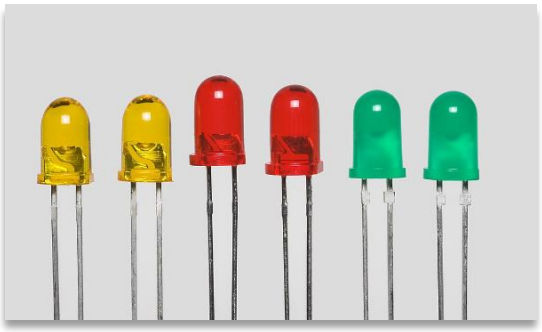


Figure 3.2: Light emitting diode

A light-emitting diode (LED), a semiconductor device, emits light when current flows through it. In this project I connected the LED to the PCB to indicate the gripping force of the patient and also to alert patients and to make sure its easier for the patients to see their progress.

Resistors

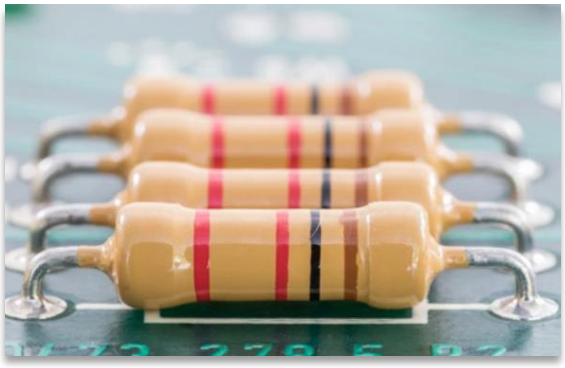


Figure 3.3: Resistors

A resistor is a passive two-terminal electrical component used in circuits to implement electrical resistance. In this project, I used the resistors to reduce the current flow into the circuit to produce a good result.

Connecting Wires, Connectors

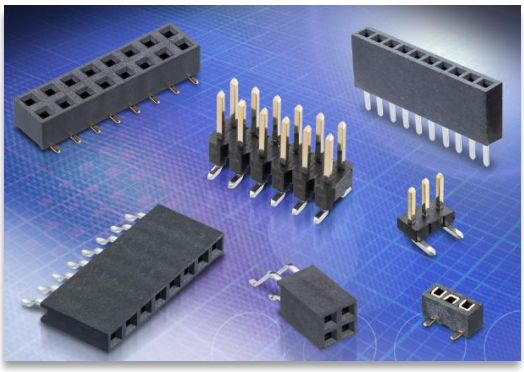


Figure 3.4: Connecting wires and Connectors

Connectors are used to connect certain components to the PCB board whether its directly or indirectly on to the PCB board to the component.

Arduino UNO R329+

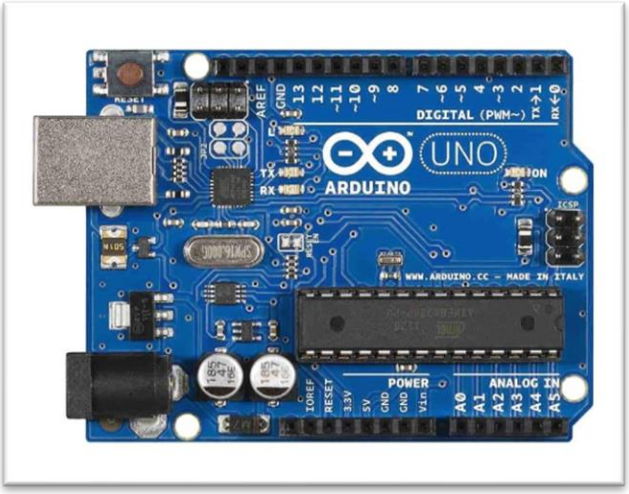


Figure 3.5: Arduino UNO

The open-source Arduino platform is used to create electrical projects. With Arduino, you can write and upload computer code to a physical programmable circuit board (commonly called a

microcontroller) using a piece of software called the IDE (Integrated Development Environment), which runs on your computer.

The Arduino Uno is an open-source microcontroller board created by Arduino.cc that is based on the Microchip ATmega328P microprocessor. Sets of digital and analog input/output (I/O) pins are included on the board, allowing it to be interfaced with other expansion boards (shields) and other circuits. The board contains 6 analog I/O pins and 14 digital I/O pins, six of which can be used for PWM output. It can be programmed using the Arduino IDE (Integrated Development Environment) with a type B USB connector. It accepts voltages between 7 and 20 volts, but it can also be powered by an external 9-volt battery or by a USB cable.

Glove

Figure 3.6: Gloves

A glove is a hand-covering item of clothing. The thumb and each finger typically have their own openings or sheaths on gloves. In this project, I used a cloth glove as its more durable than rubber or plastic gloves and I also used glove with patterns on the palm so that objects can be gripped easier. I also used an elastic glove which can fit all hand sizes perfectly for an optimum result.

LCD Display

Figure 3.7: LCD display

A type of flat panel display known as an LCD (Liquid Crystal Display) operates primarily using liquid crystals. In this project, i used this LCD to display the percentage value of the gripping force. The reason we used lcd is because LCD screen is more energy-efficient and can be disposed of more safely than a CRT can. Furthermore, It has a low electrical power consumption which enables it to be used in battery-powered electronic equipment more efficiently than a CRT.

Rubber ball

Figure 3.8: Rubber balls

This rubber ball is used for gripping and pressing in order to get the reading of the results.

Rechargeable ion batteries

Figure 3.9: Rechargable ion batteries

A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge and back when charging. Li-ion cells use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. In this project I used this lithium ion rechargeable batteries as it is cheap and can be recycled which can save cost and also it is easily available.

3.3 Block Diagram

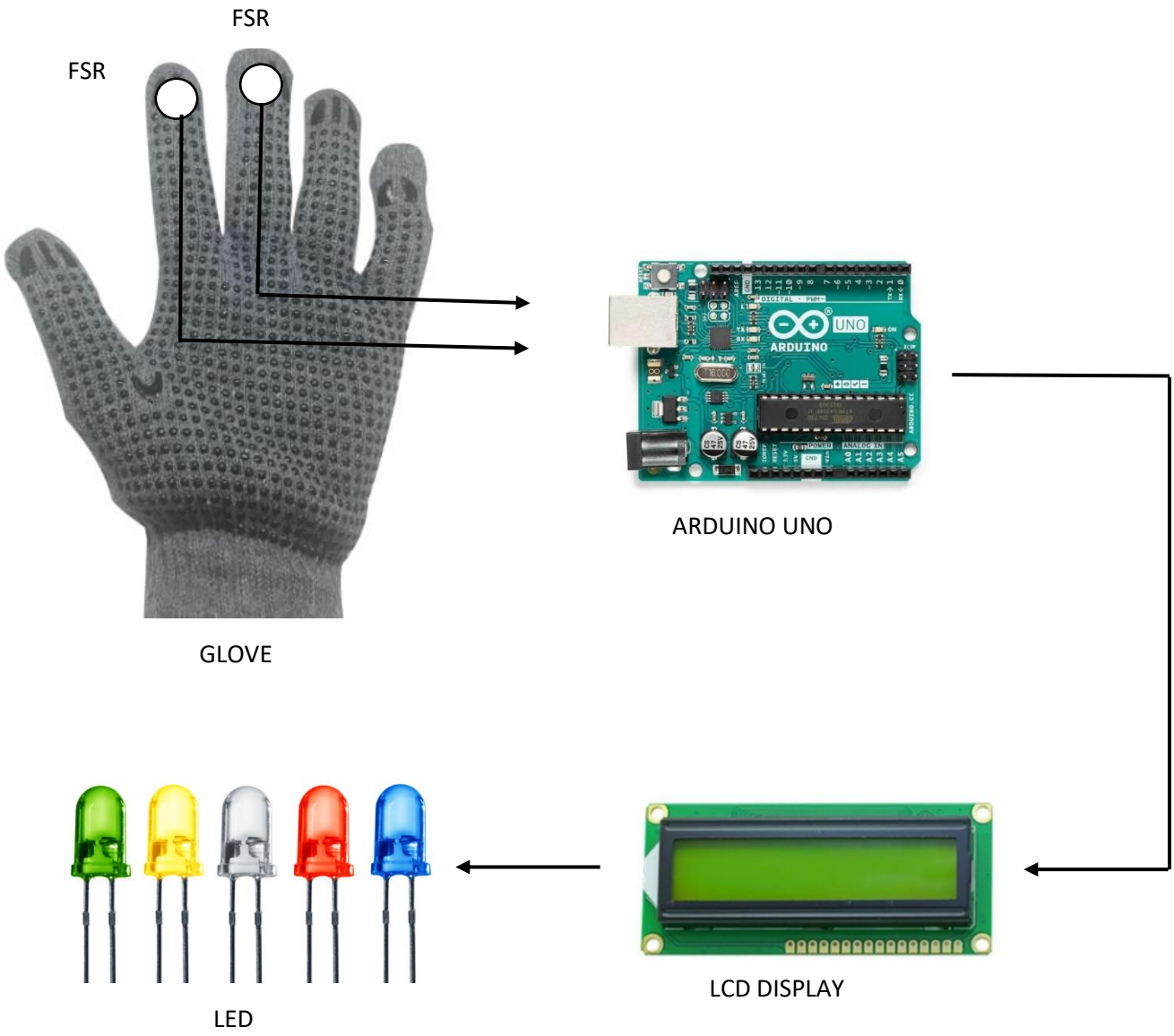


Figure 3.10: Block Diagram

3.4 Flow chart

A flowchart is a diagram which shows the processes individual steps in their proper order. This flow diagram of methodology that has been used in this project is shown below. It consists of Force Sensitive Resistor (FSR) which detects pressure at the fingertips and it is connected to the Arduino. Then a lcd display is connected to the Arduino as the output and reading is displayed on the LCD display in the form of HIGH, MID and LOW.

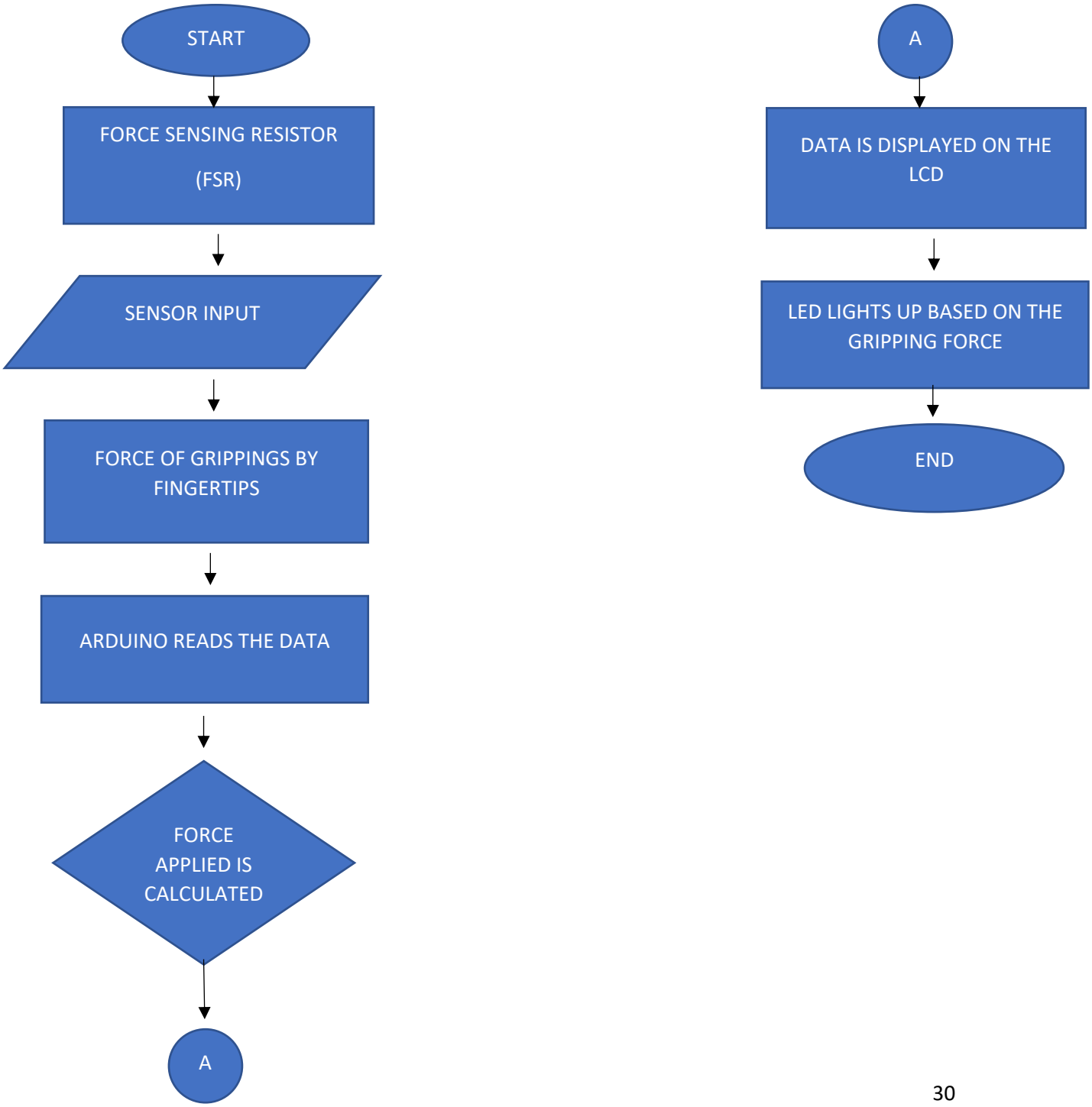


Figure 3.11: Flowchart

3.5 Schematic diagram

Breadboard

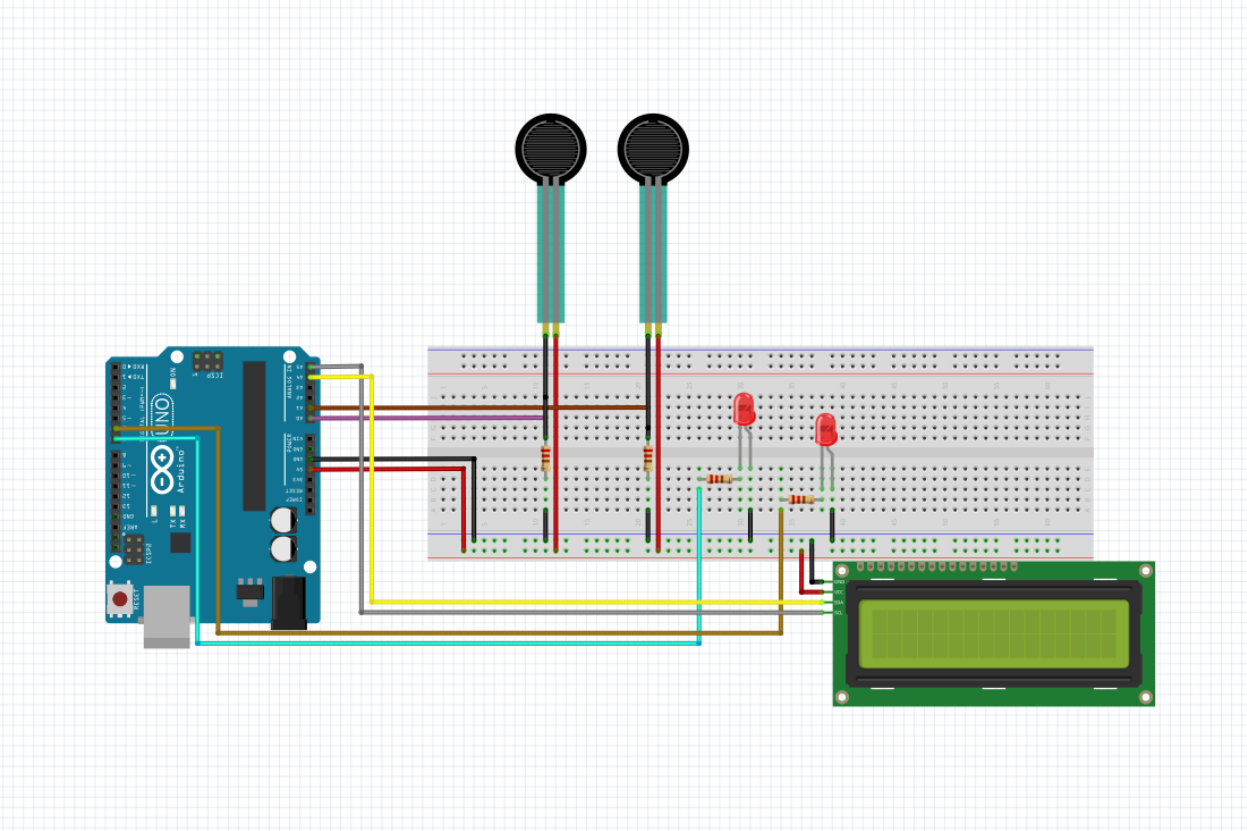


Figure 3.12: Schematic diagram of the circuit in Fritzing

PCB

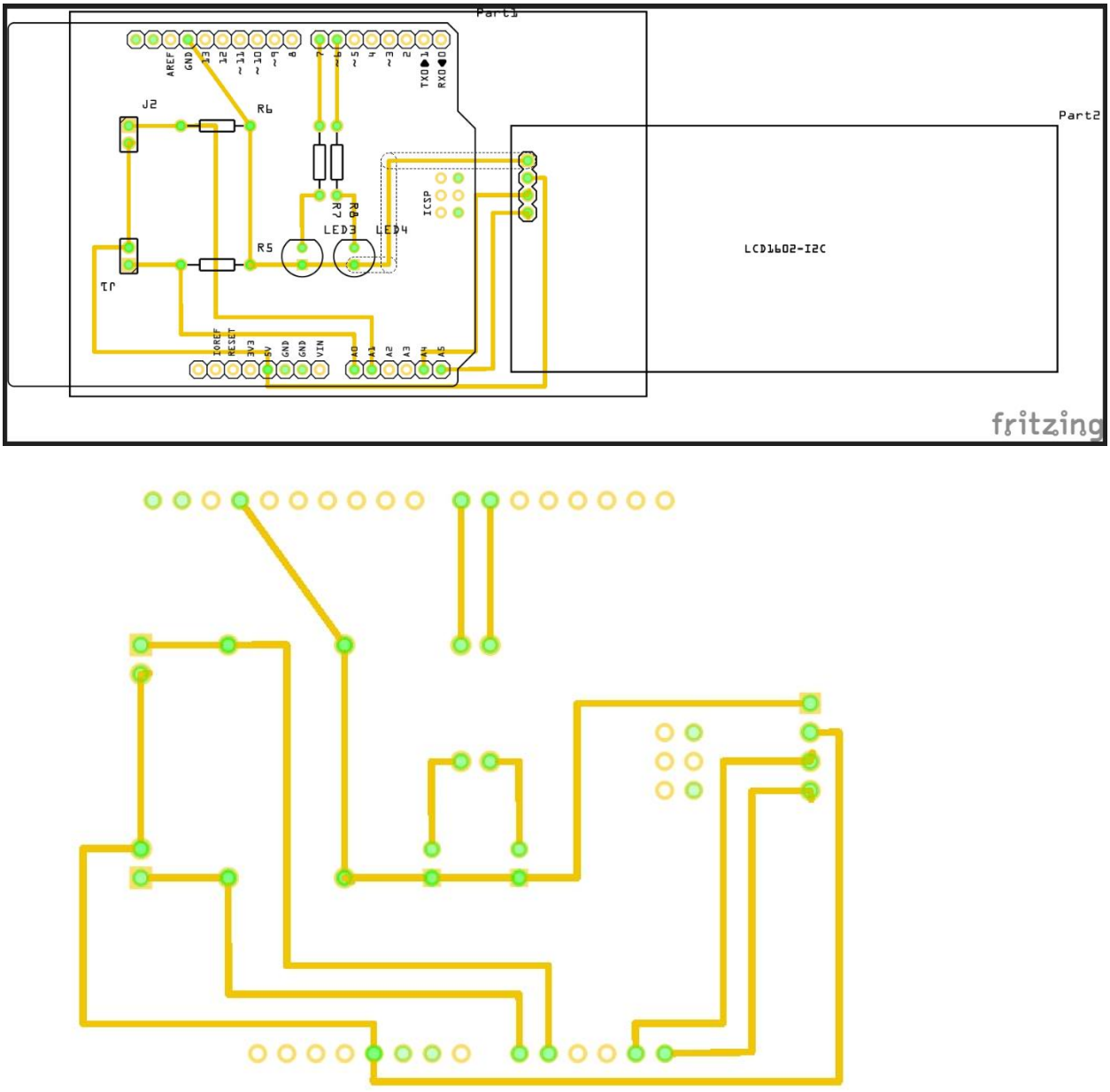


Figure 3.13: PCB diagram of the circuit to be etched

3.6 Connection of circuit in breadboard

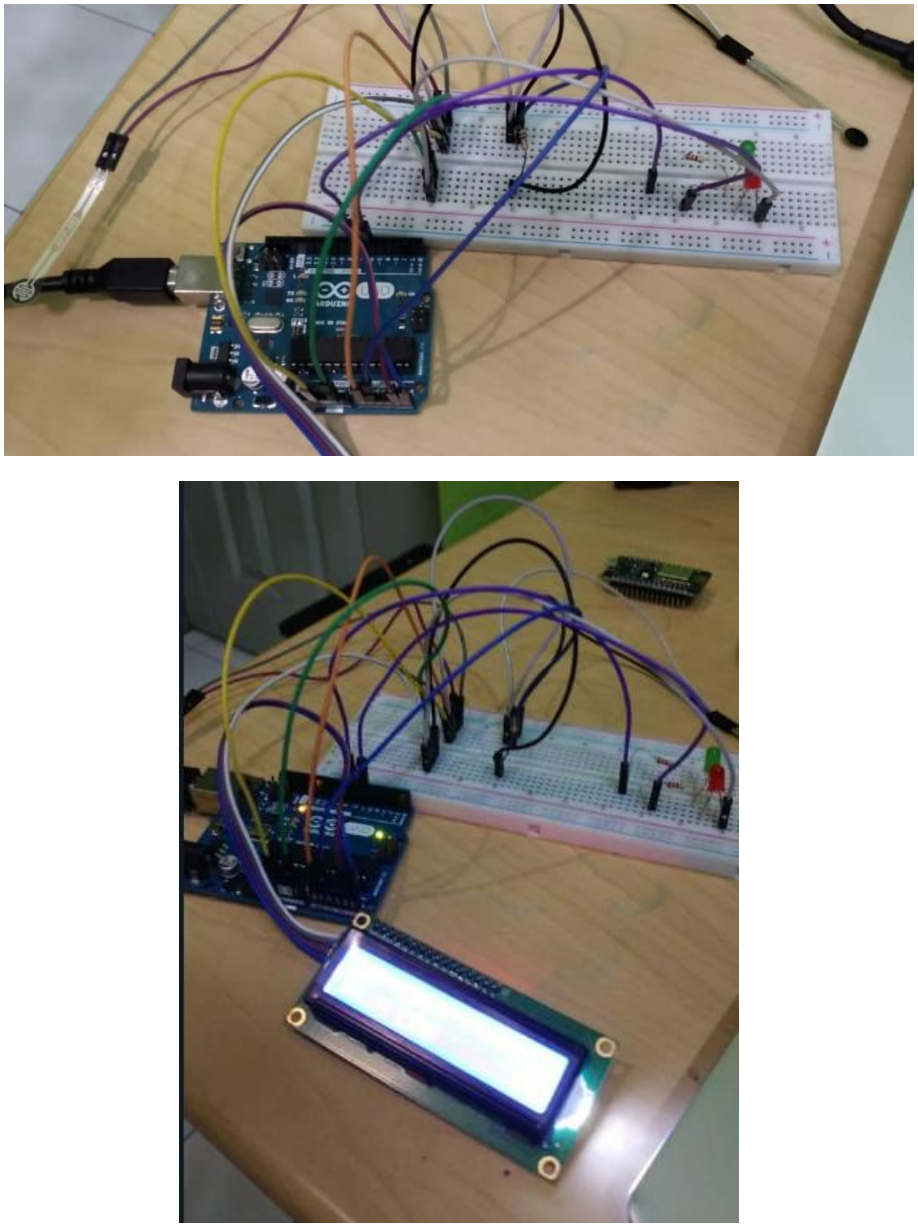


Figure 3.14: Connection of circuit on breadboard

3.7 Etching of PCB

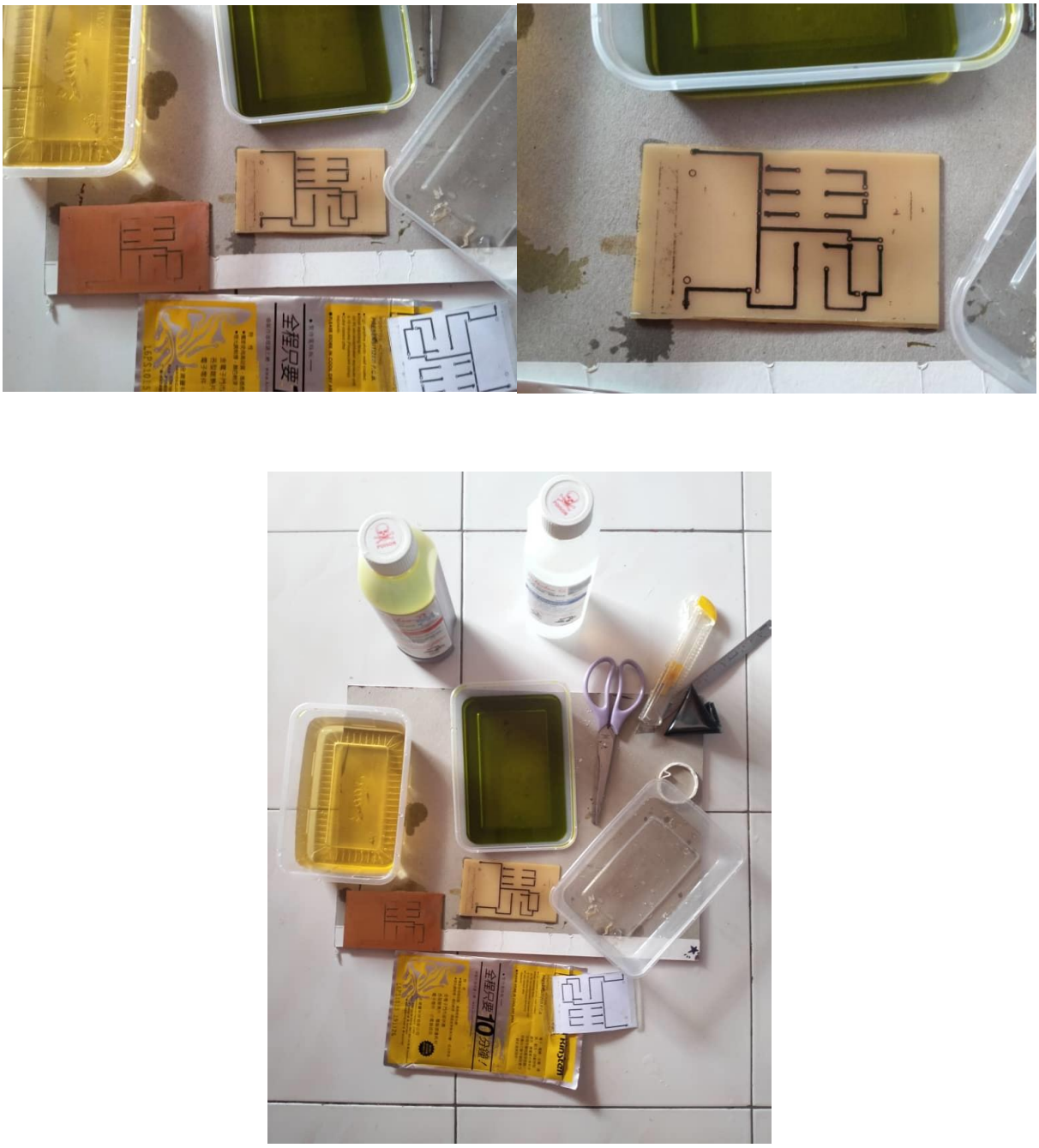


Figure 3.15: Etching of PCB

3.8 Drilling of PCB

Figure 3.16: Drilling of PCB

3.9 Soldering of the PCB

Figure 3.17: Soldering of PCB

3.10 Coding

```
#include <LiquidCrystal_I2C.h>
int fsrPinA0 = 0;     // the FSR and 10K pulldown are connected to a0
int fsrReadingA0;     // the analog reading from the FSR resistor divider
int fsrPinA1 = 1;     // the FSR and 10K pulldown are connected to a0
int fsrReadingA1;     // the analog reading from the FSR resistor divider
String valueA0;
String valueA1;

LiquidCrystal_I2C lcd(0x27,20, 4);  // set the LCD address to 0x3F for a 16 chars and
2 line display

void setup()
{
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);

  lcd.init();
  lcd.clear();
  lcd.backlight();      // Make sure backlight is on

  // Print a message on both lines of the LCD.
  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
  lcd.print("SMART GLOVE");

  lcd.setCursor(4,1);   //Move cursor to character 2 on line 1
  lcd.print("STROKE REHAB");
{
  Serial.begin(9600);
}
  delay(1000);
}
```

```
void loop()
{
  lcd.clear();
  //delay(5000); // keep LCD empty in 5 second
  fsrReadingA0 = analogRead(fsrPinA0);
  fsrReadingA1 = analogRead(fsrPinA1);

  Serial.print("Analog reading A0 = ");
  Serial.print(fsrReadingA0);     // print the raw analog reading

  if (fsrReadingA0 < 5)
  {
    Serial.println(" - Low pressure");
    valueA0="A0 = LOW";
    digitalWrite(5, LOW);
  }
  else if (fsrReadingA0 < 15)
  {
    Serial.println(" - Medium Pressure");
    valueA0="A0 = MID";
    digitalWrite(5, HIGH);
    delay(200);
    digitalWrite(5, LOW);
 }
  else
  {
    Serial.println(" - High Pressure");
    valueA0="A0 = HIGH";
    digitalWrite(5, HIGH);
  }

  Serial.print("Analog reading A1 = ");
```

```
  Serial.print(fsrReadingA1);     // print the raw analog reading
  if (fsrReadingA1 < 5)
  {
    Serial.println(" - Low pressure");
    valueA1="A1 = LOW";
    digitalWrite(6, LOW);
  }
  else if (fsrReadingA1 < 15)
  {
    Serial.println(" - Medium Pressure");
    valueA1="A1 = MID";
    digitalWrite(6, HIGH);
        delay(200);
    digitalWrite(6, LOW);
  }
  else
  {
    Serial.println(" - High Pressure");
    valueA1="A1 = HIGH";
    digitalWrite(6, HIGH);
  }

  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
  lcd.print(valueA0);

  lcd.setCursor(0,1);   //Move cursor to character 2 on line 1
  lcd.print(valueA1);


  delay(1000);

}
```

CODING_FINALISE

```
#include <LiquidCrystal_I2C.h>
int fsrPinA0 = 0;     // the FSR and 10K pulldown are connected to a0
int fsrReadingA0;     // the analog reading from the FSR resistor divider
int fsrPinA1 = 1;     // the FSR and 10K pulldown are connected to a0
int fsrReadingA1;     // the analog reading from the FSR resistor divider
String valueA0;
String valueA1;

LiquidCrystal_I2C lcd(0x27,20, 4);  // set the LCD address to 0x3F for a 16 chars and 2 line display

void setup()
{
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);

  lcd.init();
  lcd.clear();
  lcd.backlight();      // Make sure backlight is on

  // Print a message on both lines of the LCD.
  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
  lcd.print("SMART GLOVE");

  lcd.setCursor(4,1);   //Move cursor to character 2 on line 1
  lcd.print("STROKE REHAB");
{
  Serial.begin(9600);
}
  delay(1000);
}


void loop()
{
  lcd.clear();
  //delay(5000); // keep LCD empty in 5 second
  fsrReadingA0 = analogRead(fsrPinA0);
  fsrReadingA1 = analogRead(fsrPinA1);

  Serial.print("Analog reading A0 = ");
  Serial.print(fsrReadingA0);     // print the raw analog reading
```

```
  if (fsrReadingA0 < 5)
  {
    Serial.println(" - Low pressure");
    valueA0="A0 = LOW";
    digitalWrite(5, LOW);
  }
  else if (fsrReadingA0 < 15)
  {
    Serial.println(" - Medium Pressure");
    valueA0="A0 = MID";
    digitalWrite(5, HIGH);
    delay(200);
    digitalWrite(5, LOW);
 }
  else
  {
    Serial.println(" - High Pressure");
    valueA0="A0 = HIGH";
    digitalWrite(5, HIGH);
  }

  Serial.print("Analog reading A1 = ");
  Serial.print(fsrReadingA1);     // print the raw analog reading
  if (fsrReadingA1 < 5)
  {
    Serial.println(" - Low pressure");
    valueA1="A1 = LOW";
    digitalWrite(6, LOW);
  }
  else if (fsrReadingA1 < 15)
  {
    Serial.println(" - Medium Pressure");
    valueA1="A1 = MID";
    digitalWrite(6, HIGH);
        delay(200);
    digitalWrite(6, LOW);
  }
  else
  {
    Serial.println(" - High Pressure");

    valueA1="A1 = HIGH";
    digitalWrite(6, HIGH);
  }

  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
  lcd.print(valueA0);

  lcd.setCursor(0,1);   //Move cursor to character 2 on line 1
  lcd.print(valueA1);


  delay(1000);

}
```

Figure 3.18: Diagram of coding in the arduino application

RESULTS, ANALYSIS & DISCUSSION

4.1 Introduction

The project's results and discussion will be covered in this chapter. This section also discusses how patients and medical experts evaluate this product. This will guarantee that the scope and objectives of the research are met. Every bit of data had been examined to guarantee the project's success.

4.2 Result and Discussion

As it is obvious that practise makes perfect, this project was created to enable stroke patients to carry out their rehabilitation exercises for quick recovery. When a patient performs this exercise frequently, they can quickly rebuild their motor abilities in their hands and fingers. Additionally, this product is created at a reasonable cost, making it simpler for everyone to possess it without worrying about a high price. People of all ages can use this device because it is simple to use and just needs little adult supervision. According to doctors and some patients, this product is helpful and can assist people with hand spasticity get better. I think this product could potentially have a positive effect on the medical market.

4.3 Analysis from the Project

Overall, this project was simple to construct, although there were a few challenging steps, particularly the coding and component soldering. I used Google and a few youtube videos to help me learn how to carry out those tasks correctly. It had aided in my ability to comprehend more and generate quality work. This project had its ups and downs, but I was able to finish it thanks to my supervisor, my friends, and my family, who were always there for me.

4.4 Project Design

This project design is made to be compact and portable to allow the patient to carry around this product and conduct their exercises anywhere. This project has a LCD display and LED lights which enables two-way view of result by the patient, where they can view the result by the LCD display or by the lighting up of the LED lights.

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the smart glove for stroke rehabilitation has been successfully developed. This device has a lot of benefits, and new developments in this system may have a significant impact on the medical industry. Patients may perform their exercises anywhere, resulting in a quick recovery and achieving the main goal of helping stroke patients restore their motor abilities, particularly in their hands and fingers because having spastic muscles in the hands may make it difficult to carry out basic everyday tasks.

This product's design is also intended to be portable and compact so that patients can use it wherever they are to exercise. This gadget only needs a powerbank or can be utilised with readily available batteries rather than large power supplies. And as a result, patients can be used easily with little supervision. Additionally, it offers an easy viewing area so that patients can see view their results on the LCD or LED display.

Last but not least, this product could have a significant impact on the medical sector because it is created at a reasonable cost, making it accessible to everyone, unlike the majority of stroke rehabilitation gloves now on the market, which are quite expensive and out of reach for most people.

5.2 Recommendation

In order to commercialize this device to the public usage, some improvement and recommendation need to be considered. Therefore, some improvement could be added such as

- Allowing the users to change the settings for easier usage (edit the coding to an easier level of force based on patients requirements)
- Using a flex sensor instead of the force sensing resistor as the flex sensor could sense the angle of flexing but the force sensing resistor only senses the pressure at the tip of the fingers
- Placing the sensors at all fingers of the glove
- Add IoT using the NodeMcu so that the doctors or far family members could keep a record of the progress.

REFERENCE

1) Henry Hoffman (2017), *Guide To Recovering Hand Function After A Stroke*, Saebo
2) Stroke Foundation ABN (2022), *Arm and Hand Function*, VERSA
3) American Physiological Society (2009), *How A Stroke Affects Hand Function; Roadmap For Rehabilitation*, ScienceDaily
4) Tan K.S., Venketasubramanian N. (2022), *Stroke Burden in Malaysia*, Karger
5) Mikaela Frigillana (2017), *The Top Diseases In Malaysia*, The Borgen Project
6) Camille E. Proulx (2020), *Review of the effects of soft robotic gloves for activity-based rehabilitation in individuals with reduced hand function and manual dexterity following a neurological event*, Université de Montréal, Journal of Rehabilitation and Assistive Technologies Engineering
7) Cătălina Luca; Doru Andriţoi; Călin Corciovă; Robert Fuior (2020), *Intelligent Glove for Rehabilitation of Hand Movement in Stroke Survivor*, IEEE, Iasi, Romania
8) Mir Muneeb Ullah; Uzair Hafeez; M. Naeem Shehzad; M. Naeem Awais; Haroon Elahi (2020), *A Soft Robotic Glove for Assistance and Rehabilitation of Stroke Affected Patients*, IEEE, Islamabad, Pakistan
9) Sergiu Hartopanu, Serea Florin, Marian Silviu Poboroniuc, G.Livint (2014), *Towards human arm rehabilitation in stroke patients by means of a hybrid FES&robotic glove*, ResearchGate
10) David Dunmur (2015), *liquid crystal display*, Britannica
11) Muhammad Shoaib, Ehsan Asadi, Joono Cheong, Alireza Bab-Hadiashar, *"Cable Driven Rehabilitation Robots: Comparison of Applications and Control Strategies"*, IEEE Access, vol.9, pp.110396-110420, 2021.
12) *Arduino Uno* (2022), Wikipedia
13) *Arduino* (2022), Wikipedia
14) Chris Perabo (2016), *How do force sensitive resistor (FSR) sensor work?*, CapLinq Blog
15) Prior, H. (2022), *Causes of Stroke*, NHS
16) Wachirayongyot Thimabut, Pim Terachinda, Wasuwat Kitisomprayoonkul (2022 april 25), *Effectiveness of a soft robotic glove to assist hand function in stroke patients: a cross-sectional pilot study*, National Library of Medicine(NIH)
17) Elizabeth Denslow (26 May 2022), *Gloves for Stroke Patients: How to Choose the Best fit for you*, FlintRehab
18) Nicoleta Bugnariu, Rita Patterson, Timothy Niacaris (2022), *Robotic Gloves may help rehab stroke patients*, hsc
19) *Neofect Smart Glove* (2022), neofect
20) Jennifer Kite-Powell (Nov 8, 2015), *This Smart Glove Speeds Rehabilitation of Stroke Patients*, Forbes

APPENDIX

Bill of Materials

No.	Items	Amount	Cost	Total cost
1.	Arduino UNO R329+	1	RM 34.50	RM 34.50
2.	Force Sensing Resistor Electrode	2	RM 23.90	RM 47.80
3.	LCD Display	1	RM 12.90	RM 12.90
4.	Rechargable Lithium Ion Battery	3	RM 8.00	RM 24.00
5.	LED	2	RM 0.50	RM 1.00
6.	Connecting wires (M to F/ F to F/ M to M)	3	RM 4.50	RM 13.50
7.	PCB connectors	5	RM 2.00	RM 10.00
8.	Cloth gloves	1	RM 2.12	RM 2.12
9.	Rubber ball	1	RM 2.12	RM 2.12
10.	Resistors	5	RM 0.30	RM 1.50
11.	Acrylic sheet	2	RM 16.90	RM 16.90
12.	Hot glue gun, refill	1	RM 10.00	RM 10.00
13.	Battery holder	1	RM 7.80	RM 7.80

Total costage: RM 184.14

Survey form

POLITEKNIK MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH

SURVEY FORM

QUESTIONNAIRE ABOUT "SMART GLOVE FOR STROKE REHABILITATION"

This smart glove is used for rehabilitation and physiotherapy. It is created to help people with stroke to regain their hand movement skills, in detail their finger movement skills such as holding a pen or gripping an object. The aim for this product is to help patients to conduct their rehabilitation wherever they are, at home or at clinics and rehabilitation centre.

The objective for this questionnaire is to collect feedbacks about the effectiveness of this smart glove for stroke rehabilitation in helping stroke patients to regain their motor skills. Your cooperation is appreciated and thank you for your time.

For each question, please tick (/) based on your opinion.

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

NO.	QUESTIONS	1	2	3	4	5
1.	Do u agree that this smart glove for stroke rehabilitation is easy to be used?					
2.	Do u think this smart glove for stroke rehabilitation can help patients to recover and regain their motor skills?					
3.	Do u agree that this smart glove for stroke rehabilitation can allow patients to do their rehabilitation therapy without the need to go to rehabilitation centers, or can be done independently?					
4.	Overall, are u satisfied with this smart glove in helping patients to conduct their rehabilitation therapy anywhere?					
5.	Is this product, the smart glove for rehabilitation suitable to be commercialized?					

Comment/ suggestions/ opinions:

Name:

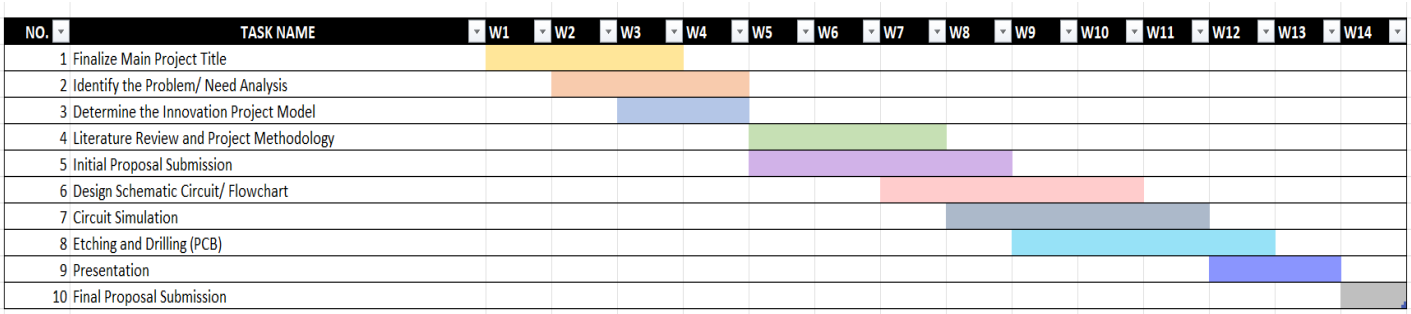
Position:

Occupation:

Official stamp:

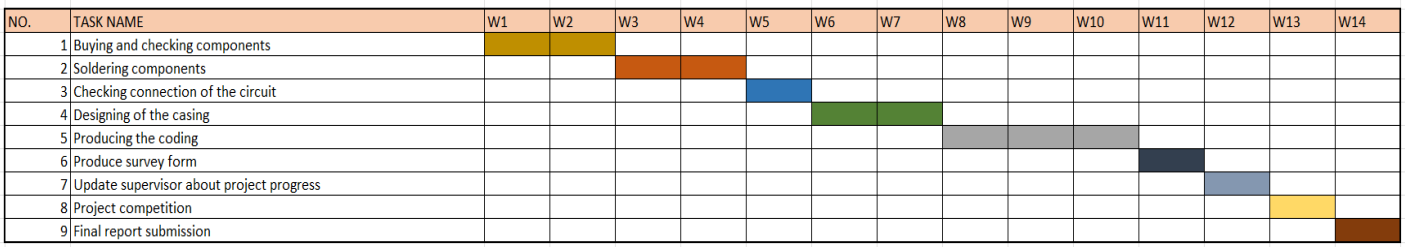
-THANKYOU!

Gantt chart (Project 1)



NO.	TASK NAME	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Finalize Main Project Title														
2	Identify the Problem/ Need Analysis														
3	Determine the Innovation Project Model														
4	Literature Review and Project Methodology														
5	Initial Proposal Submission														
6	Design Schematic Circuit/ Flowchart														
7	Circuit Simulation														
8	Etching and Drilling (PCB)														
9	Presentation														
10	Final Proposal Submission														

Gantt chart (project 2)



NO.	TASK NAME	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Buying and checking components														
2	Soldering components														
3	Checking connection of the circuit														
4	Designing of the casing														
5	Producing the coding														
6	Produce survey form														
7	Update supervisor about project progress														
8	Project competition														
9	Final report submission														

Brochure for usage of this product