

**AUTOMATED WHEELCHAIR USING WIRELESS
TECHNOLOGY**

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DECLARATION

I hereby declare the final year project book is an authentic record of my own work carried out for one-year Final Year Project for the award of Bachelor of Electronic Engineering Technology (Medical Electronic) With Honours, under the guidance of Yaakub Bin Omar from 4 September 2016 to 25 May 2017.

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ABSTRACT

Manual wheelchair propulsion in daily life is increasing day by day. So, preliminary study of human factors engineering is important in designing the wheelchair to be more ergonomics for them in doing daily activities. The main objective of this project is to improve the existing wheelchair in term of daily usage and to facilitate the lives of those among us who are unfortunate enough to have lost the ability to move their legs due to a significant amount of paralysis, accident or due to old age. Many differently abled people usually depend on others in their daily life especially in moving from one place to another. This project represents the “Automated Wheelchair Using Wireless Technology” for the physically differently disabled person where the command controls the direction of the wheelchair. The command is given through a cellular device having Bluetooth and the command is transferred to Arduino and paired to Bluetooth Module HC-05 connected to the Arduino board for the control of the wheelchair. This system was designed and developed to save cost, time and energy of the patient. During this usability testing, 20 normal subjects were tested, and questionnaires were distributed to them. Usability testing consist of 4 main items which are analysis on survey question, percentage of population getting illness, age and gender differences in stroke among older adult and comfortability, These are the items data was collected through the usability test, which the subject have tested the developed Automated Wheelchair Using Wireless Technology Device, then answered questionnaire.

ABSTRAK

Penggunaan kerusi roda manual dalam kehidupan harian semakin meningkat hari demi hari. Jadi, kajian awal kejuruteraan faktor manusia adalah penting dalam mereka bentuk kerusi roda untuk menjadi lebih ergonomik untuk pengguna dalam melakukan aktiviti harian. Objektif utama projek ini adalah untuk penambahbaikan kerusi roda yang sedia ada, dari segi penggunaan harian dan untuk memudahkan kehidupan pengguna di antara yang bernasib malang telah kehilangan keupayaan untuk menggerakkan kaki, jumlah yang mengalami lumpuh, kemalangan atau disebabkan sakit tua. Biasanya, pengguna kerusi roda bergantung pada orang lain dalam kehidupan harian mereka terutamanya dalam pergerakan dari satu tempat ke tempat yang lain. Projek ini merupakan 'Kerusi Roda Automatik yang Menggunakan Teknologi Wireless' bagi membantu orang yang mempunyai kecacatan fizikal yang berbeza di mana kita boleh mengawal pergerakan kerusi roda tersebut. Arahan itu diberikan melalui peranti selular mempunyai Bluetooth dan arahan itu dipindahkan ke Arduino dan dipasangkan ke Modul Bluetooth HC-05 berhubung dengan papan Arduino untuk mengawal pergerakan. Semasa ujian kebolegunaan, alat ini telah diuji pada 10 staf jurupulih anggota dan 10 orang awam, dan data telah dikumpul dengan mengedarkan soal selidik kepada responden. Data yang dikumpul telah dianalisis menggunakan Microsoft Excel. Keputusan telah menunjukkan bahawa majoriti adalah sangat setuju bahawa penambahbaikan peti simpanan tersebut selesai untuk digunakan. Tidak kurang juga berberapa responden kurang setuju untuk pengubahsuaian kerusi roda. Kesimpulannya kerusi roda ini direka untuk mengurangkan beban pengguna serta menjimatkan masa dan tenaga pengguna.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Stroke is a prevalence global health problem lead to major mortality for developed countries. According to study of Cheah Wee Kooi had found that stroke is the second largest causes of death and the third most common cause of Disability Adjusted Life Years (DALYs) from the Global Burden of Diseases. However, listed stroke as the third leading cause of mortality for males in Malaysia, in 2009. During the third National Health and Morbidity Survey (NHMS) in 2006, the stroke was estimated to be 0.3% among Malaysians. In the fourth survey NHMS survey in 2011, the prevalence of stroke was reported as 1.7% among ages 55-59 years, 2% years, 3% in 65-69 years, 3.5% in 70-74 years and 7.8% in 75 years and beyond [1].

Automated wheelchair using wireless technology is one of rehabilitation device that help patient with lower extremity problem. This wheelchair is generally designed for elderly homes and hospital usage. Wheelchair are usually heavy and bulky to carry from one to another place. This device is used by elderly, patient that have been injury and disabilities.

Those with mobility limitations those having difficulty in walking, or who are unable to walk, can be provided with mobility devices such as wheelchairs and scooters so as to facilitate mobility and thus enable activity. There are some benefits by using automated wheelchair using wireless technology whereas the user cannot manipulate the wheelchair with their arms due to lack of force [2]. While there are some limitations in the cost and direction movement, the concept developed in this project are proven convenience innovation and provides better benefits to the targeted market and public interest. Android technology is a key which may provide a new approach of human interaction with machines or tools. The system is designed to control the directions of wheelchair by using the android application.

1.2 Problem statement

Almost all wheelchairs are used for disability population as a transportation. The common problem faced by wheelchair users are difficult to use a wheelchair to wheel around and depend on others need, and upon patient's condition tend to use more energy to keep moving around. Beside, electric wheelchairs are too heavy and difficult to control. Many wheelchairs are available with various running technologies, but the cost is very high. For that, an automated wheelchair using android technology has developed by using application to make their daily routine.

1.3 Objective

The main objective of this project is: -

- (i) To develop an existing wheelchair that controlled by using software application.
- (ii) To designed an android application to control the movement of a wheelchair.
- (iii) To upgrade the existing wheelchair to become comfortable to use and easy to handle.

1.4 Significant of study

This study is to analysis the problems that always occur on the pedal exerciser and find a solution to solve it. This wheelchair will overcome the issues that arise in old age homes and hospital usage. For instance, wheelchair user not enough strength to move around. This will reduce manpower and dependency on other human however wireless control helps to monitor the wheelchair easily.

1.5 Scope of project

This device is specifically design to control the movement of the wheelchair without rely on others need. This wheelchair has developed by using software application. By developing this wheelchair is to reduce physical effort of others. This will make user's life more convenient. This wheelchair can weigh about 70 to 100 kg.

1.6 Theoretical of the study

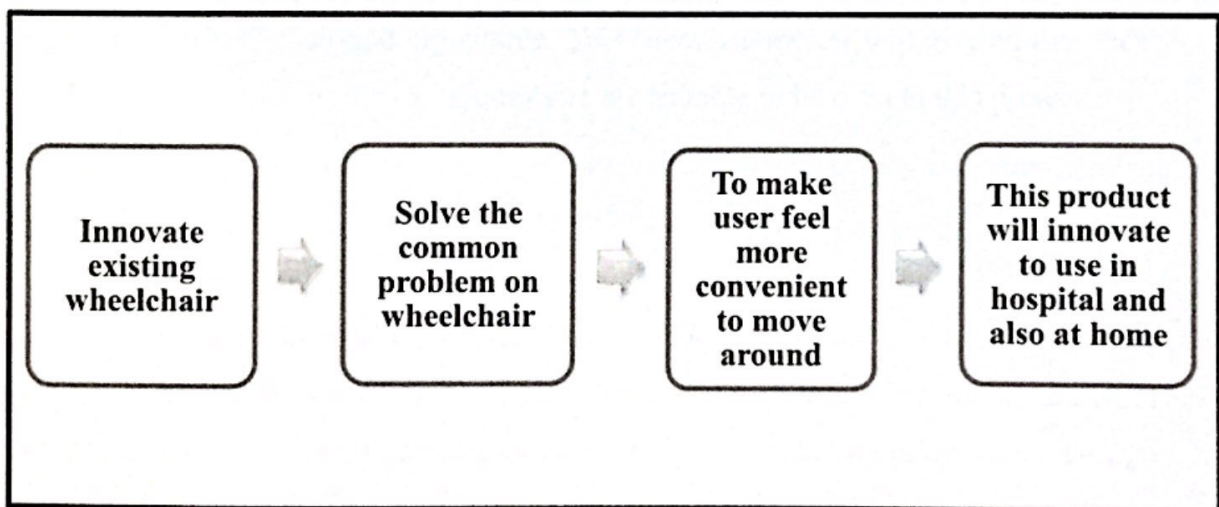


Figure 1.6: Theoretical of the study

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides the description of literature review that has done according to the title of “Automated Wheelchair using Wireless Technology”. Since the aim of this project is to facilitate the movement of elderly people, disability and handicapped. Thus literature review related definition of design, wheel chair and handicap. Obviously literature review related with definition of human factor engineering, wheel chair and ergonomic. This literature review will give an overview or a brief introduction of the techniques that are suitable to be used in this project.

2.2 Design

Design is an innovative process it is also a decision-making process. Decisions sometimes have to be made with too little information, occasion ally with just the right amount of information, or with an excess of partially contradictory information. Design is a communication-intensive activity in which both words and pictures are used and written and oral forms are employed. Engineers have to communicate effectively and work with people of many disciplines. Design is the human power to conceive, plan, and realize products that serve human beings in the accomplishment of any individual or collective purpose.

2.3 Wheelchair

Wheelchair is a wheeled mobility device that can be found and used in hospital or at home. Wheelchair has become an assistive technology among the disabled, handicapped and elderly population and the number of users has increase rapidly [3]. The device comes in variations allowing either manual propulsion by the seated occupant turning the rear wheels by hand, or electric propulsion by motors. There should be some means of machine that could provide this population to move from one place to another. The disability population needs a transport that facilitate their movement.

The primitive wheelchair is the one which the user has to wheel by themselves. The user needs to use force energy to wheel for a long distance and also they rely on other's needs. It may lead to stress on the user. With the help of human efficiency, the idea of automated wheelchair was built. An automated wheelchair is based on android application which interacts to the motor. The motor processes the input provided and takes the corresponding action. The application of android in the system, it made users life convenient and to move without difficulty. The system becomes user-friendly to the user.

There has been tremendous development in wheelchair design due to the many technological and innovative developments. Nowadays, automated wheelchair is fitted with electronic circuits that are nonlinear, and other components to make the wheelchair ride safely. There are a number of different wheelchair designs and models available, but they are basically classified as either manual or electric. It is important to understand the limitations and safe operation of wheelchair and a wheelchair assists people to become more mobile and independent

2.4 Types of Wheelchair

Nowadays, there are many sorts of wheelchair that is available in the market. It is design based on their design and functions as well. Mainly, the wheelchair is also use for doing regular activities. The types of wheelchair are manual wheelchair, electric powered wheelchair, sport wheelchair and cross-braced wheelchair. These wheelchair has provided various system and function.

2.4.1 Manual wheelchair

Manual wheelchairs in figure 2.1 are the primitive type of wheelchair available and are either classified as self-propelled or attendant propelled. One of the first self-propelled wheelchairs was developed by a blacksmith over 300 years ago and used a hand crank to move the wheelchair. The user must wheel themselves without battery support. It requires the user to push using their limbs, and companion propelled, which means that user needs someone to wheel them. Manual wheelchair incorporates a seat, foot rests and four wheels which is two, caster wheels at the front and two large wheels at the back. The two larger wheels in the back usually have hand-rims or plastic circles approximately 3/4" thick.



Figure 2.1 Manual wheelchair

2.4.2 Electric Power Assisted Wheelchair

Electric-powered wheelchairs in figure 2.2 provide functional mobility for people with both lower and upper extremity impairments. The current state of EPW control technology does not provide adequate mobility and comfort for many Electric powered wheelchair users, especially under adverse driving conditions. The purpose of this review is to convey the depth of the research conducted on EPW control technology as well as provide insights into future directions.

Based on Kazuki Takahashi, Hirokazu Seki and Susumu Tadakuma, electric power assisted wheelchair which help the driving force by electric motor is the main to be used as a mobility support system for elderly people and disabled people [4] who have difficulty in walking are increasing. Electric power assisted wheelchair is one of the mobility which safety driving control scheme for electric power assisted wheelchairs based on the regenerative braking system and the driving mode switching.



Figure 2.2 Electric Power Assisted Wheelchair

2.4.3 Toddler or Junior Chair

Toddlers need chairs that can accommodate their changing needs as they grow. In addition, it is important that wheelchairs for children that adaptable in classroom environments and is "user friendly" to help the user fit more into social issue. Nowadays, most of the develop manufactures are becoming miserly to available in market demands and are attempting to address them with innovative chair designs and a variety of "kid-oriented" lifestyles.

2.4.4 Specialty Chair

Because of the diverse needs of wheelchair users, wheelchairs have been designed to accommodate many lifestyles and user needs. Hemi chairs, which are lower to the floor than standard chairs, allow the user to wheel the chair using leg force strength. Chairs that can be wheeled by one hand are available for people who have paralyze on one side. Oversized chairs and designed to bear the weight of obese people are also offered. Rugged, specially equipped chairs are suites for outdoor activities. Aerodynamic three-wheeled racing chairs are used in marathons and other racing events. Manual chairs require for those who are need able to do their jobs by standing on own feet. The other chairs are generally designed independent wheelchair to meet the needs of specific target markets.

2.4.5 Institutional Chair

The least expensive type of chair available, an institutional chair, is designed for institutional usage only, such as transporting patients in hospitals or nursing homes. It is not an appropriate alternative for anyone who requires independent movement, as the institutional chair is not fitted for a specific individual. These types of chairs are now also used as rental chairs and by commercial enterprises such as grocery stores and airports for temporary use.



Figure 2.3 Institutional Wheelchair

2.4.6 Existing wheelchair

Recently, there are many projects that related to wheelchair have been developed in industry. Based on the journal survey the existing systems are equipped by joystick, eye-ball movements, gesture-based, voice based, patterns made by hand. In past few years, in joystick based control wheelchair person with not ordinary disabilities may find it hard to move joystick as it requires lack of force energy and it may affect the reaction time of the wheelchair which may be dangerous [5]. So with the help of technology and human intelligence the idea of automated wheelchair was evolved. An automated wheelchair is based on some input interfacing machine which provides input to the motor.

In the eye-ball movements [6] controlled wheelchair and head/neck [7-9] movement controlled wheelchair, the user has more strain on the eyes, head, neck. In this issue, user has restricted sight as the motion of the eye-ball, head, neck is taken as an input by system that can give incorrect output for that instance. Voice controlled system [10] can provide inaccurate response in noisy environment and it can become difficult for the user to locomotive. In Accelerometer-based controlled system [11], the tilting direction of the mobile phone should be precise to receive accurate result. And moreover it will be complex for people with disabilities in wrist movements. And pattern recognition based system [12] will require training of the user as well as the system.

The training of the system will vary for different users. Also in brain signal controlled system [13] acquires and converts the brain signal to give direction signals. This signals are generated due to electrical activity that is stimulated by brain. But brain signal cannot be relied on for motion of wheelchair as in some external electric field the device may not able to capture the accurate signal. The overall framework of automated wheelchair using wireless technology was developed for the electronic wheelchair controlling system, which could be capable for user and helping them to live independent life.

2.5 Wheelchair Components

2.5.1 Frame

One of the biggest breakthroughs in wheelchair technology has been the development of new, lightweight materials for wheelchair frames. Whereas stainless steel used to be the only frame material available, wheelchair users today have their choice of stainless steel, chrome, aluminium, airplane aluminium, steel tubing, an alloy of chrome and lightweight materials, titanium, and other lightweight composite materials. The type of material used to construct the frame affects the weight of the frame, and therefore the overall weight of the wheelchair. The type of frame material also can affect the wheelchair's overall strength. The two most common types of frames currently available are rigid frame chairs where the frame remains in one piece and the wheels are released for storage or travel, and the standard cross-brace frame which enables the frame to fold for transport or storage.

2.5.2 Upholstery

Upholstery for wheelchairs must withstand daily use in all kinds of climate. Consequently, production provide a variety options to users, ranging from cloth to new synthetic fabrics to leather. Many manufacturers also offer a selection of upholstery colour, ranging from black to neon, to allow for individual selection and differing tastes among consumers. While wheelchairs are designed to be comfortable enough for extended use, you may find the materials used to upholster your wheelchair aren't a great fit for your particular condition or lifestyle.

2.5.3 Arm Rests

There are variety of wheelchair arm rests available in market to meet the needs of wheelchair users. Armrest on wheelchairs have their functions depending on the user's needs but the most common aids for transferring, comfort while sitting and weight shifting. Wheelchair users are able to use the arms for balance when sitting or standing and should be strong enough to support their weight. The action stimulates blood flow in the buttocks and reduces the chances of developing pressure aches ensuring the comfortable and well-supported when using wheelchair.

2.5.4 Seating systems

Footrests are the most common type of front rigging on a wheelchair and are the basic need. Footrest for wheelchair usually removable and swing away to the side to make transfers easier. The footrest available in two or three different angled at 90° to keep the feet directly below the knees which are positioned at 90° to the thigh. While 90° is the optimum position for everyone, it isn't practical for adults as their lower legs are usually too long to be set at 90°. So adults usually have a choice of 70° or 60° hangers to keep the hangers clear of the swiveling casters and keep the seat height at a reasonable height.

2.5.5 Wheels

The rear wheels on a manual wheelchair come in several different sizes and a couple of different styles as normal options. There are variety types for tires and each will have its own advantages. Beside, wheelchair have three types of tires, air filled, solid and foam filled or flat free inserts. The tires will be a factor on how easily the wheelchair will roll over all terrain. Generally, the harder the tire, the easier the wheelchair will roll and turn corners. The softer the tire, the harder it will be to propel the wheelchair.

Air tires are fairly common on the rear of a wheelchair because they are to roll over soft ease the ride. The disadvantage of air tires is they will go flat if punctured and they will go soft even without any damage eventually. Air tires and tubes need to be replaced more often than solid tires. Solid tires are the best tires for those who want a wheelchair to roll as possible but they give the roughest ride over bumps and ridges in the ground surface. The biggest advantage is to look over on regular maintenance free, they won't go flat and they won't likely wear out in the life of the wheelchair. Solid tires are most suitable for wheelchairs that are expected to stay indoors most of the time such as nursing home use.

Foam filled or flat free inserts are basically air tires that have a semi-solid core. The advantage is they will stay harder than air tires and not be subject to flat tires but still give a bit softer ride than a solid tire. This type of caster tire will wear out over time and have to be replaced on wheelchairs that have heavy use and would be considered a compromise between air filled and solid caster tires.

2.6 Ergonomic Aspects of Wheelchair

Ergonomics is known as scientific discipline apprehensive to understand the connection between human beings and element of the system. It is employed in fulfilling the goals of health and productivity. Wheelchair users overcome the problem of being forced to spend long term in the same position. The result can be pain, deformities and decubitus ulcers [14]. Ergonomics deals with four key criteria which are force, repetition, duration, posture. Force is a heavy impact jolts our joints can cause tension in our muscles as a response. Many users have their own way of direction where they end up snapping their arms at the end of a push which consequently puts undesirable pressure on the shoulder joints. Running over a bump at a significant speed in a power wheelchair or scooter can result in unnecessary impact.

Repetition is a pretty obvious phenomenon. In order to minimize the number of pushes coasting by keeping your tires inflated and your chair well maintained and slow speed can be advantageous as more pushes are needed to go faster. Continuous muscular effort refers to duration. Small continuous exertions are as more stressful to your tissues

than a brief yet heavy effort. For example, leaning on armrests usually due to the reason of poor seat and back relation, puts continuous load on shoulders. It is a classic example of "static" exertions. Poor posture is a duration overexertion. Heavy and continuous work is imposed on the neck and shoulder if we are seated in a poor posture, like slumping or leaning forward. But the real key here is movement. Remaining active and altering posture throughout the day would not involve in the continually exertion of muscles.

Despite, lack of good posture in their chairs often lead to people spending a lot of time on armrests or table. This is a matter of seat angle and back angle, adjusting them in accordance to your degree of upper body balance and your body shape. In order to get stabilized poor seating makes you slump. The suggested posture which is considered to be optimal is relatively more upright, allowing your spine to support a person.

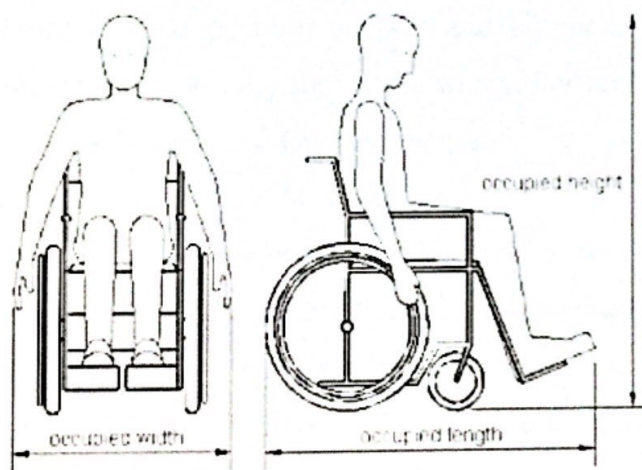


Figure 2.4 Diagram for occupied width, height and length

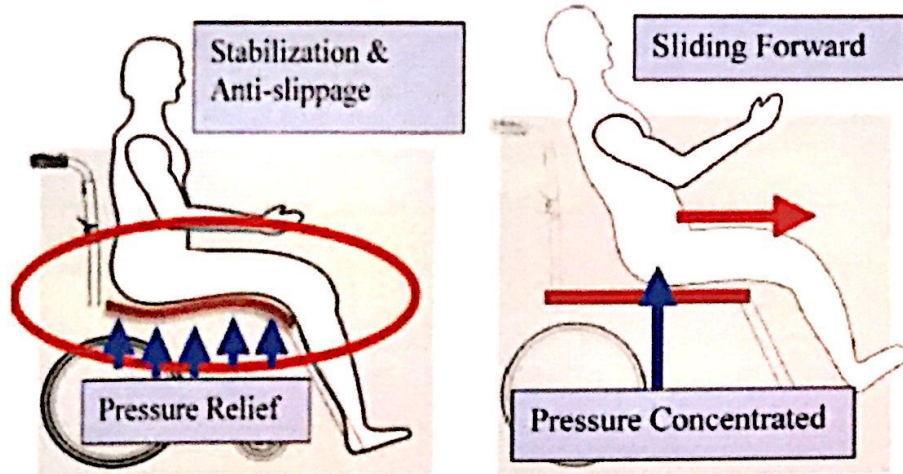


Figure 2.5 Ergonomic surface Design of wheelchair seat

2.6.1 Seating and Postural support elements

Wheelchairs mobility provide postural support and sitting as well. Good postural support is very important, especially for people who suffer unstable spine or are likely to develop secondary deformities. Good seating and postural support have high significance can mean the difference between the user being active and an independent member of society and the user being completely dependent and at risk of serious injury or even death. Seating and postural support is provided by all body contacts. All these parts together of the wheelchair help the user to maintain a functional posture and comfort and to provide pressure relief. This is important for people who have problems like sensation in skin [14].

2.7 Human dimension and ergonomic study

Ergonomics is the methodical discipline concerned to comprehend the interaction between human beings and various elements of the system where a person is living. Ergonomics is employed in fulfilling the goals of health and productivity. Ergonomics is the scientific discipline concerned with designing according to the human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. The field is also called human engineering, and human factors engineering.

2.7.1 Ergonomics with Wheelchair Users

Ergonomic study of wheelchair is the interaction in relation to various aspects of vehicle mechanics and user's physical and mental condition. Wheelchair designed ergonomically reduces the strain that is caused due to longer use of product. Ergonomics in the wheelchair considers four main criteria's like force, repetition, duration, posture [15].

2.8 Bluetooth Technology

Bluetooth is a wireless interaction technology that connect to nearby electronic device. Rather than creating a local-area network (LAN) or a *wide-area network* (WAN), Bluetooth provides a *personal-area network* (PAN) which can be paired with wireless Bluetooth headsets in mobiles. The transmission of data is small compare to other modes of wireless communication. This technology eradicates the use of cords, cables, adapters and permits the electronic devices to communicated wirelessly. In order to improve quality life of elderly automated wheelchair has developed by using Bluetooth module to ease the movement.

According to Indra H Mulyadi, and Eko Supriyanto, telemedicine can be defined as the delivery of health care and the communication of medical information over a distance using telecommunication [16]. The Bluetooth Module provides the communication media between the user through the android phone [17]. Once the Bluetooth module is paired, to android phone it will interpret the system and direct the movement of wheelchair.

2.8.1 Advantage and Disadvantage of Bluetooth Technology

Bluetooth technology is leading the future of wireless connections between different technological devices. Bluetooth is developed into a variety of different devices including phones, iPods, headsets, and even medical devices. There are advantage of Bluetooth, is that cheap and easy to install. It is now widely used across countries and almost by everyone. It easily connects to technological devices together with wireless. Besides, it is free to use if the device is paired. It has simple feature in order to run Bluetooth. Those who are lack of knowledge about the sophisticated technology can still able to use Bluetooth feature and make use of it easily. Even though you are able to exchange data through your cell phones, still have the ability to keep your information private.

Furthermore, the disadvantages use of battery this occurs on cell phone and the device you interact as music player, Bluetooth module and so on. The Bluetooth possibly indicating for the whole day. After use, enable or disable the indicator it so that it wouldn't run out of phone battery. Throughout all devices, when using Bluetooth internet, the connection can sometimes run very slow so Bluetooth internet is not highly suggested for all cases. Overall, Bluetooth is a great thing to be using on all devices that supports it.

2.9 Stroke

Stroke occurs when a blood vessel bringing blood and oxygen to the brain gets blocked or ruptures. When this happens, brain cells don't get the blood and oxygen that they need to survive. This causes nerve cells stopped working and die within minutes. Then, the part of the body they control can't function either. The effects of stroke may be permanent depending on how many cells are lost, where they are in the brain, and other factors. Figure 2.7 shows the functional of brain, brain controls human's move, feel, communicate, think and act. Brain injury from a stroke may affect any of these abilities. One side of the body may be paralyzed are common no matter which side of the brain the injury is on. Others are based on which side of the brain the stroke injures.

Symptoms of Stroke are sudden numbness or weakness of face, arm or leg (especially on one side of the body), sudden confusion, trouble speaking or understanding, sudden trouble seeing in one or both eyes, sudden trouble walking, dizziness, loss of balance or coordination, and sudden severe headache with no known cause.

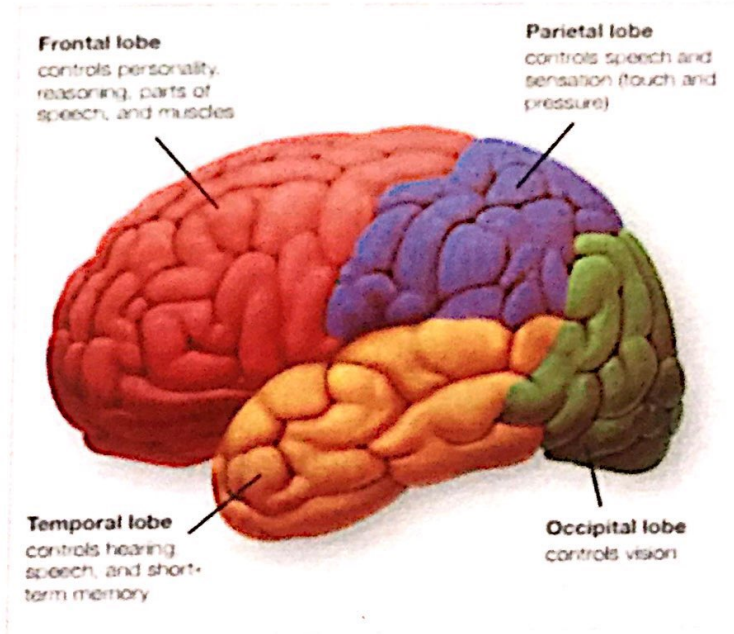


Figure 2.6 Functional of brain

2.9.1 Effect of stroke

The effects of a stroke vary from person to person, depending on which part of the brain is damaged and the extent of that damage. For some, the effects are relatively minor and short-lived; others are left with more severe, long term disabilities. Common problems include weakness or paralysis, Cognitive Problems, Problems Using Language and also Vision and Perception Problems.

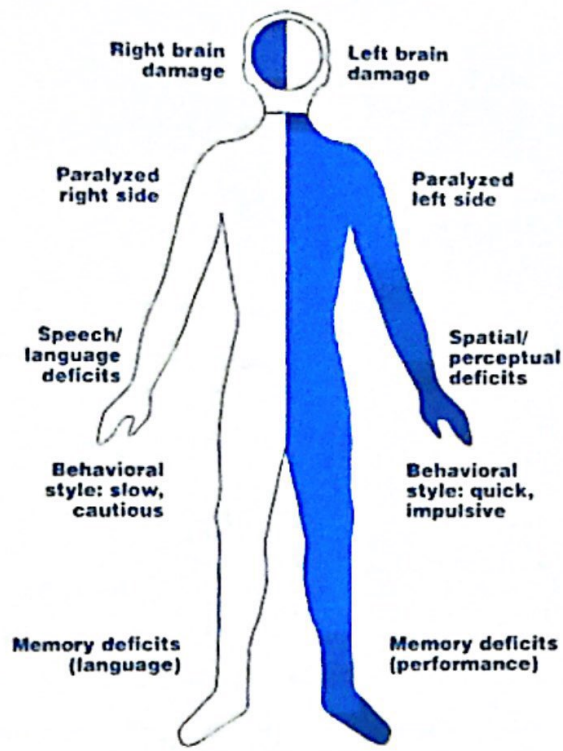


Figure 2.7 Effect of stroke

The figure 2.8 shows most common effects of stroke are weakness or paralysis. Weakness (hemiparesis) or paralysis (hemiplegia) 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.

The second common effect is 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. Furthermore, Problems Using Language also ones of the effects of stroke. Some of the stroke patients may have a problem in aphasia and trouble understanding speech or writing. They may understand but be unable to think of the right words to speak or write.

Vision and Perception Problems also often occurs in stroke survivors, because of vision and perception problems, 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 muscle are stiff and resistance in the joints when patients try to make a movement [18].

2.10 Anatomy of knee joint

According to Cindy Schmidler, the knee joint is a synovial joint which connects the femur, our thigh bone and longest bone in the body, to the tibia, our shinbone and second longest bone. There are two joints in the knee, the tibiofemoral joint, which joins the tibia to the femur and the patellofemoral joint which joins the kneecap to the femur. These two joints work together to form a modified hinge joint that allows the knee to bend and straighten, but also to rotate slightly and from side to side. Based on Tim Taylor, the knee joint help in everyday activities, including walking, running, sitting and standing. The main parts of the knee joint are bones, ligaments, tendons, cartilages and a joint capsule, all of which are made of collagen. Collagen is a fibrous tissue present throughout our body.

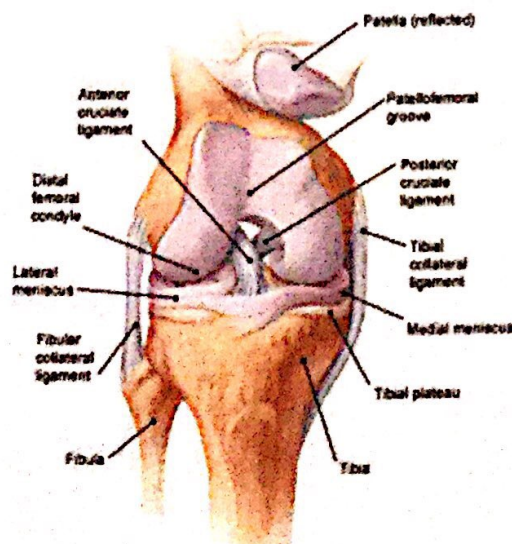


Figure 2.8 Anatomy of Knee Joint

2.11 Osteoarthritis

Osteoarthritis is the most common form of arthritis in the knee that known as musculoskeletal disease that causes joint pain, inflammation and stiffness. It commonly seen in over the age of 65, but it can also develop in children, teenagers and younger adults. Osteoarthritis is a leading cause of impaired mobility in the elderly. Many persons with knee pain have limitations in function that prevent them from engaging in their usual activities. Based on Arthritis Research UK, when the knee has osteoarthritis its surfaces become damaged and it doesn't move as well as it should do [19], where the cartilage is a firm but flexible connective tissue in your joints. According to knee osteoarthritis, (OA) is the most common form of arthritis that affects the elderly. It is a leading cause of disability and has a formidable societal and public health impact [20]. By absorbing the pressure and shock it protects the joints when you move and put stress on them. This cartilage tissue cause reduction in the normal amount forms of arthritis. When a joint is inflamed it may be swollen, tender, warm to the touch.

Severe osteoarthritis may lead in chronic pain, inability to do daily routine and make it difficult to walk. Wear and tear of joint cartilage is the continuous of osteoarthritis. If the cartilage becomes thinner it loses the ability to cushion, when the bones rubery each other caused the painful when it is less elastic. Therefore, the complete loss of cartilage may lead friction between bones, causing pain at rest or pain with limited motion.

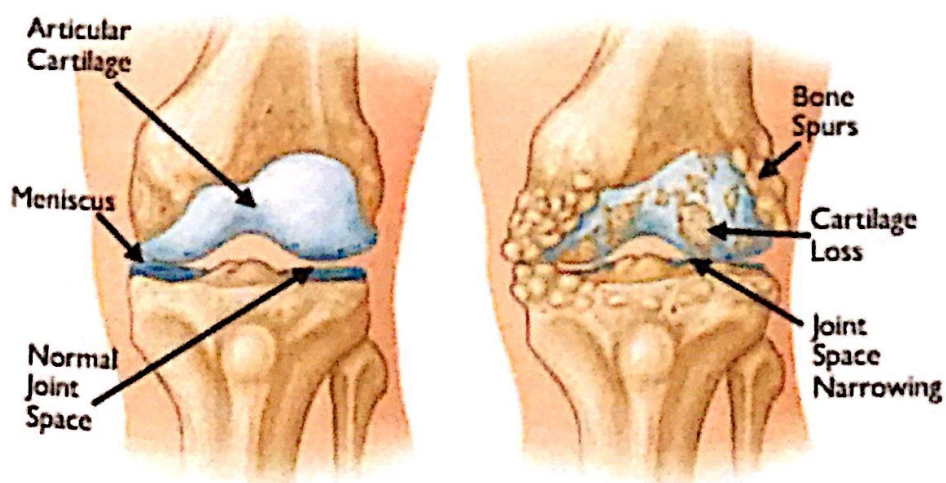


Figure 2.9 Osteoarthritis

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the methodology of project will be explained. The project development consists of idea of the device, consideration of hardware and software implementation and the flow chart of protocol of project. The purpose of this study is to overcome three problems that arise in available wheelchairs are available with various running technologies, which is to upgrade the existing wheelchair to become comfortable to use and easy to handle and reduce production costs, and to designed an android application to control the movement of a wheelchair. Besides that, ensure the device appearance, stability and safety was also required. In order to produce a best solution there are four methods should apply which is proposed, designed, verified and implemented. Furthermore, the both hardware and software implementation may reflect great results and satisfy the plan objective.

3.2 Block Diagram

Block diagram is a diagram showing in schematic form the general arrangement of parts or components of a complex system or process. All the elements represented in block diagram has their own function. It is a complex sketch of block diagram.

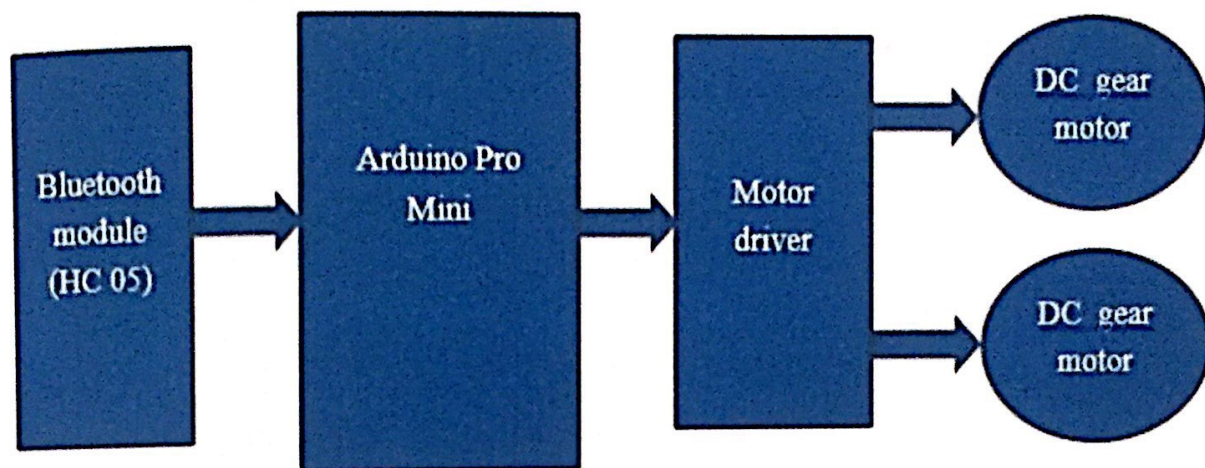


Figure 3.0 Block diagram of project

3.2.1 Bluetooth module (HC 05)

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication.

3.2.2 Arduino Pro Mini

The Arduino Pro series is meant for users that understand the limitations of system voltage (3.3V), lack of connectors, and USB off board.

3.2.3 Motor driver

To take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

3.2.4 DC Gear motor

The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed.

3.3 Flow Chart

Flow chart below had showed that the whole process to implementing this study and it has been described with detail explanation for every step of the process.

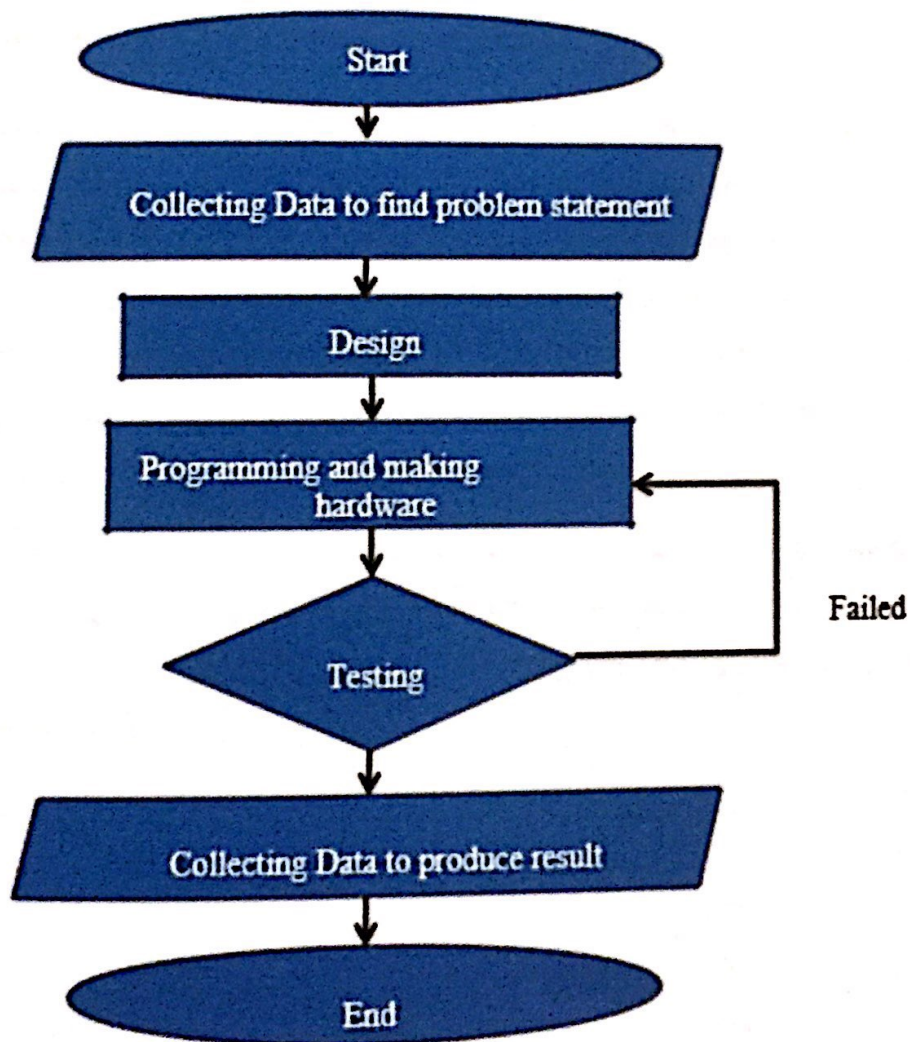


Figure 3.1 Flow chart of project

Data collection was the first step of this study. To study the design and variety pattern of wheelchair, the After that, evaluate the data from study, then find and create the problems statement. After problems statement was created, design the shape and the device. Automated wheelchair using wireless technology device is developed to overcome the issues. Design the suitable shape of the device according to problems statements. Determine the suitable hardware and software that will be attach. Planned the software that suitable used to control a motor driver, because it provides almost all of the many features found in Arduino pro mini that are made by the many suppliers of these small yet comprehensive logic engines. This use offers advantages such as lower voltage drops when turn on and the ability to control motors. Besides that, DC geared motor was used in this study, because it variously used in the industrial and widely used in robotics, used to control the movement of a robots.

Arduino pro mini is a microcontroller board based on the ATmega328. It acts as a Central Processing Unit in this device, and it used to control the electronic component to function well. The direction of wheelchair control by android application. Besides, designing and making the hardware for the devices can also executed. When the hardware is completed, the device is tested to ensure the device is working in good and safe aspect. (If testing failed, return to the step before, redo the process, testing again the devices).

Final step of project process is testing and collect data. Test the device on 20 subjects (10 public and 10 disability patients) for the clinical testing and usability testing. Then, collect the data from patient by distribute questionnaire and analysis the data by using Microsoft excel.

3.4 Hardware Implementation

3.4.1 DC Gear motor

A gear motor is a specific type of electrical motor that is designed to produce high torque while maintaining a low horsepower, or low speed, motor output. Gear motors are commonly used in commercial applications of a gear motor include hospital beds, commercial jacks, cranes and many other applications that are too many to list. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps increasing the torque and reducing the speed. This concept where gears reduce the speed of the vehicle but increase the torque.

A gear motor can be either an AC (alternating current) or a DC (direct current) electric motor. These types of motors also have two different speed specifications: normal speed and the stall-speed torque specifications. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. The output speed of the rotor is reduced through a series of large gears until the rotating, RPM speed, of the final gear is very low. The low RPM speed helps to create a high amount of force which can be used to lift and move the heavy objects.

Motors in figure 3.3 are arguably one of the most important parts of a mobile robotics platform. Overpowered motors cause waste the already limited supply of power and inefficiency from the on-board batteries. The available speed range as well as the optimal rotation speed of the motor must also be taken into consideration. Too high of an output rpm from the motor shaft will cause the robot to operate at a fast, uncontrollable speed. Too low of an output and the robot will not be able to attain a speed and the available speed range of the motor must also be considered. Too high of an output rpm from the motor shaft will cause the robot to operate at a fast, uncontrollable speed. To meet the user's needs it is low of an output and the robot will not be able to attain a suitable speed.

The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor design the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor.

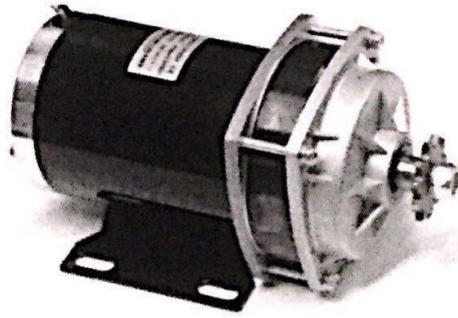


Figure 3.2 24VDC gear motor

3.4.2 Arduino Pro Mini

Arduino is an open-source electronics prototyping platform based on flexible, easy-to use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. 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 projects can be stand-alone, or they can communicate with software running on a computer.

In addition to Arduino's simplicity, it is also inexpensive, cross-platform and open source. The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontrollers. The plans for the modules are published under a Creative Commons license, so experienced hobbyists and professionals can make their own version of the Arduino, extending it and improving it. Although there are many different types of Arduino boards available and the most popular Arduino board around is Arduino Uno.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

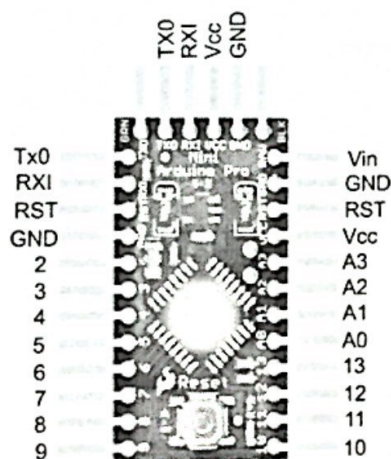


Figure 3.3 Arduino pro mini

3.5 Software Implementation

3.5.1 Programming

Arduino pro mini is used in this project, because it has ATmega328 running at 8MHz with external resonator, which the program that load into the Arduino can be erased and rewrite. Arduino act as a CPU, which control all the activities on board and also the movement of device. The process of programming shown as the diagram below:

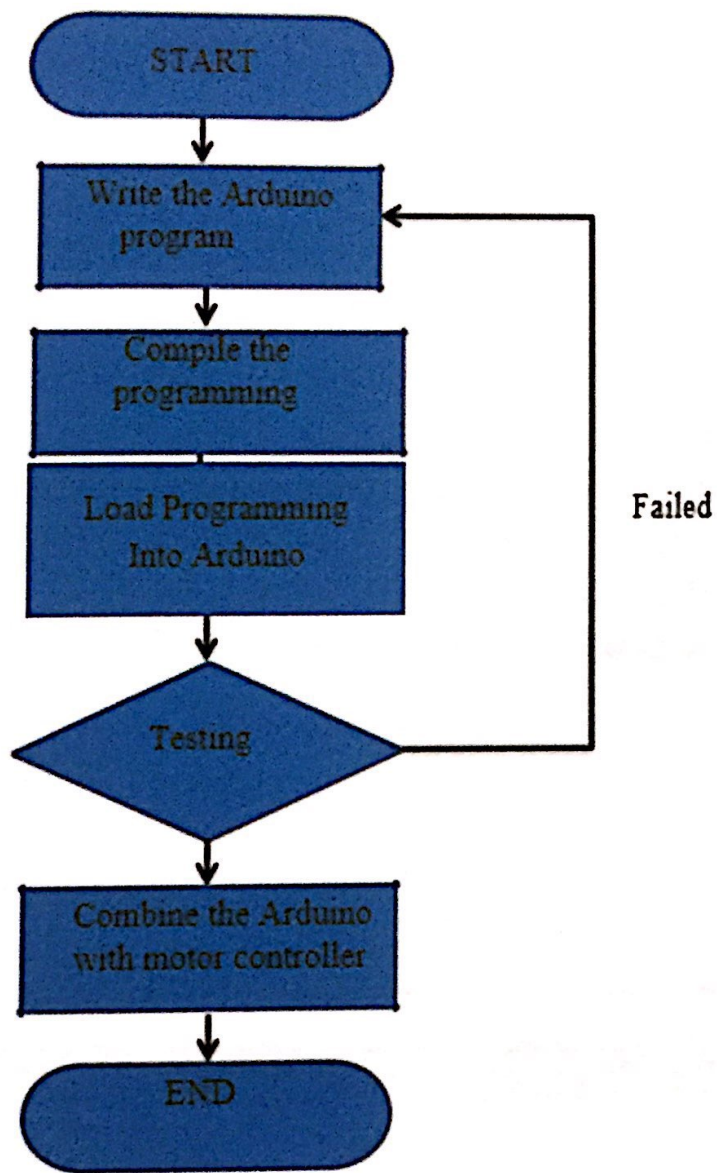


Figure 3.4 Process of programming

To program the Arduino, Arduino IDE v8.56 was used to execute the programming. First, open the Arduino board, and click tools and select the board which is Arduino Pro Mini. The next, will be click serial/com port that Arduino is attached. Once Arduino board is connected and the blink sketch open press the upload button. After a second, can see some LEDs flashing on Arduino, followed by the message 'Done Uploading' in the status bar of the Blink sketch. If everything worked, LED on Arduino board will be blinking.

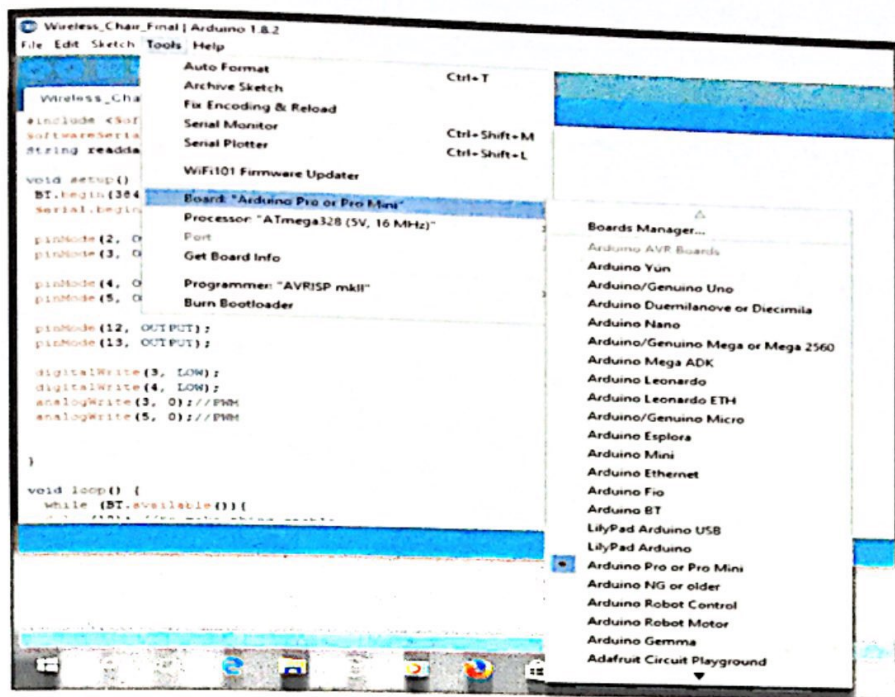


Figure 3.5: Interface of Arduino IDE

3.5.2 Programming code of device

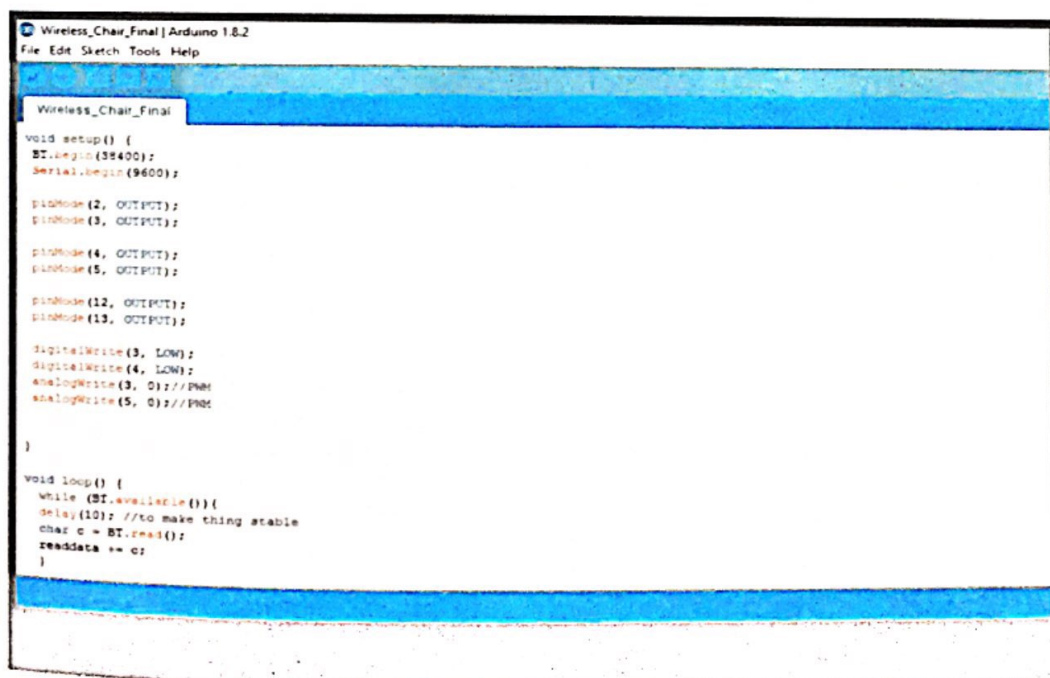


Figure 3.6: Programming Code 1

```
Wireless_Chair_Final | Arduino 1.8.2
File Edit Sketch Tools Help

Wireless_Chair_Final
digitalWrite(13,HIGH);
digitalWrite(12,LOW);

if (readdata.length() > 0) {
  Serial.println(readdata);

  if(readdata == "forward"){
    digitalWrite(2, HIGH);           //Left Motor
    digitalWrite(4, HIGH);           //Right Motor
    analogWrite(3,900);               //Left PWM
    analogWrite(5,900);
    Serial.println("Received F");
    digitalWrite(13,LOW);
    digitalWrite(12,HIGH);
    delay(1000);}

  else if(readdata == "reverse"){
    digitalWrite(2, LOW);
    digitalWrite(4, LOW);
    analogWrite(3,900);
    analogWrite(5,900);
    Serial.println("Received Rev");
    digitalWrite(13,LOW);
    digitalWrite(12,HIGH);
    delay(1000);}

  else if (readdata == "right"){
```

Figure 3.7: Programming Code 2

```
Wireless_Chair_Final | Arduino 1.8.2
File Edit Sketch Tools Help

Wireless_Chair_Final

  else if(readdata == "reverse"){
    digitalWrite(2, LOW);
    digitalWrite(4, LOW);
    analogWrite(3,900);
    analogWrite(5,900);
    Serial.println("Received Rev");
    digitalWrite(13,LOW);
    digitalWrite(12,HIGH);
    delay(1000);}

  else if (readdata == "right"){
    digitalWrite(2, LOW);
    digitalWrite(4, HIGH);
    analogWrite(3,0);
    analogWrite(5,900);
    Serial.println("Received R");
    digitalWrite(13,LOW);
    digitalWrite(12,HIGH);
    delay(1000);}
```

Figure 3.8: Programming Code 3

3.6 Microsoft excel

Microsoft excel is used to interpret questionnaire or early survey in analysis my device among hospital staff and public. By using this software, can spot patterns and trends in data that collected.

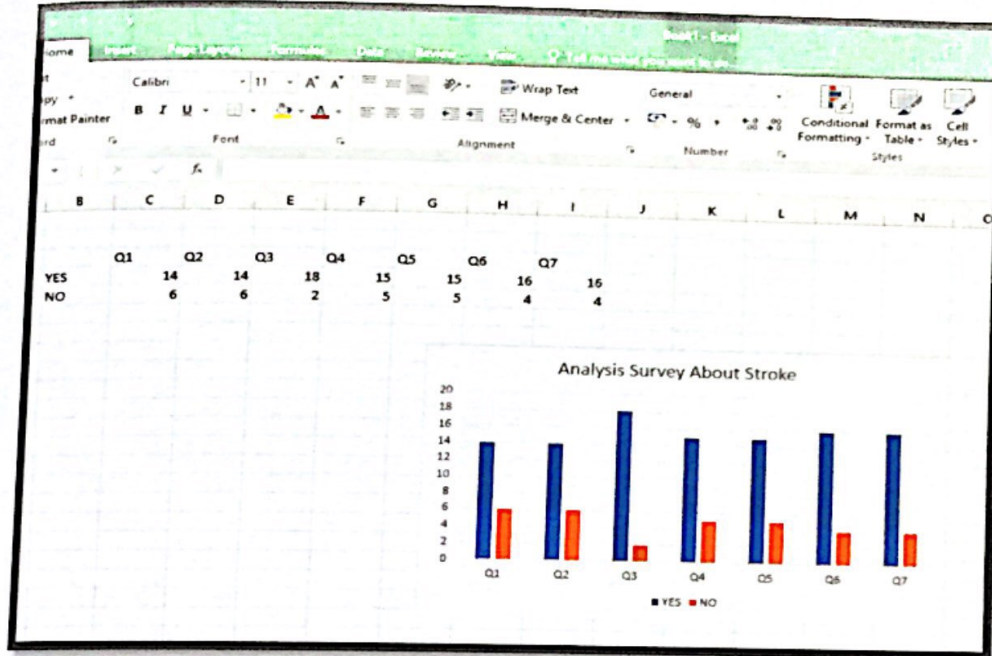


Figure 3.9: Making of graph on Excel

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter shown the result from our collected data such as questionnaire and the data is analyzed and generated graph by using Microsoft Excel. And then the result that analyzed is discussed in this chapter. Since the aim of this project is to develop an automated wheelchair using wireless technology which is to facilitate the movement of elderly people, disability and handicapped. The user can control the wheelchair android application the software and hardware implementation of the platform is described in detail.

4.2 Automated Wheelchair Using Wireless Technology

Automated Wheelchair Using Wireless Technology is a device using android application and Bluetooth interface to control the movement of wheelchair. This device provided five directions that are forward, backward, left and right. Furthermore, this developed device has an easy installation, which the devices only need to install the DC rechargeable batteries before implement. While the exiting devices, have a complex of installation before provide movement, which it needs to connect with Bluetooth module

HC-05 after successfully paired the device can be operate. This device used two batteries to operate the device which are 3.7V battery and 24V DC rechargeable batteries. The 24V DC batteries used to control the DC geared motor movement and the 3.7V battery used to indicate the Bluetooth module and allow to control movement.



Figure 4.0 Automated Wheelchair Using Wireless Technology

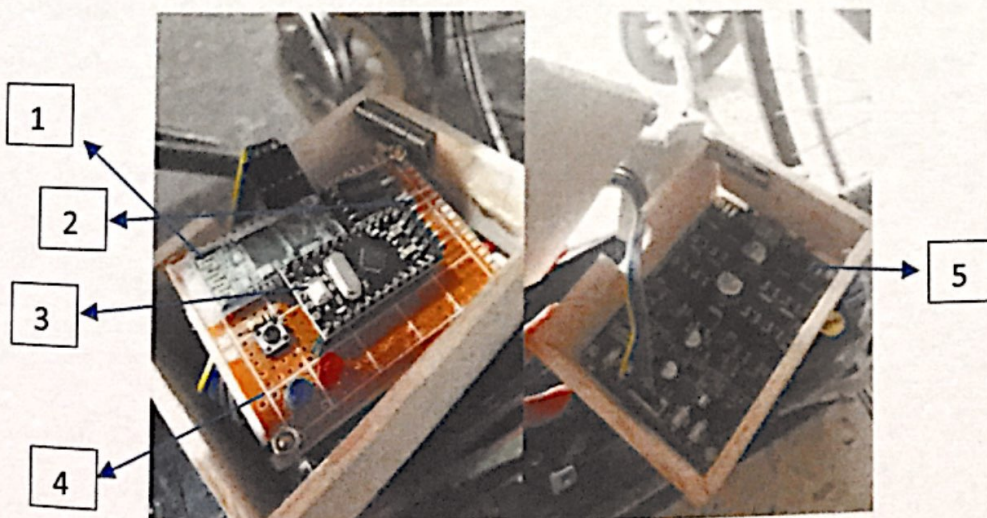


Figure 4.1 Control panel of device (Top View)

Figure 4.2 had shown the top view and the function of components on control panel

Table 1: Function of control panel

No	Components	Function
1	Arduino pro mini	To stored and execute the program
2	3.7V Bluetooth connector	Connect with the Lipo 3.7V battery
3	Bluetooth module HC-05	To interact with Bluetooth interface
4	Led indicator	Power up once Lipo battery is connect to connector
5	Module driver	To control the movement of dc gear motor

4.3 Usability

During this usability testing, 20 normal subjects were tested, and questionnaires were distributed to them. Usability testing have consisted of 4 main items which are analysis on survey question, percentage of population getting illness, age and gender differences in stroke among older adult and comfortability. These are the items data was collected through the usability test, which the subject has tested the developed Automated Wheelchair Using Wireless Technology Device, then answered questionnaire.

4.3.1 Analysis survey on wheelchair

This survey is done based on wheelchair users, from the data collection as we see that response from physiotherapy unit staffs and ordinary subject.

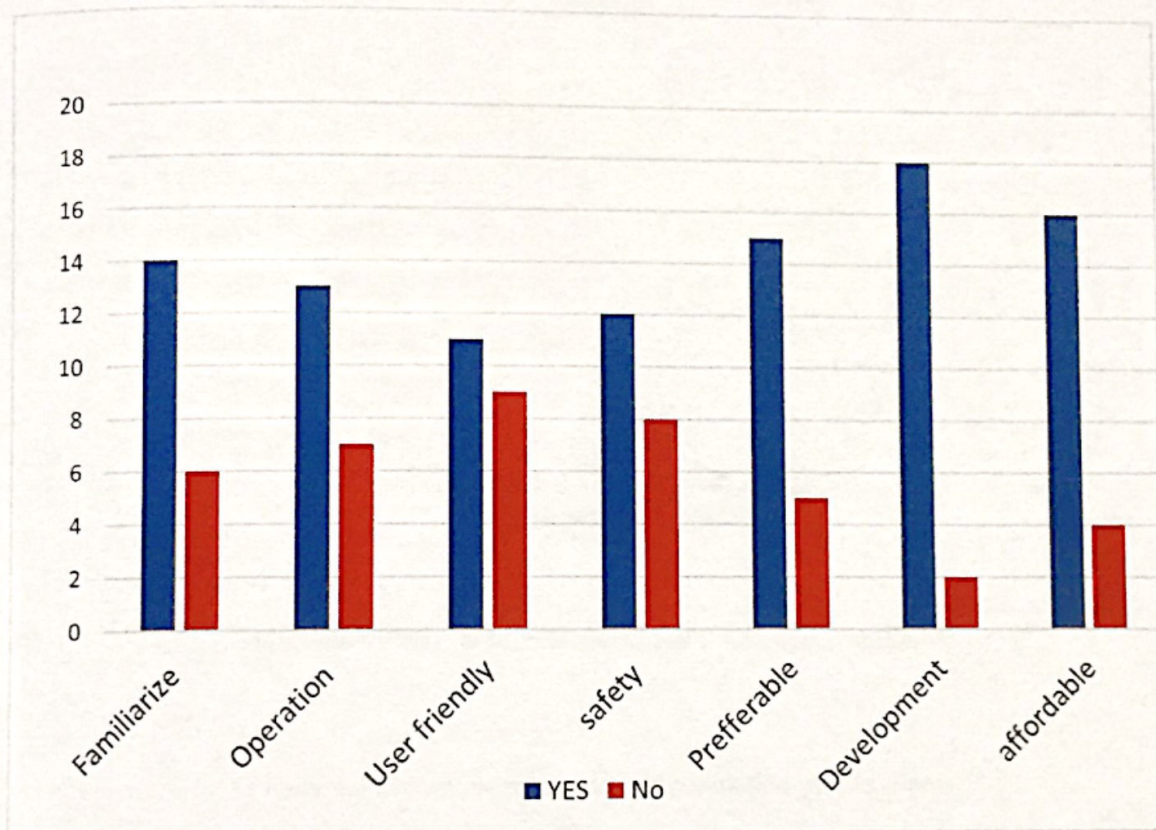


Figure 4.2: Analysis survey on automated wheelchair

From the figure 4.2, through this part the questionnaire is conducted among physiotherapy unit staff's and ordinary subjects. A part from that, all the data in the survey form is tabulated on bar chart. As overall, through the data collection almost the staff has showed positive feedback on development of wheelchair.

4.4 Population of getting diseases

Throughout the illness survey majority of them were picked variety types of illness amongst the elderly population.

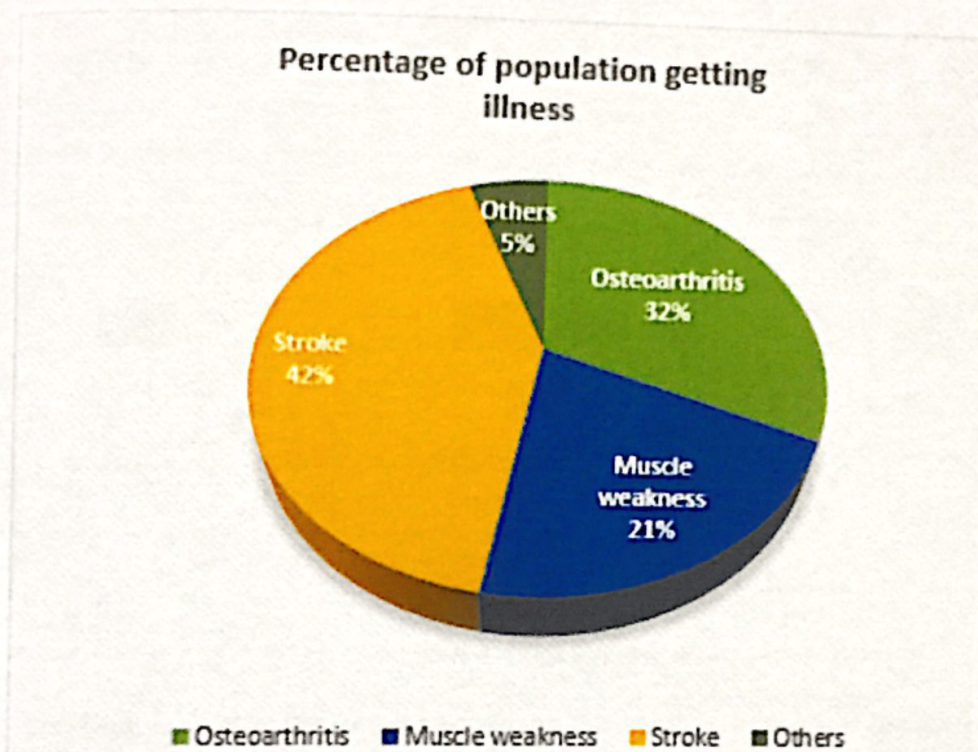


Figure 4.3 Shows the percentage of population getting illness

4.5 Age and gender Differences in Stroke Among Older Adults

Stroke is a common disease in the older population. Although these differences are not fully understood, recognition of gender differences may help with appropriate treatment and improve outcomes

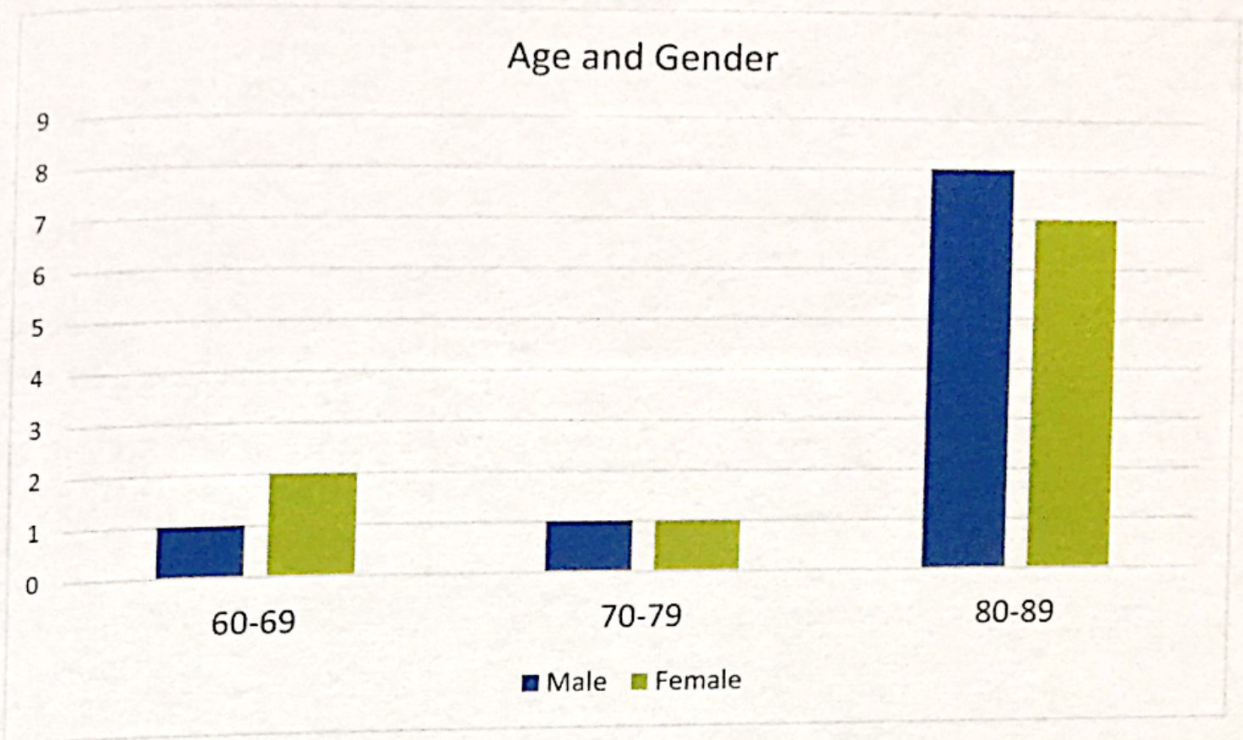


Figure 4.4 Age and gender

The stimuli show a bar graph comparing the number of age and gender getting stroke. From the graph above, majority risk of getting stroke among the gender between the age of 80-89 while female has slightly dropped.

4.6 Comfortability

The data of comfortability about the developed devices was takes. 5 questions are consisted in this part, below is the table of the comfortability.

Table 2: Data of Comfortability

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
I ENJOY USING THIS DEVICE	0	2	4	10	4
THIS DEVICE IS SAFE TO USE	0	2	3	11	4
WE WOULD PREFER TO HAVE ONE	0	2	5	9	4
THIS DEVICE BRINGS MORE BENEFIT TO USER	0	2	3	6	9

From the table above, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.1.

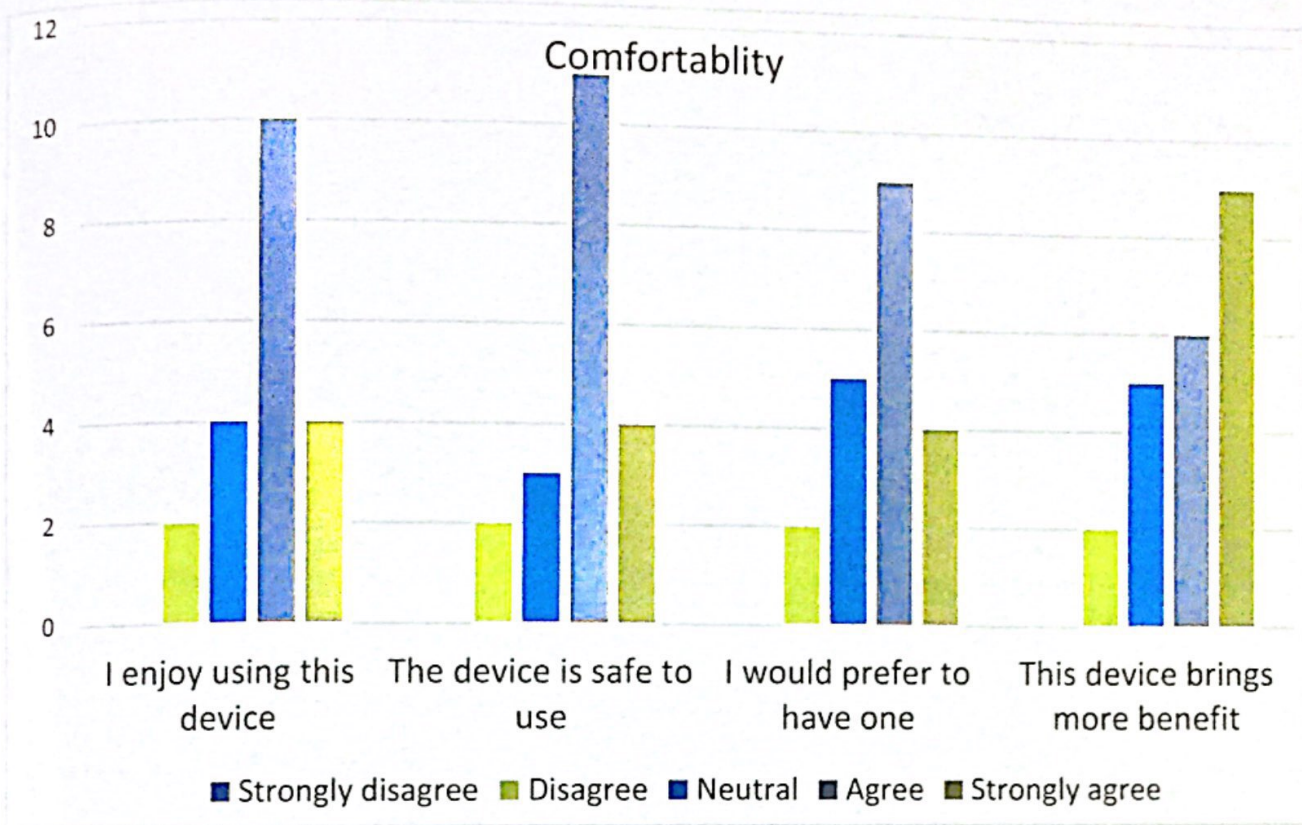


Figure 4.5: Graph of the Comfortability

From the figure 4.4, 10 subjects are agreeing that this device is enjoyable to be used, 4 subjects are strongly agreeing with that, and only 2 subject is disagreeing with it. After that, 11 subjects were agreed that this device is safe to be used, 4 subjects are strongly agreed with it and only 2 subject was disagreed.

Based on the third question, 9 subjects were agreed to have at least one device, 5 subjects were neutral with it, 2 of the subjects were disagree with it. Besides that, 9 subjects were strongly agreed that the device brings more benefit to user and 6 subjects were slightly agreed with the statement. 2 subjects were neither agreed nor neutral.

Besides, there are few recommendations among the 10 subjects, this device would better if the device can be used up for 4 hours which can be useful for patients that will able to travel for long journey. This problem will be solved for the future research or study

RECOMMENDATION AND CONCLUSION

5.1 Conclusion

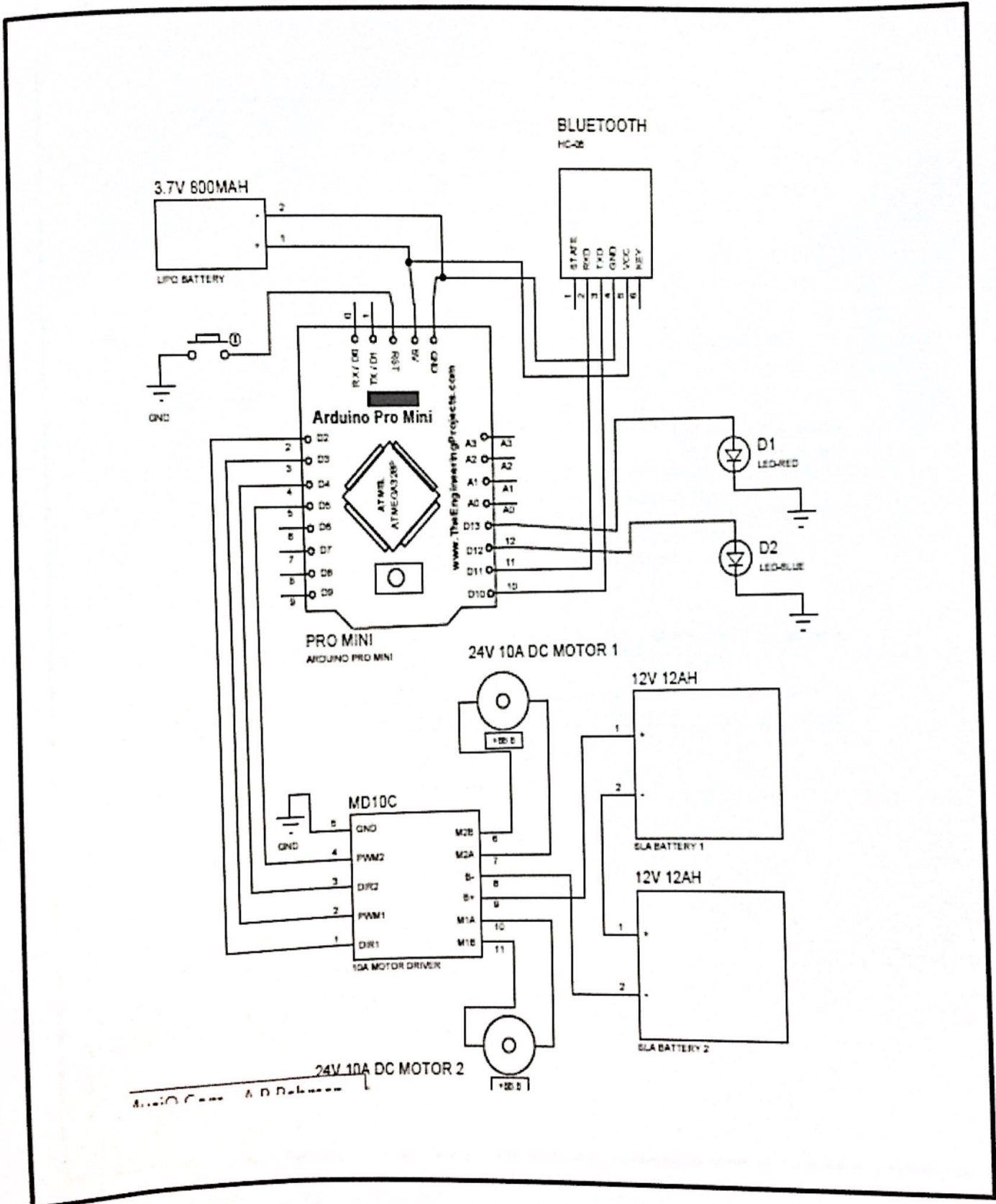
As a conclusion, an automated wheelchair using wireless technology Device is developed for the purpose of helping elderly people whom find difficulty in walking due to illness, injury or disability. Many wheelchairs are available with various running technologies, but the cost is very high. Android technology is a key which may provide a new approach of human interaction with machines or tools. This system is to controlled the direction of wheelchair.

From the usability test that has done, 10 subjects of physiotherapist and 10 ordinary subjects were volunteer to answer the distributed questionnaire based on effectiveness of device. Once the data is collected and it will be analysis by using Microsoft Excel. From the result, the device is comfortable to be used. Furthermore, this device operates well in DC rechargeable batteries and able to weigh up to 70 kg.

5.2 Recommendation

Here is the recommendation from Physiotherapist of Salam Hospital for automated wheelchair using wireless technology which are productive device and this device can reduce the manpower and will be better if it is portable in size

APPENDIX A: SCHEMATIC DIAGRAM



APPENDIX B: SURVEY QUESTIONNAIRE



POLITEKNIK
Sultan Salahuddin Abdul Aziz Shah
Jabatan Pengajian Politeknik



SURVEY QUESTIONNAIRE – AUTOMATED WHEELCHAIR USING WIRELESS TECHNOLOGY

DISCLAIMER:

The survey is based on final year of Bachelor of Electronic Engineering (Medical Electronic) project device, an Automated Wheelchair Using Wireless Technology. 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 future. It is to overcome difficulty among elderly people who are not able to move well because of their disabilities. Participation of this survey are entirely voluntary and anonymous. You may discontinue this survey at any time. No harm will fall to any participants. All the data will be recorded and analysed.

CONSENT:

I have read and understood all the information stated 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 two sections. Section A and B

SECTION A

**Please read and answer(✓) these questions below.*

1. What gender are they?

Male
Female

2. Which age group are they belong to?

60-69
70-79
80-89

3. Are you familiar with this device?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

4. What types of illness are they suffered from?

<input type="checkbox"/>	Osteoarthritis
<input type="checkbox"/>	Muscle weakness
<input type="checkbox"/>	Stroke
<input type="checkbox"/>	Paralyze

5. Is this device easy to operate?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

6. Is this device user-friendly?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

7. Is this device safe to be used?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

8. Do you prefer to use this device at your place?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

9. Does this innovation help user to wheel independently?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

10. If this device available on market, do you effort to have it?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

SECTION B

Please rate how strongly you agree or disagree with each of these statements.

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This device is safe to use					
We would prefer to have it					
This device brings more benefit to user.					

Recommendation / Comments:

THANK YOU

APPENDIX C: PROJECT COSTING

ITEM	PRICE	UNIT	TOTAL
12V DC Gear Motor	RM 45.00	2	RM 90.00
Sealed Lead Acid Battery	RM 80.00	2	RM 160.00
Arduino Pro Mini	RM 39.00	1	RM 39.00
Bluetooth Module HC 05	RM 28.00	1	RM 28.00
3.7V Lipo Battery	RM 29.90	1	RM 29.90
Wire and Connector	RM 12.50	-	RM 12.50
Wheelchair	RM 100.00	1	RM 100.00
Circuit Board and Component	RM 100.00	-	RM 100.00
Micro USB Lipo Battery	RM 20.00	1	RM 20.00
TOTAL			RM 579.40

APPENDIX D: PROGRAMMING CODE

```
#include <SoftwareSerial.h>
SoftwareSerial BT(10, 11);
String readdata;

void setup() {
  BT.begin(38400);
  Serial.begin(9600);

  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);

  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);

  pinMode(12, OUTPUT);
  pinMode(13, OUTPUT);

  digitalWrite(3, LOW);
  digitalWrite(4, LOW);
  analogWrite(3, D); //PWM
  analogWrite(5, D); //PWM
}

void loop() {
  while (BT.available()){
    delay(10); //to make thing stable
    char c = BT.read();
    readdata += c;
  }
}
```



```

digitalWrite(13,HIGH);
digitalWrite(12,LOW);

if (readdata.length() > 0) {
Serial.println(readdata);

if(readdata == "forward"){
digitalWrite(2, HIGH);    //Left Motor
digitalWrite(4, HIGH);    //Right Motor
analogWrite(3,900);       //Left PWM
analogWrite(5,900);
Serial.println("Received F");
digitalWrite(13,LOW);
digitalWrite(12,HIGH);
delay(1000);}

else if(readdata == "reverse"){
digitalWrite(2, LOW);
digitalWrite(4, LOW);
analogWrite(3,900);
analogWrite(5,900);
Serial.println("Received Rev");
digitalWrite(13,LOW);
digitalWrite(12,HIGH);
delay(1000);}

else if (readdata == "right"){
digitalWrite(2, LOW);
digitalWrite(4, HIGH);
analogWrite(3,0);
analogWrite(5,900);

```

```
Serial.println("Received R");
digitalWrite(13,LOW);
digitalWrite(12,HIGH);
delay(1000);}

else if ( readdata == "left"){
digitalWrite(2, HIGH);
digitalWrite(4, LOW);
analogWrite(3,900);
analogWrite(5,0);
Serial.println("Received L");
digitalWrite(13,LOW);
digitalWrite(12,HIGH);
delay(1000);}

else if (readdata == "stop"){
digitalWrite(2, LOW);
digitalWrite(4, LOW);
analogWrite(3, 0);
analogWrite(5, 0);
Serial.println("Received S");
digitalWrite(13,LOW);
digitalWrite(12,HIGH);
delay(1000);}

readdata="";}
}
```


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