REPORT PROJECT

TITTLE OF PROJECT :

THE HARDWARE PART OF A GLOVE FINGER REHABILITATION BY USING ARDUINO

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GLOVE FINGER REHABILITATION

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This Report is Submitted In Partial Fulfillment Of The Requirements for Diploma Electronic Engineering (Medical)

Jabatan Kejuteraan Elektrik

Politeknik Sultan Salahuddin Abdul Aziz Shah

JUNE 2019

ENDORSEMENT

This report is submitted to the Department of Electrical Engineering as a partial fulfillment of the requirements for the Diploma in Electrical Engineering. The members of the supervisory committee are as follow:

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ACKNOWLEDGEMENT

In the name of the most loving and loving God, Salawat and greetings to the Prophet Muhammad Ibn Abdullah, his holy family member and his chosen companions. Alhamdulillah, we express our gratitude to God for His authorization, mercy and guidance enable us to complete the full report on this project.

We would like to give our sincere thanks and appreciation to our supervisor :

- Madam Mariana Binti Rosli

-Madam Emy Satira Azrin Binti Mohamed Hakke

-Madam Nur Ayuni Binti Ahmad

-Madam Nur Syafiqah Binti Abdullah

whose encouragement, guidance and support from initial to final level enabled us to develop an understanding of this project.

Lastly, we offer our regard and blessing to all of those who supported us in any respect during the completion of the project.

ABSTRACT

Stroke is one of the top five diseases in Malaysia contributing to major morbidity and mortality not only in Malaysia but in the whole world. Severe stroke can lead to death while the stroke survivors will face weakness, spasticity and decrease in proprioceptive sensation depending on the affected part of the brain. The cost of **rehabilitation** session as well as the restriction in mobility demotivates the patient to undergo rehabilitation therapy in occupational therapy. This device has been **developed** for patient to do a daily treatment without frequent assistance from therapist. The patient would practice grasp and release concept of their finger mobility in a self-help manner. The device also could measure how much percent of the finger of patient can be bent. This glove-like device uses the application of **Arduino**, **flex sensor** and **servo motor** mechanical as a main component and has been identified as the most suitable concept for this project. This device also applying a **green technology concept** which is related with the **environment**. The design were created to suit perfectly with patient's wrist and finger. Quantitative analysis was conducted to acquire public opinion on the prototype produced. Strongly, all of them agreed on this concept although a lot of improvement needs to be done regarding the design of the prototype.

Keywords: ***Stroke, Rehabilitation, Arduino, Flex Sensor, Servo Motor, Green technology concept, environment.***

ABSTRACT

Stroke adalah salah satu daripada lima penyakit utama di Malaysia yang menyumbang kepada morbiditi dan mortaliti utama bukan sahaja di Malaysia tetapi di seluruh dunia. Strok yang teruk boleh membawa kepada kematian manakala mangsa strok yang selamat akan menghadapi kelemahan, spastik dan penurunan sensasi proprioceptive bergantung kepada bahagian otak yang terjejas. Kos sesi **pemulihan** serta sekatan dalam mobiliti merendahkan pesakit untuk menjalani terapi pemulihan dalam terapi pekerjaan. Peranti ini telah dibangunkan untuk pesakit untuk melakukan rawatan harian tanpa bantuan terapi yang kerap. Pesakit akan mengamalkan genggaman dan melepaskan konsep mobiliti jari mereka dengan cara membantu diri sendiri. Peranti ini juga boleh mengukur berapa peratus jari pesakit boleh dibengkokkan. Peranti ini menggunakan aplikasi **Arduino**, **sensor flex** dan **motor** mekanikal **servo** sebagai komponen utama dan telah dikenal pasti sebagai konsep yang paling sesuai untuk projek ini. Peranti ini juga menggunakan **konsep teknologi hijau** yang berkaitan dengan **alam sekitar**. Reka bentuk diciptakan sesuai dengan sempurna dengan pergelangan tangan dan jari pesakit. Analisis kuantitatif telah dijalankan untuk memperoleh pendapat umum mengenai prototaip yang dihasilkan. Sangat, mereka semua bersetuju dengan konsep ini walaupun banyak peningkatan perlu dilakukan mengenai reka bentuk prototaip.

Kata kunci: ***Strok, Pemulihan, Arduino, Sensor Flex, Servo Motor, Konsep teknologi hijau, persekitaran***.

CHAPTER 1 : Introduction

Stroke is the third largest cause of death in Malaysia. Only heart disease and cancer cope. It is considered the main cause of severe disability, and every year, an estimated 40,000 Malaysians suffer a stroke . Preventing a stroke from happening is comparable to preventing cancer from developing; unattainable. Insufficient blood flow to the brain can occur at any age, causing brain cell damage which leads to memory loss, loss of vision and impaired mobility dependent upon which side of the brain is affected. Physical therapy is vital to recovery and current rehabilitation products such as our glove hand treatment, is in need of much improvement. Stroke victims have greatly increased in recent years and the technology has remained dormant. The existing design lacks proper function and accessibility for individuals who have become paralysed due to a stroke. A new modified design is imperative to actually aiding these people. The design will focus on the patient their input will be essential to designing a new product that will be of benefit to regaining muscle function in their hand

Stroke have 3 categories which are transient ischemic Attacks, ischemic stroke and haemorrhage stroke. This three categories of stroke affecting in patient arm. Haemorrhage stroke is very dangerous stroke. It can cause die. While the transient ischemic attacks and ischemic stroke can be treat

My group decide to create glove for rehabilitation patient after stroke, we name as Glove Finger Rehabilitation. Glove finger rehabilitation is a glove that will be a therapy equipment at patient’s finger. We build this glove to help patient to grip and release their hand using control with servo motor. Not only that, the glove also to facilate to measure their finger bent level. For our final project, we create and focus our Glove Finger Rehabilitation by using green term. We focus low cost therapy equipment which we decide to use a recycle thing such as box. Arduino is the main board in this project.

1.1 Background project

The Arduino is a controller board which allows user to record data flex sensor and servo motor movement and playback it back exactly without writing source code to it. With this one unit of this controller board, we can operate up to 5 servo motors at a time or simultaneously.

Servos are small but powerful motors that can be used in a multitude of products ranging from toy helicopters to robots. A servo consists of three basic parts: an electric motor, a feedback potentiometer that connects to the output shaft, and a controller. This allows the servo to rotate to specific angles by keeping track of its current angular position. The servo is controlled via Pulse-Width Modulation, or PWM.

The motor aligns the shaft to a specific angle depending on the duty cycle of the signal that is sent. The ability to rotate to a certain position rather than at a certain speed makes servos very useful in prosthetic devices by making very precise movements through the elimination of the time variable. Normal DC motors require running the motor for a given amount of time at a certain speed to derive a distance; servos can directly choose a position.

1.2 Problem statement

Nowadays, patients who are suffered from stroke diseases always have issues or difficulties in starting their own rehabilitation or recovery especially by the guided of physiotherapy specialised or even home physiotherapy by their own. This problem will absolutely effect their own health to the point where they no longer can be cured.

One of the top excuses or problems that have been state by most of the patients are their guardian didn't have enough time to give a full commitment in every appointment that they have to attend at the hospital. Besides, the certain robotic devices has been developed especially for shoulder, elbow,wrist and finger rehabilitation. However, devices for finger rehabilitation are still limited till this day.The patient also does know about the health status of their finger.

Nowadays, the patients had a little awareness on how effectively the rehabilitation by using the technology. Furthermore, the patients also have financial problem to afford physiotherapy session that absolutely will cost them a number of money and also always tired during therapy session.

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1.3 Objective

1) To develop for Glove Finger Rehabilitation Controller by using Arduino.
2) It is designed to help all people stroke to recover finger or wrist after stroke using grasp and release concept og their finger mobility in a self-help manner.
3) It will be easier to monitor the patient for the doctor by showing the data of bent level.
4) To facilate the patient to measure their bent level at home

1.4 Scope of project.

- For adult and children

- Traumatic condition

- For patient who got stroke especially the stroke that involve arm and more specific the area from wrist to finger of the patient

1.5 Background study

A stroke or “brain attack” occurs when a blood clot blocks the blood flow in a vessel or artery or when a blood vessel breaks. There are two types of “brain attacks” — ischemic and hemorrhagic. When brain cells die during a stroke, abilities controlled by that area of the brain are lost. These abilities include speech, movement and memory. How a stroke patient is affected depends on where the stroke occurs in the brain and how much the brain is damaged.

With **ischemic** strokes, a blood clot blocks or “plugs” a blood vessel in the brain. Limited treatments are tPA “clot buster” or surgical removal of the clot within a 2-3h time-window (and sometimes up to 6h).

- An estimated 7,000,000 Americans 20 years of age have had a stroke. Overall stroke prevalence during this period is an estimated 3.0%.
- The prevalence of silent cerebral infarction between 55 and 64 years of age is ~11%. This prevalence increases to 22% between 65 and 69 years of age, 28% between 70 and 74 years of age, 32% between 75 and 79 years of age, 40% between 80 and 85 years of age, and 43% at 85 years of age. Application of these rates to 1998 US population estimates results in an estimated 13 million people with prevalent silent stroke every year.
- Silent stroke may be important in the development of AD since cerebral perfusion isoften found to be reduced in association with an increased oxygen extraction fraction during an attack, a hemodynamic presentation typically found in AD patients.

With **hemorrhagic** strokes, a blood vessel in the brain breaks or ruptures.The occurrence rate of ischemic stroke is ~83% and for hemorrhagic it is ~17%.

- Among people 45 to 64 years of age, approximately 8% to 12% of ischemic strokes and 37% to 38% of hemorrhagic strokes result in death within 30 days.
- In a study of people 65 years of age recruited from a random sample of Health Care Financing Administration Medicare Part B eligibility lists in four US communities, the 1-month case fatality rate was 12.6% for all strokes, 8.1% for ischemic strokes, and 44.6% for hemorrhagic strokes.
- Approximately half of incident childhood strokes are hemorrhagic. Despite current treatment, 1 of 10 children with ischemic or hemorrhagic stroke will have a recurrence within 5 years.

1.6 Rational project

The first rational for this project is to give the patient a physiotherapy. There is good evidence that organised stroke care given by a co-ordinated specialist team reduces disability and rates of institutionalisation. Within the overall package of stroke unit care, there is a growing evidence base for individual components. There is now evidence from RCTs supporting the use of physiotherapy, occupational therapy and family support for carers.

The second rationale is to give patient to make the patients practice grasp and release concept of their finger mobility in a self-help manner.Patient can having daily treatment without frequent assistance from therapist.

1.7 The important and Impact of Project

This project has an importance in terms of improvements in excess waste disposal. Besides that this project is also important for the manufacture of a faster and easier to use.

- Use a green technology concept and clinical field
- Easy to control.
- Easy to use at home also at hospital

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

Literature review is a type of study which has been done in process designing in project. This chapter include the study of different types of stroke and the type of Rehabilitation Therapy and Exercise for Finger Disability. It also find out most suitable design circuit to use in this project. It shown about the component that been used in this Glove Finger Rehabilitation.

2.2 Stroke

Stroke is a medical emergency. Strokes happen when blood flow to your brain stops. Within minutes, brain cells begin to die. There are two kinds of stroke. The more common kind, called ischemic stroke, is caused by a blood clot that blocks or plugs a blood vessel in the brain. The other kind, called haemorrhagic stroke, is caused by a blood vessel that breaks and bleeds into the brain. "Mini-strokes" or transient ischemic attacks (TIAs), occur when the blood supply to the brain is briefly interrupted.

Physical effects on either side of the brain. Stroke usually affects one side of the brain. Movement and sensation for one side of the body is controlled by the opposite side of the brain. This means that if your stroke affected the left side of your brain, you will have problems with the right side of your body. If your stroke affected the right side of your brain, you will have problems with the left side of your body . Stroke patients suffer with varies condition depends on the part of the brain damage. The stroke will be effect on the half side (unilateral) and opposite of body depending on which part of the brain damage.

The Symptoms of stroke are patient sudden numbness or weakness of the face, arm or leg especially on one side of the body. After that, patient sudden confusion, trouble speaking or understanding speech. Next, patient sudden trouble seeing in one or both eyes. Then, patient will sudden trouble walking, dizziness, loss of balance or coordination. Lastly, patient sudden severe headache with no known cause

2.3 Symptom of Stroke (Brain)

When this happens, the brain does not get enough oxygen or nutrients which causes brain cells to die. Strokes occur due to problems with the blood supply to the brain; either the blood supply is blocked or a blood vessel within the brain ruptures

2.4 Three main kinds of stroke:

1. **Ischemic Stroke**

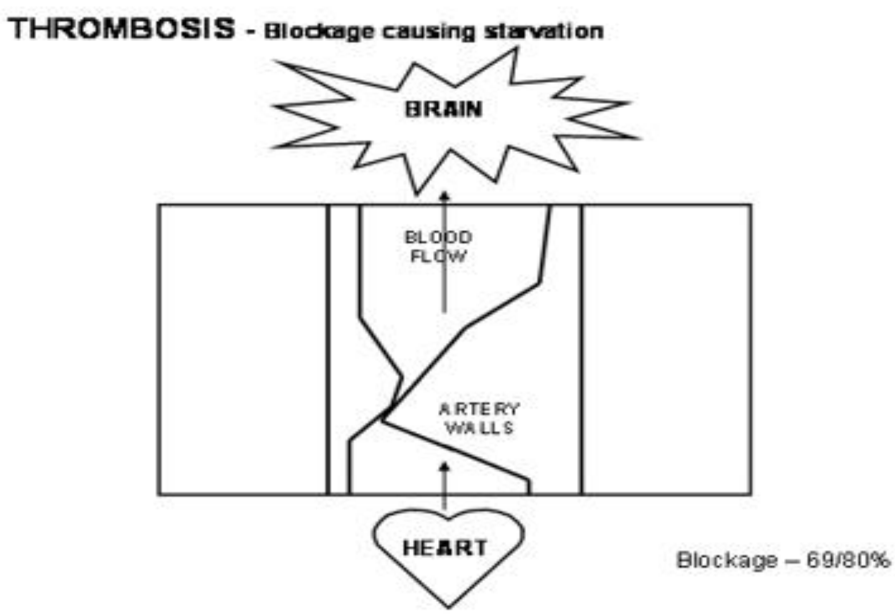


Figure 2.1

2. **Haemorrhagic stroke**

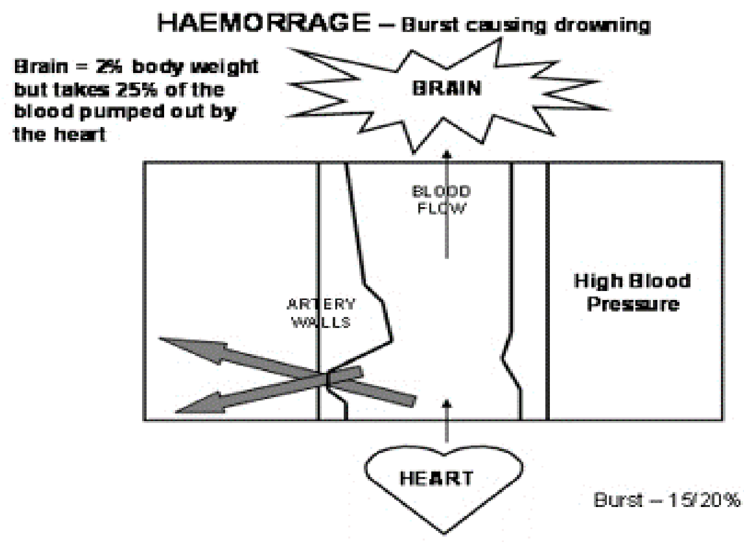


Figure 2.2

3. **TIA (transient ischaemic attack)**

Figure 2.3

A mini-stroke – the effects usually pass quickly but a TIA must be taken seriously as it can be a warning sign. A transient ischemic attack (TIA) happens when blood flow to part of the brain is blocked or reduced, often by a blood clot. After a short time, blood flows again and the symptoms go away. With a stroke, the blood flow stays blocked, and the brain has permanent damage. Some people call a TIA a mini-stroke, because the symptoms are those of a stroke but don't last long. A TIA is a warning: it means you are likely to have a stroke in the future. If you think you are having a TIA, call 911 or other emergency services right away. Early treatment can help prevent a stroke. If you think you have had a TIA but your symptoms have gone away, you still need to call your doctor right away .

Symptoms of a TIA are the same as symptoms of a stroke. But symptoms of a TIA don't last very long. Most of the time, they go away in 10 to 20 minutes. They may include a sudden numbness, tingling, weakness, or loss of movement in your face, arm, or leg, especially on only one side of your body. Next, sudden vision changes. After that, patient will sudden trouble speaking, sudden confusion or trouble understanding simple statements. After that, patient will sudden problems with walking or balance.

2.5 Ischemic stroke

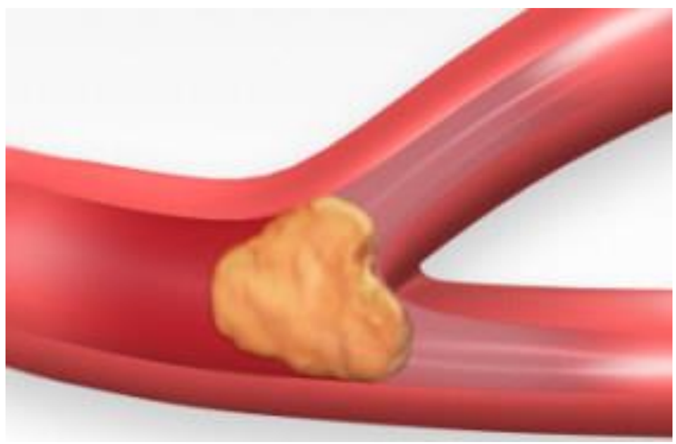


Figure 2.3

Ischemic stroke accounts for about 87 percent of all cases. Ischemic strokes occur as a result of an obstruction within a blood vessel supplying blood to the brain. The underlying condition for this type of obstruction is the development of fatty deposits lining the vessel walls. This condition is called atherosclerosis.

These fatty deposits can cause two types of obstruction which are cerebral thrombosis and cerebral embolism. Cerebral thrombosis refers to a thrombus (blood clot) that develops at the clogged part of the vessel. Cerebral embolism refers generally to a blood clot that forms at another location in the circulatory system, usually the heart and large arteries of the upper chest and neck. A portion of the blood clot breaks loose, enters the bloodstream and travels through the brain's blood vessels until it reaches vessels too small to let it pass. A second important cause of embolism is an irregular heartbeat, known as atrial fibrillation. It creates conditions where clots can form in the heart, dislodge and travel to the brain. Silent cerebral infarction (SCI), or "silent stroke," is a brain injury likely caused by a blood clot interrupting blood flow in the brain. It's a risk factor for future strokes which could lead to progressive brain damage due to these strokes.

2.6 Haemorrhagic stroke.

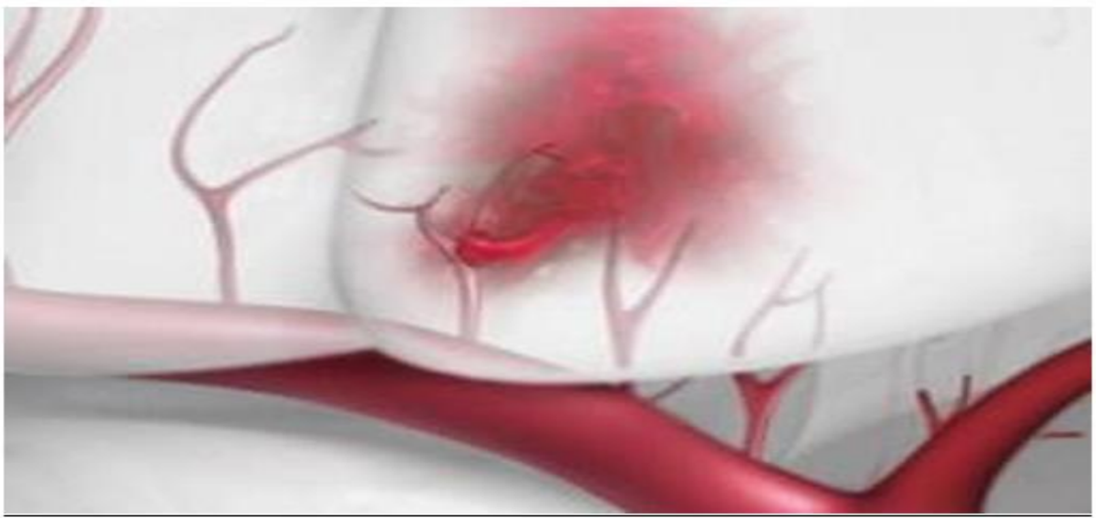


Figure 2.4

Haemorrhagic stroke accounts for about 13 percent of stroke cases. It results from a weakened vessel that ruptures and bleeds into the surrounding brain. The blood accumulates and compresses the surrounding brain tissue. The two types of haemorrhagic strokes are intracerebral (within the brain) haemorrhage or subarachnoid haemorrhage. Haemorrhagic stroke occurs when a weakened blood vessel ruptures. Two types of weakened blood vessels usually cause haemorrhagic stroke: aneurysms and arteriovenous malformations (AVMs) [8].

An **aneurysm** is a ballooning of a weakened region of a blood vessel. If left untreated, the aneurysm continues to weaken until it ruptures and bleeds into the brain. An **arteriovenous malformation** (AVM) is a cluster of abnormally formed blood vessels. Any one of these vessels can rupture, also causing bleeding into the brain [8]

Normally, **arteries** carry blood containing oxygen from the heart to the brain, and **veins** carry blood with less oxygen away from the brain and back to the heart. When an **arteriovenous malformation (AVM)** occurs, a tangle of blood vessels in the brain or on its surface bypasses normal brain tissue and directly diverts blood from the arteries to the veins.

2.7 Hand Disabilities

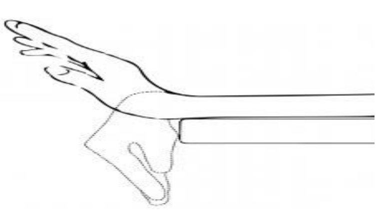
Most common disability by stroke is paralysis or problems controlling movement (motor control) [9]. Motor control is motor learning loosely or abnormal that encompasses motor adaptation, skill acquisition and decision making [10]. Half side paralysis of body called hemiparesis where the stroke suffer having difficulties of doing daily activities such as picking small objects, grasping or eating [11]

Hand therapy exercises after stroke will help regain the fine motor skills and finally get your hand back. Hand movement is one of the most stubborn functions to get back after stroke, so it's important to experiment with all of your options and find the one that works best for you.

2.8 The type of Rehabilitation Therapy and Exercise for Finger Disability

1. **2 Hand Stretching Exercises**

a) Wrist Extension and Flexion



b) Thumb Extension and Flexion

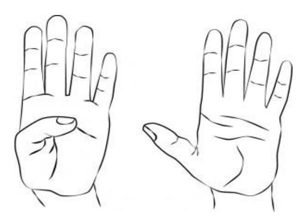


Figure 2.5

2. 6 Easy Hand Therapy Exercises

For those with some hand movement, try these simple tasks that involve common household items. There were six easy way to running a Hand Therapy Exercise, stacking coins, pinching clothespins, playing board games like chess or checkers, putting together a puzzle, playing the piano and lastly paying a virtual piano app.

3. 2 Rotation and Shift Hand Exercises

Once patient mastered the complex hand manipulation exercise, patient will be ready to work on performing rotation and shift exercises. Take a pen, and try rotating it around middle finger, using thumb, index, and ring finger to help patient manipulate the pen. Think about twirling the pen around fingers. Then, practice a shifting movement by holding the pen in a writing position (in between thumb, index, and middle finger) and shifting the pen forward until patient are holding the end of the pen. Then, shift the pen back until holding the tip once again. Think about inching fingers along the pen.

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4. An Advanced Hand Exercise

For this complex hand exercise, gather 10 small objects (like uncooked beans) and practice picking them up with patient fingers. But instead of immediately setting them down, try holding all of the objects in your palm (of the same hand) while continue to pick the rest up. Patient will be working on pinching movements with index finger and thumb while the rest of fingers work to keep the objects in palm. Then, once all the objects are in patient hand, practice putting them down one by one. Patient will use their thumb to move each object from palm down to index finger and thumb, and then place the object back down onto the table. This requires a great deal of coordination and control, so if patient can't get it at first, remember that it's a difficult task and patient will get better with practice [12]

5. 8 Hand Therapy Putty Exercises

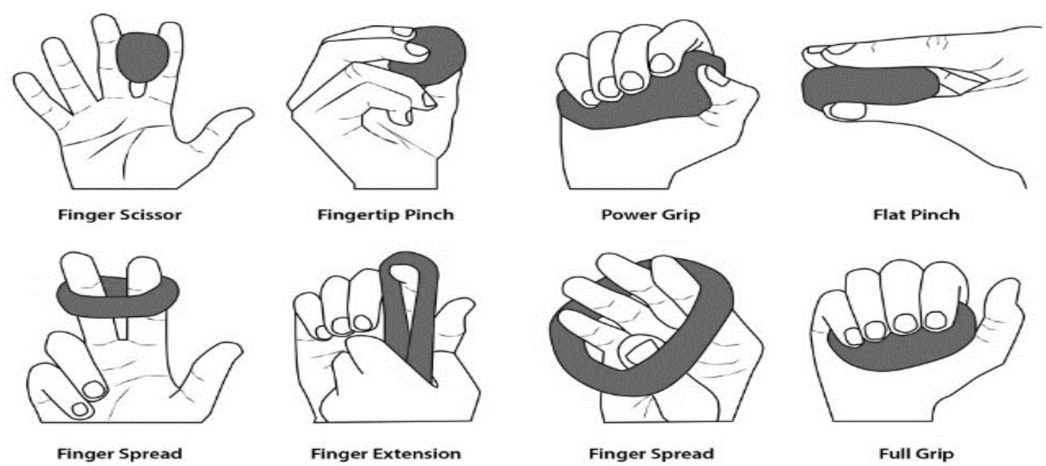


Figure 2.6

For the patient who need a little creativity in doing their own exercise, there are 8 Hand Therapy Putty Exercise are been provided for the patient. First, there were Finger Scissors that need the patient to squeeze the putty between the patient fingers. Second, Fingertip Pinch that involve the patient to pinch the putty using thumb and fingertips. Third, Power Grip who needs the patient to squeeze all your fingers into the putty. Fourth, Flat Pinch that needs to pinch the putty down into patient thumb with straightened fingers. Fifth, Finger Spread that involve the patient to wrap the putty around two fingers and spread your fingers apart. Sixth, Finger Extension that involve the patient to wrap the putty around a hooked finger and then straighten your finger using the putty as resistance Seventh, Finger Spread that needs to wrap the putty around the patient hand and then spread the fingers out to stretch the putty. Lastly, Full Grip involve the patient Squeeze down on the putty, pressing the fingers into your palm.

6. 8 Hand Therapy Ball Exercises

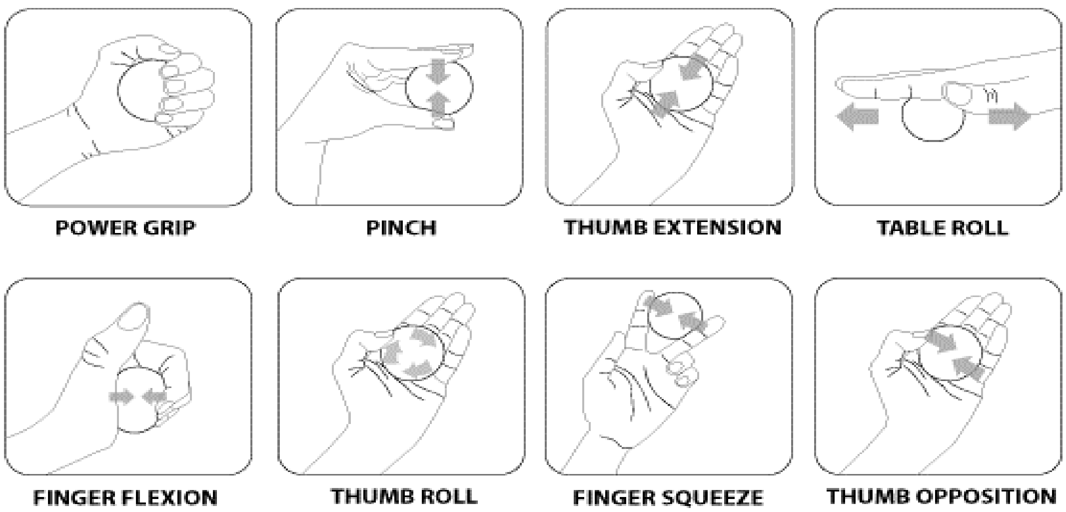


Figure 2.7

7. Strengthening motor skills

A motor skill is a learned series of movement that combine to produce efficient action. Motor skill can be divided into two: Gross motor skills and fine motor skills. Gross motor skills are concerning for grasping large object, balancing, walking and lifting one's head. The motor development follows a pattern where large muscles develop before smaller ones as ignition to fine motor skills. Fine motor skills include the ability to grasping or picking small object, knitting, writing or transfer objects from hand to hand. These skills required very precise motor movement in order perform delicate task. Combination of small muscle usually performs the task. Weak muscles can effects the motor skill of the stroke patient. Therefore by strengthening motor skills using varies exercise will help improve muscle strength and coordination. Exercise of muscles involving finger extension and flexion to certain degree of movement. The exercise starting from proximal muscle group and extent the distal muscle group at the finger tips.

8. Range of motion therapy (ROM)

Spasticity is one of the effects of stroke. It allows muscle to contract and cannot move anymore. The patient would get out of the way using the impaired hand and do activities using unaffected hand contributing to loss of fine motor control. The upper extremity become worse because of loss of control and increasing impaired. The activities of extent and flexion of finger and improvement of upper extremity will be analysing by range motion therapy (ROM) also as indicator how the patient could compensate for stroke. Range motor therapy is a measurement of the extent and flexion of finger to which a joint can go through all of it normal range of movements. There are two types of motion exercise in rehabilitation therapy: passive and active range motion. The patient will be asked to move a limb repeatedly in passive range motion to avoid the contraction of muscles and active exercise perform by the patient without physical assistance from the therapist usually at home. The patient must do the strengthening and bending of thumb and finger also flexion and extension exercise according schedule in order to make the muscle regain the strength to operate.

9. Physical Therapy (Mallet Exercise)

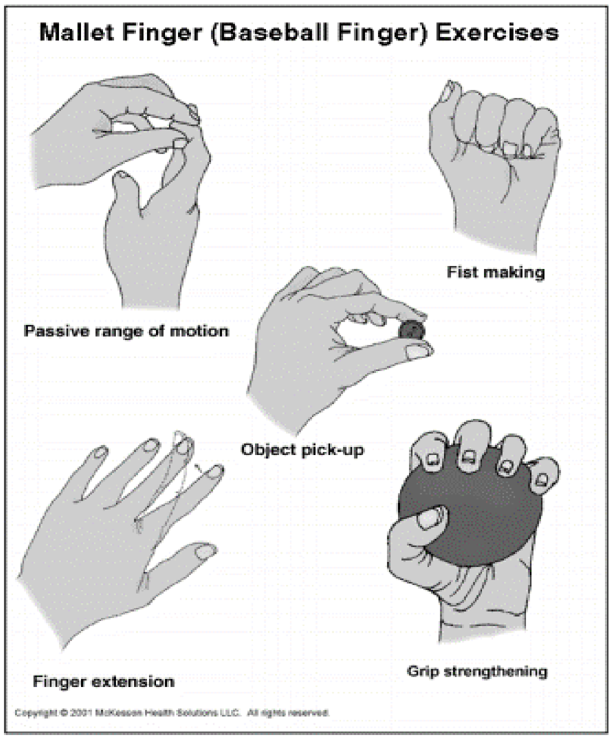


Figure 2.8

2.9 Flexion Tracking

Figure 2.9 : Finger flexion with joints identified

Movements and flexing of the fingers is known as flexion of the finger joints. A human finger has an approximate total flexion range of about 260°, although fingerjoints have varying ranges of motion based on each individual person. The finger joints acquainted with flexion are the distal-interphalangeal (DIP) joint also referred to as the fingertip joint, proximal-interphalangeal (PIP) joint or center joint of the finger, and the metacarpal-phalangeal (MP) joint commonly known as the joint of the knuckles [1]. Fig 1.1 shows the human hand flexed to a clenched fist posture with the main joints articulated to their flexion positions.

2.10 Brain reorganization after stroke

An online literature search on Pubmed under ‘‘brain reorganization after stroke’’ gives a rough indication of the increase in interest in the neural correlates of recovery from stroke. From 1981 to 1990 there were three publications; from 1991 to 2000, 48; and from 2001 to 2004, [14]. These studies reveal that, in addition to recovery through reduction in oedema and metabolic disturbances, restitution of the ischemic penumbra, and resolution of diastasis, the adult brain is capable of reorganization to recover lost function. Reorganization can occur in cortical regions immediately adjacent to the infarct [15] or remote from the infarct, both in the same [16], and in the opposite hemisphere [17]. The mechanisms of both adjacent and remote reorganization are under active investigation and are thought to include unmasking of latent synapses, facilitation of alternative networks, synaptic remodelling, and axonal sprouting [18, 19]. Several reviews on the subject of brain reorganization have been published recently,[20-26] and so this section will be selective and focus on conceptual and methodological issues pertaining to inferring recruitment of brain areas remote from the infarct.

2.11 Natural history of arm paresis and predictors of recovery

Stroke is the leading cause of long-term disability among adults in the United States, and hemiparesis is the most common impairment after stroke. Longitudinal studies of recovery after stroke suggest that only 50% of patients with significant arm paresis recover useful function. Initial severity of paresis remains the best predictor of recovery of arm function [27, 28]. One study showed that the Fugal-Meyer (FM) [29] score at 30 days predicted 86% of the variance in recovery of motor function at 6 months. This oft-cited study raises several important issues pertinent to the study of stroke recovery [30]. First, the authors make a good case for using a measure of impairment, the FM score, rather than a measure of disability, the Barthes index, to assess recovery of function. The difference between impairment and disability highlights the critical distinction between true recovery and restoration of function, as opposed to compensation. For example, a patient with right arm paresis who learns to perform activities of daily living (ADLs) with her left arm has compensated but has not recovered. Measurements of impairment are more likely than measurements of ADLs or handicap to distinguish true recovery from compensation. Second, the FM score at 30 days was a better predictor of the FM score at 6 months than the FM score at day 5, which indicates that there is significant variability in the degree of spontaneous recovery occurring in the first month post stroke. Third, the finding that most of the variance in outcome at 6 months was determined by the first 30 days implies that whatever occurred in terms of rehabilitation in the ensuing 5 months made little impact. This suggests that patients with the worst prognosis at 6 months need to be the focus of novel and intensive rehabilitation strategies. Indeed, it will be easier to detect an effect of a novel treatment strategy in this group. Attempts to use lesion location to predict arm recovery have so far only been able to show greater probability of recovery from hemiparesis for cortical than for subcortical lesions. In particular, lesions in the most posterior part of the posterior limb of the internal capsule have the poorest outcome, presumably due to convergence of a majority of axons from primary motor cortex (M1). One study followed 41patients, with near plague or plague 2 weeks after stroke (Action Research Arm Test score <9/56), for 2 years.75 percent of those patients with lesions restricted to cortex recovered isolated upper limb movements, whereas only 6% of patients with subcortical strokes did so. This marked difference may be because initial measurements were only 2 weeks post stroke. It is possible that patients with cortical lesions who remain pelagic at 1 month would not show such a favourable outcome. Nevertheless, the results suggest that hemiparesis may come in distinct subtypes. In summary, severity of arm paresis in the first month after stroke remains the strongest predictor of outcome and likely reflects the degree of damage done to cortical motor areas and the corticoid spinal tract. It is to be hoped that the impact of initial severity can be lessened with new rehabilitation techniques in the first 6 months post stroke. Cortical and subcortical strokes may require different rehabilitative approaches. Finally, it is now known that chronic stroke patients(>6 months) respond to rehabilitation, and so it is conceivable that the patients who do not show significant responses by 6 months may need more extended periods of rehabilitation.

2.12 The Ipsilesional Arm

In 1973, Alf Brodal, a Norwegian professor of anatomy, published an article entitled: ''Self-Observations and Neuroanatomical Considerations after a Stroke.'' [31] This article is filled with observations of great physiological interest. In particular, Brodal became aware that although he had suffered a right subcortical stroke, the quality of his writing with his right hand had deteriorated. Several studies have subsequently reported abnormalities in the ''unaffected'' arm after stroke, including control of distal movements. Interestingly, the nature of these deficits can differ depending on whether the infarct is in the dominant or no dominant hemisphere [3233]. Most recently, strikingly abnormal step-tracking movements have been described in the ipsilesional wrist of patients with hemiparesis [34-38]. The observed trajectory errors in amplitude and direction were due largely to inappropriate temporal sequencing of muscle activity [39]. One possible explanation is that there is interruption of the uncrossed ipsilateral corticospinal projection to distal muscles. Support for this explanation comes from functional imaging studies, which show bilateral M1 activation during unilateral finger movements. An alternative explanation isthat stroke in one hemisphere alters transcallosally mediated inhibitory effects on M1 in the opposite hemisphere [40-41]. The involvement of the ''unaffected arm'' after stroke has several important implications [42-44]. First, even distal control of the arm is under bilateral hemispheric control. Second, age-matched healthy subjects should be used as controls in future studies rather than patients' unaffected arm. Third, collapsing findings for left and right hemiparesis are questionable given the differences in some control abnormalities in the ipsilesional arm with dominant and no dominant hemisphere strokes. Finally, the involvement of the ipsilesional arm reinforces the importance of sensitive quantitative studies to detect differential abnormalities that would otherwise be missed on bedside examination or by outcome scales.

2.13 Type of Arduino

There are 4 type Arduino. Arduino Mega, Arduino Uno, Arduino micro and Arduino Pro mini.

Figure 2.10. Arduino Mega

Arduino mega are The MEGA 2560 that is designed for more complex projects. With 54 digital I/O pins, 16 analogue inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects. This gives your projects plenty of room and opportunities . The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno.

Table 2.1 Technical specs

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

The Mega 2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector .The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

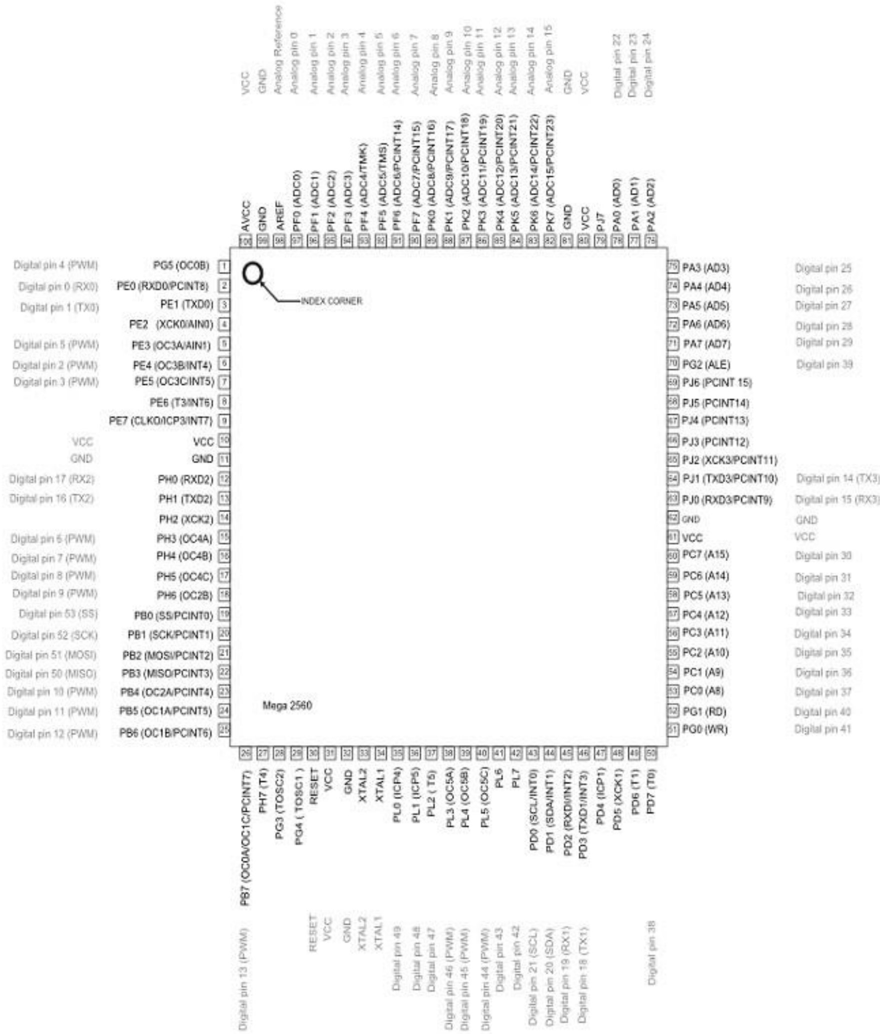


Figure 2.11 Arduino Mega 2560 PIN mapping table

Table 2.2 pin number, pin name and, apped pin name

Pin Number	Pin Name	Mapped Pin Name
1	PG5 (OC0B)	Digital pin 4 (PWM)
2	PE0 (RXD0/PCINT8)	Digital pin 0 (RX0)
3	PE1 (TXD0)	Digital pin 1 (TX0)
4	PE2 (XCK0/AIN0)	
5	PE3 (OC3A/AIN1)	Digital pin 5 (PWM)
6	PE4 (OC3B/INT4)	Digital pin 2 (PWM)
7	PE5 (OC3C/INT5)	Digital pin 3 (PWM)
8	PE6 (T3/INT6)	
9	PE7 (CLKO/ICP3/INT7)	
10	VCC	VCC
11	GND	GND

12	PH0 (RXD2)	Digital pin 17 (RX2)
13	PH1 (TXD2)	Digital pin 16 (TX2)
14	PH2 (XCK2)	
15	PH3 (OC4A)	Digital pin 6 (PWM)
16	PH4 (OC4B)	Digital pin 7 (PWM)
17	PH5 (OC4C)	Digital pin 8 (PWM)
18	PH6 (OC2B)	Digital pin 9 (PWM)
19	PB0 (SS/PCINT0)	Digital pin 53 (SS)
20	PB1 (SCK/PCINT1)	Digital pin 52 (SCK)
21	PB2 (MOSI/PCINT2)	Digital pin 51 (MOSI)
22	PB3 (MISO/PCINT3)	Digital pin 50 (MISO)
23	PB4 (OC2A/PCINT4)	Digital pin 10 (PWM)
24	PB5 (OC1A/PCINT5)	Digital pin 11 (PWM)
25	PB6 (OC1B/PCINT6)	Digital pin 12 (PWM)
26	PB7 (OC0A/OC1C/PCINT7)	Digital pin 13 (PWM)
27	PH7 (T4)	
28	PG3 (TOSC2)	
29	PG4 (TOSC1)	
30	RESET	RESET
31	VCC	VCC
32	GND	GND
33	XTAL2	XTAL2
34	XTAL1	XTAL1
35	PL0 (ICP4)	Digital pin 49
36	PL1 (ICP5)	Digital pin 48
37	PL2 (T5)	Digital pin 47
38	PL3 (OC5A)	Digital pin 46 (PWM)
39	PL4 (OC5B)	Digital pin 45 (PWM)
40	PL5 (OC5C)	Digital pin 44 (PWM)
41	PL6	Digital pin 43
42	PL7	Digital pin 42
43	PD0 (SCL/INT0)	Digital pin 21 (SCL)
44	PD1 (SDA/INT1)	Digital pin 20 (SDA)
45	PD2 (RXDI/INT2)	Digital pin 19 (RX1)

46	PD3 (TXD1/INT3)	Digital pin 18 (TX1)
47	PD4 (ICP1)	
48	PD5 (XCK1)	
49	PD6 (T1)	
50	PD7 (T0)	Digital pin 38
51	PG0 (WR)	Digital pin 41
52	PG1 (RD)	Digital pin 40
53	PC0 (A8)	Digital pin 37
54	PC1 (A9)	Digital pin 36
55	PC2 (A10)	Digital pin 35
56	PC3 (A11)	Digital pin 34
57	PC4 (A12)	Digital pin 33
58	PC5 (A13)	Digital pin 32
59	PC6 (A14)	Digital pin 31
60	PC7 (A15)	Digital pin 30
61	VCC	VCC
62	GND	GND
63	PJ0 (RXD3/PCINT9)	Digital pin 15 (RX3)
64	PJ1 (TXD3/PCINT10)	Digital pin 14 (TX3)
65	PJ2 (XCK3/PCINT11)	
66	PJ3 (PCINT12)	
67	PJ4 (PCINT13)	
68	PJ5 (PCINT14)	
69	PJ6 (PCINT 15)	
70	PG2 (ALE)	Digital pin 39
71	PA7 (AD7)	Digital pin 29
72	PA6 (AD6)	Digital pin 28
73	PA5 (AD5)	Digital pin 27
74	PA4 (AD4)	Digital pin 26
75	PA3 (AD3)	Digital pin 25
76	PA2 (AD2)	Digital pin 24
77	PA1 (AD1)	Digital pin 23
78	PA0 (AD0)	Digital pin 22
79	PJ7	
80	VCC	VCC
81	GND	GND
82	PK7 (ADC15/PCINT23)	Analog pin 15
83	PK6 (ADC14/PCINT22)	Analog pin 14
84	PK5 (ADC13/PCINT21)	Analog pin 13
85	PK4 (ADC12/PCINT20)	Analog pin 12
86	PK3 (ADC11/PCINT19)	Analog pin 11
87	PK2 (ADC10/PCINT18)	Analog pin 10

88	PK1 (ADC9/PCINT17)	Analog pin 9
89	PK0 (ADC8/PCINT16)	Analog pin 8
90	PF7 (ADC7)	Analog pin 7
91	PF6 (ADC6)	Analog pin 6
92	PF5 (ADC5/TMS)	Analog pin 5
93	PF4 (ADC4/TMK)	Analog pin 4
94	PF3 (ADC3)	Analog pin 3
95	PF2 (ADC2)	Analog pin 2
96	PF1 (ADC1)	Analog pin 1
97	PF0 (ADC0)	Analog pin 0
98	AREF	Analog Reference
99	GND	GND
100	AVCC	VCC

Figure 2.12

Arduino UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino & Genuine family. Arduino/Genuine Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started [46]. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Table 2.3: Technical specs

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6

DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

The Arduino/Genuino Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on your board). The ATmega328 on the Arduino/Genuino Uno comes preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. Also can bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar [46]. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated on Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then rese ing the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. Then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information [46]. The Arduino/Genuino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-toserial converter. The Arduino/Genuino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm centerpositive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector. The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are Vin. The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source) [46]. You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. 5V.This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it. 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND. Ground pins. IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V. The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

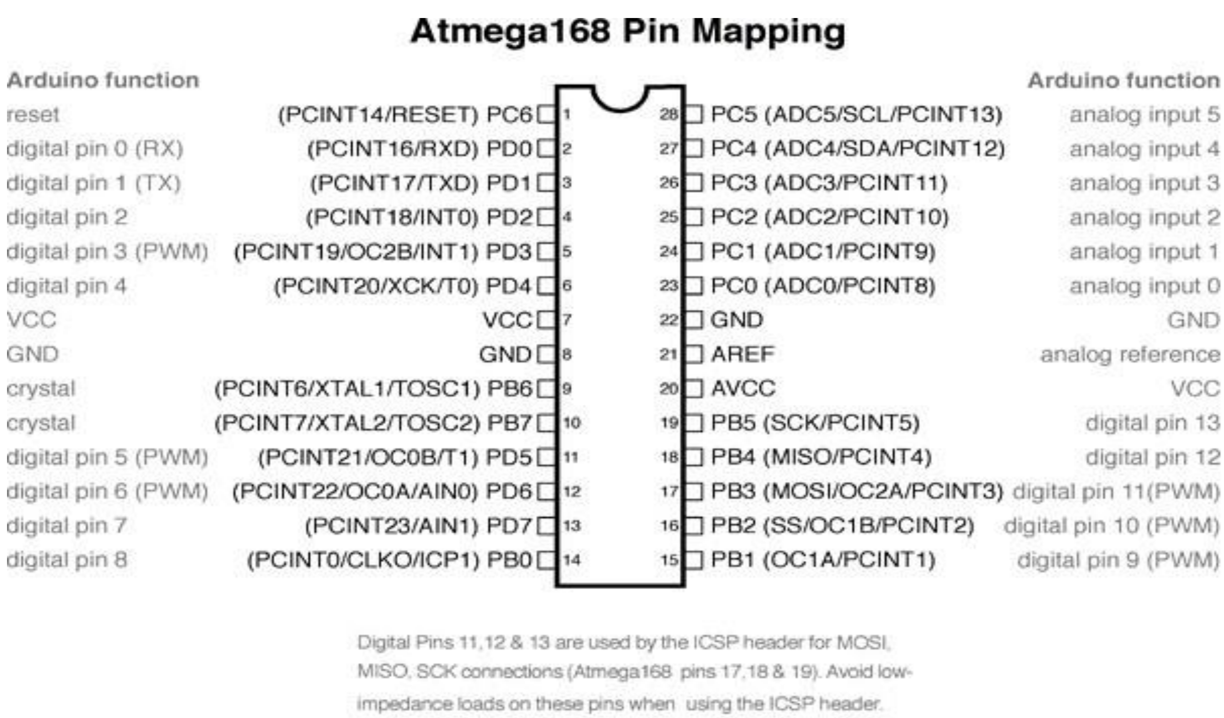


Figure 2.13

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical.Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller [46]. In addition, some pins have specialized functions. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details. PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library. LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. There are a couple of other pins on the board which is AREF. Reference voltage for the analog inputs. Used with analogReference(). Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board [46]. Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and

A Software Serial library allows serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library [46]. Automatic (Software) Reset. Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow to upload code by simply pressing the upload button in the interface toolbar. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload [46]. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data [46]. The Uno board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details [46].

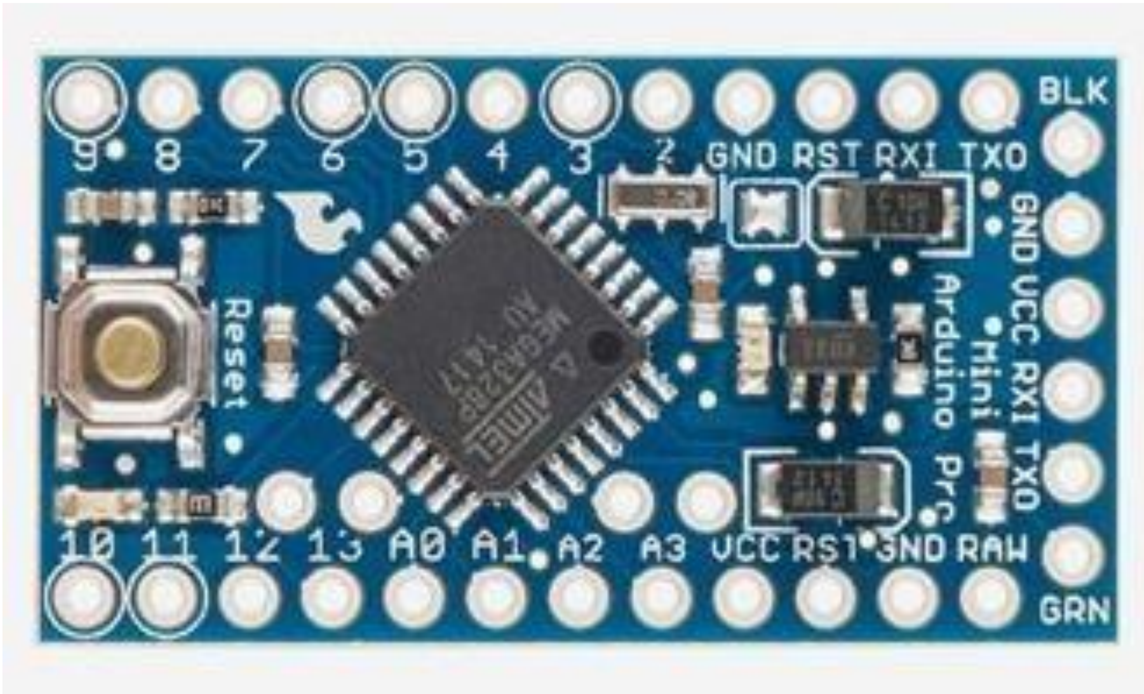


Figure 2.14

Arduino pro mini was developed for applications and installations where space is premium and projects are made as permanent set ups. Small, available in 3.3 V and 5 V versions, powered by ATmega328. The Arduino Pro Mini is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable or Spark fun breakout board to provide USB power and communication to the board. The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino Mini [47]. There are two version of the Pro Mini. One runs at 3.3V and 8 MHz, the other at 5V and 16 MHz. The Arduino Pro Mini was designed and is manufactured by SparkFun Electronics .

Table 2.4: Technical specs

Microcontroller	ATmega328 *
Board Power Supply	3.35 -12 V (3.3V model) or 5 - 12 V (5V model)
Circuit Operating Voltage	3.3V or 5V (depending on model)
Digital I/O Pins	14
PWM Pins	6
UART	1
SPI	1
I2C	1
Analog Input Pins	6
External Interrupts	2
DC Current per I/O Pin	40 mA
Flash Memory	32KB of which 2 KB used by bootloader *
SRAM	2 KB *
EEPROM	1 KB *
Clock Speed	8 MHz (3.3V versions) or 16 MHz (5V versions)

(*) Older boards were equipped with ATmega 168 with this specs:

- Flash memory: 16 KB
- SRAM: 1 KB
- EEPROM: 512 bytes

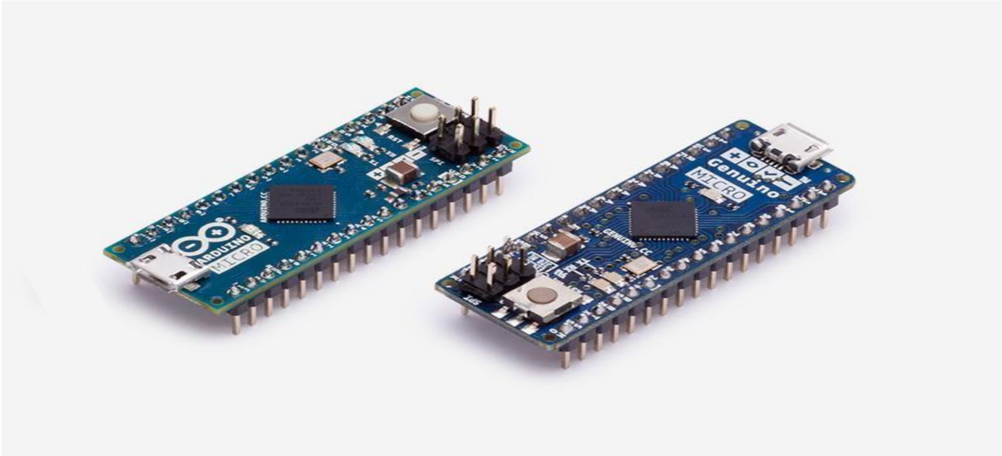


Figure 2.15

Arduino micro is the smallest board of the family, easy to integrate it in everyday objects to make them interactive. The Micro is based on the ATmega32U4 microcontroller featuring a built-in USB which makes the Micro recognisable as a mouse or keyboard. The Micro is a microcontroller board based on the ATmega32U4 (datasheet), developed in conjunction with Adafruit. It has 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analogue inputs), a 16 MHz crystal oscillator, a micro USB connection, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a micro USB cable to get started. It has a form factor that enables it to be easily placed on a breadboard. The Micro board is similar to the Arduino Leonardo in that the ATmega32U4 has built-in USB communication, eliminating the need for a secondary processor. This allows the Micro to appear to a connected computer as a mouse and keyboard, in addition to a virtual (CDC) serial / COM port. It also has other implications for the behaviour of the board; these are detailed on the getting started page .

Table 2.5 Technical specs

Microcontroller	ATmega32U4
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	20
PWM Channels	7
Analog Input Channels	12
DC Current per I/O Pin	20 mA

DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega32U4) of which 4 KB used by bootloader
SRAM	2.5 KB (ATmega32U4)
EEPROM	1 KB (ATmega32U4)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	48 mm
Width	18 mm
Weight	13 g

The Micro can be powered via the micro USB connection or with an external power supply. The power source is selected automatically.External (non-USB) power can come either from a DC power supply or battery. Leads from a battery or DC power supply can be connected to the Gnd and Vin pins.The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are VI. The input voltage to the MICRO board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin. 5V the regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply. 3V. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND. Ground pins [48]. The ATmega32U4 has 32 KB (with 4 KB used for the bootloader). It also has 2.5 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library) .

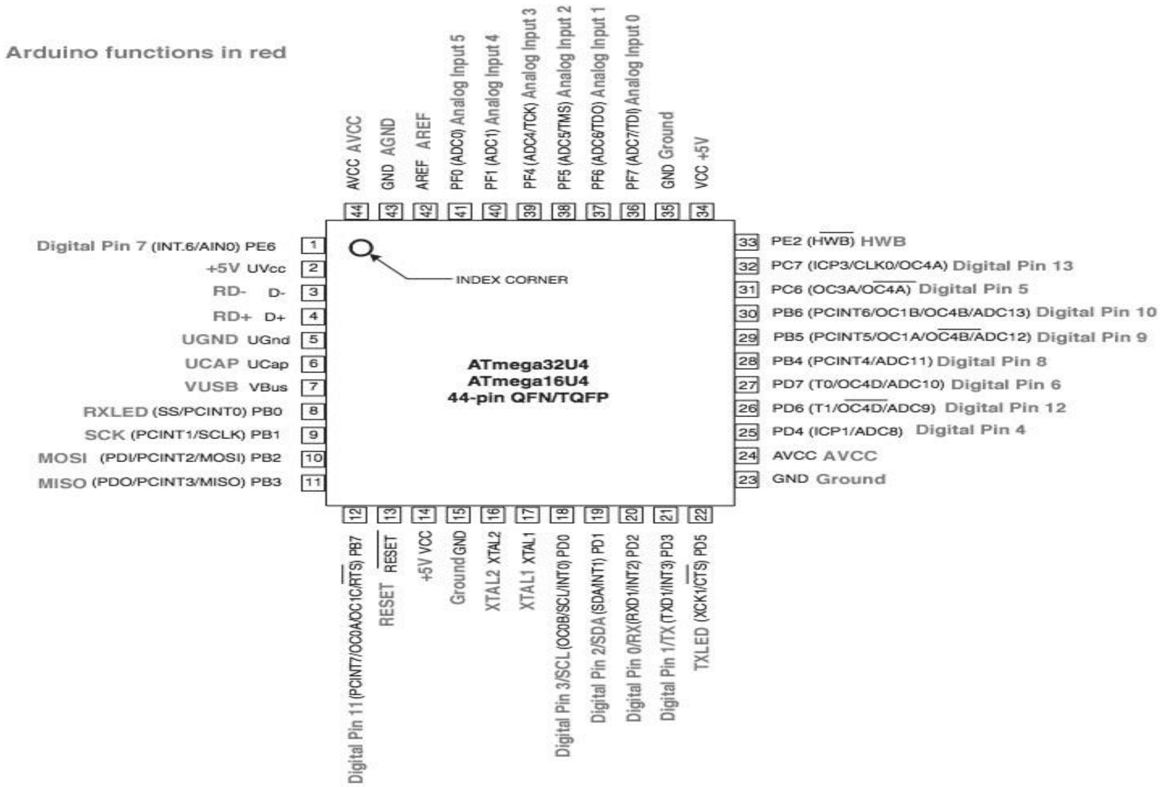


Figure 2.16: **Arduino Leonardo pin mapping table**

Table 2.6: Pin Number, Pin Name and Mapped Pin Name

Pin Number	Pin Name	Mapped Pin Name
1	PE6 (INT.6/AIN0)	Digital pin 7
2	UVcc	+5V
3	D-	RD-
4	D+	RD+
5	UGnd	UGND
6	UCap	UCAP
7	VUSB	VBus
8	(SS/PCINT0) PB0	RXLED
9	(PCINT1/SCLK) PB1	SCK
10	(PDI/PCINT2/MOSI) PB2	MOSI

11	(PDO/PCINT3/MISO) PB3	MISO
12	(PCINT7/OC0A/OC1C/#RTS) PB7	Digital pin 11 (PWM)
13	RESET	RESET
14	Vcc	+5V
15	GND	GND
16	XTAL2	XTAL2
17	XTAL1	XTAL1
18	(OC0B/SCL/INT0) PD0	Digital pin 3 (SCL)(PWM)
19	(SDA/INT1) PD1	Digital pin 2 (SDA)
20	(RX D1/AIN1/INT2) PD2	Digital pin 0 (RX)
21	(TXD1/INT3) PD3	Digital pin 1 (TX)
22	(XCK1/#CTS) PD5	TXLED
23	GND1	GND
24	AVCC	AVCC
25	(ICP1/ADC8) PD4	Digital pin 4
26	(T1/#OC4D/ADC9) PD6	Digital pin 12
27	(T0/OC4D/ADC10) PD7	Digital Pin 6 (PWM)
28	(ADC11/PCINT4) PB4	Digital pin 8
29	(PCINT5/OC1A/#OC4B/ADC12) PB5	Digital Pin 9 (PWM)
30	(PCINT6/OC1B/OC4B/ADC13) PB6	Digital Pin 10 (PWM)
31	(OC3A/#0C4A) PC6	Digital Pin 5 (PWM)
32	(ICP3/CLK0/)0C4A) PC7	Digital Pin 13 (PWM)
33	(#HWB) PE2	HWB
34	Vcc1	+5V
35	GND2	GND

36	(ADC7/TDI) PF7	Analog In 0
37	(ADC6/TDO) PF6	Analog In 1
38	(ADC5/TMS) PF5	Analog In 2
39	(ADC4/TCK) PF4	Analog In 3
40	(ADC1) PF1	Analog In 4
41	(ADC0) PF0	Analog In 5
42	AREF	AEF
43	GND3	GND
44	AVCC1	AVCC

Each of the 20 digital i/o pins on the Micro can be used as an input or output, using pinMode(),digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40mA is the value that must not be exceeded to avoid permanent damage to the microcontroller. In addition, some pins have specialized functions. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data using the ATmega32U4 hardware serial capability. Note that on the Micro, the Serial class refers to USB (CDC) communication; for TTL serial on pins 0 and 1, use the Serial1 class. TWI: 2 (SDA) and 3 (SCL). Support TWI communication using the Wire library. External Interrupts: 0(RX), 1(TX), 2, 3 and 7. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details. PWM: 3, 5, 6, 9, 10, 11 and 13. Provide 8-bit PWM output with the analogWrite() function. SPI is on the ICSP header [48]. These pins support SPI communication using the SPI library. Note that the SPI pins are not connected to any of the digital I/O pins as they are on the Uno, they are only available on the ICSP connector and on the nearby pins labelled MISO, MOSI and SCK. RX_LED/SS This is an additional pin compared to the Leonardo. It is connected to the RX_LED that indicates the activity of transmission during USB communication, but is can also used as slave select pin (SS) in SPI communication. LED: 13.

2.13 Description of project

We have decide to choose Arduino Mega as our main components in our Final Year Project. This is because Servo Player were designed with a regular small (10 cm x 10 cm) and available shape that suit with our Final Year Project that portable to bring anywhere. This regular small designed will help a lot cause it will reduce the weight and the space of our project indirectly it will help reduce the user burden on carrying it away.

We also use 5 servo motor to grasp and release a glove. Operating speed for servo motor is 0.20sec/60degree (4.8v); 0.16sec/60degree (6.0v). After that, the operating voltage is 4.8~ 6.6v. The rotation angle for servo motor is 180 degree. The weight of servo motor is 55g. The dimension is 39.5mm x 20.5mm x 40.7mm. We also use a flex sensor to measure a bent level using a finger.

For run the project, we used battery NI-CD battery 4.8v 700mah. The battery can survive with 5 RC servo motor for 2 hours. The size of battery is 50mm x 55mm x 14mm. The normal capacity is 700mah and normal voltage is 4.8v. The voltage for each cell is 1.2v battery and the number of cell is 4. The suitable charger for this battery is NI-CD battery charger 4.8v. While the charging time is 4-5 hours. For the full charged voltage is 6.4v

CHAPTER 3 :METHODOLOGY

3.1 INTRODUCTION

Methodology is a system of broad principles or rules from which specific methods or procedures may be derived to interpret or solve different problems within the scope of a particular discipline. Therefore, this chapter will show a through description of the processes used to complete this project.

This project is completed in properly procedure or according to the way of resolving that has been made as an such as process decide a project, do the block diagram of the project, decide the circuit that want to use, decide the main components that want to use, design the project, and process to complete the project.

3.2 Flow Chart/

3.2.1 Process Of Decide Project

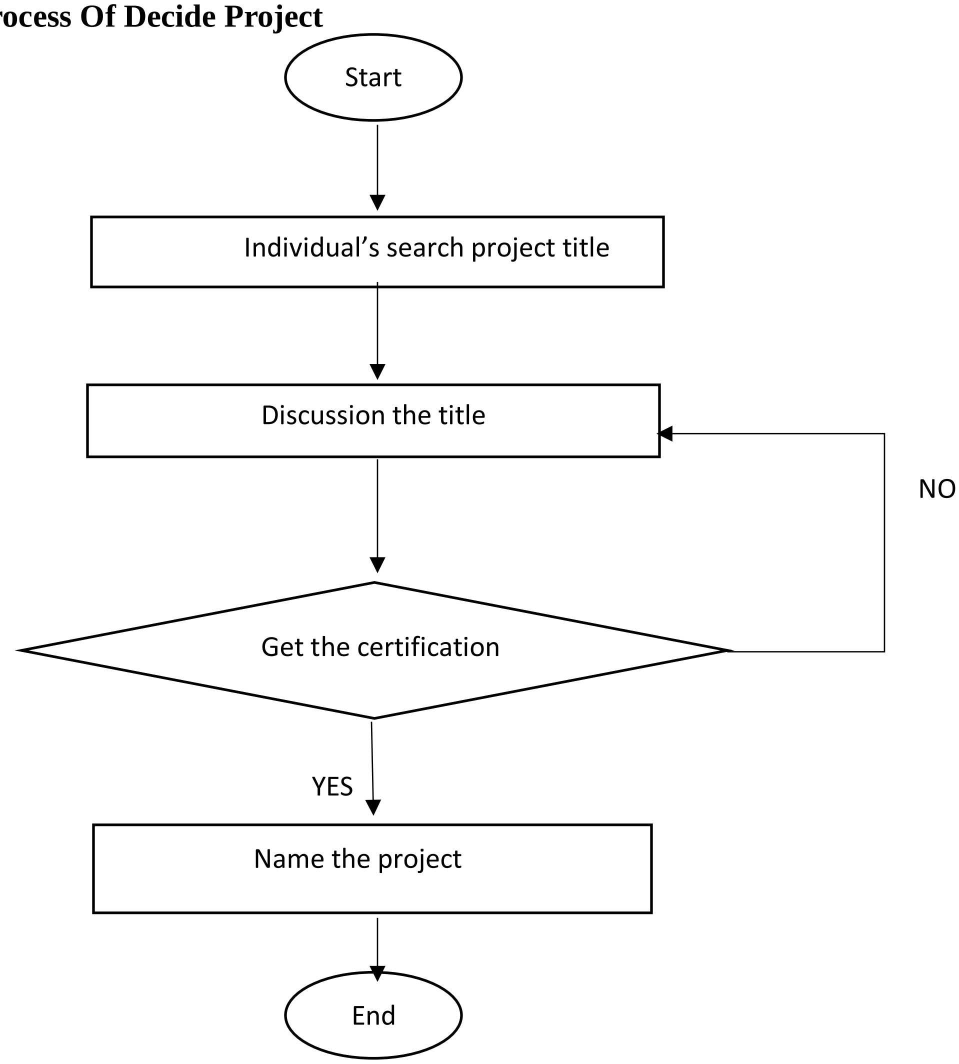


Figure 3.1: Flow chart of decide the project

3.2.2 Process Build the Project

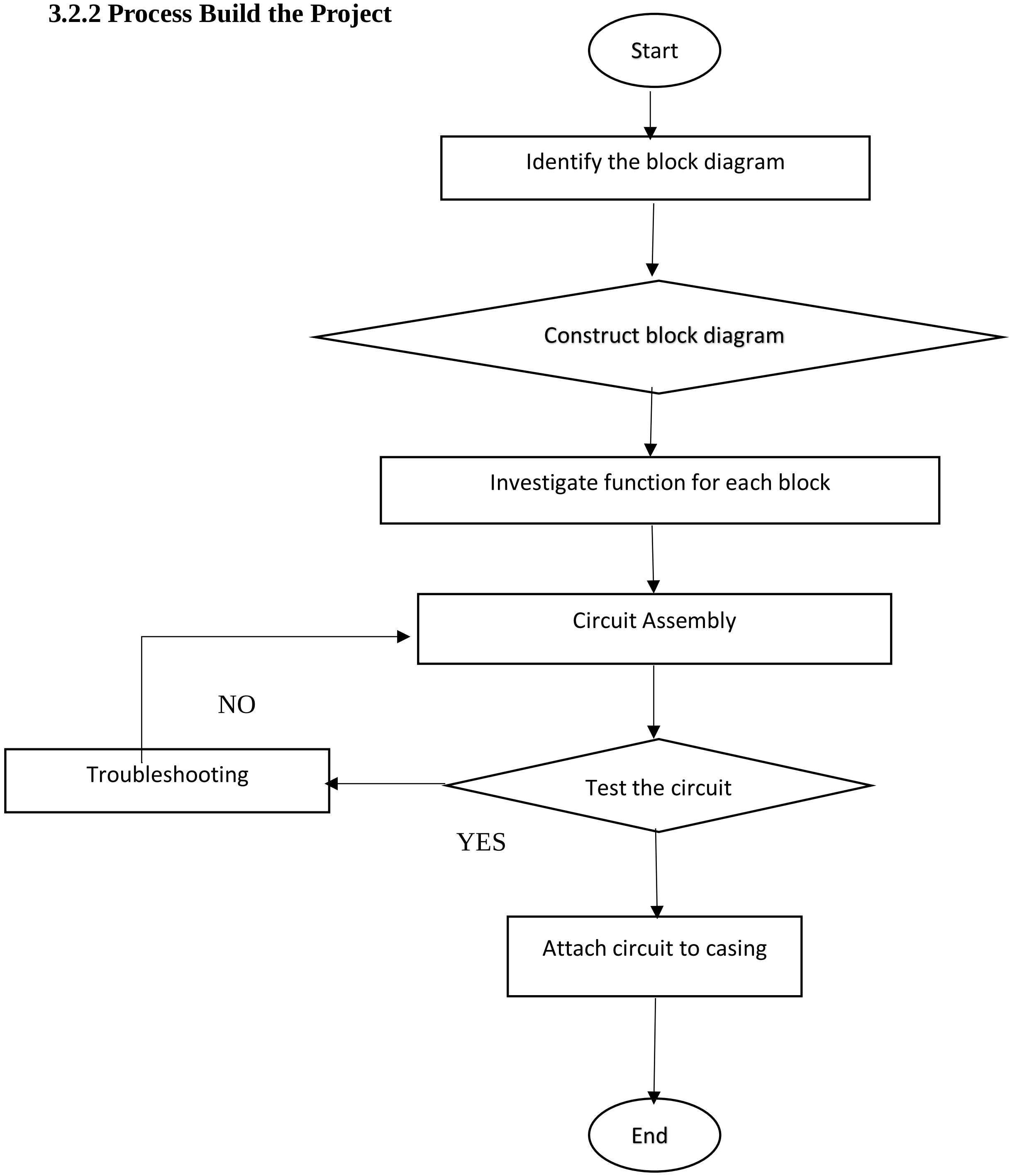


Figure 3.2 : Flow chart process of build the project

3.2.3 Process Of Output at LCD Display

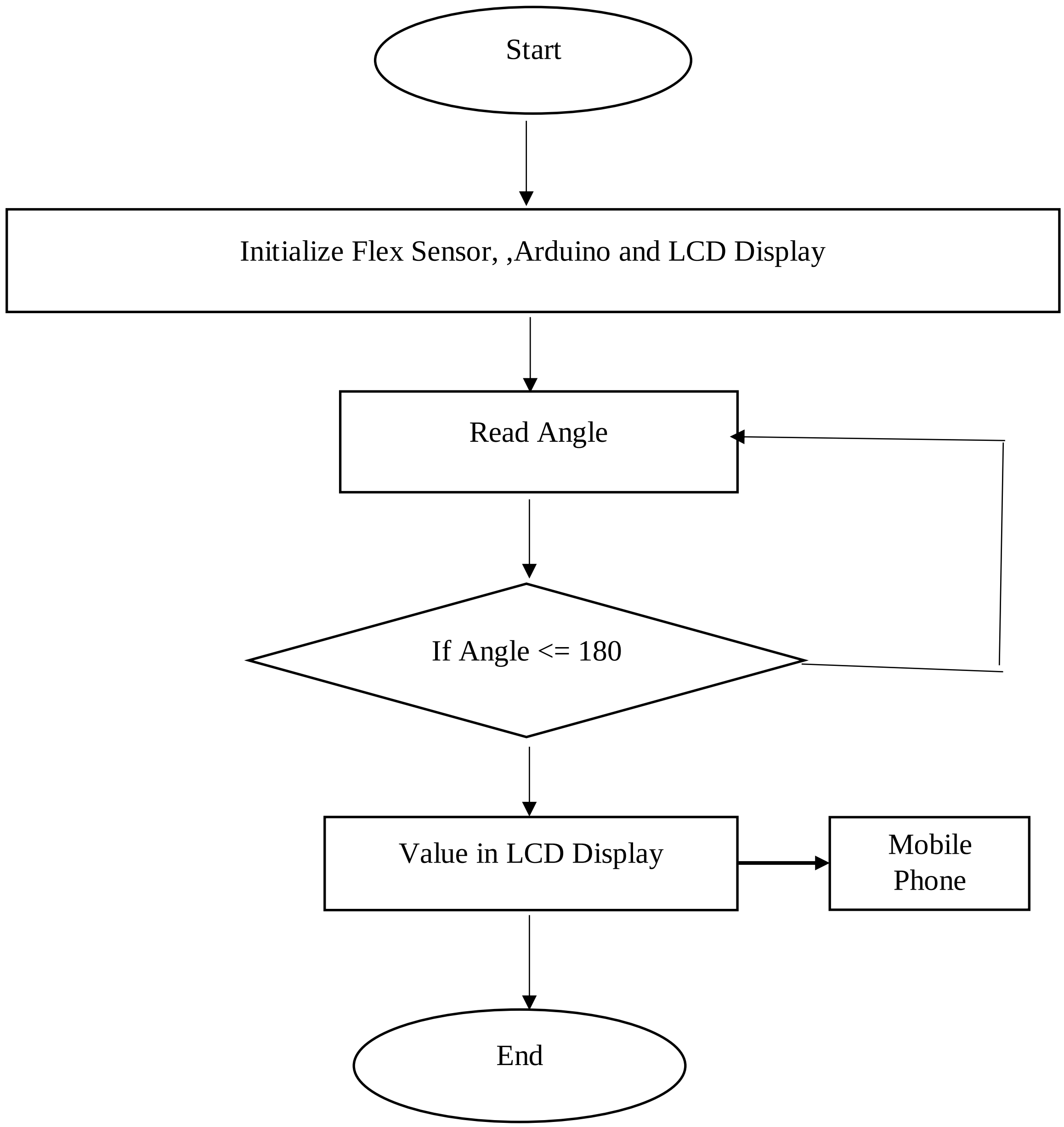


Figure 3.3 : Flow chart Output LCD Display

3.3 Block Diagram

3.3.1 Block Diagram of Planning Starting Progress to Complete the Project

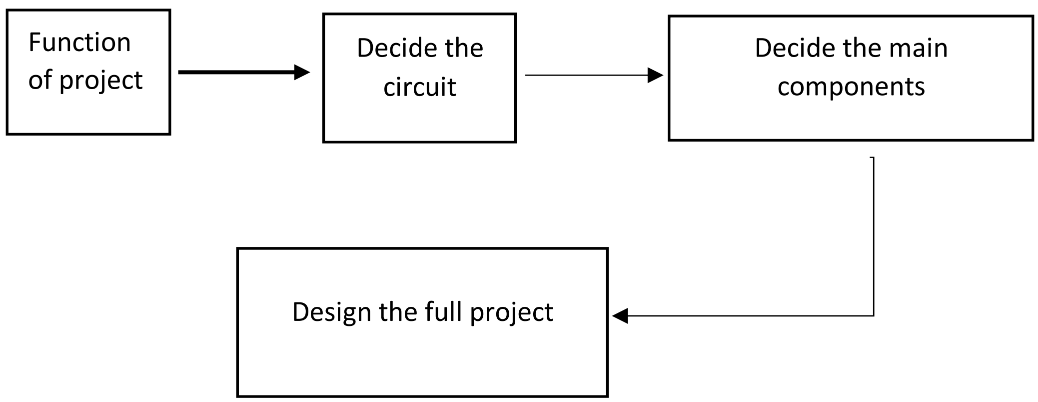


Figure 3.4 Planning Starting Progress to Complete the Project

3.3.2 Block Diagram of the Project

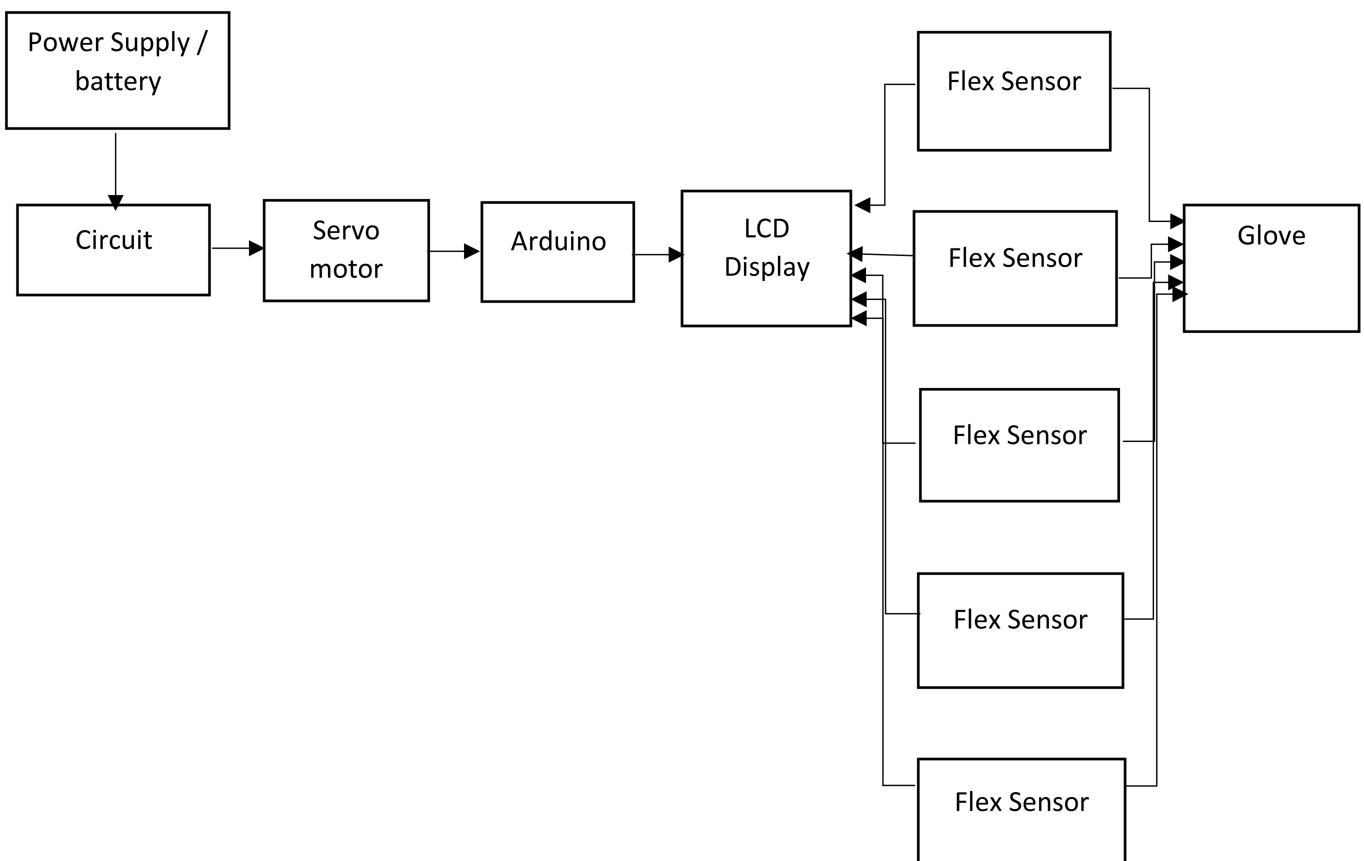


Figure 3.5 Block Diagram of the Project

The recovery of the glove finger has the function to help stroke patients to flexion and extend the hands (grasp and release) and also can measure a bent level of finger. Thus, the project block diagram described is shown as Figure 3.3.2. First, there is a power supply to support the voltage to the circuit such as adapter or battery. Second, the circuit's decision has been made based on the glove finger rehabilition function. The circuit is selected based on observations on all aspects that benefit glove finger rehabilition. The circuit has been connected to five servo motors. Thirdly, all five motor servos are fitted with nylon strings. Then, each nylon strings attached to the servo motors must be connected to all five fingers of the glove.The 5 flex sensors are operated through finger movement.

3.3.3 Block diagram for Hardware

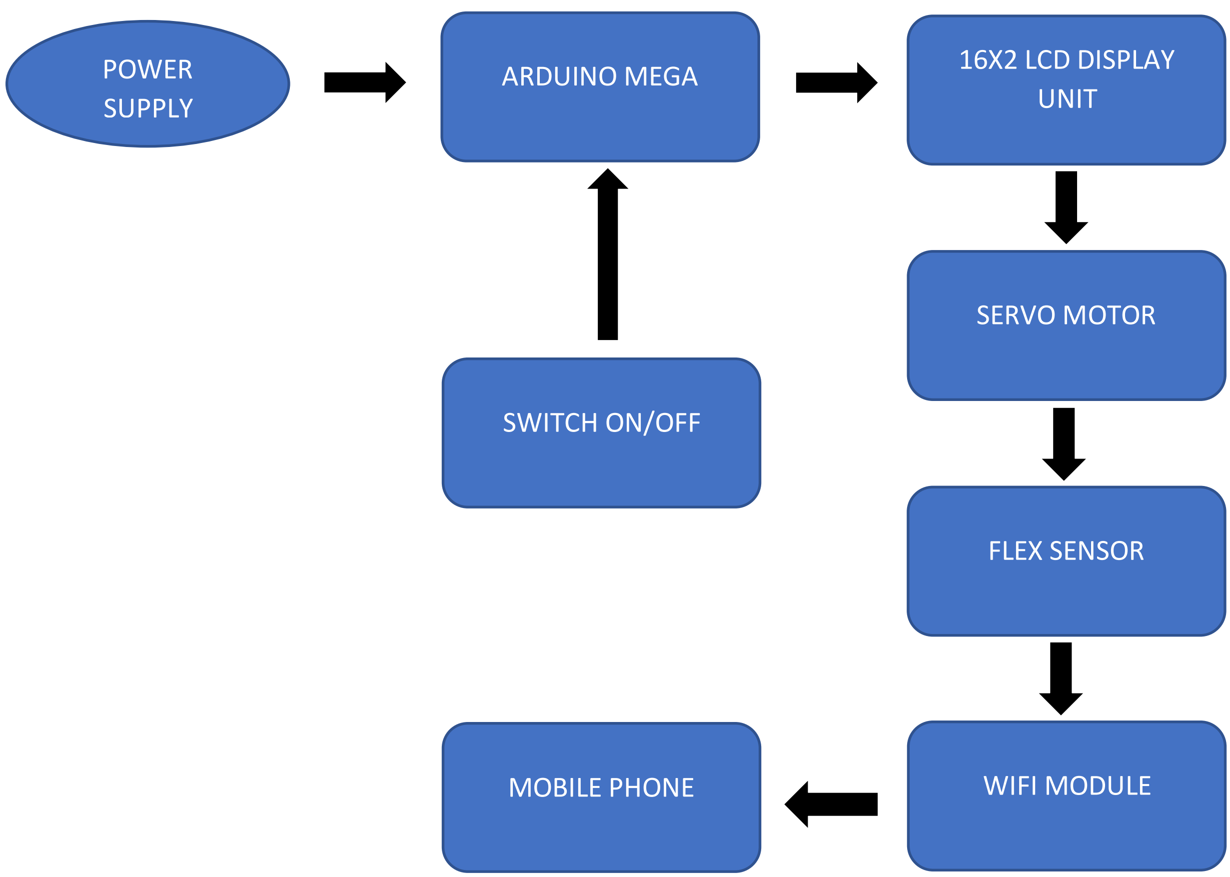


Figure 3.6 Block Diagram for Hardware

3.3.4 Block Diagram Circuit

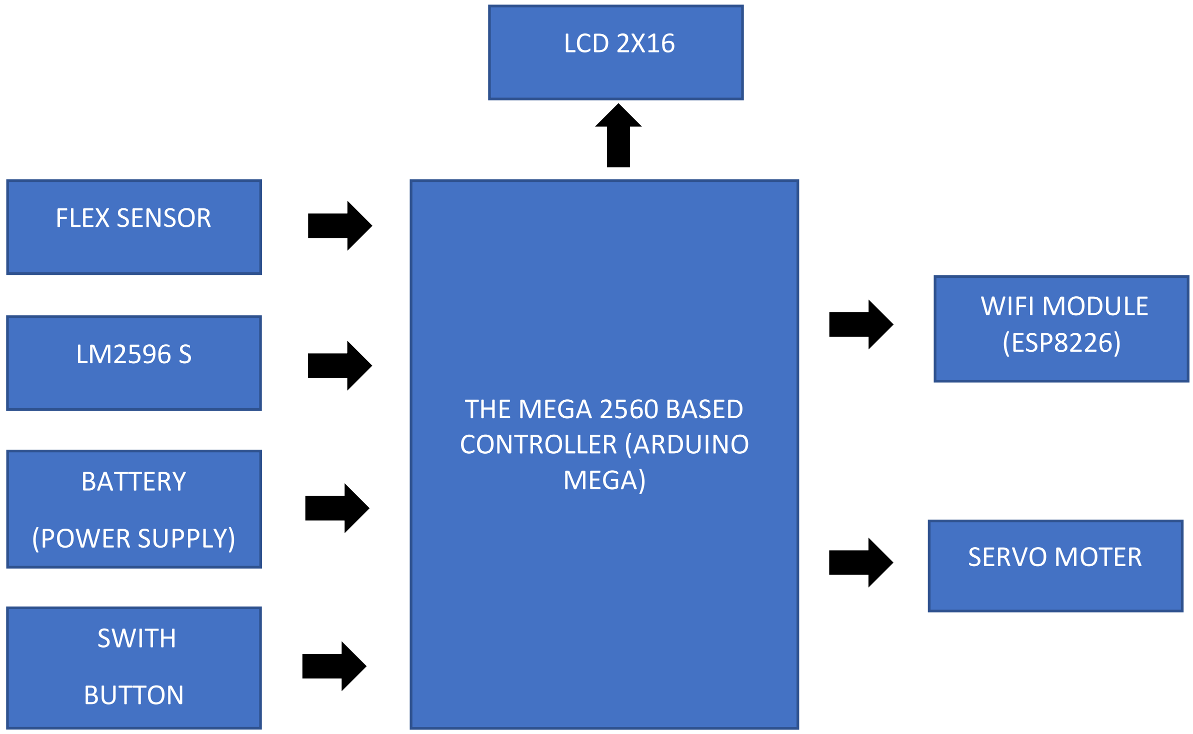


Figure 3.7 Block Diagram Circuit

3.3.5 Block Diagram of the Electronic Component

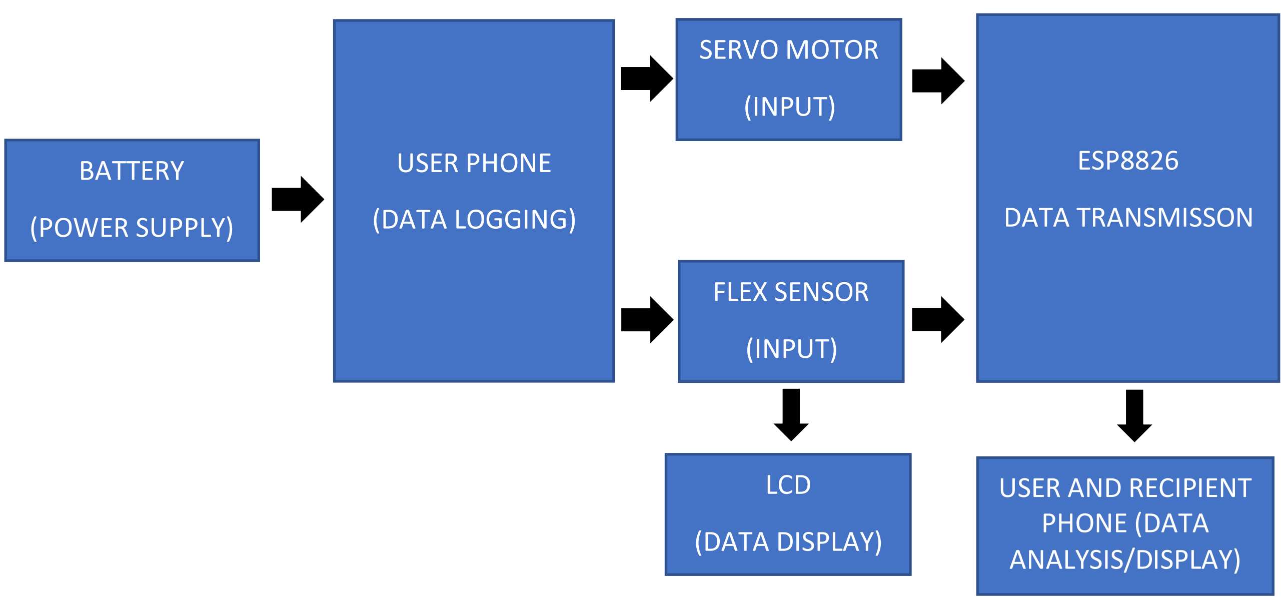


Figure 3.8 Block Diagram of the Electronic Component

3.3.6 Circuit of Project (Schematic Circuit)

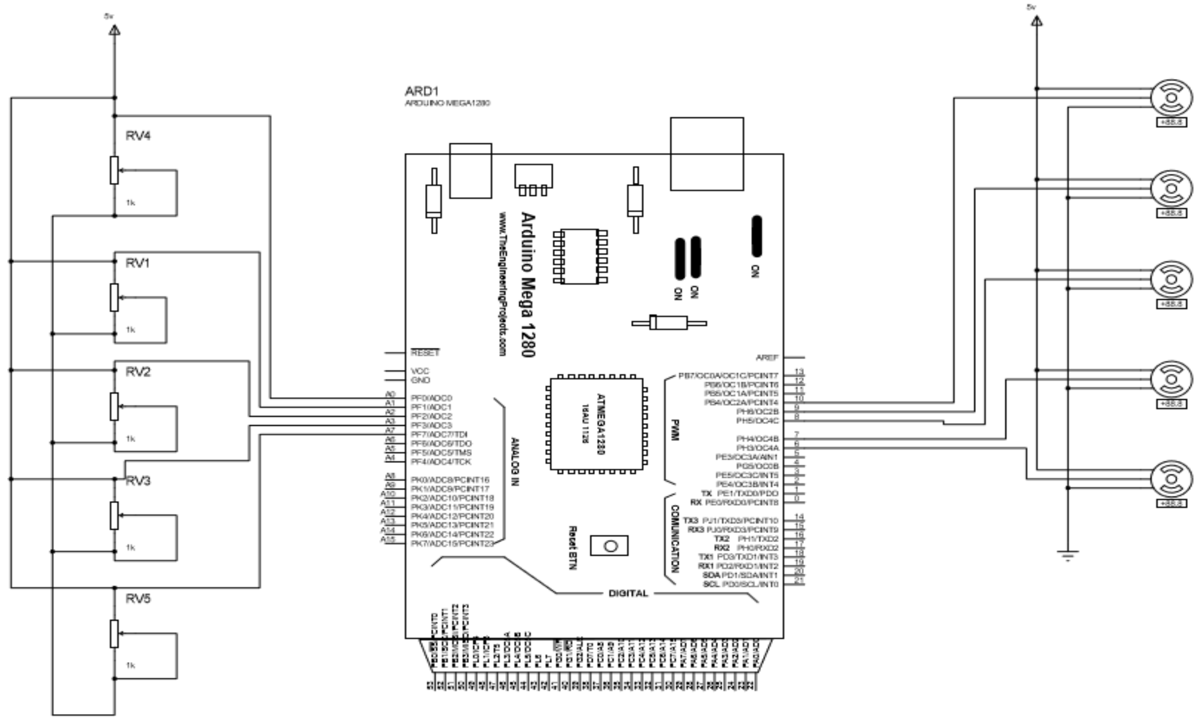


Figure 3.9 Circuit of Project

3.4 DESIGN:

3.4.1 Glove Design

Figure 3.10 Example of Glove Design

3.4.2 Structure of Project Design

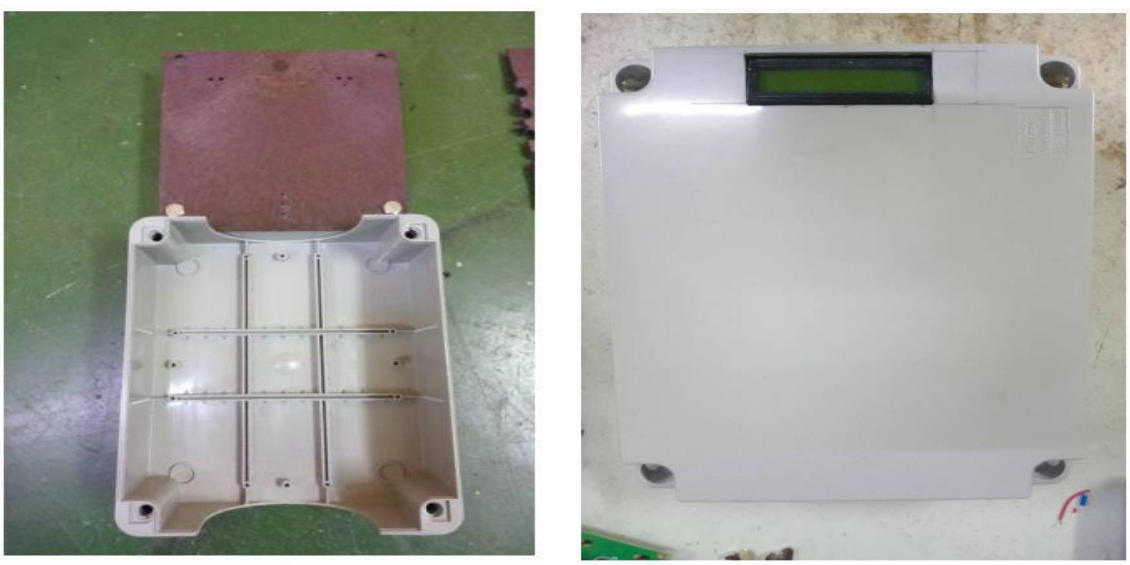


Figure 3.11 Structure of Project Design

3.5 Main Components:

1)Arduino Mega

Figure 3.12 Arduino Mega

An open source programmable circuit board that can be integrated into a wide variety of makerspace projects both simple and complex. This board contains a microcontroller which is able to be programmed to sense and control objects in the physical world. By responding to sensors and input, the Arduino is able to interact with a large array of outputs such as LEDs, motor and display.

2) Servo motor

Figure 3.13 Tower Pro SG90 Micro Gear Servo

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servo motors, or servos are self-contained electric devices that rotate or push parts of a machine with great precision. Servos are found in many places: from toys to home electronics to cars and airplanes. If you have a radio-controlled model car, airplane, or helicopter, you are using at least a few servos. In a model car or aircraft, servos move levers back and forth to control steering or adjust wing surfaces. By rotating a shaft connected to the engine throttle, a servo regulates the speed of a fuelpowered car or aircraft. Servos also appear behind the scenes in devices we use every day. Electronic devices such as DVD and Blu-ray Disc players use servos to extend or retract the disc trays.

For the project, the string is attached to the servomotor to create a movement of flexion and extension of hand. This servo can be purchased with 180 or 360 degree rotation for robotics applications.

Tabel 3.1 The Specifications for Tower Pro SG90 Gear *Servo*:

Modulation:	Analog
Torque:	**4.8V:** 25.00 oz-in (1.40 kg-cm)
Operating Voltage	**5V**
Speed:	**4.8V:** 0.1.2 sec/60°
Weight:	0.32 oz (9.0 g)
Dimensions:	**Length:**0.91 in (23.0 mm) **Width:**0.48 in (12.2 mm) **Height:**1.69 in (29.0 mm)
Motor Type:	Tower Pro SG90 Gear Servo
Gear Type:	Plastic
Rotation angle:	180 Degree
Pulse Cycle:	1 ms
Connector Type:	JR

3) Gloves @ Zipper

Figure 3.14 Example of glove

The project have used cotton glove because this glove more lightly and it will make the servo motor can more easily in pull and push sessions.

4) Flex Sensor

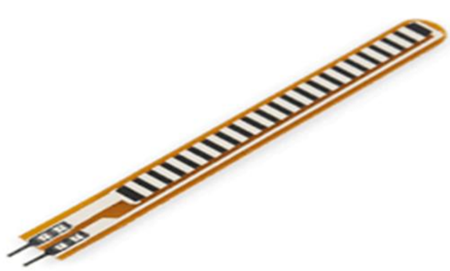


Figure 3.15 Flex Sensor

Flex sensor is a variable resistor like no other. The resistance of the flex sensor increases as the body of the component bends. Sensors like these were used in the Nintendo Power Glove. They can also be used as door sensors, robot whisker sensors, or a primary component in creating sentient stuffed animals.

4) LM2596S

Figure 3.16 LM2596S

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixedfrequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 7-pin TO-220 package with several different lead bend options, and a 7-pin TO-263 surface mount package..

5) Wifi Module ESP8266

Figure 3.17 ESP8226

The ESP8266 Wifi Module is a self contained SOC with integrated TCP/IP Protocol stack that can give any microcontroller access to wifi hospot

6) Monofilament Nylon

Figure 3.18 Monofilament Nylon

The connector between servo motor and glove

7) Liquid Crsytal Display (LCD)

Figure 3.19 LCD

It can display 16 characters per line and there are 2 such lines

3.6 Sample of Questionnaire

3.6.1 Questionnaire before use

POLITEKNIK MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH

We are a student of the Polytechnic Engineering Department of Sultan Salahuddin Abdul Aziz Shah from the Department of Electronic Engineering (Medicine) who wishes to conduct questionnaires and analysis on our Final Project. You are asked to answer some of the questions we provide below. Our project is associated with physiotherapy on the arms and fingers after the patient has been attacked by 'Stroke'.

Please mark [/] based on the space provided.

Gender:

Men [ ]

Women [ ]

Age:

Under 20 [ ]

20-30 [ ]

31-40 [ ]

41-50 [ ]

51-60 [ ]

Work Sector:

Student [ ]

Employee [ ]

Please tick (/) based on the statements provided in the scale below.

1	2	3	4	5
Disagree	Not Satisfied	Satisfly	Agree	Strongly Agree

No.	Statement	1	2	3	4	5
1	Stroke are very dangerous					
2	Stroke attack the victim from various ages.					
3	The probality of stroke that been face by the aged people are high.					
4	Stroke sufferer could be treated.					
5	Stroke patient takes a long time to recover.					
6	The frequency of physiotherapy process are the higher factors for recovery process					
7	The ability of hand (finger) are the most affected part of the patient Stroke.					
8	Stroke patient need an extra supervision.					
9	This Physiotherapy device are portable to bring anywhere.					
10	Physiotherapy device could help increasing the recovery process.					

1.6.2 Questionnaire After

QUESTION AIR

We are the student for Department of Electrical Engineering of Polytechnic Sultan Salahuddin Abdul Aziz Shah from the Department of Electronic Engineering (Medical) wanting to do questionnaires and analysis on our Final

Project. You are asked to answer some of the questions we have provided below. Our project is associated with physiotherapy on the fingers after the patient that is been attack by a 'Stroke'.

Order

Please mark [⁄] based on space that has been provide.

Gender:

Man	[ ]
Woman	[ ]

Age:

20-30	[ ]
31-40	[ ]
41-50	[ ]
51-60	[ ]

Others (State) [ ]

Work Sector:

Student [ ]

Worker [ ]

Please mark (⁄) based on the statement that has been provide by the scale below.

1	2	3	4	5
Disagree	Not Satisfactory	Satisfactory	Agree	Very Agree

Bil	Statement	1	2	3	4	5
1	The device could help the stroke patient in their rehabilitation process.					
2	This device bring an impact in increasing the frequent for the patient to perform this therapy in their recovery process.					
3	This device could help perform grasp and release of finger.					
4	This device could help the stroke patient to perform therapy without frequent supervision by the physiotherapy staff.					
5	This device are comfortable to be wearing.					
6	The device could measure how much percent of the finger of patient that can be bent.					
7	The device could can help therapist to identify the patient's health status.					
8	The project easy to identify and measurement results are displayed on the mobile phone					
9	This project can control servo motor using smart phone application					
10	This project suitable for patient that have stroke level one and two					

3.7 Gant Chart

GANT CHART

LECTURE WEEKS / PROJECT ACTIVITIES	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8	W 9	W 10	W 11	W 12	W 13	W 14	W 15
INTRODUCTION TO PROJECT															
SELECTING ON PROJECT OPTIONAL															
PRESENT AND DEFENDING PROJECT TITLE															
MAKING A PROPOSAL															
SEARCHING THE LITERATURE															
MAKE A RESEARCH ABOUT LR															
COMPLETE THE LITERATURE															
PREPARING THE METHODOLOGY															
RESEARCH AND DESIGN THE CIRCUIT															
PRODUCE A SCHEMATIC PROJECT															

FINALIZE THE CIRCUIT															
PRESENTATION OF PROJECT															
SUBMISSION OF FINAL REPORT PROPOSAL															

LECTURE WEEKS / PROJECT ACTIVITIES	**W 16**	**W 17**	**W 18**	**W 19**	**W 20**	**W 21**	**W 22**	**W 23**	**W 24**	**W 25**	**W 26**	**W 27**	**W 28**	**W 29**	**W 30**
BUILDING THE BOX AND DESIGN															
QUESTIONAIRE SESSION															
DIGEST PAPER															
BUILD PROJECT															
COMPETITION PROJECT															
REPORT SUBMISSION															

3.8 BUSINESS PLAN

Glove Finger Rehabilitation Business Plan

1.0 Executive Summary

BioRehab Physiotherapy Sdn. Bhd is a small company that produces electronic devices that focuses in society's healthcare. It is own and run by a group of two student form Politeknik Sultan Salahuddin Abdul Aziz Shah and located at Shah Alam, Selangor. The company produces electronic device and begins its operation at early 2015.

The company produces electronic devices that focuses is society's healthcare especially patient with diabetic foot. The company's product is a device which help patients with glove finger rehabilitation to develop a device for patient having daily treatment without frequent assistance from therapist. The company's product name is 'Glove Finger Rehabilitation'.

The company's goal is to produce 30 units by the end of 2019 where 1 unit will be cost among Rm800-Rm1000. In order to achieve this goal, BioRehab Physiotherapy company will sell this product among hospital, clinics and social media.

3.0 Introduction

3.1 Name of business

BioRehab Physiotherapy Sdn Bhd

3.2 Nature of business

BioRehab Physiotherapy Sdn. Bhd is a physiotherapy clinic based in Kota Kinabalu. We are specialising in the treatment of pain, sport's injuries, post operative rehabilitation, fertility massage, stroke rehabilitation, work related injuries physiotherapy and many more. With a team of professional physiotherapists, we are committed to deliver the best treatment approach to our clients with affordable rate. We are an award winning company under the category of "Excellence Brand" by The Asia Pacific International Entrepreneur Excellence Award in the year of 2017. We are also appointed as the only physiotherapy provider for the T2 Asia Pacific Table Tennis League which we saw many World Ranking Table Tennis athletes who are under our care.

3.3 Location of business

BioRehab Physiotherapy Sdn Bhd is located at Lot No. 5, Ground Floor, Block A Hong Tong Centre, Mile 4, Taman Hiburan, 88500 Kota Kinabalu, Sabah .The location is strategic because it is at the centre of business area where it was famous for retail rehabilitation centre.

3.4 Date of commencement

24 October 2015

3.5 Factors in selecting the proposed venture

We have decided to establish this business due to the concern come from myself and society around me, also for its potential to become successful. Besides that, there are several reasons that attracted me to this business and its location. Altogether, we have prepared three reasons why we decided to establish BioRehab Physiotherapy Sdn Bhd.

Firstly, I observed that Shah Alam mainly the store location is a center for society to shop. As such, this is a great opportunity for our company to be one of the customers' choices. Our company will compete with more fresh and great strategy so that we can stand tall as the competitors around us.

3.6 Future prospect of the business

Once the business is stable, we plan to open other braches and expand the business in other area. Besides that, we would also like to improve and upgrade our quality of services and the number of workers in our company. To provide better quality services, we plan to hire welltrained workers who have been trained in any training institutions such at skills institutions.

As conclusion, this business has a good future prospect by fulfilling the needs of stroke patient who to develop a device for patient having daily treatment without frequent assistance from therapist.

4.0 PURPOSE OF PREPARING BUSINESS PLAN

1.0 Help Biorehab Physioterapy Sdn Bhd to stay organized

- BioRehab's business plan helps company to clarify organize the steps that are needed to make sure the company's product successful also wanted in society
- The business plan can ensure the company won't skip any important steps that could derall the effort down the line

1.1 BioRehab Physioterapy Sdn Bhd will stay focus and on track

- A well- written plan provides the company with a starting point and outline a timetable that drives the company's activities, focuses on the target market also strategies with business tactics

1.2 Clarify and Focus for BioRehab Sdn Bhd

- It spells out the company's purpose,vision and mean of operation. It clearly states the amount of capital the needs to make the company work.

1.3 Prepare for the future of BioRehab Sdn Bhd

- Market research in the business plan should include projections based on the consumer needs and ability to fulfill those need especially for stroke patient

5.0 BUSINESS/COMPANY BACKGROUND

Name of the company	BioRehab Physioterapi Sdn Bhd
Address	Lot No. 5, Ground Floor, Block A Hong Tong Centre, Mile 4, Taman Hiburan, 88500 Kota Kinabalu, Sabah
Telephone number/fax number/email address	088-717 918/5138423722/biorehab@gmail.com
Form of business ownership	Business partnership
Main business activities	Physioterapy service
Date of commencement	24/10/2015
Date of registration and registration number	15/8/2015/1001320-A
Equity contribution (cash/asset)	Assets(RM 500000) cash
Name of the company bank	Maybank
Bank account number	162021797101

6.0 BACKGROUND OF OWNER/PARTNER/DIRECTORS

Partner 1

Name	: Muhamad Azam Hakimi Bin Khamis
Identify card number	: 990826-02-5729
Permanent address	: B4-03-09, Apartment Seri Jati,40710 Setia Alam Selangor
Telephone Number	: 0163236120
Email Address	: azamhakimi26@gmail.com
Website	: biorehabphysiotherapy.com.my
Date of Birth	: 26 August 1999
Age	: 20 years old
Marital status	: Single
Academic Qualifications	: Sijil Pelajaran Malaysia
Course attended	: Currently enrolled in Diploma of Medical Electronic
Skills & Experience	: Experience in marketing product electronic engineering
Present Occupation	: Student

Capital contribution : RM 1200

Partner 2

Name : Nur Syazwani Binti Sudin

Identify card number : 990903-03-6166

Permanent address : Blok G-9-13,Pangsapuri Sri Perantau,42000 Pelabuhan Klang,Selangor Darul Ehsan.

Telephone Number : 0182944755

Email Address : nursyazwanisudin@gmail.com

Website : biorehabphysiotherapy.com.my

Date of Birth : 03 September 1999

Age : 20 years old

Marital status : Single

Academic Qualifications : Sijil Pelajaran Malaysia

Course attended : Currently enrolled in Diploma of

Medical Electronic

Skills & Experience : Can create a creative strategy in the business product electronics

Present Occupation : Student

Capital contribution : RM 1200

7.0 ORGANIZATION/MANAGEMENT/ADMINISTRATION PLAN

7.1 COMPANY'S PRODUCT LOGO

The following below shows Logo that symbolise the company's product. 'Glove Finger Rehabilitation' is the name of the product that the company will produce. The word 'Rehabilitation' is being highlighted in the logo to emphasize that this product is to focus on people that suffered from Glove Finger Rehabilitation.

"You don't have to see the whole staircase, just take the first step" is the company trademark line as this product will help patient in rehabilitation to develop a device for patient having daily treatment without frequent assistance from therapist.

The Glove Finger Rehabilitation illustrate that the product is available to be used at all finger. The electric sparks represent sensors that has the ability to facilate the patient to measure their finger bend level at home.Besides,to make patients practice grasp and release concept of their finger mobility in a self-help manner.

Figure 11 COMPANY'S PRODUCT LOGO

7.2 COMPANY'S VISSION

• To build a healthcare device for patient having daily treatment without frequent assistance from therapist.

7.3 COMPANY'S MISSION

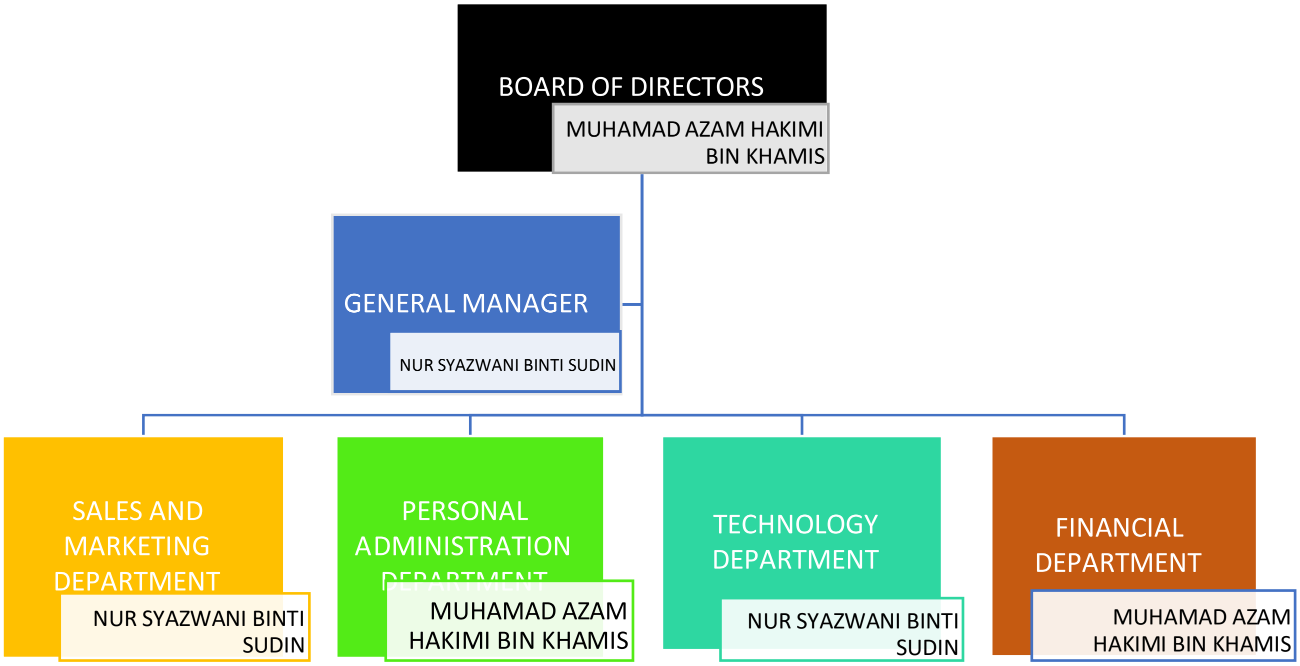
• To create a device with flex sensor and Iot (internet of things) concept that is capable to facilate the patient to measure their finger bend level at home.

7.4 COMPANY'S OBJECTIVE

- To build a low cost rehabilitation sensor device with an iot concept.
- To create a device used to measured their finger bend level at home.
- To create a device that is able to make a link to a health care provider or patient smart phone.
- To build a device that is user friendly to patients to be used anywhere and anytime.

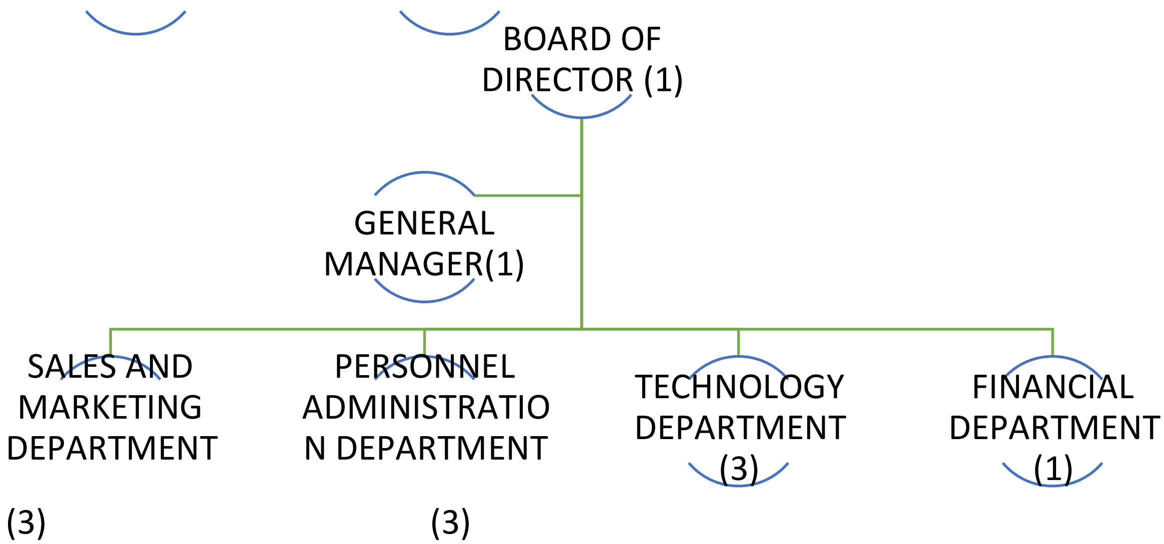
7.5 ORGANIZATIONAL CHART/STRUCTURE

An organizational chart is a diagram that visually conveys a company's internal structure by detailing the roles, responsibilities, and relationships between individuals within an entity



7.6 MANPOWER PLANNING

Manpower Planning which is also called as Human Resource Planning consists of putting right number of people, right kind of people at the right place, right time, doing the right things for which they are suited for the achievement of goals of the organization.



7.5 SCHEDULE OF TASK/RESPONSIBILTIES

POSITION	TASK/RESPONSIBILITIES	MANPOWER
BOARD OF DIRECTOS	• Determine the company's vision and mission to guide and set the pace for its current operations and future development. • Determine the company's vision and mission to guide and set the pace for its current operations and future development. • Delegate authority to management, and monitor and evaluate the implementation of policies, strategies and business plans of the company. • Ensure that communications both to and from shareholders and relevant stakeholders are effective for the company's product.	*Number of manpower: 1* *Position held by: Muhamad Azam Hakimi Bin Khamis*

GENERAL MANAGER	• Overseeing daily business operations. • Developing and implementing growth strategies of the company's business • Researching and identifying growth opportunities for the company and company's product future. Generating reports and giving presentations to all company's staff. •	*Number of manpower: 1* *Manage by: Nur Syazwani Binti Sudin*
SALES AND MARKETING DEPARTMENT	• Listening to customer needs in creating better product especially for diabetic patients. • Track trends and monitor competition • Work and brand values • Searching for new (and helpful) marketing' tools • Coordinate efforts with those of the marketing partners of the company (Aiszzy Electronics)	*Number of manpower: 3* *Manage by: Nur Syazwani Binti Sudin*
PERSONNEL ADMINISTRATIO N DEPARTMENT	• handles a variety of critical functions that help meet the needs of company owner, managers and staff • implement company policies and procedures handle specific performance issues •	*Number of manpower: 3* *Handle by: Muhamad Azam Hakimi Bin Khamis*

TECHNOLOGY DEPARTMENT	• responsible for creating new programs for the company's organization. • IT department creates and maintains the company's application. • provides support to computer users in the company • responsible for installing and setting up the computer network in an organization	*Number of manpower: 3* *Managed by: Nur Syazwani Binti Sudin*
FINANCIAL DEPARTMENT	• tracking of all expenses (purchases, payments etc.) and sales of finished products • prepare the company's budgets and forecasts	*Number of manpower: 1* *Managed by: Muhamad Azam Hakimi Bin Khamis*

7.7 RUMENARATION PLAN

POSITION	MONTHLY SALARY (RM)	EPF/KWSP (13%) (RM)	SOCSO (2%) (RM)	TOTAL (RM)
MANAGER'S DEPARTMENT	**1000.00**	**130.00**	**20.00**	**1150.00**
WORKER	**800.00**	**104.00**	**16.00**	**920.00**

7.8 LIST OF OFFICE EQUIPMENT

EQUIPMENT	TOTAL
LAPTOP	**3**
PRINTER	**1**
A4 PAPER (CARTON)	**1**

7.9 ADMINISTRATIVE BUDGET

Administration Budget		
	RM	RM
Fixed asset/Capital expenditure		
-		
Working capital/monthly expenditure		
Manager's allowance	2000	
Worker's salaries	3000	
EPF	270	
SOCSO	60	
Office maintenance	100	
Office supplies	1000	
Rental	30	
Water bill	100	
Electricity bill	100	
Telephone / Fax	100	
Transportation		6860
Other expenditures		
Clear & promotion	100	
		100
Total		6960

8.0 Marketing Plan

BioRehab Physiotherapy Sdn Bhd is involved in the medical and health industry. We believe that our country's economy which is expanding positively place its part in the development in BioRehab Physiotherapy Sdn Bhd . With the increasing number of working men in the community, BioRehab Physiotherapy Sdn Bhd is able to take advantage of this development but offering medical and health industry to them. By coming out with high quality service, we are sure that our business will able to compete with other competitors in Kota Kinabalu area.

8.1 Description of Products

Type of Product	Price (RM)
Glove Finger Rehabilitation	900

Table 1.8

8.2 Target Market

The target market of BioRehab Physiotherapy is comprised stroke patient for rehabilitation therapist at home around Kota Kinabalu.

8.3Market Size

The market size is calculated to be 8000 individuals from area listed below with a rough estimation of RM900.00 per month to buy stroke product rehabilitation .This will give a rough monthly income of RM7200000.00.

8.4 Competitors (Strength and weakness)

It is important for a business to identify their competitors, that also apply to us. Competitors is a businesses which offer similar product as us. Based on a survey we had done, here we listed a few competitors for our business. The table below also shows the strengths and weaknesses of our competitors.

Competitor	Product	Strength	Weaknesss
Biorehab Physiotherapy Centre Tawau TB 133, 1st Floor, Jln. St Patrick, Lorong Bengkok, 91000 Tawau, Sabah	Rehabilitation for Stroke Patient	Customer friendly.	No embroidery services.
Biorehab Physiotherapy Centre, Sandakan Branch Ground Floor, Lot No. 4 Utama Zone 3 Commercial Mile 6 North Road, 90000 Sandakan, Sabah.	Rehabilitation for Stroke Patient	Very popular.	Not many products offered.
BioRehab Physiotherapy Centre - Kulai No. 5252, Jalan Matahari, Bandar Indahpura, 81000 Kulai, Johor	Rehabilitation for Stroke Patient	Competitive pricing.	No embroidery service.

Table 1.9

8.5 Market Share

We are not able to identify the actual market share for our business as the data is ambiguous. However, we have taken our market share as 10% of the number of population in the age 4070 within our market area. Below is a table shows the percentage of share and its value.

No	Name	Share Percentage	Value
1.	Biorehab Physiotherapy Centre Tawau	30	30 000

2.	Biorehab Physiotherapy Centre, Sandakan Branch	20	20 000
3.	BioRehab Physiotherapy Centre - Kulai	30	30 000
4.	Others	20	20 000
	Total	100	100 000

Table 1.10

8.6 Sales Forecast

Month	ales forecast for three consecutive years (RM)				
	First year	**Second year**	**Third year**	**Total sales**	**Remarks**
August	-	7 200	8 300	15 500	
September	6 000	7 400	8 400	21 800	
October	6 000	7 500	8 600	22 100	
November	6 300	7 650	8 670	22 620	
December	6 400	7 800	8 880	23 080	Clearance sale
January	7 200	8 500	9 500	25 200	
February	6 800	7850	8 800	23 450	
March	6 850	7900	8 800	23 550	
April	6 800	7905	8 850	23 555	
May	6 900	8000	8 900	23 800	
June	6 950	8200	8 950	24 100	
July	7 000	8250	9 200	24 450	
Total	**73 200**	**94155**	**105 850**	**273 205**	

Table 1.11

8.7 Marketing Strategy

Criteria	Description
Product strategy and service strategy	We ensure that the products offered to the customers are of high quality and meet the customers' needs and demands. To maintain the high quality of our products, we : • Ensure that we selected the best design. • Only offered products that used high quality material.
Pricing strategy	The products and services we offered are reasonably priced to ensure that they remained affordable to customers. The business also keeps track of the changes of products rates by observing the rates offered by our competitors.

Distribution strategy	The location of our business is very strategic because it is located at the center of the shopping area in Kota Kinabalu. This area also have a high population of residents.
Promotion strategy	Our promotions will be done using social media platforms and through website. At the moment we rely more on "words of mouth" promotions by our existing customers.

Table 1.12

8.8 Marketing budget

Our marketing budget is mentioned as part of our administrative expenditure as shown in Table 1.7.

Administration Budget		
	RM	**RM**
Fixed asset/Capital expenditure		
-		
Working capital/monthly expenditure		
Manager's allowance	2000	
Worker's salaries	3000	
EPF	270	
SOCSO	60	
Office maintenance	100	
Office supplies	1000	
Rental	30	
Water bill	100	
Electricity bill	100	
Telephone / Fax	100	
Transportation		6860
Other expenditures		
Clear & promotion	100	
		100
Total		6960

9.0 Operational Plan

Operational plan is the most important factors to consider in a business. Like other companies, our target is to ensure that our customers is satisfied with our product. So, we always keep our products in its best quality. In order to keep all that in place, we create a systematic operational plan is formed so that our business runs smoothly and achieves its objectives.

9.1 Process Flow Chart

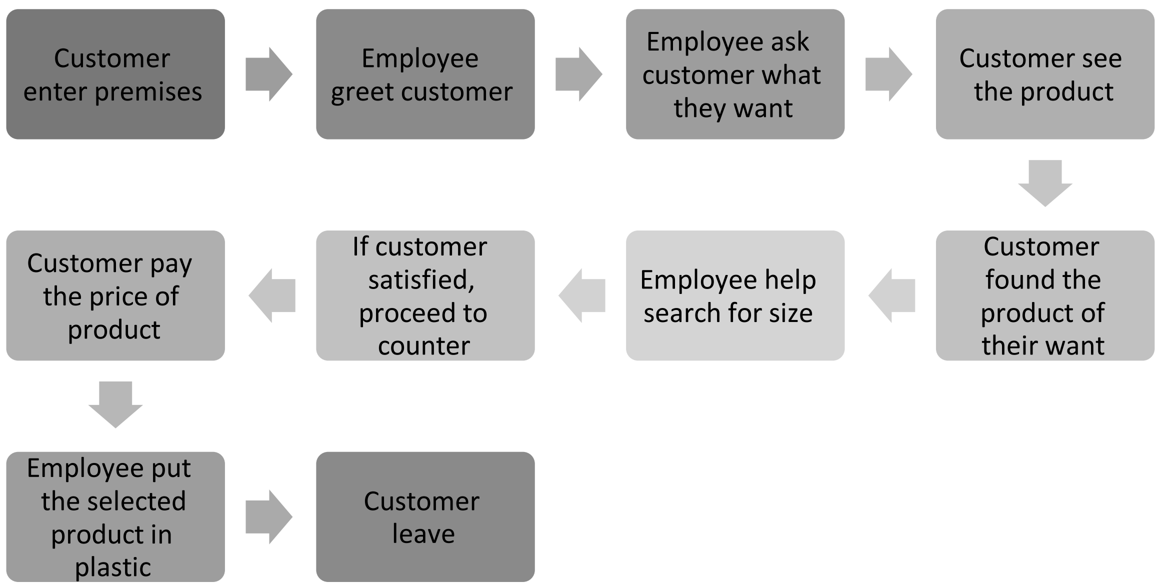


Figure 1.2

9.2 Production Schedule

Our store open for eight hours a day, starting from a 9.00 a.m. until 6.00 p.m. every Tuesday to Sunday. Our web and social media opened 24-hour and have fast response.

9.3 Material Requirements (Suppliers)

We obtained our products from a few suppliers. Table below shown the suppliers of our business.

No.	Name and Address	Type of products	Mode of payment
1.	Pizo Electronics Lot 1-33, Kenanga Wholesale Mall	Hardware	Cash

2.	Zd Electronic J1143, Bandar Sungai Long, 90000,Sandakan.	Programming Coding And Apps	Cash
3.	Electronic Hardware Supplier, 22F, Jalan Nanas, 91000,Tawau	Component electronic	Credit

Table 1.13

9.4 Location of Operation

- Lot No. 5, Ground Floor, Block A Hong Tong Centre, Mile 4, Taman Hiburan, 88500 Kota Kinabalu, Sabah

10.0 Financial Plan

10.1 Project implementation cost schedule and sources of finance

PROJECT IMPLEMENTATION COST AND SOURCES OF FINANCE							
Project implementation cost				**Suggested sources of financing**			
Requirements		**Cost**		**Loan**	**Hire Purchase**	**Own contribution**	
						Cash	**Existing assets**
Fixed assets							
Programming		250		15 000		5 965	
Component		45					
Hardware		150					
Air-Conditioner		3000					
Renovation		3000					
Cash counter machine		3000					
Furniture		3000					
			11445				
Working capital (per month)	1	8520					
Other expenses							
Registration		500					
Deposit		500					
Total				**15 000**		**5 965**	
		20 965		**20965**			

Table 1.14

10.3 Pro forma cash flow statement for 3 consecutive years

Table 1.18 Pro forma cash flow statement for 3 consecutive years

Year	Year 1	Year 2	Year 3
Cash inflow			
Owners capital	5 965		
Cash sales	73 200	94 155	105 850
Credit collection			
MARA	15 000		
Total cash inflow	94 165	94 155	105 850
Cash payments			
Administrative expenses			
Permanent asset	11 445	14 400	16 800
Manager's allowance	12 000	12 000	12 000
Building rent	12 000	33 600	38 400
Worker's salaries	28 800	3 600	3 840
EPF	3 240	900	984
SOCSO	720	360	1 200
Water bill	360	1 200	1 800
Electricity bill	1 200	1 200	1 800
Phone bill	1 200	1 200	1 800
Office maintenance	1 200	1 200	1 800
Office expenses	1 200	1 200	1 800
Marketing expenses			
Promotion	1 200	1 200	1 800
Transport	1 200	1 200	1 800
Operational expenses			
Registration	500		
Deposit	500		
Loan repayments			
Principal	1 800	2 400	2 400
Interest	855	1 140	1 140
Total cash outflows	78 240	75 840	86 604
Excess/deficit	15 745	18 315	19 246
Opening balance	-	14 475	32 725
Final balance	14 745	32 725	51 971

10.4 Pro forma income statement

Table 1.19 Pro forma income statement for the first year

BioRehab Physiotherapy Sdn Bhd Pro forma income statement for the first 31 year July 2019	
Less : Cost of sales (good sold)	
Goods available for sales	73 200
Gross profit	
Less : Operating expenses	
Administrative expenses	
Manager's allowance	12 000
Workers' salaries	28 800
EPF	3 240
SOCSO	720
Building rent	12 000
Electricity bill	1 200
Telephone bill	1 200
Office maintenance	1 200
Office expenses	1 200
Marketing expenditure	
Transport	1 200
Promotion	1 200
Operational expenditure	
Financial expenditure	
Diminishment (15%)	1 000
Payment interest (75)	650
Other expenditure	

Registration	500
Total operating expenses	64 460
Total net profit/loss before tax	7 090

Table 1.20 Pro forma income statement for the second year

BioRehab Physiotherapy Sdn Bhd Pro forma income statement for the first year 31 July 2019		
Less : Cost of sales (good sold)		
Goods available for sales		94 155
Gross profit		
Less : Operating expenses		
Administrative expenses		
Manager's allowance		14 400
Workers' salaries		33 600
EPF		3 600
SOCSO		900
Building rent		12 000
Electricity bill		1 200
Telephone bill		1 200
Office maintenance		1 200
Office expenses		1 200
Marketing expenditure		
Transport		1 200
Promotion		1 200
Operational expenditure		
Financial expenditure		
Diminishment (15%)		1 000
Payment interest (75)		650

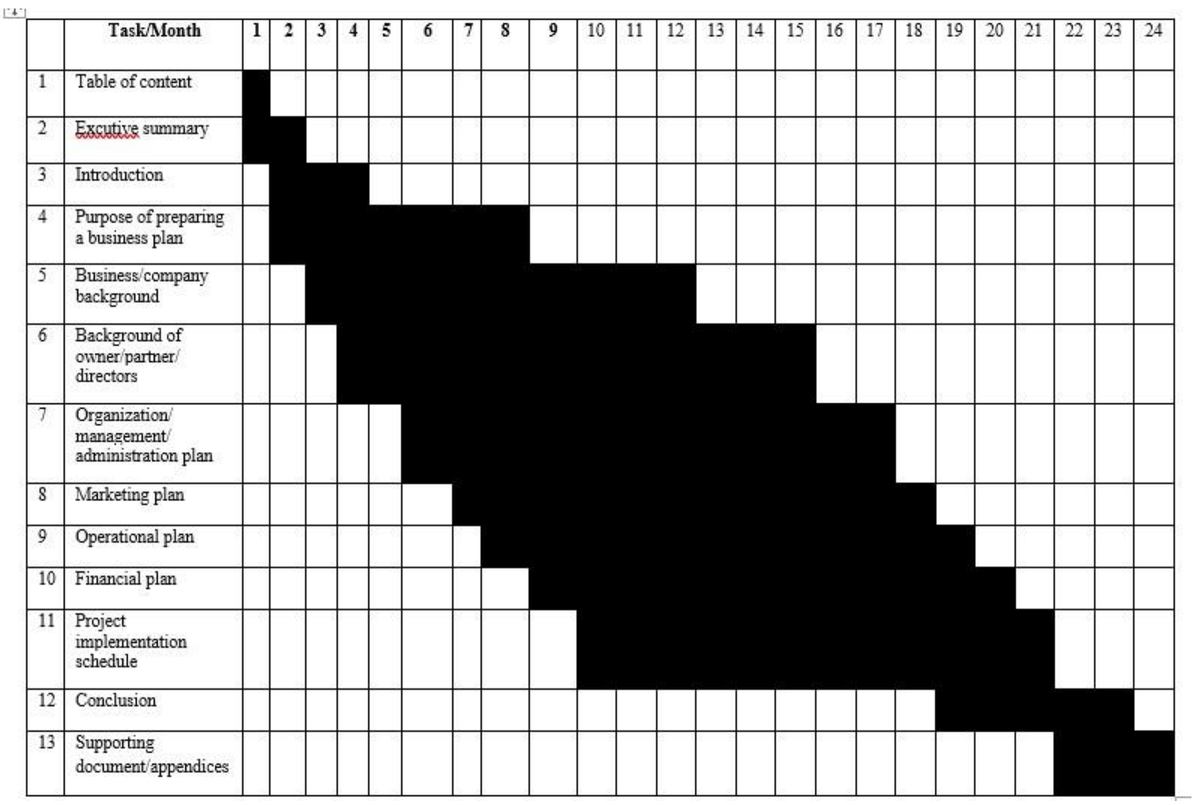
Other expenditure	
Registration	
Total operating expenses	72 510
Total net profit/loss before tax	19 246

Table 1.21 Pro forma income statement for the third year

Orchid Blouse Enterprise Pro forma income statement for the first 31 ʼear July 2019		
Less : Cost of sales (good sold)		
Goods available for sales		105 850
Gross profit		
Less : Operating expenses		
Administrative expenses		
Manager's allowance		16 800
Workers' salaries		3 840
EPF		984
SOCSO		12 000
Building rent		1 200
Electricity bill		1 800
Telephone bill		1 800
Office maintenance		1 800
Office expenses		1 800
Marketing expenditure		
Transport		1 800
Promotion		1 800
Operational expenditure		
Financial expenditure		

Diminishment (15%)	1 000
Payment interest (75)	650
Other expenditure	
Registration	
Total operating expenses	83 474
Total net profit/loss before tax	19 976

11. Project implementation schedule



12. Conclusion

12.1 Summary of business plan

Based on all the planning and projection of income and expenses, the company is very confident that this business venture will create a satisfactory return on investment from the second year of operation. For the first year, we are estimating to incur a very minimal loss as we have made a conservative estimate of sales and expenses based on the fact that the company has just started operation. The business will continuously perform the business startegies, especially on the marketing aspects to ensure that the business is well known to the customer and we hope to build a loyal customer base in the second year of operation.

We also hope this business plan and all the application of financing will be given due consideration from MARA for us to start the business. We also hope to becomeone of the most successful stroke rehabilitation product in Malaysia.

RESULT/ANALYSIS AND DISCUSSION

4.1 Introduction

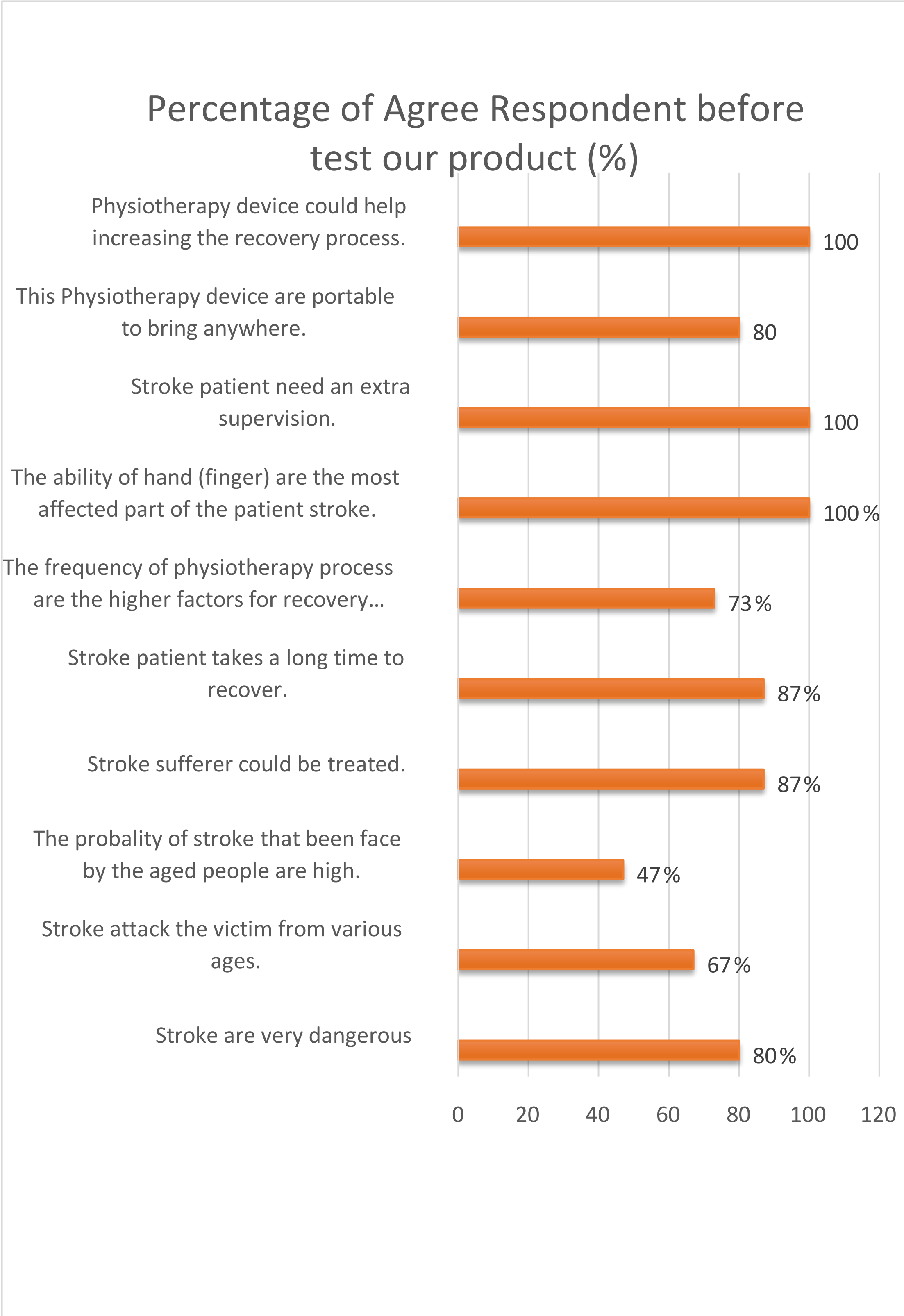
By the end of this project, this therapy glove (zipper) has been successfully created and we believe that it can help and ease the stroke rehabilitation process. This project can help people with stroke diseases to recover their senses by doing this simple rehabilitation. It is also to help minimize the movement of patient on their own during treatment and to help stroke victims or patients with lack of finger movement regain mobility in their hand. This therapy glove can perform the extension and flexion movement, the same movement that was made by the hand.

4.2 Result

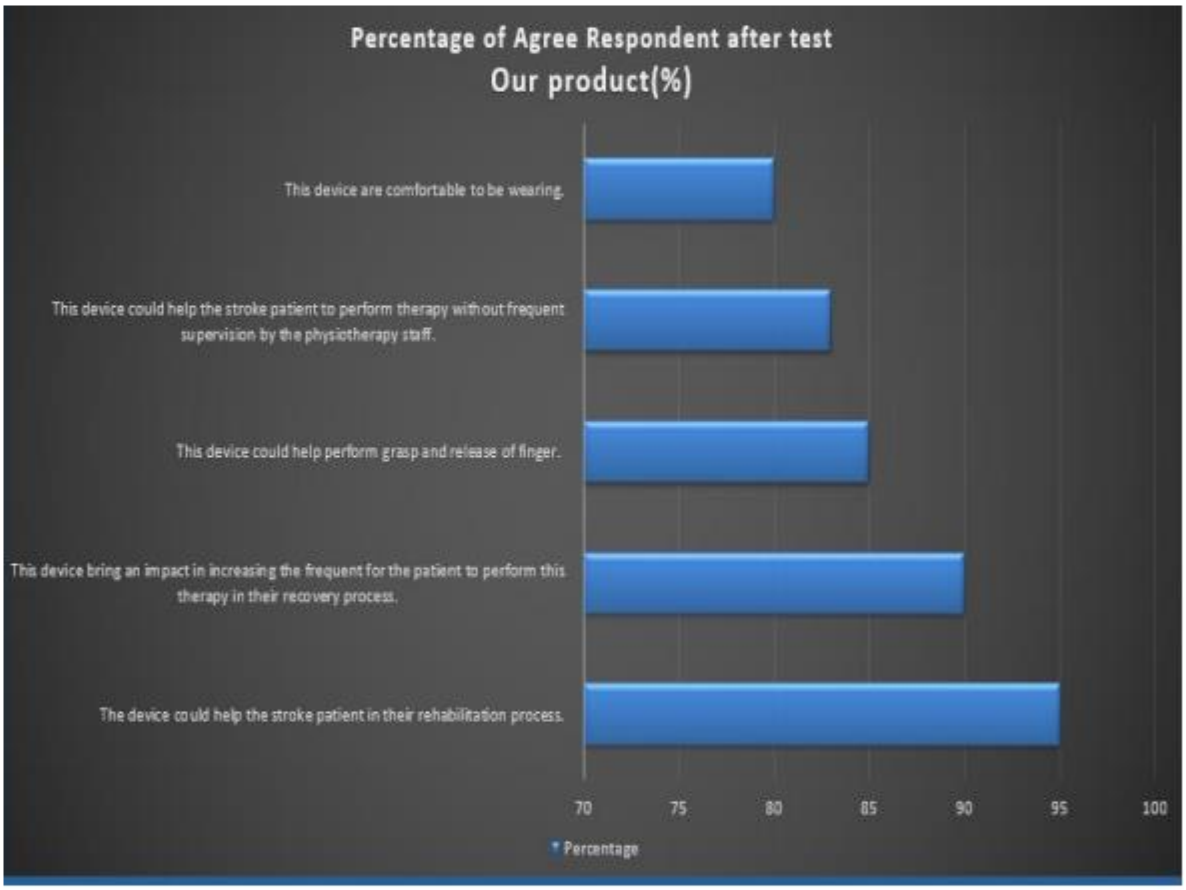
After doing some survey, a few questions were create regarding the idea of Glove Finger Rehabilitation (GFR). The questions consist of people's opinion and acceptance about the idea. The feedback regarding the idea is analysed.

Do qualitative and quantitative chart based on responders' answers. Below is the sample of the questionnaire that is divided to two sections. First section is demography part and the laryngoscope application satisfaction.

Figure 4.1: Analysis Question Air before Test GFR



In the pre questionnaire, we are doing survey on the need of rehabilitation equipment and about the stroke patient itself. We have prepared10 questions on this part and the result is shown in **Figure 4.1.** As the result, there were 3 questions that reach the highest result (100%), firstly, the rehabilitation equipment can improve the recovery process, stroke patients need to be monitored more often and hand's ability is frequently be part of body that affected by stroke. Then, there were there questions that reach between 80% and 87% where the respondents agreed stroke takes a long time to recover, stroke can be treated, and stroke is very dangerous disease. Finally, the lowest percentage which is 47% on the probability the old citizen to have stroke is high.



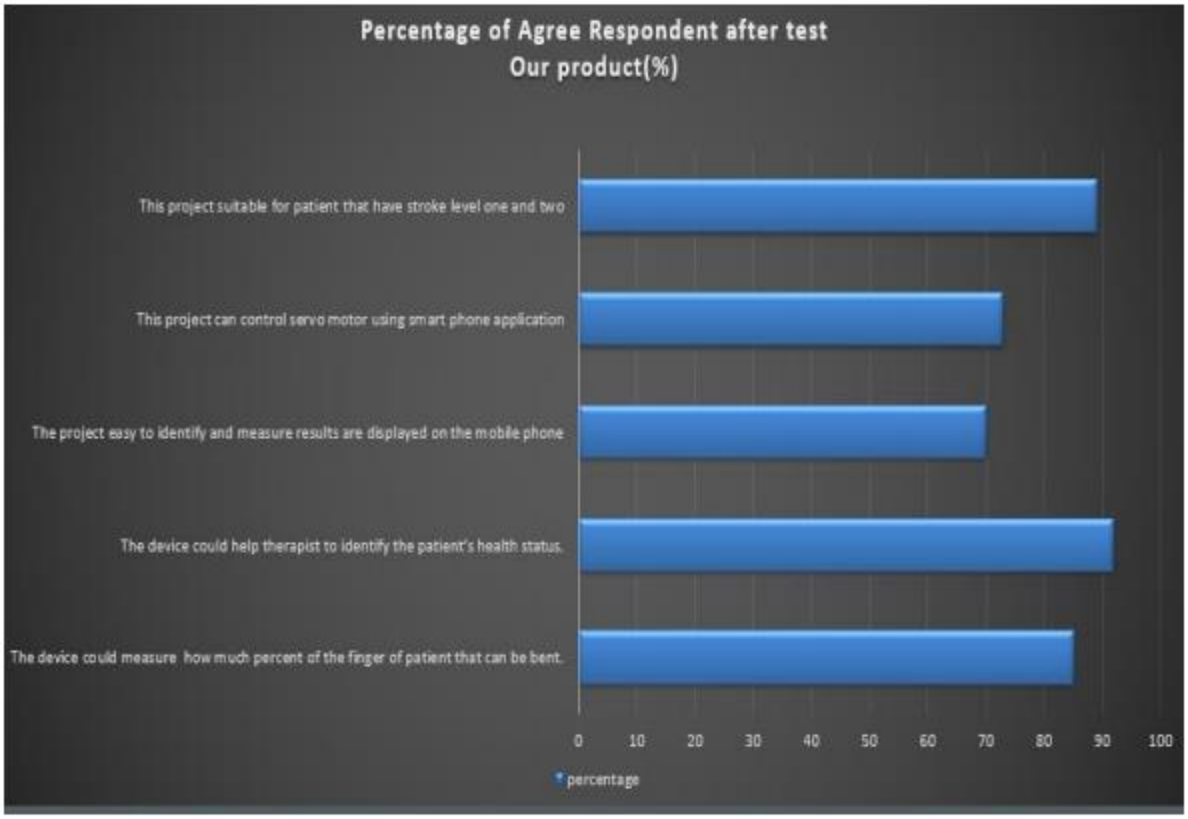


Figure 4.2: Analysis Questionnaire after Using GFR

Based on analysis on the post questionnaire that has been made as shown in Figure 4.2, that many respondents agreed that the glove finger rehabilitation can be a helper in rehabilitation process, which reach the highest percentage which is, 95% compared to others. The lowest percentage hits at 70% on the device could can help therapist to identify the patient's health status.Next, 95% respondents agreed that the device could help the stroke patient in their rehabilitation process.

4.3 Analysis

Analysis that can be made due through some observation, researches and questionnaires are, majority of the respondents have family members that suffers from stroke. This shows that in Malaysia, stroke is one of the usual medical issues that happens. The problem is, not all family are capable to support the high cost for rehabilitation in stroke which then may lead to death, or permanent disabilities. When the truth is, rehabilitation is something that is important for post-stroke patients to maintain a good and healthy life.

The stroke also usually attack those who is in the middle age and above especially for those who does not follow a healthy lifestyle such as, alcoholic, drug users, unhealthy diet but can also because of certain medical conditions. Majority of person that suffers from stroke usually lost their sense of touch.

These shows that, we need something that is available in our country, something that has ability to help rehabilitation process on low-cost. Also, a mobile and small device can be a big helper to the users to perform the process at anytime and anywhere. We can say that the invention of therapy glove brings a lot of advantages to the middle-age families and to the society itself.

4.4 Result at Blynk Application and LCD Display 4.3.1 Using button flex Sensor

4.4.1 Using button flex Sensor

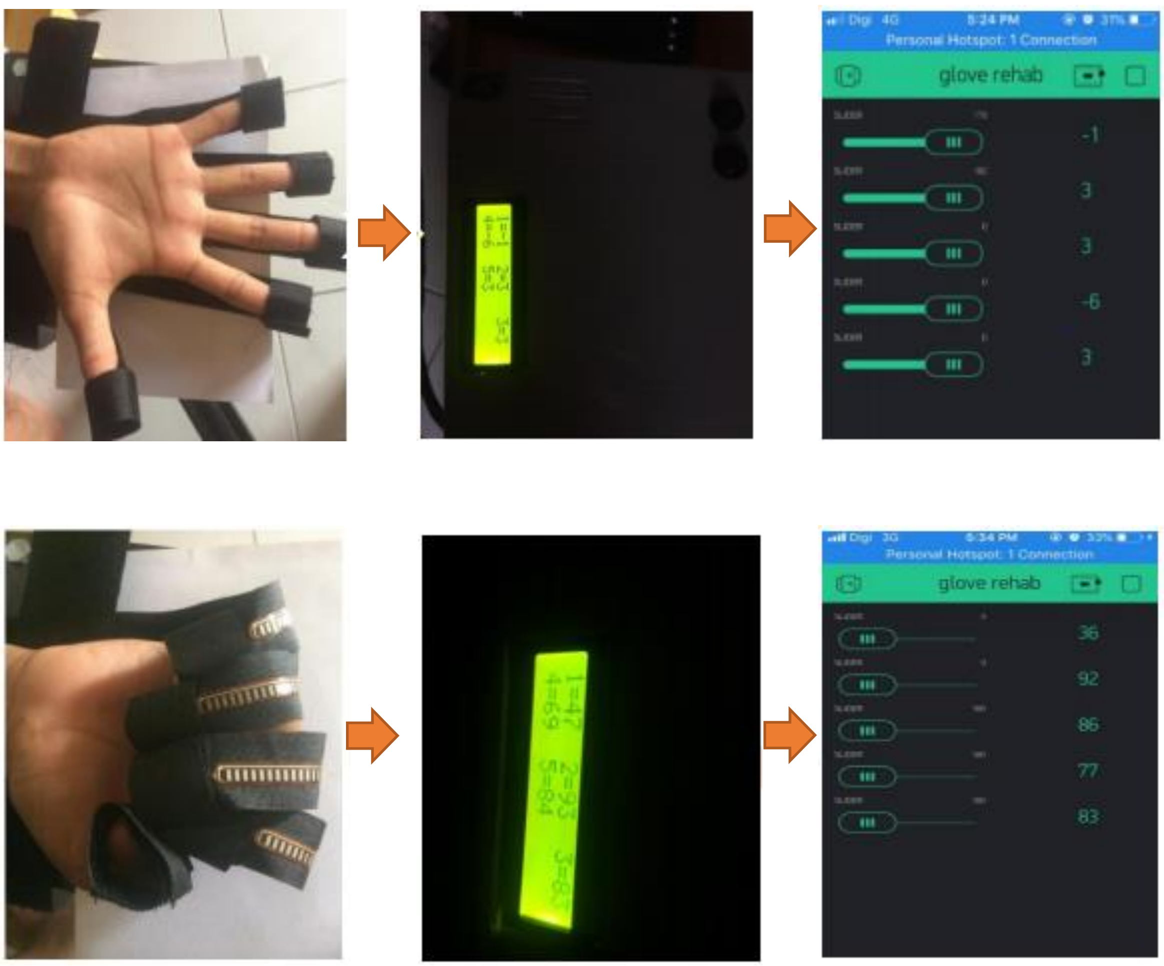


Figure 4.3 Result at Blank Application and LCD Display for Flex Sensor

4.4.2 Using button Servo Motor

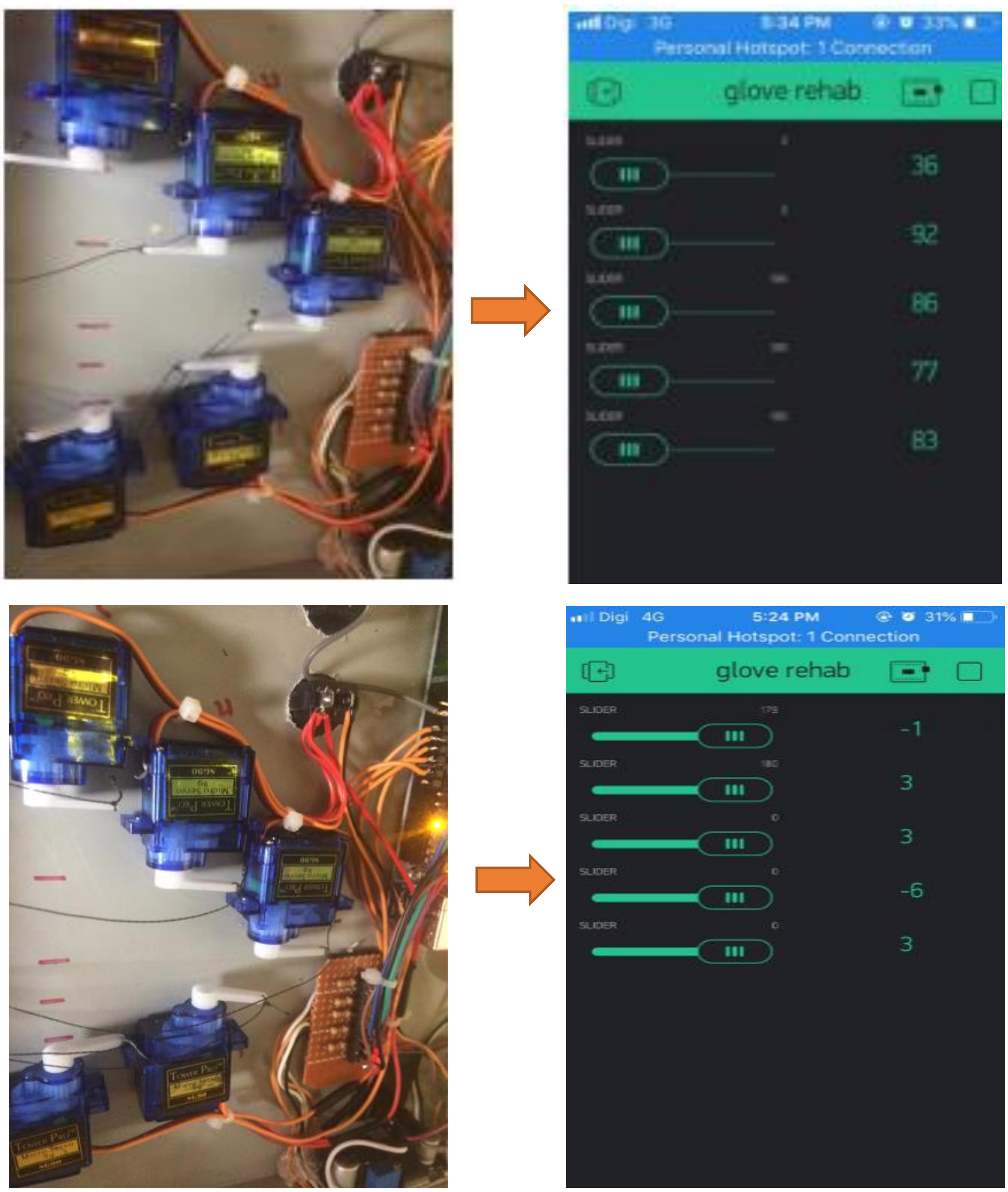
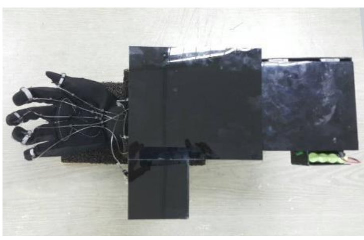


Figure 4.4 Result at the Blank Application for Servo Motor

4.5 Differentiation between Rehabilitation with other device rehabilitation

Design	Microcontroller	Motion	Battery	Component
Glove FingerRehabilitation	Servo Player	-Can control all five finger and can control finger one by one based on the user using Bylink Application. -Flex sensor measure a bent level and result display at the LCD and Bylink Application	Converter AC/DC /Battery	Servo Motor (SG90)
Glove Rehabilitation 	Servo Player	Can control all five finger and can control finger one by one based on users desire	Rechargeable battery	Servo motor (MG995)
Robotic Hand in Motion Using Arduino-Controlled Servos 	Arduino	Can control all finger at same time	Disposable battery	Servo motor

There are several type of differentiation about Glove Finger Rehabilitatio, Finger Rehabilitation and also with Robotic Hand in Motion Using Arduino-Controlled Servos. For the first differentiation is based on the microcontroller. In Glovr Finger Rehabilitation , we used Arduino Mega as a main circuit. It's because it easy to control with patient desire. In servo player, it have a button control at the Bylink Application and result 5 servo motor in Bylink. While Robotic Hand in Motion Using Arduino-Controlled Servos used Arduino as a main circuit to move 5 servo motor continuously and Finger Rehabilitation use a Servo Player as microcontroller have a button record and play where we can record 5 servo motor in simultaneously. It also can record 3 finger without changing any coding in the circuit. Besides that, the circuit can record four different type of motion according to what they want If want to move two or three finger, they must change the programming in the Arduino. Almost of guardian didn't know how to create or change the programming. Its take time to learn and to understand about programming. The second differentiation is a motion. Glove Finger Rehabilitaion can control all five finger and can control finger one by one based on users desire using Bylink Application same with Glove Rrehabilitation while Robotic Hand in Motion Using Arduino-Controlled Servos just only control all finger at same time. Lastly, the different between Glove Finger Rehabilitation, Finger Rehabilitation and Robotic Hand in Motion Using Arduino-Controlled Servos is in their battery. Glove Finger Rehabilitation use battery converter AC/DC that have a more energy. The Glove Rehabilitation use battery use a battery rechargeable and Robotic Hand in Motion Using Arduino-Controlled Servos use a disposable battery after using it.

4.6 Costing To Build Glove Finger Rehabilitation

Table 4.2: Costing to build Glove Finger Rehabilitation

Material	Quantity	Cost
Arduino Mega	1	RM 179.00
Servo Motor	5	RM 35.00
Flex Sensor	5	RM 225.00
LM2596S	2	RM 6.60
Glove @ Zipper	1	RM 15.00
ESP8266	1	RM 18.00
Box	1	RM 17.00
LCD	1	RM 11.00
Converter AC/DC	1	RM 40.00

Total to build this project is RM 546.60. There 8 material we use to build a Glove Finger Rehabilitation. The first item is arduino, the costing of this circuit is RM 179. Second item we use 5 servo motor because one finger will use one servo motor to make it grasp and release. The costing for 5 servo motor is RM 35. After that we use are flex sensor with price RM 225 use for measure bent level.The cost of 2 component of LM2596 is RM 6.60.Then, Wifi module ESP8226 is a RM 18.00 while a LCD price is RM 11.00.The main component that we use is a Converter AC/DC with a RM 40 and the glove price is in RM 15.00. The costing of the box is RM 17.00.

4.7 Discussion

Based on the analysis that has been done, this rehabilitation glove is highly suitable as a problem solver because of the affordable price which can be bought by middle-class and high-class families. The strings that we use for this Glove Finger Rehabilitation is highly suitable. Before this, we already tried by using guitar strings to replace the catgut string, but it does not provide comfort due to its hardness. The therapy glove is also, equipped with safety where there are no tangled wire hanging, and all the circuits were put in a case. We also use a box to put patient hand on it. It can be considered on their characteristics.

All of the components use include, box, Arduino mega, servo motor, flex sensor, glove and others are all we believed were the best components that is the most suitable for our therapy glove to provide comfort to the patients, and also equipped with a simple procedure to use it.

In the middle of this Project, we got a problem where 5 servo motor were broken because of the adaptor didn't have enough current to support servo motors to move 180 degree. So we decide to buy a converter AC/DC to support 5 servo motor in ability to motion simultaneous. After that, we also had a problem to specify the length of the optic cable which is monofilament nylon. The problem is when we must decide the length of monofilament nylon from servo motor to glove

By the end of this project, this therapy glove has been successfully created and we believe that it can help and ease the stroke rehabilitation process. This project can help people with stroke diseases to recover their senses by doing this simple rehabilitation. It is also to help minimize the movement of patient on their own during treatment and to help stroke victims or patients with lack of finger movement regain mobility in their hand. This therapy glove can perform the extension and flexion movement, the same movement that was made by the hand.

4.8 Processing to build Glove Finger Rehabilitation (GFR)

First Phase

Figure 4.5

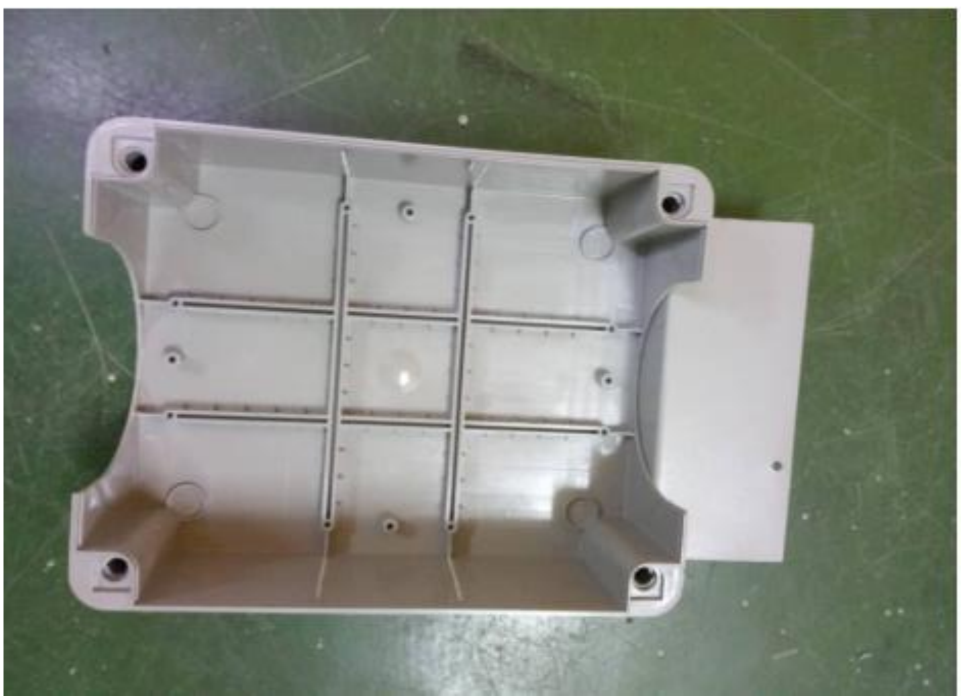


Figure 4.6

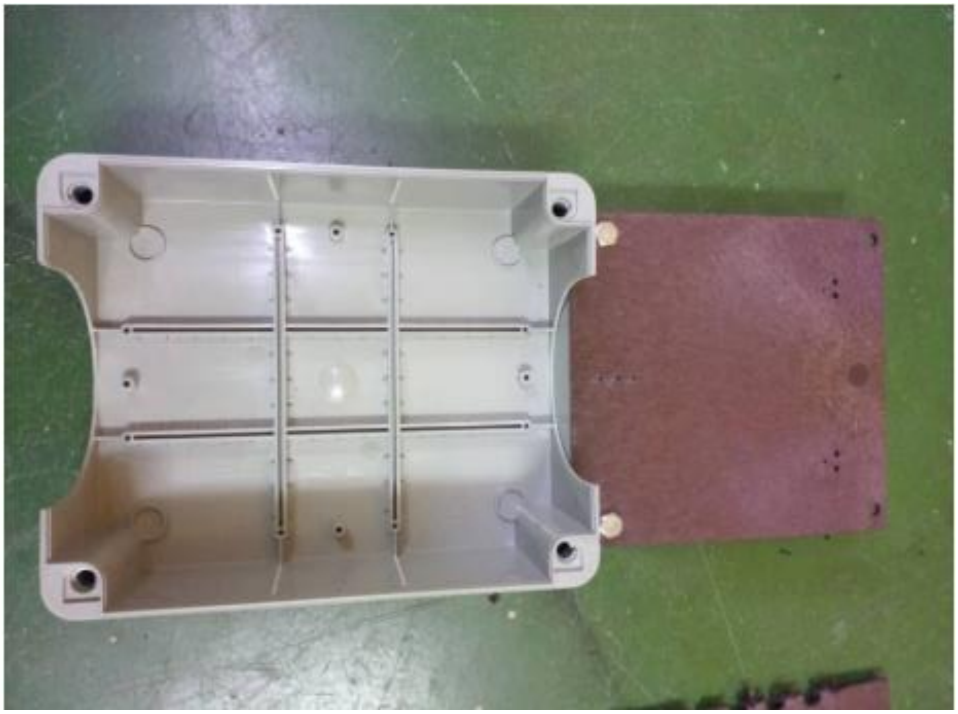


Figure 4.7

Figure 4.8

Figure 4.9

Figure 4.10

Figure 4.11

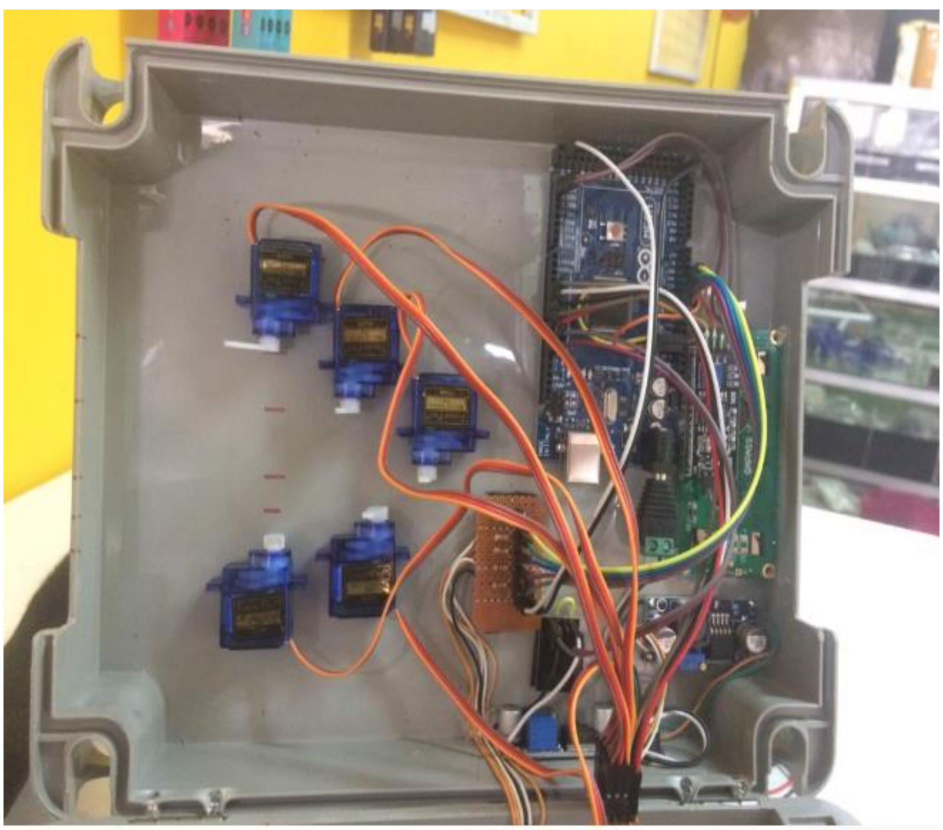


Figure 4.12

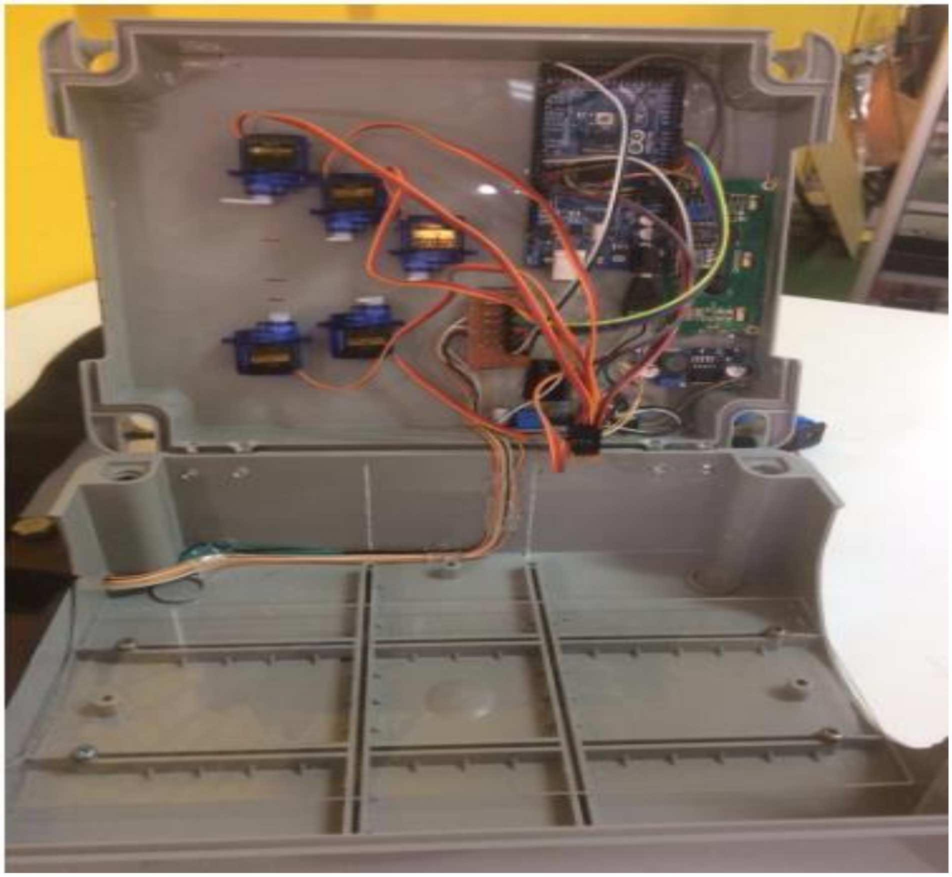


Figure 4.13

Figure 4.14

Figure 4.15

4.9 Standard Operation Procedure (SOP)

Blynk application using button Servo Motor

1. The guardian should help the patient insert his hand into the glove.

2. The guardian must ensure the patient's hands are comfortable.

3. Push the button Servo Motor “ON” for switch on the device.

4.The button of Flex Sensor must in a condition “OFF” for switch on the device.

5. Connect blynk application with hotspot for " ON" blynk at mobile phone.

6. Set movement servo motor at blynk application for move the patient hand.

7. The degree of movement servo motor displayed at blynk application in degrees unit.

Blynk application using button flex sensor

1. The guardian should help the patient insert his hand into the glove.

2. The guardian must ensure the patient's hands are comfortable.

3. Push the button Flex Sensor “ON” for switch on the device.

4. Connect blynk application with hotspot for " ON" blynk at mobile phone.

5. The button of Servo Motor must in condition “OFF” for switch on the device

5. Move your hands in grasp and release to get results in degrees in lcd display and blynk applications.

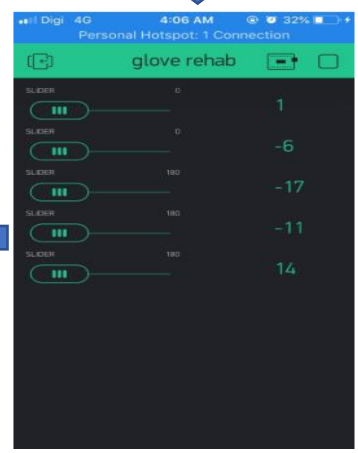
6. Data is displayed in percent unit at blynk application and lcd display at project.

4.9.1 SOP Guided in Diagram

The guardian should help the patient insert his hand into the glove.

The guardian must ensure the patient's hands are comfortable.

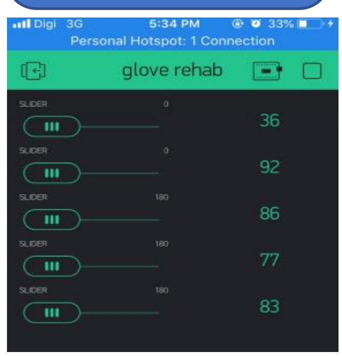
Push the button Flex Sensor “ON” for switch on the device and “OFF” the button of Servo Motor



Connect blynk application with hotspot for " ON" blynk at mobile

Move your hands in grasp and release to get results

Get results in percent in lcd display for 5 fingers.



Data also is displayed in percent unit at blynk application

CHAPTER 5

CONCLUSION

After a serious health event that requires hospitalization, many people will need rehabilitation services, such as physical therapy, speech therapy or nursing care until they are fully recuperated. Many families are not aware that they have choices regarding where to complete rehabilitation, and that it can take place in a variety of settings. Determining the best location for a loved one to do rehabilitation depends on family situation, personal preference and the availability in our area.

Rehabilitation may be started in the hospital but is usually completed at home, in a relative's home, at a skilled nursing facility (SNF) or in an assisted living community. The most important factor in determining where to complete rehabilitation is to find a setting that will reduce their risk of hospital readmission while helping them regain their strength and confidence as quickly as possible. There are many ways to do rehabilitation for stroke rehabilitation. One of the usual techniques that is used for this kind of stroke is that by massaging the hand of the patient. It requires energy from other persons to do this process.

Next, this product would help the patient to perform grasp and release concept of their finger mobility in a self-help manner. A recovery focused atmosphere that allows for learning, personal growth, coping and self-care strategies for the patient. Opportunities to learn effective techniques in areas of personal development, which enable one to recover their identity and being to experience life beyond a mental health addiction issue.

This device it could help the patient to having a daily treatment without frequent assistance from the therapist. We also help improve posture, which if left uncorrected can cause damaging musculoskeletal conditions.We help patients who have undergone surgeries and who are in need of therapy to regain optimal physical functionality.

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APPENDIX

Business Card