THE DEVELOPMENT OF DEXTERITY THERAPY DEVICE FOR STROKE PATIENTS

AINUL BASYIRAH BINTI JOHARI

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

DR. HJ. ZUNUWANAS BIN MOHAMAD
KETUA PROGRAM
IJAZAH SARJANA MUDA TEKNOLOGI KEJURUTERAAN ELEKTRONIK
(ELEKTRONIK PERUBATAN)
POLITEKNIK SULTAN SALAHUDDIN
ABDUL AZIZ SHAH

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AINUL BASYIRAH BINTI JOHARI

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2017

DECLARATION

I hereby declare that the work in this thesis is my own work carried out of one year Final Year Project for the award of Bachelor of Electronic Engineering Technology (Medical Electronic) With Honours. Under the guidance of my supervisor Rusnani Binti Yahya.

Signature	: ....
Name	: AINUL BASYIRAH BINTI JOHARI
Registration No.	: 08BEU15F3001
Date	: 21/6/2017

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ABSTRACT

Stroke or in other words is known as a “brain attack” might happen any time at anyone. During stroke, the brain does not receive enough oxygen or nutrients that may cause brain cells to die. When brain cells die, the abilities controlled by that area of the brain such as memory and muscle control are lost. Dexterity Therapy Device is one of the occupational therapy that will reclaim fine motor skills for stroke patients as early recovery. Dexterity Therapy Device needed the stroke patients to do the therapy session in a repetitive way as an exercise to their hand and fingers movement. According to numerous studies about occupational therapy, many physical therapies incorporate repetition of movement in a patient with neurological damage. Usability Test are conducted to 30 subjects. Subjects were tested by using the dexterity therapy device and questionnaire were distributed to them after the tested. This usability test consists of 3 main section to be considerate which are Section A for the Comfort ability, Section B for the Design and Section C for the effectiveness of the therapy device. The data then are analyzed by referred to the number of subjects responds toward the survey.

ABSTRAK

Strok atau dalam erti kata lain dikenali sebagai "serangan otak" mungkin berlaku bila-bila masa kepada sesiapa sahaja. Semasa strok, otak tidak menerima oksigen yang mencukupi atau nutrien yang boleh menyebabkan sel-sel otak mati. Apabila sel-sel otak mati, kebolehan yang dikawal oleh otak seperti memori dan kawalan otot hilang. Peranti Terapi Ketangkasan adalah salah satu terapi pekerjaan yang akan menuntut semula kemahiran motor halus untuk pesakit strok sebagai pemulihan awal. Peranti Terapi Ketangkasan diperlukan oleh pesakit strok untuk melakukan sesi terapi dalam dengan cara yang berulang-ulang sebagai latihan kepada pergerakan tangan dan jari mereka. Menurut banyak kajian mengenai terapi pekerjaan, banyak terapi fizikal menggabungkan pengulangan pergerakan dalam pesakit dengan kerosakan neurologi. Ujian Kepenggunaan dijalankan untuk 30 subjek. Subjek telah diuji dengan menggunakan peranti terapi ketangkasan dan soal selidik telah diedarkan kepada mereka selepas diuji. Ujian kebolehgunaan terdiri daripada 3 bahagian utama yang terdiri daripada Bahagian A untuk keupayaan keselesaan, Bahagian B untuk rekabentuk dan Bahagian C untuk keberkesanan peranti terapi. Data akan dianalisa berdasarkan jumlah tindak balas subjek terhadap soal selidik.

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CHAPTER I

INTRODUCTION

1.1 Background of Study

Dexterity therapy device is one of rehabilitation device that help stroke patient with upper extremity problem. Dexterity is the skill in performing tasks, especially with the hands. In this project, the development of the therapy device is more concern to the finger dexterity for stroke patients who have difficulty to move their finger. Finger is the most important part in any action of our daily life.

The purpose for this project is to develop a dexterity therapy exercise for stroke patients in a repetitive way. For the concept of this dexterity therapy device, the user will wear a glove that has red, blue and green light on each fingertip. The glove are wired to the lap table which has light up buttons with the same three colors. As the exercise is started, a LED on one of the fingertips and a matching color button on the table-top will illuminate. The user has to push the illuminated button with matching color on fingertips to turn off the light. As the light is turn off, another LED color is illuminated one after another. If the user push wrong color, buzzer will give signal to the user. LCD will be used to display the score.

This exercise used hands, fingers and cognitive skills to equate the correct color and corresponding muscle reflex. When the user identifying matching color sets and directing the correct muscles to actuate, it will reclaim fine motor skills and hand-eye coordination.

1.2 Problem Statement

Based on survey obtained from physicians in unit of occupational therapy at Hospital Kuala Lumpur, they used only manual dexterity therapy for stroke patients. Example of manual dexterity therapy used at the hospital are hole peg test. So we came up with simple Dexterity Therapy Device that functions specifically in occupational therapy.

Rather than looking on the technical problem, there are also treatment problem solving included. Majority of therapeutic devices available on the market are not portable or lack of mobility. This will cause the patient to attend therapy sessions at the hospital. One of the purpose of this study is to help stroke patients do the treatment whenever they want without have to goes out from home. Stroke patients need a device that will assist them in improving their hand and finger dexterity to help them in their daily living activities such as dressing, bathing and so on. This device will help patients to improve the movement of their hands and fingers to make neural connections that require patients to use spatial reasoning skills / cognitive together with the use of a finger in a repetitive.

1.3 Objective

The main objectives of this project are:

i. To develop dexterity therapy exercises for stroke patients in a repetitive way.
ii. To design a device that are easy to use and very portable so that stroke patient may do the exercise session at their home.

1.4 Scope Project

The scope for this project is to develop a device that can improve the dexterity for a patient that has impairment of finger and hand movement because of stroke. Besides that, this device will help stroke patients to reclaim their fine motor skills. Easy to used and it is lighter therapy device.

1.5 Significant of Study

This study is to develop dexterity therapy device for the patients who has stroke disease. This device act as an exercise which can help early recovery for stroke patients especially for patients that has impairment with their hand and finger movement. Current device used in the hospital today are majority manual dexterity. Thus, this study is to develop a therapy device which can help stroke patients to improve the dexterity of fingers and hand to do their ADL (Activities of Daily Living)

CHAPTER II

LITERATURE REVIEW

2.1 Stroke Rehabilitation

Brain cell will loss if oxygen does not reach to the brain because something blocking the arteries or blood vessel in the brain burst. This may result in the system inside of human body. Stroke may change a person ability to live in a normal life where it can lead to paralysis, loss of speech, memory, vision, diminished reasoning and even death.

Stroke rehabilitation or called 'stroke rehab' is the recovery for stroke patients. Stroke rehabilitation help to enhance and counter the disabilities of patient by relearn skills due to the part of brain damaged. Early recovery for stroke patients is the basic activities of their daily life. Specific rehabilitation activity may involve in order to enhance a successful recovery. It is included speech therapy which help stroke patients that have impairment in producing and understanding speech. Second is the physical therapy that help a stroke patients to relearn their movement and coordination [11].

Others, is the occupational therapy. This therapy helps stroke patients to improve their ability to carry out routine daily activities. The dexterity therapy device for this study is one of the occupational therapy that help the patients to reclaim their dexterity in finger and hand as early recovery for their basic ADL (Activities of Daily Living).

2.1.1 Acute Rehabilitation

The treatment is provided in a special unit of the trauma hospital, a rehabilitation hospital or another inpatient setting. During acute rehabilitation, a team of health professionals with experience and training in brain injury work with the patient to regain as many activities of daily living as possible. Activities of daily living including dressing, eating, toileting, walking, speaking and more

2.1.2 Post acute Rehabilitation

When patients are well enough to participate in more intensive therapy, they may be transferred to a post-acute rehabilitation setting, such as a residential rehabilitation facility. The goal of post-acute rehabilitation is to help the patient regain the most independent level of functioning possible. Rehabilitation channels the body's natural healing abilities and the brain's relearning processes so an individual may recover as quickly and efficiently as possible.

Rehabilitation also involves learning new ways to compensate for abilities that have permanently changed due to brain injury. There is much that is still unknown about the brain and about brain injury rehabilitation. Treatment methods and technologies are rapidly advancing as knowledge of the brain and its function increases.

2.1.3 Sub-acute Rehabilitation

Patients who cannot tolerate intensive therapy may be transferred to a sub-acute rehabilitation facility. Sub-acute rehabilitation programs are designed for persons with brain injury who need a less intensive level of rehabilitation services over a longer period of time. Sub-acute programs also be designed for persons who have made progress in the acute rehabilitation setting and are still progressing but are not making rapid functional gains.

Sub-acute rehabilitation may be provided in a variety of settings, often a skilled nursing facility or nursing home.

2.2 Issues Typically Addressed During the Recovery Process.

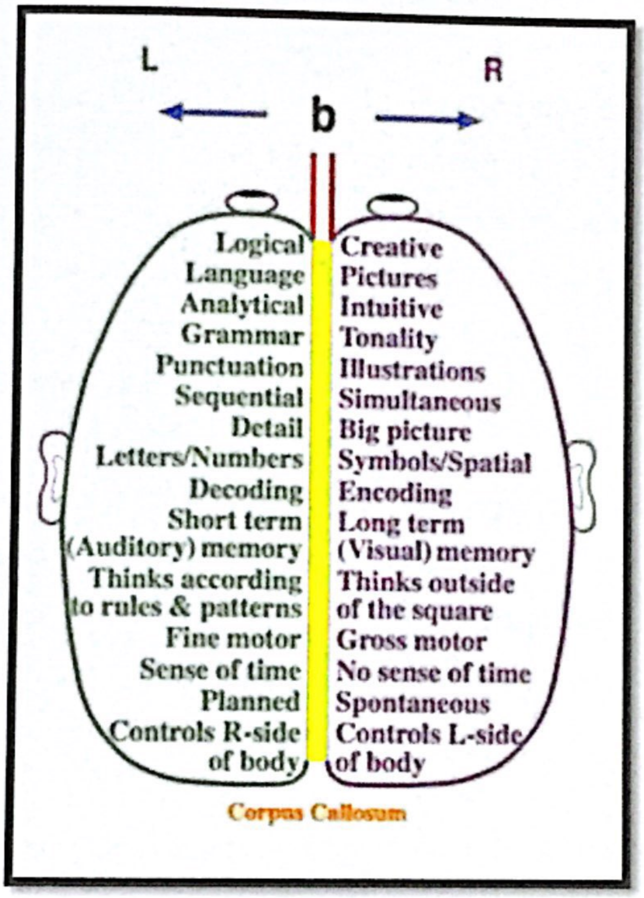


Figure 2.1: Left and Right of the Brain Control Structure

First issues that occur during the recovery process are Cognitive, Emotional and Behavioral Needs. As shown in figure 2.1, Cognition is a group of mental processes that includes attention, memory, communication, reasoning, solving problems and making decisions. Cognitive changes affect a person's behavior, emotional responses, social skills and all relationships. After thoroughly evaluating a patient's cognitive abilities, the team may assist patient with memory enhancement and decision making, using a variety of tools including reality orientation, cognitive therapy, computer tasks, memory aids, films, games and academic training.

Sensory stimulation in the early critical stage of recovery involves consistent interaction with a patient, stimulating all five senses. Patients also may experience mood swings, anxiety, personality disorders and decreased inhibitions. Our team treats these emotional and behavioral problems with counseling, medication, positive reinforcement and psychiatric consultation.

Secondly, is the Activities of Daily Living. Learning how to meet daily needs is an essential part of rehabilitation following a brain injury. Through individual and group treatment programs, we help patients re-learn and accomplish daily tasks related to self-care (i.e. dressing, eating, bathing and toileting), home management and driving. We can also access home, work and school sites and recommend modifications and assistive equipment.

Next issues are the Mobility. Brain injury patients participate in exercise programs designed to promote nerve conduction, strengthen intact muscles, maintain or gain mobility and build confidence to perform functional activities. Work with patients on maintaining general positioning for improved alignment, preventing complications due to immobility.

Lastly, is the Communication/Cognition. Speech therapists evaluate skills related to listening, thinking, speaking, reading and writing and work with the patient and family to develop the most effective communication system possible. This may include guidance in selecting assistive communication devices.

2. 3 Dexterity and Finger

Dexterity includes the ability to grasp and hold objects, and to perform fine finger movements to manipulate small objects. A hand is used to grasp, move and mobilize energy to use and operate a variety of products. The objects can be grasp, push and pull. As shown in figure 2.2, the human hand has four fingers and an opposable thumb, which is key to many dexterity tasks [2].

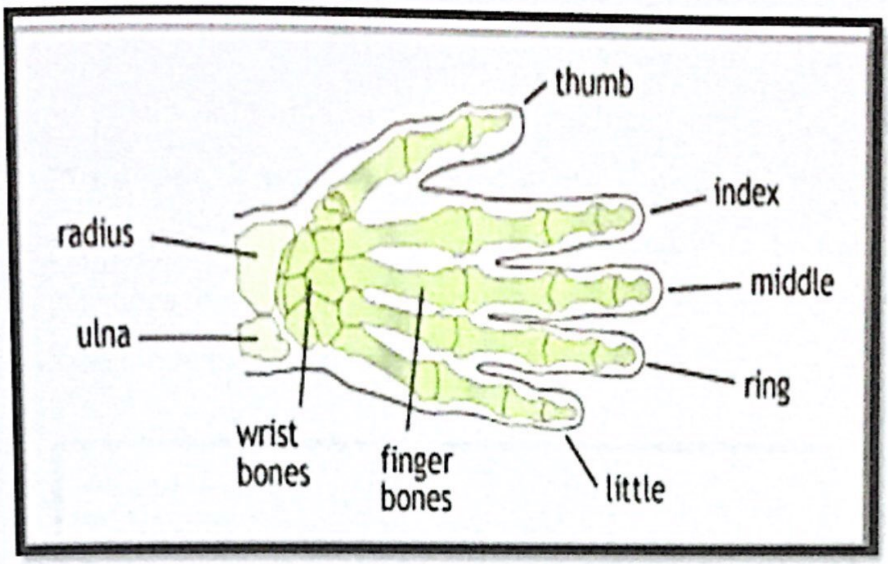


Figure 2.2: Structure of hands

Clamping forces can be exert between fingers and also clamp and hold larger objects in the palm of the hand. Individual fingers can be used to apply pulling and pushing forces. To manipulate objects, we frequently use both hands at the same time. This coordinated movement requires strength and dexterity in the fingers along with the ability of sensory and motor control. There are many causes of pain that can limit dexterity.

Arthritis is one of the most significant examples for older people, causing stiffness, swelling and pain in the joints. Satisfaction level for use of a product is seriously impaired when it causes pain, even if the product is still usable. Many able bodied people will experience temporary bruising or breakages that can affect the ability of their dexterity. This caused a certain frustration when trying to use products that require a high levels of extraordinary strength or two-hand coordination [2].

2.4 Stroke Disease

Brain injury does not diminish a person's intelligence, it simply changes how the brain performs a task. It can be described as mild, moderate or severe, but no matter what the severity, every brain injury is serious and must be treated as such. And, brain injury does not show prejudice. A person gender, age, race, culture, religion or socioeconomic background makes no difference.

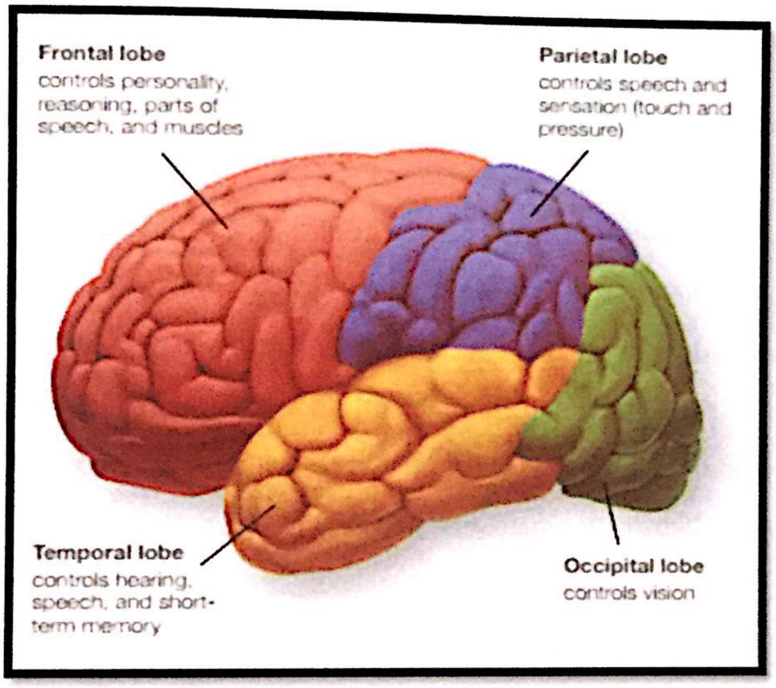


Figure 2.3: Functional of Brain

Figure 2.3 has shown that brain has 4 lobe which known as the frontal, parietal, occipital and temporal. During a stroke, the brain does not receive enough oxygen or nutrients will cause brain cells to die. There are three main types of stroke: ischemic strokes, hemorrhagic strokes and transient ischemic attacks. Ischemic strokes are caused by a narrowing or blocking of arteries to the brain. Hemorrhagic strokes are caused by blood vessels in and around the brain bursting or leaking. Strokes should be diagnosed and treated as early as possible in order to minimize brain damage. Treatment that can be consider is depends on the type of stroke. Ischemic strokes can be treated with 'clot-busting' drugs. Hemorrhagic strokes can be treated with surgery to repair or block blood vessel weaknesses. The most effective way to prevent strokes is maintain a healthy lifestyle [1].

2.4.1 Symptoms of Stroke

Mostly of our people does not recognize the earlier symptom of stroke. They only can recognize it when the people surround them get stroke attack. Normal person might assume that he/she get stroke when there are several changes in their posture such as their hand become bended, eye drop and half of the body become numbness. However, there are another symptom was included such as, person with stroke attack will suffer sudden numbness or weakness of face, arm or leg, especially on one side of the body. Other than that, is they will get sudden confusion, trouble speaking or understanding.

This is also the symptom of stroke that major people did not know about it. Else, they might get trouble seeing in one or both eyes. Their sight will be limited. In addition, the person that gets stroke attack will get sudden trouble walking, dizziness, loss of balance or coordination. Besides that, the most symptom that people might seem it was not too dangerous is sudden severe headache with no known cause. Headache is normal for us but it will be one of the symptom of stroke too.

2.4.2 Effect of stroke

The effect of stroke attacks a person is depending on the part of the damage brain. For some, the effects are relatively minor and short-lived; others are left with more severe, long term disabilities. The common problems include weakness or paralysis, cognitive problems, problems using language and also vision and perception problems.

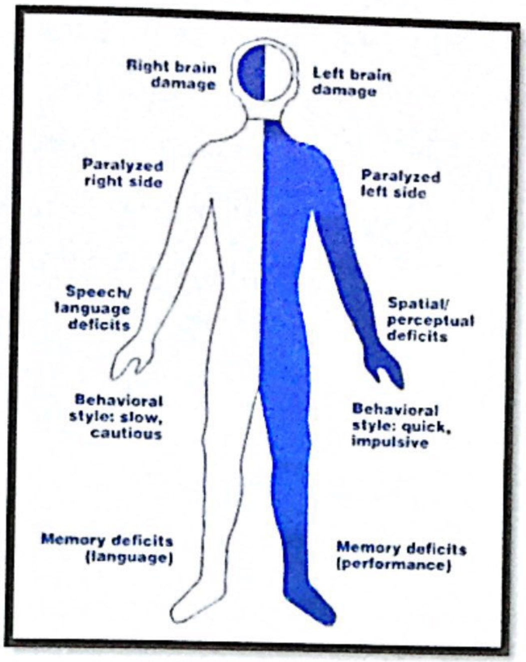


Figure 2.4: Effect of Stroke

In the figure 2.4, there is several effect of stroke. First common effects are weakness (hemi paresis) or paralysis (hemiplegic). Weakness (hemi paresis) or paralysis (hemiplegic) may affect one whole side of the body, or just an arm or leg. The weakness or paralysis is on the side of the body opposite the side of the brain injured by the stroke. This leads to problems with balance or coordination, because the weight of the weak side pulls against the strong side. It can make it difficult for the stroke patients to sit, stand, or walk, even if his or her muscles are strong enough to perform these activities.

Second, person with stroke attack will get cognitive problems. Strokes often cause problems with memory, thinking, attention, learning, and other mental activities. For example, trouble following directions, may get confused if something in a room is moved, or may not be able to keep track of the date or time.

In addition, problems using language are also common problem that might affect stroke patients for their interaction. Some of the stroke patient may have a problem in aphasia (a-FAY-zha), and trouble understanding speech or writing. They may understand but be unable to think of the right words to speak or write. A person with dysarthria (dis-AR-three-a) knows the right words but has trouble saying them clearly.

Else, the vision and perception problems. This problem seems to give stroke patients feel down in their life because, stroke survivors will not turn to look toward their weakened side. For example, may not eat food from one side of the plate because he or she doesn't see it.

The most common physical effect of stroke is muscle weakness and loss/less of control movement of arm or leg. Brain damage due to stroke can cause an arm or leg to become paralyzed and/or to develop spasticity. Spasticity refers to the abnormal symptom of having muscles are stiff and resistance in the joints when patients try to make a movement [8, 9].

2.5 Colors Improve the Emotion

For TBI patient there are several after effect they would had. Depending on which parts of brain has injured. For example, if injured at the area of frontal lobe. It helps govern personality and impulsivity. If damaged, there might be no "braking mechanism" for self-control. A person may find he cannot control his anger or aggression. Different colors are perceived to mean different things. for example, tones of red lead to feelings of excitement while blue tones are often associated with feelings of relaxation. Both of these emotions are pleasant, so therefore, the colors themselves procure positive feelings in advertisements. The chart from the figure 2.5 gives perceived meanings of different color in the United States.

Functional (F): fulfills a need or solves a problem

Sensory-Social (S): conveys attitudes, status, or social approval

Red	Yellow	Green	Blue	Pink	Violet/Purple	Brown	Black	
Lust (S)[23]	Jealousy (S) [23]	Good Taste (F)[23]	Masculine (S)[23]	Sophistication (S)[21]	Authority (S) [23]	Ruggedness (S)[21]	Grief (S)[23]	Happiness (S)[23]
Negative Issues (F) [24]	Competence (S)[21]	Envy (S)[23]	Competence (S)[21]	Sincerity (S) [21]	Sophistication (S)[21]		Sophistication (S)[21]	Sincerity (S)[21]
Excitement (S)[21]	Happiness (S)[23]		High quality (F)[23]		Power (S)[23]		Expensive (F) [23]	Purity (S) [23]
Love (S)[23]			Corporate (F)[23]				Fear (S)[23]	

Figure 2.5: Color Meaning

Color has long been used to create feelings of coziness or spaciousness. However, how people are affected by different color stimuli varies from person to person. Children's preferences for colors they find to be pleasant and comforting can be changed and can be varying, while adult color preference is usually non-malleable. Some studies find that color can affect mood. However, these studies do not agree on precisely which moods are brought out which colors. Color is used as a means to attract consumer attention to a product that then influences buying behavior. It is not only for emotion. It also can affect the buying behavior. Attractive color receives more consumer attention than unattractive color packaging.

A study had said that expression of a subjective cognitive experience is from color. People will react psychologically to colors by stimulate to the visual cortex and generate psychological phenomena. Different brightness, saturation, and changes in color coordination may influence an individual emotions and sense [12]. Thus, the purpose of color therapy is to eliminate patients' negative thoughts about themselves by allowing them to express their negative inner thoughts through coloring different kinds of complex geometric patterns [13].

2.6 Manual Dexterity

Manual dexterity involves the development of hand-eye coordination and motor control which is very smooth. Imagine the level of care and precision needed in certain activities, hobbies and professions involved, conscientious little action with your hands, like sewing, drawing and playing musical instruments. Many people in certain professions, such as dentists, doctors, gardeners and musicians, require and rely on manual ability to perform their duties properly and consistently.

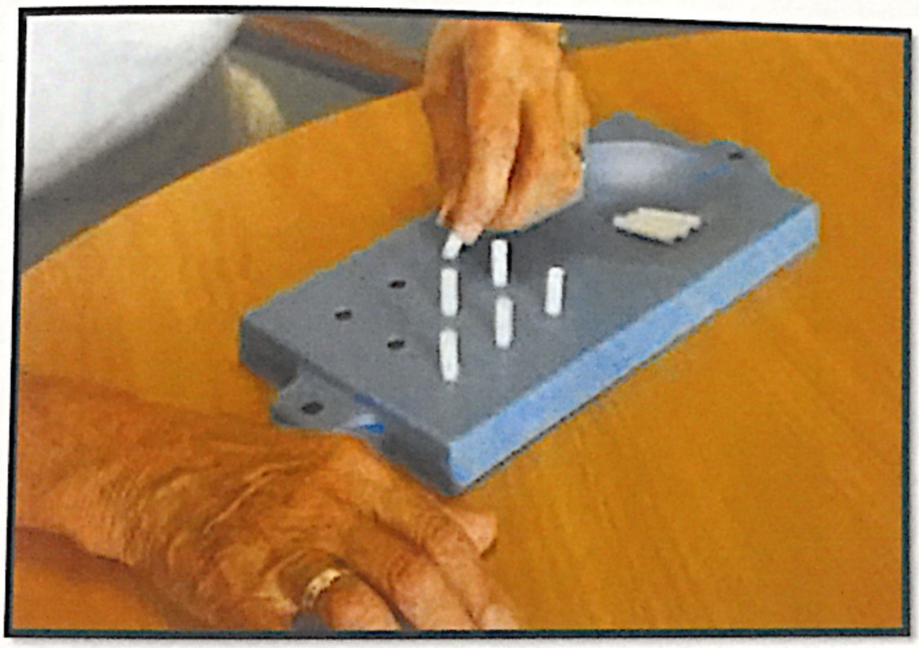


Figure 2.6: Pegboard

Examples for manual dexterity test that are existed at the occupational therapy unit are the pegboard test as shown in figure 2.6. This test evaluate a person's ability of the coordination hand-eye movement to perform a manual task quickly and accurately [10]. The pegboard had 24 holes and it was arranged on the table with spacing similar to that of the pegboard's holes. Subjects will lift the peg in the upper left corner (first column) of the table and placed it in the corresponding pegboard hole, and then continued on to the second peg in the same column, and so on. After finishing the first column, the subject will proceed with the next column. The time taken to relocate the 24 pegs was recorded as the dependent variable for this test.

Another manual dexterity tools that exist at the hospital is Block and Box Test (BBT) as shown in figure 2.7. To use this tool an individual are seated at a table, facing a rectangular box that is divided into two square compartments of equal dimension by means of a partition. Next, one hundred and fifty, 2.5cm, colored, wooden cubes or blocks are placed in one compartment or the other. Then, the individual is instructed to move as many blocks as possible one at a time, from one compartment to the other for a period of 60 seconds. Standardized dimensions for the test, the materials and procedures for test administration and scoring have been provided.

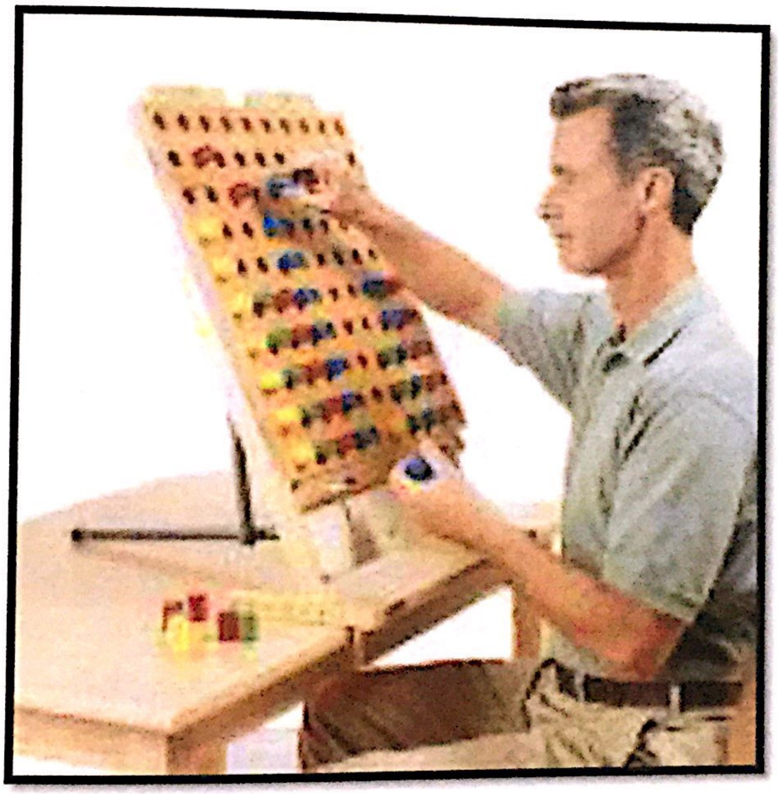


Figure 2.7: Block and Box Test (BBT)

To administer the test, the examiner is seated opposite the individual in order to observe test performance. The BBT is scored by counting the number of blocks carried over the partition from one compartment to the other during one-minute trial period. Patient's hand must cross over the partition in order for a point to be given, and blocks that drop or bounce out of the second compartment onto the floor is still rewarded with a point. Lastly higher scores on the test indicate better gross manual dexterity.

2.7 Dexterity Therapy Device

Therapy is limited due to the continue rehabilitation exercise delivered done-on-one rehabilitation therapist is expensive. The gyms do not have a proper equipment to facilitate practice of the fine motor skills needed to improve dexterity. Some devices are commercially available for home hand therapy and these are either expensive or not encouraging. For example the Hand Mentor and Hand Tutor [2, 3] cost several thousand dollars, and the Amado (Tyro Motion) is even more expensive. Objectively measuring the used of hand during therapy can be beneficial in providing effective rehabilitation. Quantitative feedback on the performance of the movement can improve the recovery of motor function in people with stroke [4]. It also allows users to track improvements in hand use, and provides an objective, unbiased, patient movement practice account.

Unfortunately, sometimes the recovery does not bring back full control and uses of hands, making these daily tasks are tremendous challenge. While begin the recovery it is crucial to incorporate hand exercises for stroke recovery into daily life to bring back dexterity and use of your fingers [5]. The design of the hand muscles as shown in figure 2.8 allow a changes in the involvement of the intrinsic and extrinsic muscles in MVC and sub maximal accurate force production tasks by varying the point of force application along the fingers, at the fingertips (the distal site), and at the proximal phalanges (the proximal site) [6, 7].

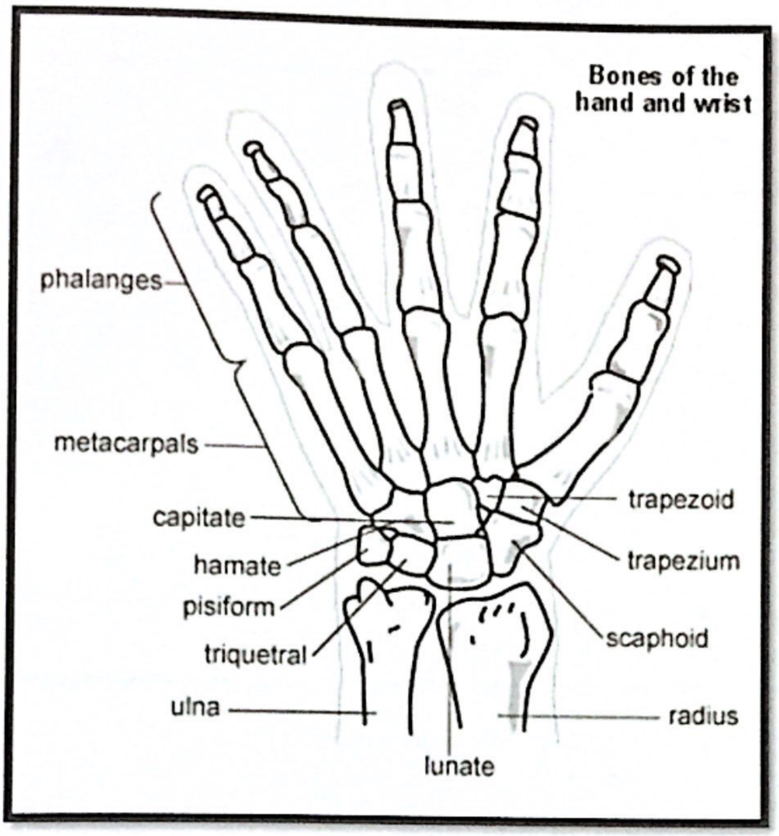


Figure 2.8: Bones of the Hand and Wrist

2.8 Arduino Mega 2560

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 analog 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 and the former boards Duemilanove or Diecimila.

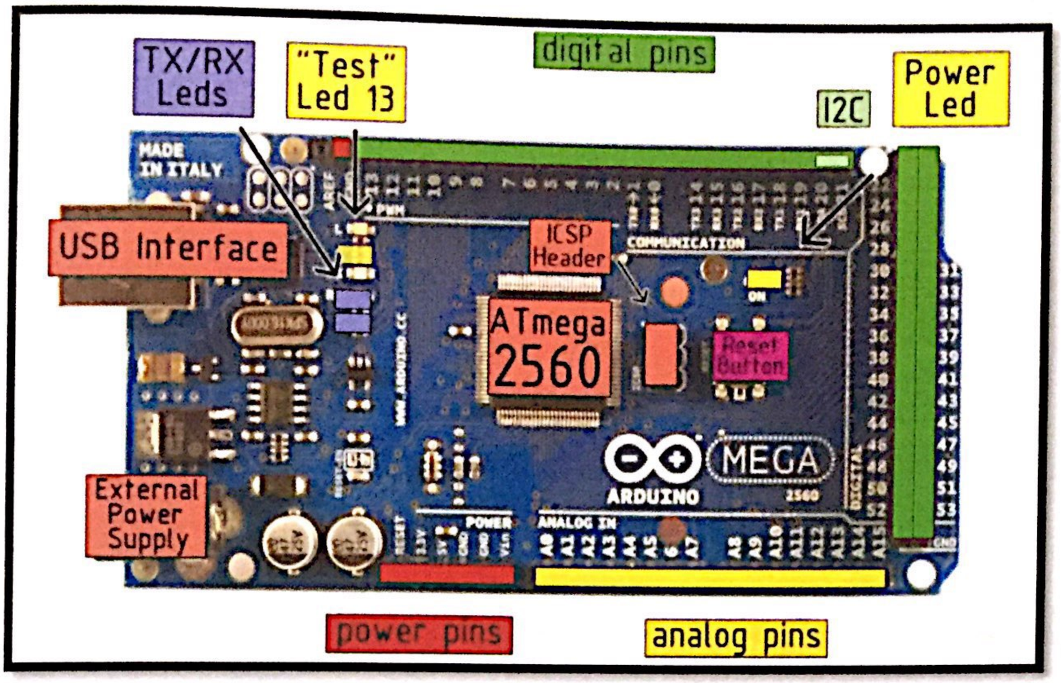


Figure 2.9: Arduino Mega 2560

Figure 2.9 has shown the arduino mega 2560 board diagram. Arduino mega or Arduino AT mega 2560 have 54 pins for power, digital pins and analogue pins. Besides that, this board are completely design with the USB interface and External power supply. Arduino are widely used in this era of globalisation because of its function and its easy coding compared to others programmable interface controller board. For this study, Arduino AT mega 2560 are being used because of its input and output pins suitable to the amount needed to run this device.

The Arduino Mega2560 can be powered via the USB connection or with an external power supply. The power source isselected 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 batterycan be inserted in the Gnd and Vin pin headers of the POWER connector.

The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software onthe computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the boardas a COM port automatically. The Arduino software includes a serial monitor which allows simple textualdata to be sent to and from the board. The RX and TX LEDs on the board will flash when data is beingtransmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communicationon pins 0 and 1).

2.8.1 Pin 2560 Diagram

Pins Arduino Mega 2560 contains 54 digital input/output pins in which every pin has its own function. Figure 2.10 have shown the pins diagram and its function.

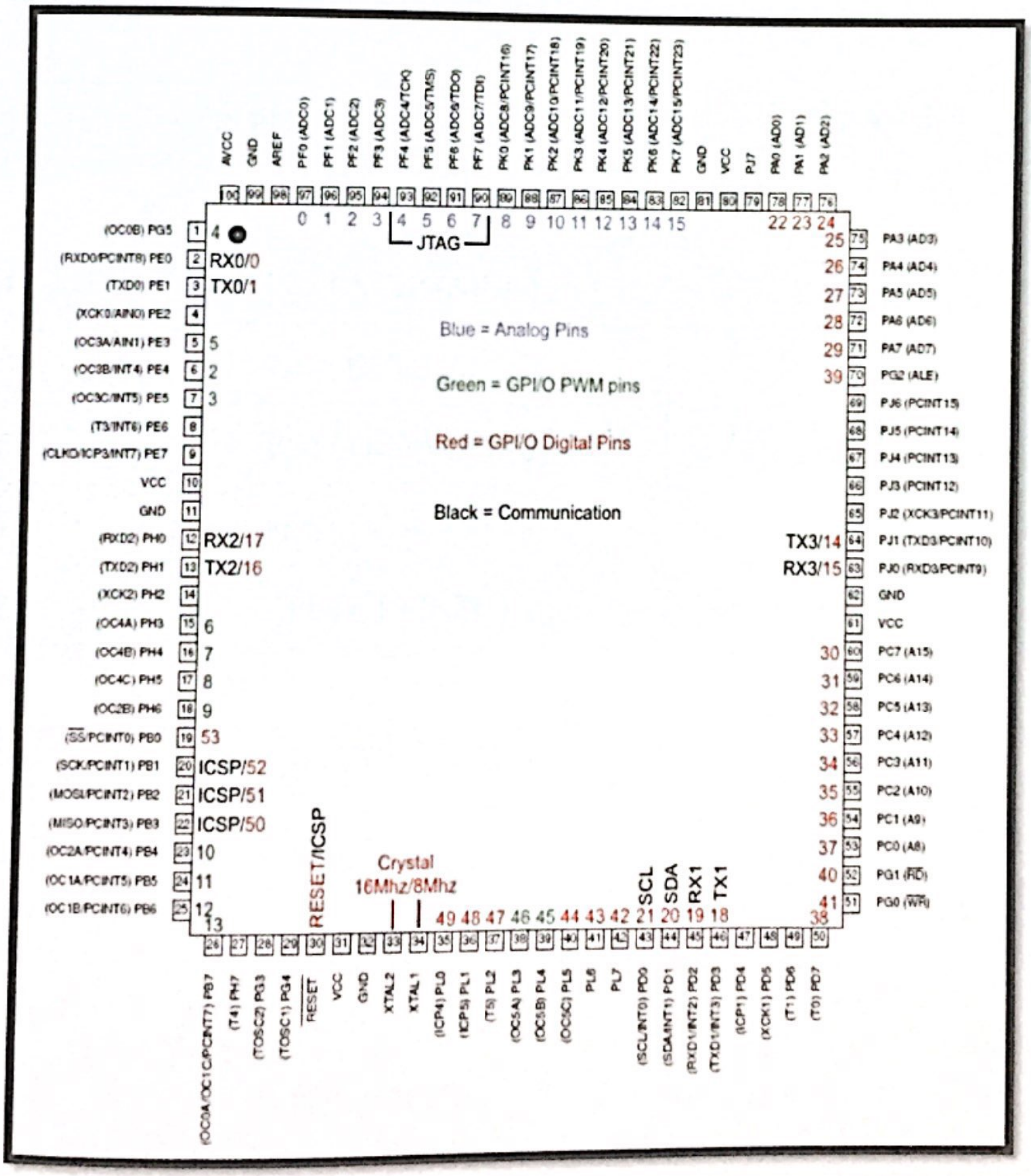


Figure 2.10: Arduino Mega 2560 Pins Diagram

Table 2.1 has shown the Arduino Mega Mapping for each pins. Each of the 54 digital pins on the Mega can be used as an input or output, using the pin Mode(), digital Write(), and digital Read() 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.

Table 2.1 Arduino Mega Mapping Table

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

2.8.2 Technical Specification for Arduino Mega 2560

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. Table 2.2 below has shown the specifications of Arduino Mega 2560.

Table 2.2: Arduino Mega 2560 Specification

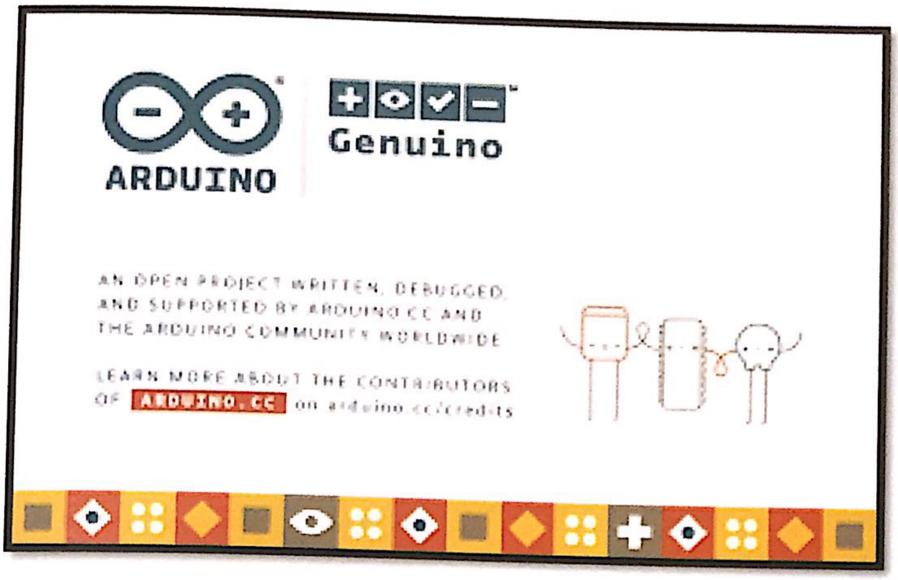
Microcontroller	**ATmega2560**
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM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

2.8.3 Programming

The Mega 2560 board can be programmed with the Arduino Software (IDE). The ATmega2560 on the Mega 2560 comes preprogrammed with a boot loader that allows to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

Besides that, it can also be bypass the boot loaderand program the Microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details. 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 boot loader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting 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. You can 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 boot loader). See this user-contributed tutorial for more information.




```
int ledPin = 13;                 // LED connected to digital pin 13

void setup()
{
  pinMode(ledPin, OUTPUT);       // sets the digital pin as output
}

void loop()
{
  digitalWrite(ledPin, HIGH);    // sets the LED on
  delay(1000);                   // waits for a second
  digitalWrite(ledPin, LOW);     // sets the LED off
  delay(1000);                   // waits for a second
}
```

Figure 2.11: Arduino Software IDE and Example Coding Using Arduino Software IDE

CHAPTER III

METHODOLOGY

3.1 Flow Chart Of Project

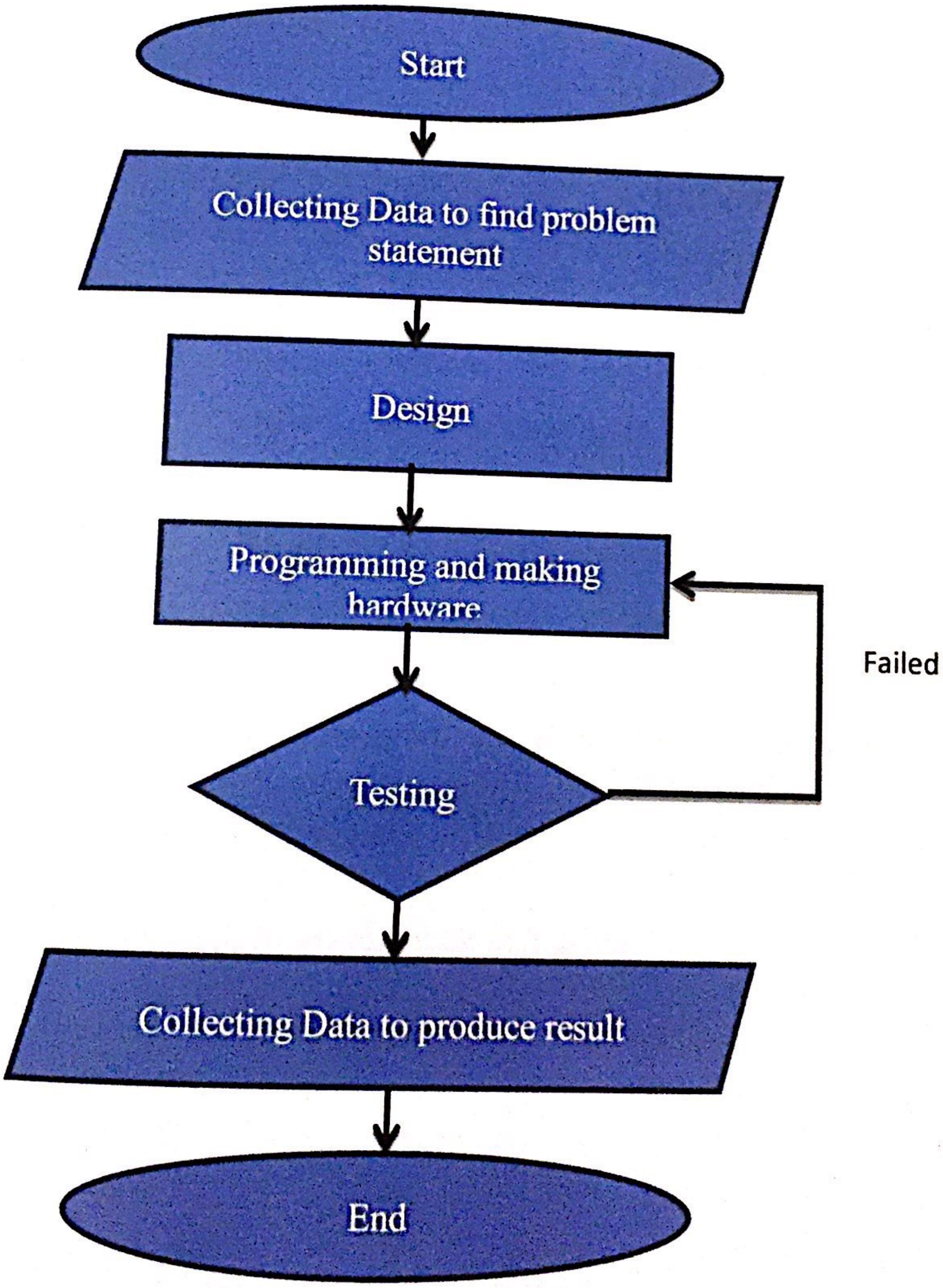


Figure 3.1: Flow Chart of Project

3.1.1 Method Implementation

For this chapter, method that is used to development the Dexterity Therapy Device is collecting data by distribute questionnaire (APPENDIX C) to the physiotherapist and publics. After that, the collected data is evaluated in order to find and create the problems statement. Problem that can be identified at the Hospital Kuala Lumpur is, they only used manual dexterity therapy for stroke patients and most of the therapy device is large and heavy. So, the design for the new therapy device should be very light and portable. In addition, the suitable materials, hardware or software need to be considered to overcome this problem.

After design the therapy device, it need programming to function the operation. So, ArduinoMega are used to store the programming and control the device. In other hand, the hardware for this therapy device also can be executing. When the hardware is done, the operation of the device needed to be test to ensure its functioning before being used by to others. If testing failed, return to the step before and redo the process until it is success.

After everything are functioning well without any error, the last step in This process is collecting data. The device is tested on 30 subjects for usability testing. Then, data are collect by distribute questionnaire (APPENDIX D) to the subjects and the data is analyzed. All of this process is decrypted as Figure 3.1.

3.2 Flow Chart of Implementation of Project Dexterity Therapy Device

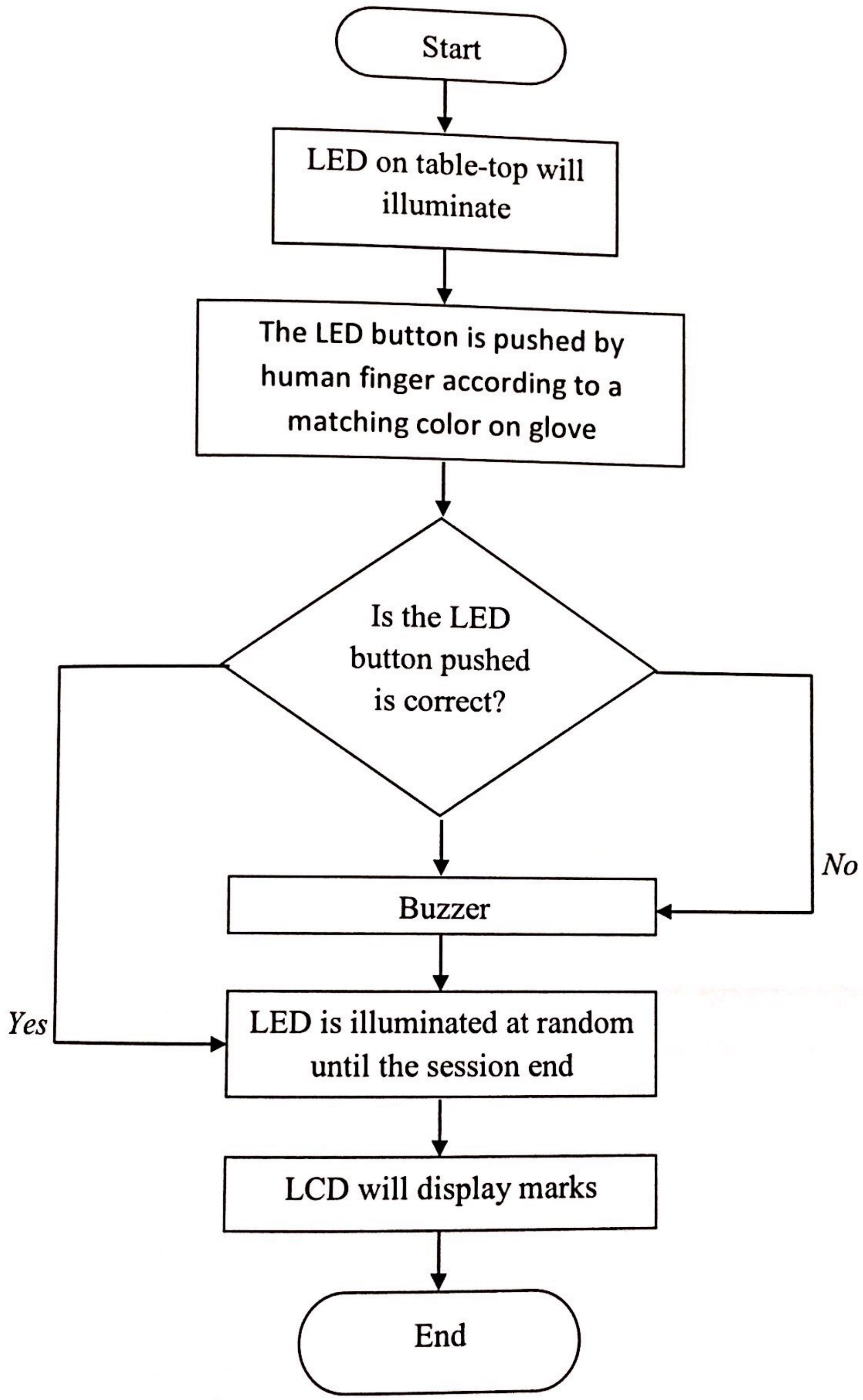


Figure 3.2: Flow Chart Of Implementation Of Project Dexterity Therapy Device

3.2.1 Project Implementation

The user wears the glove on each hand that has red, blue, and green LED lights on each the fingertip. The gloves are wired to the lap table which has light up buttons with the same three colors. As the exercise is started, a LED on one of the fingertips and a matching color button on the table will illuminate. The goal is to use the finger to touch the lit button, which turns it out. As each light is turned out, another LED is illuminated in random. If the user push wrong color, buzzer will give signal to the user. LCD will be used to display the score.

3.3 Programming

Arduino Mega as shown in figure 3.3 was decided to uses in this project because it has 54 digital input/output pins (of which 14 can be used as PWM outputs). Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language and the Arduino Development Environment (Arduino IDE) or also known as Arduino Software (IDE).

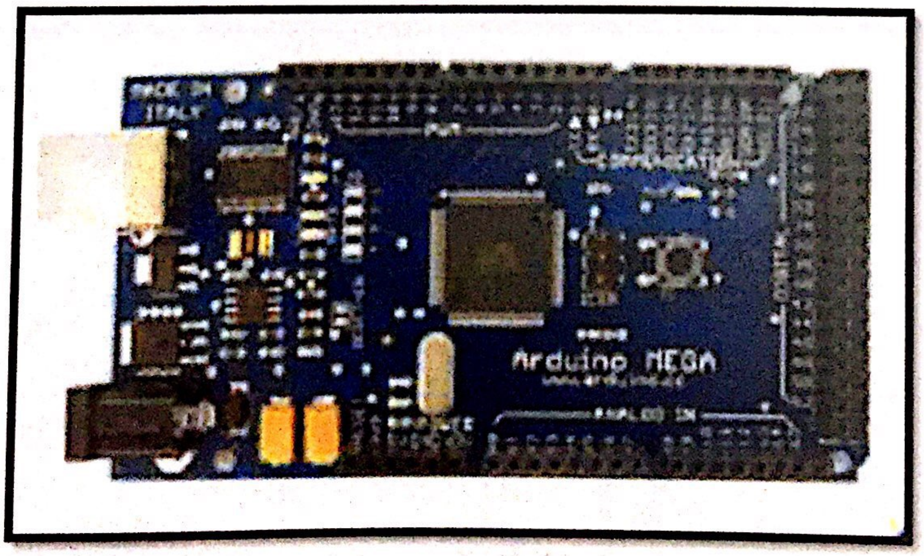


Figure 3.3: Arduino Board

3.4 Hardware

The material that is used for the design is Perspex. The devices are made in fully Perspex. Perspex is chosen because it is strong to hold the components, circuit and others. It also makes the device looks exclusive with acrylic material.

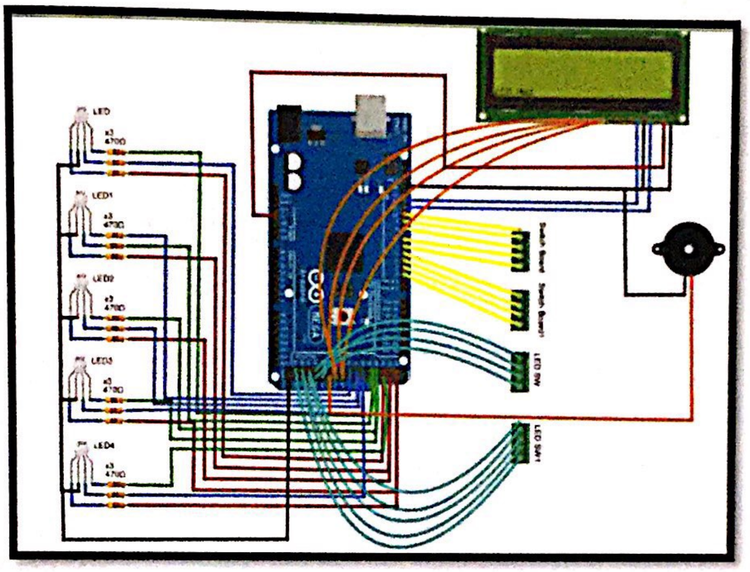
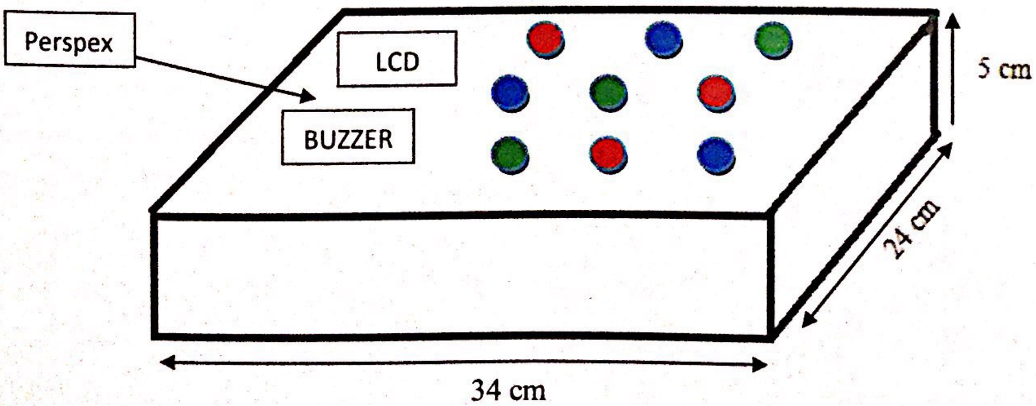


Figure 3.5: Schematic diagram

3.5 Design of Project

To build the casing of our project, we use material of Perspex as it is strong to hold the components, circuit and others. It also makes the device looks exclusive with acrylic material.



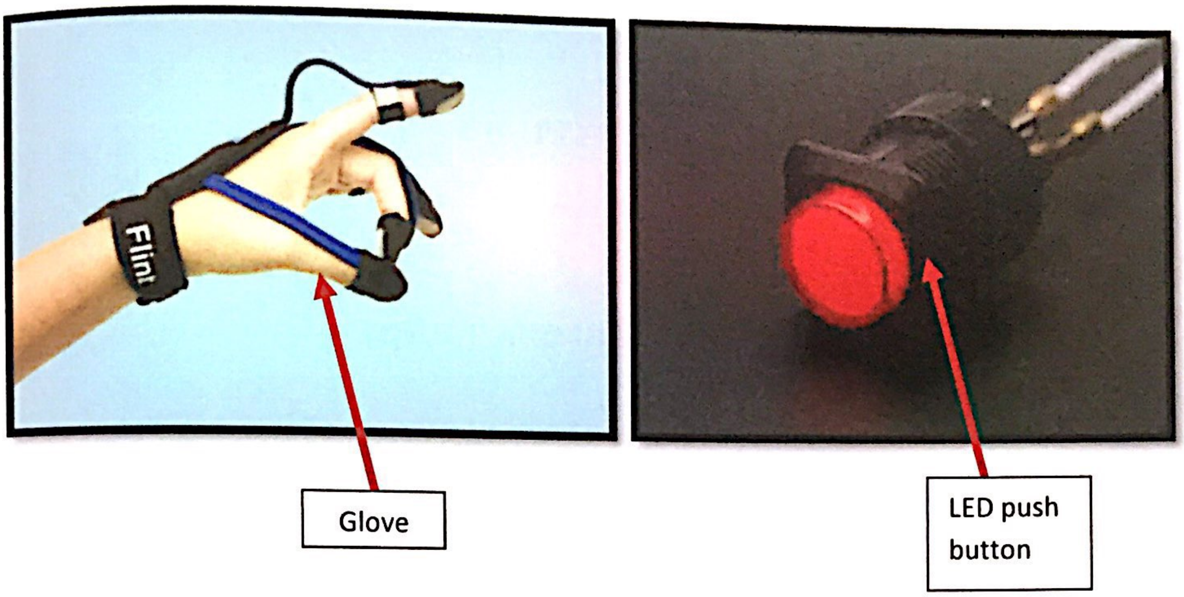


Figure 3.6: Dimension of Casing Project and Material Used

3.6 Block Diagram

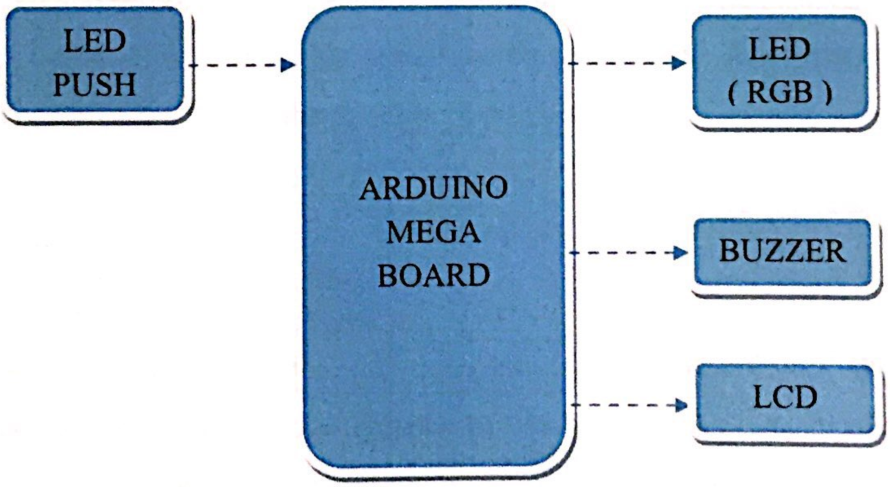


Figure 3.7: Block diagram of Dexterity Therapy Device

CHAPTER IV

RESULT AND DISCUSSION

4.1 Introduction

This chapter descript the analysis for pre-survey and post-survey of data collection from the questionnaire that has been distribute. Pre-survey questionnaire are about stroke that have been distribute to 30 respondents and then the data is analyzed to generate the problem statement for this project. Next, after the development of the product, post-survey will be conducted. This survey is to evaluate about the usability of the device. There are 3 sections include in the questionnaire which is section A, B and C. Each section consists of 5 questions and overall has 15 questions that need to be answer by the respondents. The questionnaire will be distributed and answer by the respondents after each of them has tested the therapy device. After that, the data is generated according to the feedback of the respondents.

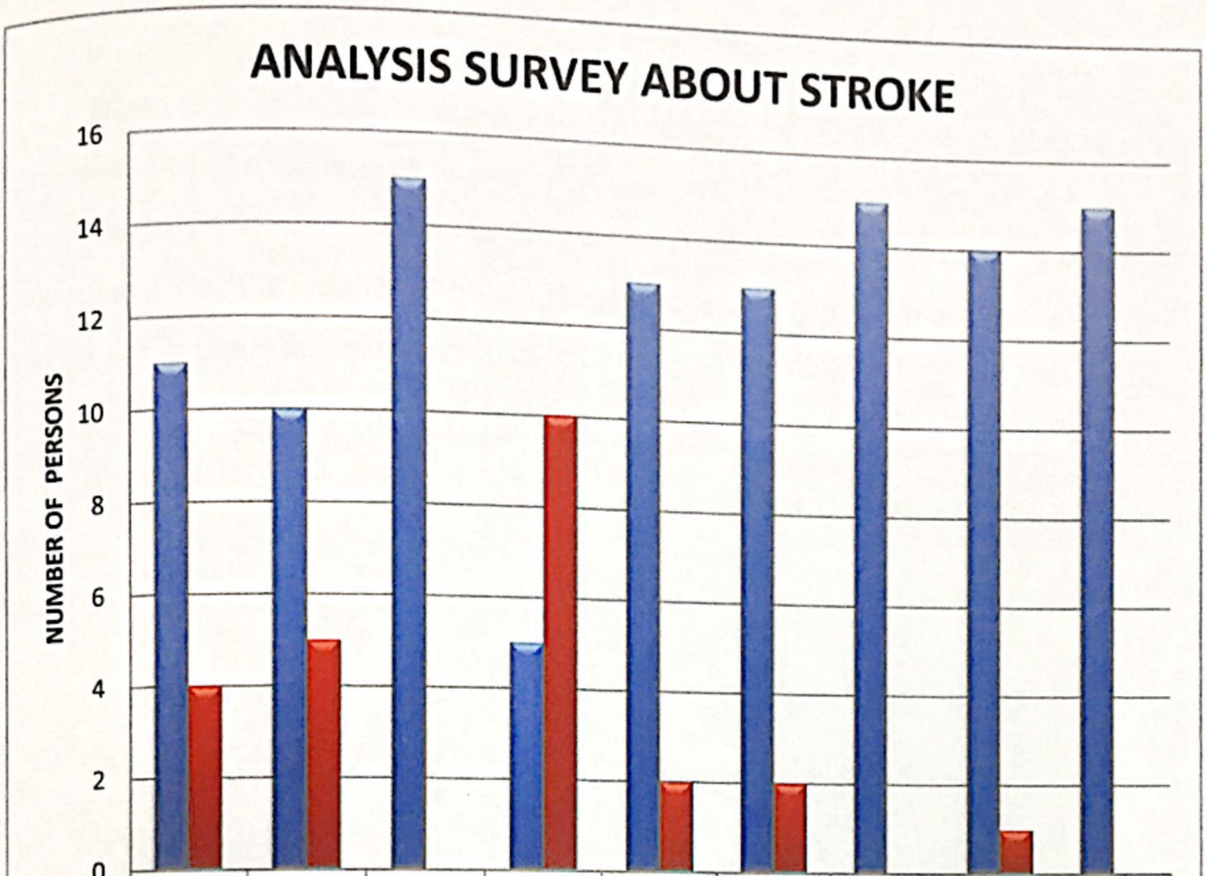
4.2 Pre-survey

This survey has been done to 15 respondents. The question is about stroke. This survey is distributed to the therapist at the hospital. As a feedback from the questionnaire, several problem statements is recognize which help in the development of the dexterity therapy device. The problem that has recognize is, most of the therapy device at the hospital are heavy and it give difficulties to the stroke patients to go to the hospital for their therapy exercise. Besides that, the therapy exercise at the hospital used only manual therapy. Table below shows the data that has been recorded from 15 respondents.

Table 4.1: Data from Pre-Survey

NO	QUESTION	YES	NO
1	Do you familiar with stroke disease?	11	4
2	Do you think stroke is a hindrane to happy life?	10	5
3	If you are a stroke patients, would you like to improve the existing device during the treatment?	15	0
4	Are all stroke patients has symptom of face droppy?	5	10
5	Do stroke patients has trouble organizing tasks and activities ?	13	2
6	Can stroke patients lead a normal life?	13	2
7	Do you think that the therapy device will regain the use and dexterity of hands?	15	0
8	Did you know that during stroke, the brain does not receive enough oxygen or nutrients that will cause brain cells to die ?	14	1
9	Is it important for stroke patients to have the hand therapy exercise?	15	0

From the data on the table 4.1, the graph is generated as shown in figure 4.1 below:



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
YES	11	10	15	5	13	13	15	14	15
NO	4	5	0	10	2	2	0	1	0

Figure 4.1:Pre-Survey Graph

Refer to the figure 4.1, it shows that majority of the respondent's familiar with the stroke disease. They familiar with the disease through their family experiences also from their wide knowledge that is easy to get from the internet now days. Besides that, they also realized that the existed therapy device needed to be improving to the others effective device which may help to enhance more in stroke rehabilitation. In addition, most of the respondents agree that the dexterity exercises may lead to the rehabilitation for basic activities of daily living for stroke patients as their early recovery.

Dexterity therapy device as showed in figure 4.2 is the device that has been developed. This device is used as one of the occupational therapy that helps stroke patients to do a repetitive exercise in early recovery of their finger and hand. Counter are used to count the number of button that the user may push. The number will be used for the therapist as parameters to check their progression.

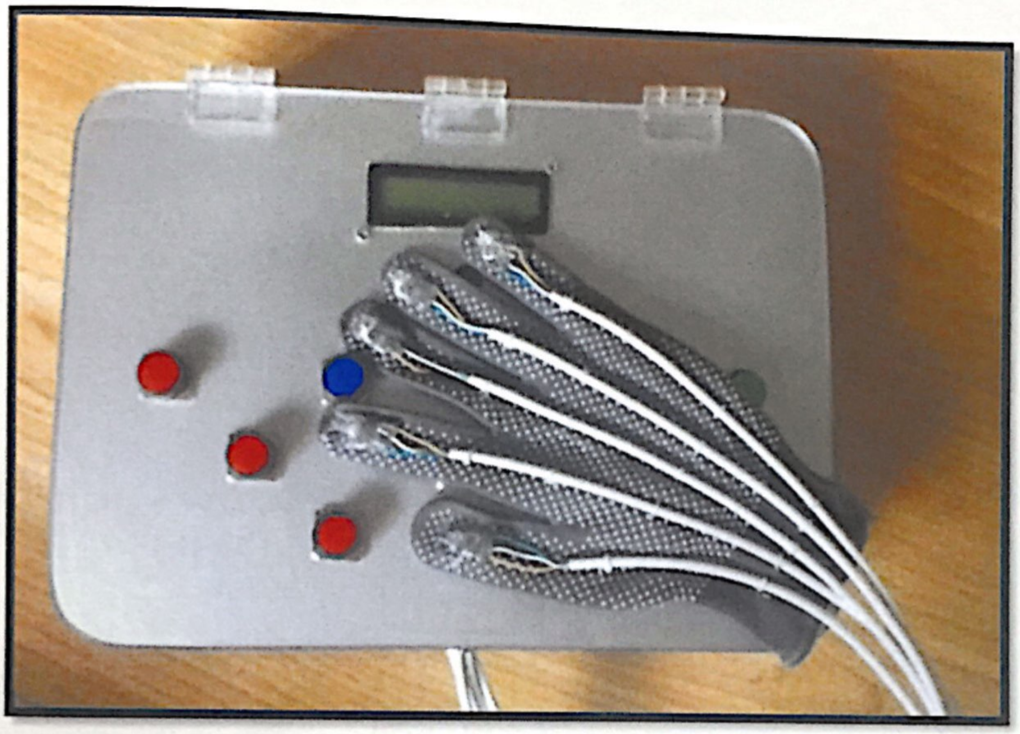


Figure 4.2: Dexterity Therapy Device

Figure 4.3: Glove with RGB LED

4.4 Usability Test

In this test, 30 subjects were tested by using the dexterity therapy device and questionnaire were distributed to them after the tested. This usability test consists of 3 main sections to be considerate which are Section A for the Comfort ability, Section B for the Design and Section C for the Effectiveness of the therapy device.

Figure 4.4: Subject Tested the Device and Answer the Questionnaire

4.4.1 Comfort ability

Section A consists of 5 questions about the comfort ability of the device. The data are recorded as shown in table below:

Table 4.2: Data for Comfort ability

	STRONGLY DISAGREE	DISAGREE	NEUTRAL (Agree Nor Disagree)	AGREE	STRONGLY AGREE
GLOVE ARE EASY TO WEAR AND COMFORTABLE	0	0	1	15	14
LED PUSH BUTTON ARE SUITABLE AND EASY TO USED	0	0	0	8	22
THIS DEVICE ARE STABLE AND LESS MOVING WHILE OPERATING	0	0	0	11	19
THIS DEVICE ARE LIGHTER AND SUITABLE TO FIT ON LAP OR ON THE TABLE	0	0	1	9	20
EASY TO DISTINGUISH THE COLOR ON THE GLOVE	0	0	1	8	21

From the data on the table 4.2, the graph is generated as shown in figure 4.5 below:

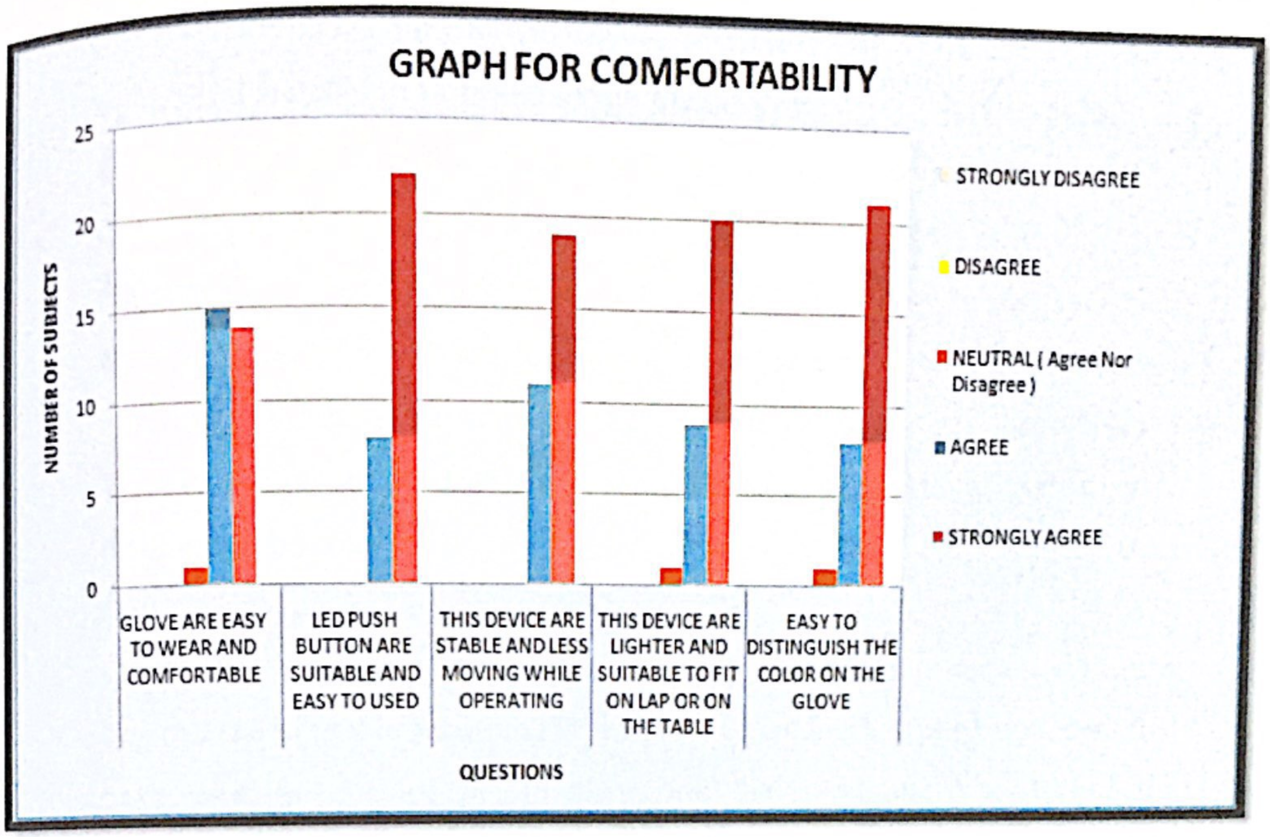


Figure 4.5: Graph for Comfort ability

From the figure 4.5, it was clearly showed that 15 subjects are agree that the glove are easy to wear and comfortable when worn it. The number of subjects that are strongly agree a slightly difference just 1 subjects from the subject that are agree with the glove. However, it seems to be huge differences in the number of subject that are only 1 subject's neutral neither (agree nor disagree) with the glove and none of them are disagree.

Now let's move forward to the second question, huge number of subjects about 22 subjects are strongly agree that the LED push button on the device are suitable and easy to used and 8 subjects are also agreed with the push button. In addition, the third question about 19 subjects is strongly agreed and 11 subjects are agreed about the stability of the device and it is less moving while operating. This will give the comfort ability to the users.

Next, higher number of subjects is strongly agreed that the device is lighter and suitable to fit on lap or on the table. 9 subjects just agree with the device while only 1 subjects seem to be confused with neither agree or disagree with the device weight. None of them disagree with it. Besides that, majority of the subjects are strongly agreed that it is easy to distinguish the color on the glove which are very important to the user to recognize it. If not, it might give difficulty and discomfort ably to the users. None of them disagree. This is the evidence that every subject feels comfortable and easy to distinguish the color.

From this evaluation, what I can conclude is the dexterity therapy device is comfortable according to the positive feedback of the respondent that have used this device before answering the questions. Majority of the respondents are strongly agreed that this therapy device give comfortable to them.

4.4.2 Design

Section B consists of five questions about the design of the device. There are 5 questions involve in this section. First question is about the design of the device whether it is portable or not. Second question is about the design of the glove. This is the main function of this device to operate which it need the users to freely move their finger. The size of the push button also needs to be evaluating in order to give comfortable to the users. Besides that, components arrangement also gives huge impact to the users. It is also had to be considerate in this usability test. The data are recorded as shown in table below:

Table 4.3: Data for the Design

	STRONGLY DISAGREE	DISAGREE	NEUTRAL (AgreeNorDisagree)	AGREE	STRONGLY AGREE
DESIGN ARE PORTABLE	0	0	0	11	19
GLOVE DESIGN: EASY TO MOVE THE FINGER	0	0	0	15	15
THE SIZE OF THE PUSH BUTTON ARE SUITABLE FOR FINGERTIP	0	0	0	8	22
ORDERLY COMPONENTS ARRANGEMENT	0	0	0	13	17
THE DESIGN OF THE DEVICE IS APPROPRIATE	0	0	1	11	18

From the data on the table 4.3, the graph is generated as shown in figure 4.6 below:

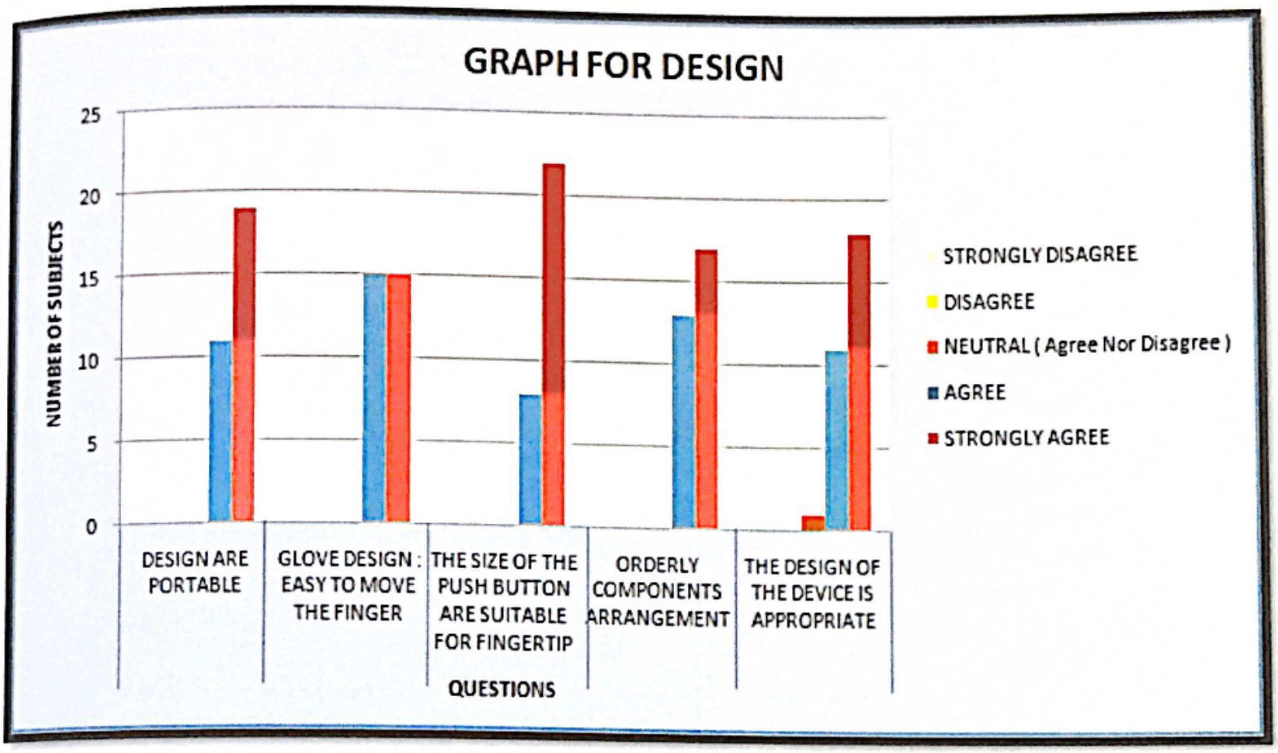


Figure 4.6: Graph for Design of the Device

Refer to the figure 4.6, 19 from 30 subjects are strongly agreed that the design for this device is portable and 11 subjects are also agreed for the portable design of the device. After that, the design of the glove is also important to this device. It seems that the number of the subjects are equal between strongly agree and agree. None of them disagree with the glove design.

After that, almost all subjects strongly agree about the size of the push button are suitable for the fingertip only 8 subjects just agree with the size of the push button. Let's move forward again, majority of the subjects agree that the components of the device are in orderly arrangements which are suitable for the design and none of them are disagree.

Lastly, the design of the device is appropriate according to 29 subjects. Only 1 subjects being confused neither agree or disagree with the design. None of them disagree with the statements.

4.4.3 Effectiveness / Operation

Section C consists of five questions about the design of the device. The data are recorded as shown in table below:

Table 4.4: Data for the Effectiveness / Operation

	STRONGLY DISAGREE	DISAGREE	NEUTRAL (Agree Nor Disagree)	AGREE	STRONGLY AGREE
EASY/COMFORTABLE TO USED	0	0	0	14	16
DEVICE FUNCTIONING WELL	0	0	3	14	13
RELIABILITY DURING USAGE	0	1	2	12	15
SAFETY, SECURE AND USER FRIENDLY	0	0	2	9	19
PRODUCTIVENESS TO DAILY ROUTINE/TASKS	0	0	2	10	18

From the data on the table 4.4, the graph is generated as shown in figure 4.7 below:

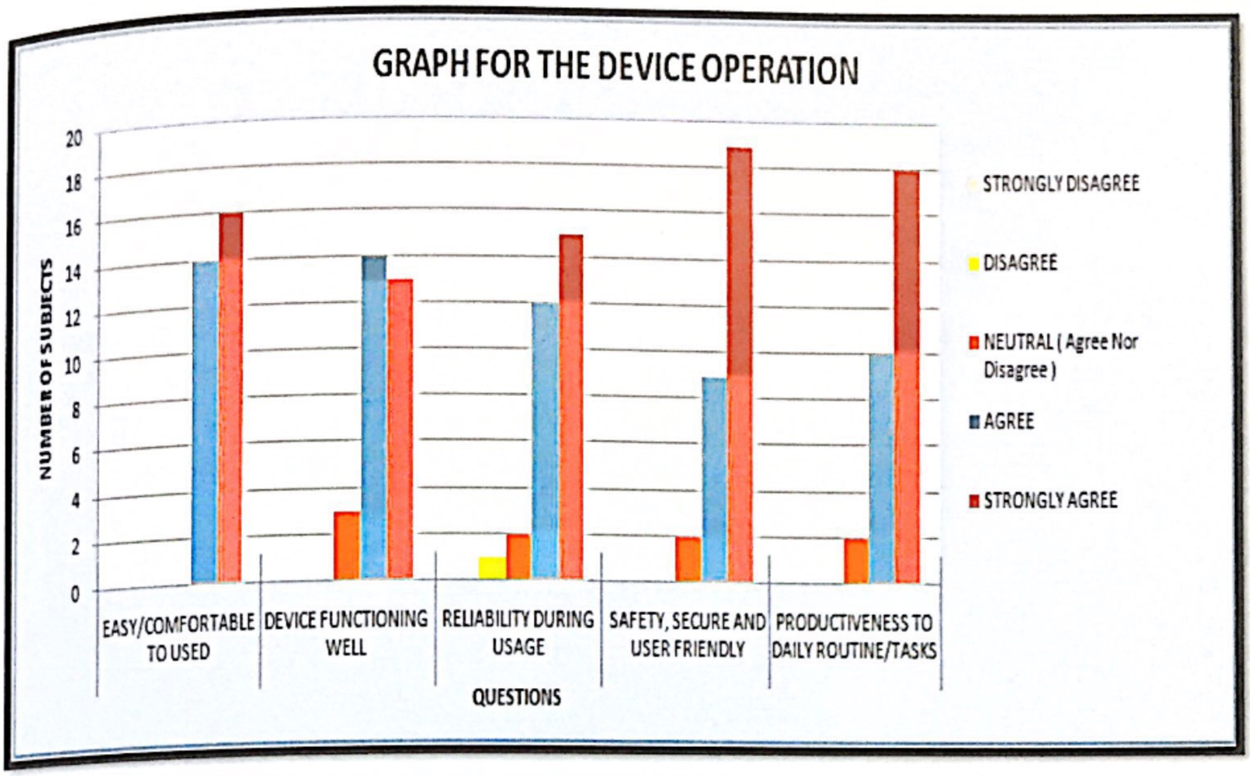


Figure 4.7: Graph for the Effectiveness / Operation of the Device

From the figure 4.7 above, 16 subjects were strongly agreed that the device is easy / comfortable to use. Besides that, 14 of the subjects agreed with it. None of them are disagree with the statements. During the usability test, 14 subjects agree that the devices are functioning well while 13 subjects are strongly agreed with the device functionality. However, 3 subjects are being neutral to agree or disagree with the statement.

Majority of the subjects are strongly agreed about the reliability during usage. 15 subjects are strongly agreed and 12 subjects are agreed with the reliability during usage where overall total of the agree subjects are 27 subjects out of 30 subjects. Another 2 subjects are neutral and only 1 subject disagrees with the reliability during usage.

Besides that, 19 subjects are strongly agreed that the device are safe, secured and user friendly. 9 subjects also agree with the statements. However, only 2 subjects neutral neither agree nor disagree with the statements. Next lets go through the productiveness of the device to daily routine / tasks, maintain its position with higher number of subjects strongly agree that this device are productive to be used in daily routine / tasks. 10 subjects are agreed and 2subjects being neutral with the statements.

CHAPTER V

CONCLUSION AND RECOMMENDATION

This chapter discusses the conclusions of the study, the results and analysis of the project. Suggestions for improvement projects in the future were also discussed to produce a project that is suitable for users.

5.1 Conclusion

As a conclusion, the Dexterity Therapy Device is developed, and the objective has been achieved. The device has achieved the first objective which are it is easy to used and the design are portable so that patients may do the exercise / therapy session at their home.

Thirty subjects are involved in this study to measure the comfort ability, design of the device and the effectiveness / operation of the device. The device are tested to the subjects and after that, the questionnaire are distributed as a data collection. Once the subjects have done testing the device, the data that have been collected are analyzed by using the Microsoft Excel. The result finding of this study is the developed device is comfortable to be used. Besides that, the design of this therapy device also is appropriate and portable. So, this may help stroke patients to do the exercise / therapy session at their home. In addition, the developed device is operating well and it is very productive to do daily / routine tasks.

5.2 Recommendation

After done the survey, there are several recommendations from the 30 subjects which is the cable at the glove need to extend it so that the finger may move freely. Besides that, some of the subjects give a comment about the color. The colors that are using on the developed device are appropriate but they need some color that may increase the patient's mood and emotions. In addition, some of the panel gives a suggestion to try this device to the autism or dyslexia children so that they may focus in their learning. Others, they also give a suggestion to make the glove from one becomes two gloves so that stoke patients with both hand impairment may also do this exercise session. Also, make the random led become complicated in order to enhance patients dexterity.

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APPENDIX A: - PROGRAMMING

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 41, 40, 39, 38);
//---------------------------------------------
#define BUZZ 43
#define SW1 2
#define SW2 3
#define SW3 4
#define SW4 5
#define SW5 6
#define SW6 7
#define SW7 8
#define SW8 9
#define SW9 10
#define Light1 44 //R
#define Light2 45 //R
#define Light3 46 //R
#define Light4 47 //G
#define Light5 48 //G
#define Light6 49 //G
#define Light7 50 //B
#define Light8 51 //B
#define Light9 52 //B
#define LED1  22 //R
#define LED2  23 //R
#define LED3  24 //R
#define LED4  25 //R
#define LED5  26 //R
#define LED6  27 //G
#define LED7  28 //G
#define LED8  29 //G
#define LED9  30 //G
```

```
#define LED10  31 //G
#define LED11  32 //B
#define LED12  33 //B
#define LED13  34 //B
#define LED14  35 //B
#define LED15  36 //B

int LIGHTcount=1;
int LIGHTcountX;
int LEDR=5;
int LEDG=4;
int LEDB=1;
int STARTx=0;
int COUNTER=0;

void setup(void)
{
pinMode(BUZZ,OUTPUT);
pinMode(SW1,INPUT);
pinMode(SW2,INPUT);
pinMode(SW3,INPUT);
pinMode(SW4,INPUT);
pinMode(SW5,INPUT);
pinMode(SW6,INPUT);
pinMode(SW7,INPUT);
pinMode(SW8,INPUT);
pinMode(SW9,INPUT);
pinMode(Light1,OUTPUT);
pinMode(Light2,OUTPUT);
pinMode(Light3,OUTPUT);
pinMode(Light4,OUTPUT);
pinMode(Light5,OUTPUT);
pinMode(Light6,OUTPUT);
```

```
 pinMode(Light7,OUTPUT);
 pinMode(Light8,OUTPUT);
 pinMode(Light9,OUTPUT);

 pinMode(LED1,OUTPUT);
 pinMode(LED2,OUTPUT);
 pinMode(LED3,OUTPUT);
 pinMode(LED4,OUTPUT);
 pinMode(LED5,OUTPUT);
 pinMode(LED6,OUTPUT);
 pinMode(LED7,OUTPUT);
 pinMode(LED8,OUTPUT);
 pinMode(LED9,OUTPUT);
 pinMode(LED10,OUTPUT);
 pinMode(LED11,OUTPUT);
 pinMode(LED12,OUTPUT);
 pinMode(LED13,OUTPUT);
 pinMode(LED14,OUTPUT);
 pinMode(LED15,OUTPUT);

 lcd.begin(16, 2);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("    WELCOME");
  lcd.setCursor(0, 1);
  lcd.print("  -------------");
delay(2000);
}
void loop(void)
{
   LIGHTcount++;
   LEDR++;
   LEDG++;
```

Scanned with CamScanner

```
LEDB++;
if (LEDR>5){
  LEDR=1;
}
if (LEDG>5){
  LEDG=1;
}
if (LEDB>5){
  LEDB=1;
}
if (LIGHTcount > 9){
  LIGHTcount=1;
}
if (STARTx==1){
  lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Counter: ");

lcd.print(COUNTER);
  ONLIGHT();
}
if (digitalRead(SW1)==0 || digitalRead(SW2)==0 || digitalRead(SW3)==0
|| digitalRead(SW4)==0 || digitalRead(SW5)==0 || digitalRead(SW6)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0){

 ONLIGHT();
}
}
void CHECKLEDR(){
 if (LEDR==1){
  digitalWrite(LED1,HIGH);
 }
 if (LEDR==2){
```

```
  digitalWrite(LED2,HIGH);
 }
 if (LEDR==3){
  digitalWrite(LED3,HIGH);
 }
 if (LEDR==4){
  digitalWrite(LED4,HIGH);
 }
 if (LEDR==5){
  digitalWrite(LED5,HIGH);
 }
}
void CHECKLEDG(){
 if (LEDG==1){
  digitalWrite(LED6,HIGH);
 }
 if (LEDG==2){
  digitalWrite(LED7,HIGH);
 }
 if (LEDG==3){
  digitalWrite(LED8,HIGH);
 }
 if (LEDG==4){
  digitalWrite(LED9,HIGH);
 }
 if (LEDG==5){
  digitalWrite(LED10,HIGH);
 }
}
void CHECKLEDB(){
 if (LEDB==1){
  digitalWrite(LED11,HIGH);
 }
```

```
 if (LEDB==2){
  digitalWrite(LED12,HIGH);
 }
 if (LEDB==3){
  digitalWrite(LED13,HIGH);
 }
 if (LEDB==4){
  digitalWrite(LED14,HIGH);
 }
 if (LEDB==5){
  digitalWrite(LED15,HIGH);
 }
}
void ONLIGHT() {

if (LIGHTcount==1){
 CHECKLEDR();
  digitalWrite(Light1,HIGH);
 while (digitalRead(SW1)==1){
  LIGHTcount++;
  if (LIGHTcount > 9){
   LIGHTcount=1;
   COUNTLED();
  }
  if (digitalRead(SW2)==0 || digitalRead(SW3)==0
||digitalRead(SW4)==0 || digitalRead(SW5)==0 || digitalRead(SW6)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

   digitalWrite(BUZZ,HIGH);

 lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
```

```
 delay(300);

 digitalWrite(BUZZ,LOW);
    }
 }
 digitalWrite(Light1,LOW);
 if (STARTx==1){
 COUNTER++;
 }
 OFFLED();
 delay(500);
}
 else if (LIGHTcount==2){
 CHECKLEDR();
 digitalWrite(Light2,HIGH);
 while (digitalRead(SW2)==1){
   LIGHTcount++;
   if (LIGHTcount > 9){
     LIGHTcount=1;
     COUNTLED();
   }
   if (digitalRead(SW2)==0 || digitalRead(SW1)==0
||digitalRead(SW4)==0 || digitalRead(SW5)==0 || digitalRead(SW6)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

   digitalWrite(BUZZ,HIGH);
    lcd.clear();
    lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);

 digitalWrite(BUZZ,LOW);
```

```
  }
}
digitalWrite(Light2,LOW);
 OFFLED();
 if (STARTx==1){
COUNTER++;
}
 delay(500);
}
 else if (LIGHTcount==3){
  CHECKLEDR();
 digitalWrite(Light3,HIGH);
 while (digitalRead(SW3)==1){
  LIGHTcount++;
  if (LIGHTcount > 9){
   LIGHTcount=1;
   COUNTLED();
  }
  if (digitalRead(SW2)==0 || digitalRead(SW1)==0
||digitalRead(SW4)==0 || digitalRead(SW5)==0 || digitalRead(SW6)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

   digitalWrite(BUZZ,HIGH);
   lcd.clear();
   lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);

 digitalWrite(BUZZ,LOW);
   }
 }
 digitalWrite(Light3,LOW);
```

```
 OFFLED();
 if (STARTx==1){
 COUNTER++;
 }
 delay(500);
 }

else if (LIGHTcount==4){
 CHECKLEDG();
 digitalWrite(Light4,HIGH);
 while (digitalRead(SW4)==1){
   LIGHTcount++;
   if (LIGHTcount > 9){
     LIGHTcount=1;
     COUNTLED();
   }
   if (digitalRead(SW6)==0 || digitalRead(SW5)==0
||digitalRead(SW2)==0 || digitalRead(SW3)==0 || digitalRead(SW1)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

     digitalWrite(BUZZ,HIGH);
     lcd.clear();
     lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);

 digitalWrite(BUZZ,LOW);
   }
 }
 digitalWrite(Light4,LOW);
OFFLED();
if (STARTx==1){
```

```
  COUNTER++;
  }
 delay(500);
}
else if (LIGHTcount==5){
 CHECKLEDG();
 digitalWrite(Light5,HIGH);
 while (digitalRead(SW5)==1){
  LIGHTcount++;
  if (LIGHTcount > 9){
   LIGHTcount=1;
   COUNTLED();
  }
  if (digitalRead(SW6)==0 || digitalRead(SW4)==0 ||
digitalRead(SW2)==0 || digitalRead(SW3)==0 || digitalRead(SW1)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

   digitalWrite(BUZZ,HIGH);
   lcd.clear();
   lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);

 digitalWrite(BUZZ,LOW);
  }
 }
 digitalWrite(Light5,LOW);
OFFLED();
if (STARTx==1){
 COUNTER++;
}
delay(500);
```

```
}
else if (LIGHTcount==6){
 CHECKLEDG();
 digitalWrite(Light6,HIGH);
 while (digitalRead(SW6)==1){
  LIGHTcount++;
  if (LIGHTcount > 9){
   LIGHTcount=1;
   COUNTLED();
  }
  if (digitalRead(SW4)==0 || digitalRead(SW5)==0
||digitalRead(SW2)==0 || digitalRead(SW3)==0 ||  digitalRead(SW1)==0 ||
digitalRead(SW7)==0 || digitalRead(SW8)==0 || digitalRead(SW9)==0
&& STARTx==1){

   digitalWrite(BUZZ,HIGH);
   lcd.clear();
   lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);

 digitalWrite(BUZZ,LOW);
  }
 }
 digitalWrite(Light6,LOW);
OFFLED();
if (STARTx==1){
 COUNTER++;
 }
delay(500);
}
else if (LIGHTcount=7){
 CHECKLEDB();
```

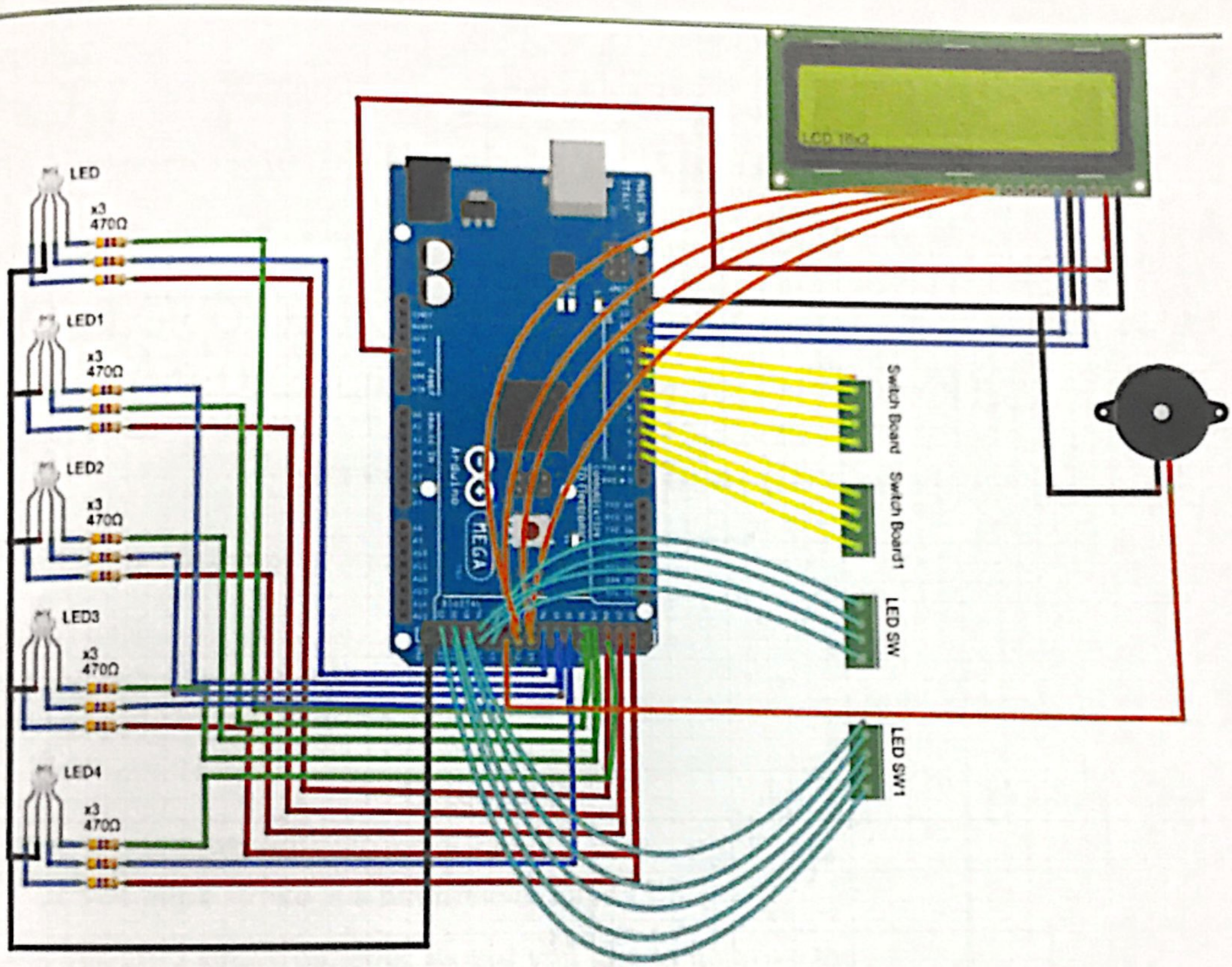
```
  digitalWrite(Light7,HIGH);
  while (digitalRead(SW7)==1){
    LIGHTcount++;
    if (LIGHTcount > 9){
      LIGHTcount=1;
      COUNTLED();
    }
    if (digitalRead(SW8)==0 || digitalRead(SW9)==0
||digitalRead(SW2)==0 || digitalRead(SW3)==0 || digitalRead(SW4)==0 ||
digitalRead(SW5)==0 || digitalRead(SW6)==0 || digitalRead(SW1)==0
&& STARTx==1){

      digitalWrite(BUZZ,HIGH);
       lcd.clear();
       lcd.setCursor(0, 1);
  lcd.print("    WRONG!!");
  delay(300);

  digitalWrite(BUZZ,LOW);
    }
  }
  digitalWrite(Light7,LOW);
OFFLED();
if (STARTx==1){
  COUNTER++;
  }
delay(500);
}
 else if (LIGHTcount==8){
   CHECKLEDB();
 digitalWrite(Light8,HIGH);

 while (digitalRead(SW8)==1){
```

```
    LIGHTcount++;
    if (LIGHTcount > 9){
     LIGHTcount=1;
     COUNTLED();
    }
   if (digitalRead(SW7)==0 || digitalRead(SW9)==0
||digitalRead(SW2)==0 || digitalRead(SW3)==0 || digitalRead(SW4)==0 ||
digitalRead(SW5)==0 || digitalRead(SW6)==0 ||  digitalRead(SW1)==0
&& STARTx==1){


    digitalWrite(BUZZ,HIGH);
     lcd.clear();
     lcd.setCursor(0, 1);
 lcd.print("   WRONG!!");
 delay(300);


 digitalWrite(BUZZ,LOW);
   }
 }
 digitalWrite(Light8,LOW);
 OFFLED();
 if (STARTx==1){
 COUNTER++;
 }
 delay(500);
 }
 else if (LIGHTcount==9){
  CHECKLEDB();
  digitalWrite(Light9,HIGH);
 while (digitalRead(SW9)==1){
  LIGHTcount++;
  if (LIGHTcount > 9){
   LIGHTcount=1;
```

```
    COUNTLED();
   }
   if (digitalRead(SW7)==0 || digitalRead(SW8)==0
||digitalRead(SW2)==0 || digitalRead(SW3)==0 || digitalRead(SW4)==0 ||
digitalRead(SW5)==0 || digitalRead(SW6)==0 || digitalRead(SW1)==0
&& STARTx==1){

    digitalWrite(BUZZ,HIGH);
    lcd.clear();
    lcd.setCursor(0, 1);
  lcd.print("   WRONG!!");
  delay(300);

  digitalWrite(BUZZ,LOW);
    }
  }
  digitalWrite(Light9,LOW);
 OFFLED();
if (STARTx==1){
  COUNTER++;
  }
 delay(500);
  }
  digitalWrite(BUZZ,LOW);

  if (STARTx==0){
   STARTx=1;
   digitalWrite(BUZZ,LOW);
   lcd.clear();
  }
}
void OFFLED(){
 digitalWrite(LED1,LOW);
```

```
 digitalWrite(LED2,LOW);
 digitalWrite(LED3,LOW);
 digitalWrite(LED4,LOW);
 digitalWrite(LED5,LOW);
 digitalWrite(LED6,LOW);
 digitalWrite(LED7,LOW);
 digitalWrite(LED8,LOW);
 digitalWrite(LED9,LOW);
 digitalWrite(LED10,LOW);
 digitalWrite(LED11,LOW);
 digitalWrite(LED12,LOW);
 digitalWrite(LED13,LOW);
 digitalWrite(LED14,LOW);
 digitalWrite(LED15,LOW);
}
void COUNTLED(){
 LEDR++;
  LEDG++;
  LEDB++;
  if (LEDR>5){
   LEDR=1;
  }
  if (LEDG>5){
   LEDG=1;
  }
  if (LEDB>5){
   LEDB=1;
  }
}
```

APPENDIX B: - SCHEMATIC DIAGRAM



KEMENTERIAN PENDIDIKAN MALAYSIA

POLITEKNIK Sultan Salahuddin Abdul Aziz Shah

BACHELOR OF ELECTRONIC ENGINEERING TECHNOLOGY (MEDICAL ELECTRONIC) WITH HONOURS

Survey Question About Stroke

NAME :...

POSITION:...

GENDER: ☐ MALE ☐ FEMALE

NO	QUESTION	YES	NO
1	Do you familiar with stroke disease?		
2	Do you think stroke is a hindrane to happy life?		
3	If you are a stroke patients, would you like to improve the existing device during the treatment?		
4	Are all stroke patients has symptom of face droppy?		
5	Do stroke patients has trouble organizing tasks and activities ?		
6	Can stroke patients lead a normal life?		
7	Do you think that the therapy device will regain the use and dexterity of hands?		
8	Did you know that during stroke, the brain does not receive enough oxygen or nutrients that will cause brain cells to die ?		
9	Is it important for stroke patients to have the hand therapy exercise?		

10. If you are a stroke patients, what will you do to improve the therapy device for dexterity?

THANKS FOR YOUR COOPERATION

APPENDIX D :- QUESTIONNAIRE (Post Survey)

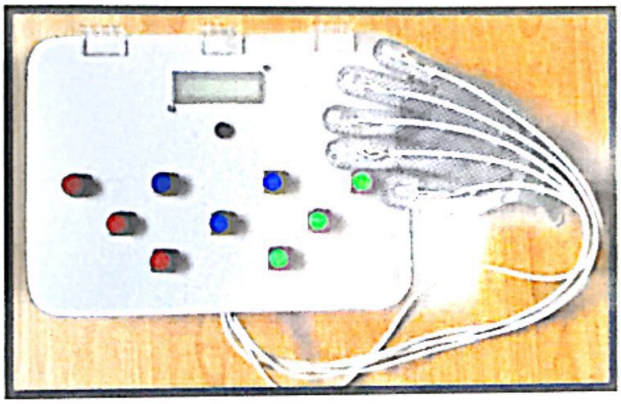
KEMENTERIAN PENDIDIKAN TINGGI

POLITEKNIK MALAYSIA SULTAN SALAHUDDIN ABDUL AZIZ SHAH

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

SURVEY QUESTIONNAIRE

DEXTERITY THERAPY DEVICE FOR STROKE PATIENTS



DISCLAIMER:

The survey is based on a final year Bachelor of Engineering Technology (Medical Electronic) project device, the Dexterity Therapy Device for Stroke Patients. The aim of this survey is to understand and evaluate the application of the device. This will be helpful in order to improve and to enhance the device in the future. Participation of this survey is completely voluntary and anonymous. You may choose to discontinue with this survey at any time. No harm will fall to any participants. All the data collected will be recorded and analysed.

CONSENT:

I have read and understood all the information mentioned above. My participation in this survey is voluntary and I am willing to share necessary information needed for this survey.

This survey is divided into three sections. Section A, B, C & D.

SECTION A

This section consist of 5 question about the comfortability of the device

**Please read and answer(√) these questions below*

NO	STATEMENTS	STRONGLY DISAGREE	DISAGREE	NEUTRAL (Agree Nor Disagree)	AGREE	STRONGLY AGREE
1.	GLOVE ARE EASY TO WEAR AND COMFORTABLE					
2.	LED PUSH BUTTON ARE SUITABLE AND EASY TO USED					
3.	THIS DEVICE ARE STABLE AND LESS MOVING WHILE OPERATING					
4.	THIS DEVICE ARE LIGHTER AND SUITABLE TO FIT ON LAP OR ON THE TABLE					
5.	EASY TO DISTINGUISH THE COLOR ON THE GLOVE					

SECTION B

This section consist of 5 question about the design of the device

**Please read and answer(√) these questions below*

NO	STATEMENTS	STRONGLY DISAGREE	DISAGREE	NEUTRAL (Agree Nor Disagree)	AGREE	STRONGLY AGREE
6.	DESIGN ARE PORTABLE					
7.	GLOVE DESIGN : EASY TO MOVE THE FINGER					

8.	THE SIZE OF THE PUSH BUTTON ARE SUITABLE FOR FINGERTIP					
9.	ORDERLY COMPONENTS ARRANGEMENT					
10.	THE DESIGN OF THE DEVICE IS APPROPRIATE					

SECTION C

This section consist of 5 question about the <u>effectiveness</u> of the device

**Please read and answer(√) these questions below*

NO	STATEMENTS	STRONGLY DISAGREE	DISAGREE	NEUTRAL (Agree Nor Disagree)	AGREE	STRONGLY AGREE
11.	EASY/COMFORTABLE TO USE					
12.	DEVICE FUNCTIONING WELL					
13.	RELIABILITY DURING USAGE					
14.	SAFETY, SECURE AND USER FRIENDLY					

15.	PRODUCTIVENESS TO DAILY ROUTINE/ TASKS					

RECOMMENDATION/SUGGESTION/COMMENT

THANK YOU