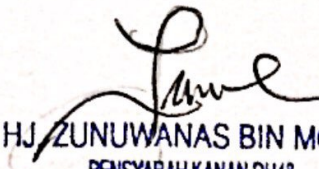


**DEVELOPMENT OF HYGIENIC MECHANICAL
PERCUSSOR FOR RESPIRATORY THERAPY**

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**POLITEKNIK SULTAN SALAHUDDIN ABDUL
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NURUL SYAZWANI BINTI MOHD ZAIDI


**THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE OF
BACHELOR OF ELECTRONIC ENGINEERING TECHNOLOGY
(MEDICAL ELECTRONICS) WITH HONOURS**

**DEPARTMENT OF ELECTRICAL ENGINEERING
POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ**

2018

DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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Date : 5 JULY 2018

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ABSTRAK

Hygienic Mechanical Percussor (HMP) digunakan untuk membantu mereka yang mengalami masalah pernafasan seperti asma, selesema, lendir dan masalah pernafasan lain di dada mereka. Terdapat pesakit yang mempunyai masalah kesihatan berbahaya yang dapat menyebarkan penyakit itu melalui jangkitan seperti pesakit HIV, pesakit eksim dan warga emas. Jadi fabrik yang terdapat pada Percussor Mekanikal tidak sesuai kerana ia tidak boleh dibasuh untuk menjaga kebersihan. HMP ini membangunkan alat pemegang mudah alih untuk menggantikan kain sedia ada pada Percussor Mekanikal. Kedua, ketika Percussor Mekanikal digunakan, getaran di tangan ahli terapi pernafasan juga dirasakan. Ini bermakna getaran tidak terjejas sepenuhnya oleh pesakit. Kemudian HMP akan menganalisis pemegang Percussor Mekanikal yang juga bergetar di tangan ahli terapi pernafasan. Ketiga, Percussor Mekanikal yang ada mempunyai reka bentuk yang tidak boleh dibuka untuk mempermudah proses pembersihan Percussor Mekanikal. HMP sesuai untuk mesin yang boleh dibasmi kuman supaya dada perkusi tidak rosak dan kebersihan dikekalkan. HMP ini mempunyai getaran yang boleh dimasukkan ke dalam dada pesakit dalam terapi selama 15 minit dan selepas 15 minit HMP akan ditutup. HMP sering digunakan bersama untuk membantu melonggarkan dan mengeluarkan lendir dari paru-paru. Pada akhir sesi terapi, pesakit akan batuk dan lendir akan keluar.

ABSTRACT

Hygienic Mechanical Percussor (HMP) is used to help those with respiratory problems such as asthma, cough, flu, mucus and others respiratory problem on their chest. There are patients who have a dangerous health problem that can spread the disease through infections such as HIV patients, eczema patients and senior citizens. So, the fabric found on the Mechanical Percussor is not suitable because it cannot be washed to keep the hygiene. This HMP develop a portable handle tool to replace the existing fabric on Mechanical Percussor. Second, when the Mechanical Percussor is used, the vibrations in the hands of the respiratory therapist are also felt. This means that the vibrations are not fully affected by the patient. Then the HMP will analyze the Mechanical Percussor holders who also vibrate on the hands of respiratory therapists. Third, the existing Mechanical Percussor has a design that cannot be opened to facilitate the process of cleaning the Mechanical Percussor. HMP suitable for machine that can be disinfected so that percussion chest is not damaged, and hygiene is maintained. This HMP has the vibrations that can put on the patient chest in 15 minutes therapy and after 15 minutes the HMP will shut down. The HMP are often used together to help loosen and remove mucus from the lungs. At the end on the therapy session, patient will cough, and the mucus will get out.

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CHAPTER I

INTRODUCTION

1.1. Background of Study



Figure 1 The Mechanical Percussor
(Source: Punithavathi Narayanan, 2014)

Hygienic Mechanical Percussor (HMP) are often used together to help loosen and remove mucus from the lungs. These airway clearance techniques help people who have a spinal cord injury, cystic fibrosis, or another condition that makes it hard for mucus to drain from the lungs. When mucus collects in your lungs, it increases your risk for lung infections. It's also uses clapping of the chest with a cupped hand to vibrate the airways in the lungs. This vibration moves the mucus from smaller airways into larger ones where it can be coughed up. HMP is done with the help of a partner, special electronic devices designed to vibrate the chest, or other instruments that a person can use to vibrate the chest safely. This HMP is available in the Rehabilitation section and is used in Physiotherapy Unit.

1.2. Problem Statement

Conventional Chest Physiotherapy (CCPT) remains the mainstay of treatment for sputum mobilization in patients with productive cough such as bronchiectasis and “Chronic Obstructive Airway Disease” (COPD). However, CCPT is time consuming requires the assistance of a physiotherapist and limits the independence of the patient.

Mechanical Percussors which are electrical devices used to provide percussion to the external chest wall might provide autonomy and greater compliance [1]. First, there are patients who have a dangerous health problem that can spread the disease through infections such as HIV patients, eczema patients and senior citizens. So, the fabric found on the Mechanical Percussor is not suitable because it cannot be washed to keep the hygiene.

Second, when the Mechanical Percussor is used, the vibrations in the hands of the respiratory therapist are also felt. This means that the vibrations are not fully affected by the patient.

Third, the existing Mechanical Percussor has a design that cannot be opened to facilitate the process of cleaning the Mechanical Percussor.

1.3. Objectives

1. To develop a Hygienic Mechanical Percussor with a portable handle tool.
2. To design Hygienic Mechanical Percussor suitable for machine that can be disinfected so that percussion chest is not damaged, and hygiene is maintained.
3. To analyse the Mechanical Percussor holders who also vibrate on the hands of respiratory therapists.

1.4. Significant of Study

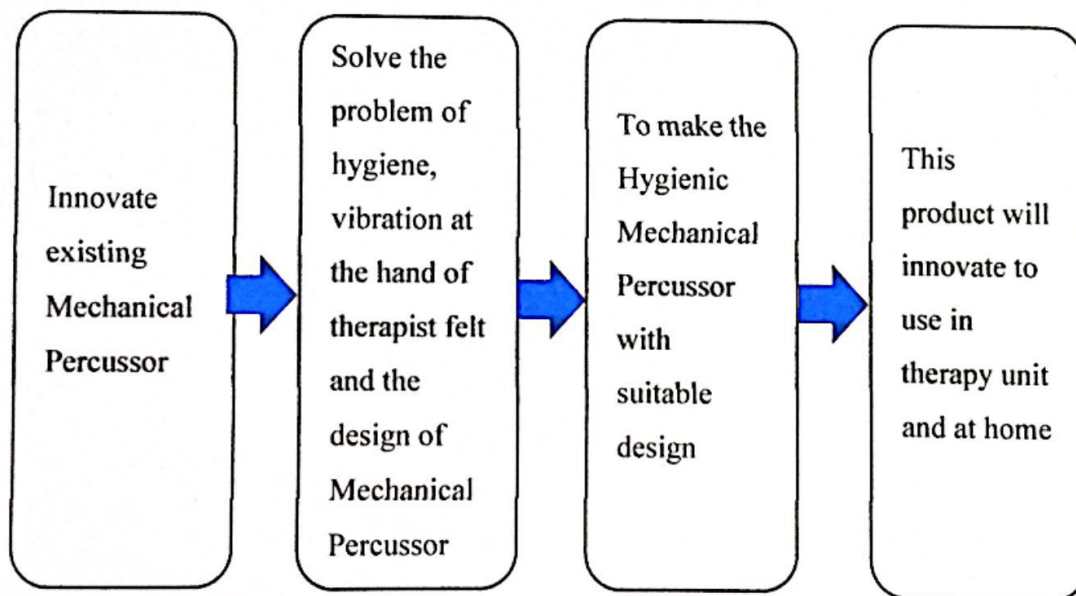


Table 1 The Significant of Study

1.5. Theoretical of Study

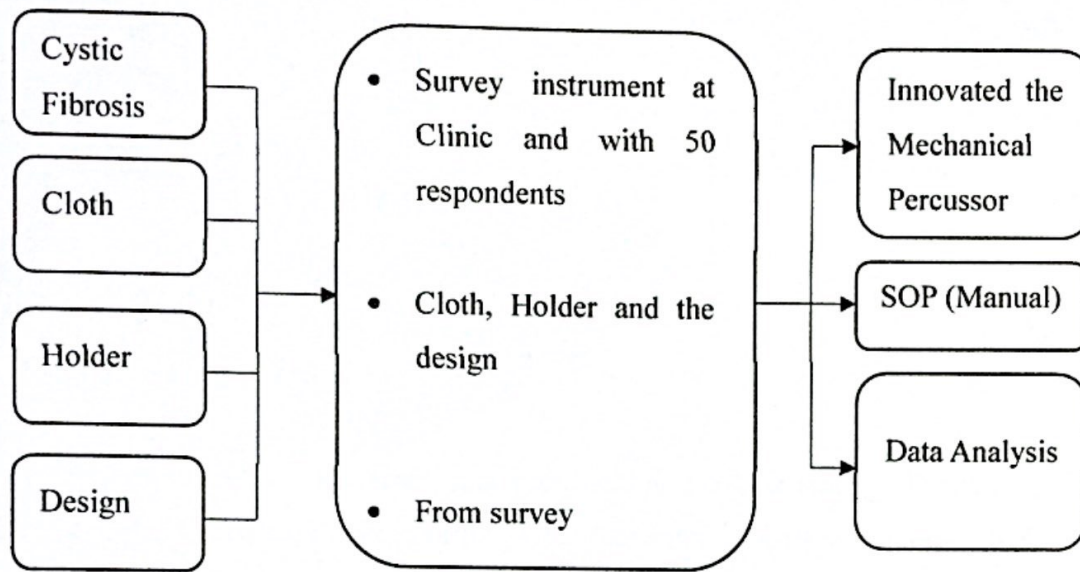


Table 2 The Theoretical of Study

CHAPTER II

LITERATURE REVIEW

2.1. Mechanical Percussor

Percussion has for some time been held as the best strategy for slackening caught bodily fluid inside the lungs. Conventional Chest Physiotherapy (CCPT) is the present standard treatment for sputum preparation in patients with gainful hack [1]. It is generally supported as a backbone of administration for this ceaseless illness. In any case, chest physiotherapy is tedious, may need the help of an advisor or other parental figure and might be awkward or, then again offensive. Then, Mechanical Percussors could be used to give applauding or percussion to the outer chest divider to mirror manual hand percussion.

The gadget could permit more self-sufficiency for patients, better consistence and less weakness for the administrator. Percussors are named Class II 510 (k) medicinal gadgets by the U.S. Food and Drug Administration (FDA). The gadgets convey predictable, programmable (i.e., speed is adjustable) profound heartbeats. The machine is moved over the patient's chest while the patient expect an assortment of waste positions [1].

2.2. Cystic Fibrosis

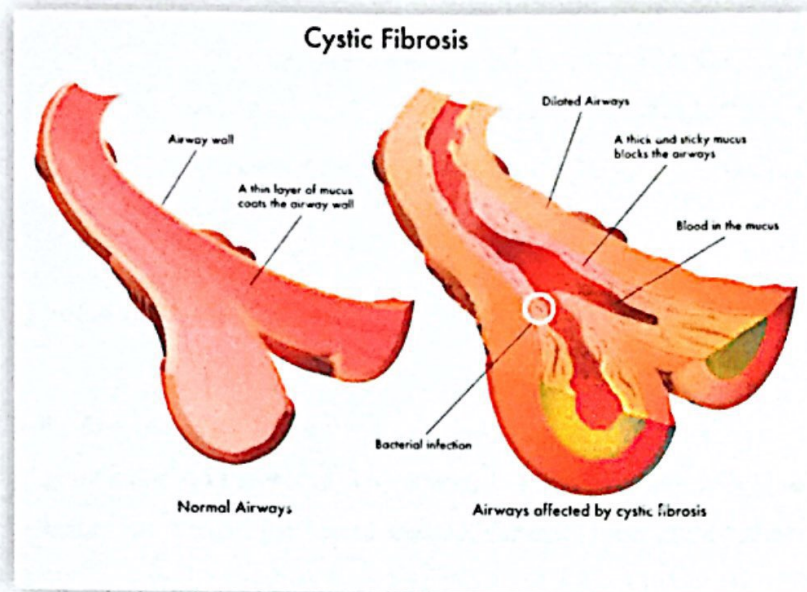


Figure 2 The Airways Affected by Cystic Fibrosis

(Source: College of Naturopathic Medicine CNM, 2016)

Cystic fibrosis is a ceaseless autosomal latent illness. As per the last WHO report with respect to cystic fibrosis, this issue is generally found in populaces of white Caucasian drop, for example, those from Europe, North America and Australasia[2]. In any case, amid the most recent decades cystic fibrosis has been progressively analysed in populaces from spots such as Latin America and the Middle East. Individuals with cystic fibrosis may experience the ill effects of: endless sinusitis; nasal polyps; respiratory contaminations fruitlessness (particularly in guys) and gastrointestinal disarranges, (for example, gastroesophageal reflux, exocrine pancreatic deficiency, a higher danger of creating diabetes mellitus, poor assimilation of supplements and inordinate retention of liquid)[2]. Albeit cystic fibrosis is a multi-framework issue, pneumonic ailment is the most well-known reason for bleakness and mortality[2].

It is an autosomal latent illness caused by changes in the quality encoding the cystic fibrosis transmembrane conductance controller (CFTR). At the clinical

level, the perpetual bacterial aviation route contamination, conspicuous neutrophilic irritation and bodily fluid in aviation routes, and dynamic bronchiectasis describe progressed cystic fibrosis lung malady, which causes most grimness and passing in individuals with cystic fibrosis[3]. Between those two extremes, the way in which loss of CFTR-interceded chloride and bicarbonate transport prompts constant aviation route disease has remained uncertain[3].

2.2.1 Factor of Cystic Fibrosis

Cystic fibrosis is an existence restricting autosomal passive issue that influences 70,000 people around the world. The condition influences basically those of European drop, albeit cystic fibrosis has been accounted for in all races and ethnicity[4]. Unusually thick emissions in the aviation routes of the lungs and in the pipes of the pancreas in people with cystic fibrosis cause obstacles that prompt aggravation, tissue harm and pulverization of both organ frameworks[4]. Other organ frameworks containing epithelia, for example, the sweat organ, biliary channel of the liver, the male conceptive tract and the digestive tract are likewise influenced. Loss of pancreatic endocrine capacity brings about ailing health and poor development, which prompts demise in the principal decade of life for most untreated people[4]. Substitution of pancreatic chemicals and escalated treatment guided by multidisciplinary groups have altered the treatment of cystic fibrosis, bringing about dynamic enhancements in survival to a middle-anticipated period of 37 years for youngsters conceived with cystic fibrosis today[4]. Obstructive lung sickness is at present the essential driver of morbidity and is responsible 80% of mortality[4].

2.2.2 Relationship between Mechanical Percussor with Cystic Fibrosis

Air way Disease (COPD). Discharges that piece the aviation route can prompt atelectasis and poor oxygenation. Enhanced activation of bronchial emissions adds to enhanced ventilation-perfusion coordinating and the standardization of the practical leftover limit[1].

An assortment of non-intrusive treatment methods, for example, turning, postural seepage, chest percussion and vibration have been utilized alone and in blend to encourage aviation routes freedom. Percussion has for quite some time been held as the best technique for relaxing caught bodily fluid inside the lungs. Conventional Chest Physiotherapy (CCPT) is the present standard treatment for sputum preparation in patients with beneficial hack[1]. It is broadly supported as a backbone of administration for this endless infection. Be that as it may, chest physiotherapy is tedious, may require the help of a specialist or other parental figure and might be uncomfortable or unpleasant[1]. On the other hand, mechanical percussors could be utilized to give applauding or percussion to the outer chest divider to imitate manual hand percussion. The gadget could permit more self-rule for patients, better consistence and less exhaustion for the administrator[1].

2.3. Description of condition for Postural Drainage

Youngsters with cystic fibrosis are more probable than sound kids to experience the ill effects of neurotic gastroesophageal reflux which might be characterized as a retrograde and rehashed stream of the gastric substance into the throat[2]. The system engaged with this procedure isn't totally portrayed. Notwithstanding, the high rate of gastroesophageal reflux in new born children furthermore, kids with cystic fibrosis might be optional to lung illness (interminable hacking, hyperinflation) and additionally being identified with postponed gastric exhausting and transient lower oesophageal sphincter relaxations which are expanded amid distension of the gastric fundus, and hyperalimentation of cystic fibrosis new born children[2]. Chest physiotherapy alone, or in blend with work out, has been broadly utilized as an aide treatment in the treatment of cystic fibrosis in individuals of all ages, adding to enhanced survival. Physiotherapy can be delegated customary, current or instrumental methods. Regular chest physiotherapy methods may incorporate postural seepage, percussion and vibration, huffing and hacking[2].

2.3.1 Postural Drainage Position

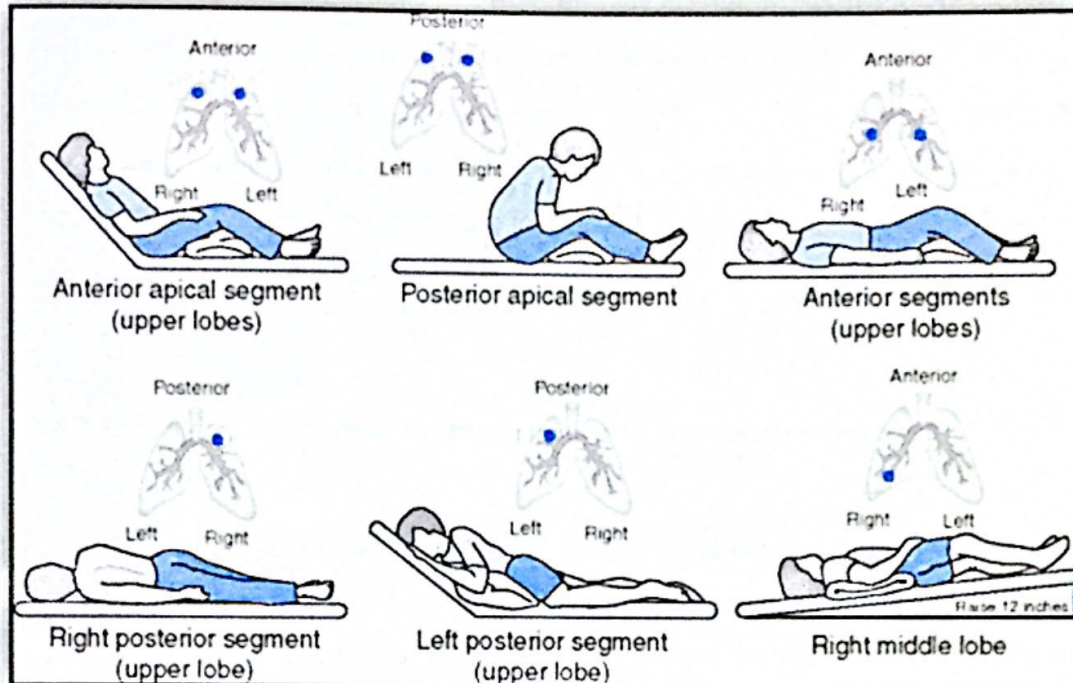


Figure 3 The Posterior Drainage during do the Therapy

(Source: Dr Niriksha Khasgiwala, 2017)

Postural seepage comprises of putting the patient in a position that utilizes gravity to move bodily fluid halfway from the focused-on lung unit. There are 12 postural seepage positions, one for each pneumonic portion. Postural seepage is typically related with vibration, percussion, inward breath treatment, hacking, furthermore, breathing activities. There are two regimens of postural waste methods (standard postural seepage and adjusted postural waste). Standard postural seepage incorporates more noteworthy (30° to 45°) head-down tilt and lesser (15° to 20°) head-down tilt[2]. More prominent altered postural waste incorporates three level positions and 30° head-up tilt for the prostrate position while lesser changed postural waste incorporates three even positions and 15° to 20° head-up tilt for the prostrate position.

How the intercession may function Chest physiotherapy has been related with an expansion in gastroesophageal reflux scenes in individuals with cystic fibrosis. Past examines have recommended that postural seepage systems may uel reflux, possibly bringing about goal or reflex bronchospasm furthermore, promote disability of aspiratory work. Such contemplates related the higher frequency of gastroesophageal reflux with the head-down tilt position, particularly when situating the head and lungs lower than the lower oesophageal sphincter in new born children with cystic fibrosis[2].

2.3.2 Relationship Between Postural Drainage and Cystic Fibrosis

Cystic fibrosis lung infection is described by drained aviation route surface fluid volume and thickened bodily fluid, which brings about impeded bodily fluid freedom[2]. Such occasions advance aviation route deterrent and colonization with an assortment of microscopic organisms, which creates an endless loop of disease bringing about aviation route harm[2]. Chest physiotherapy is a suggested mediation to advance aviation route freedom and progress lung ventilation and gas trade. Amid physiotherapy sessions, methods to encourage aviation route freedom, for example, postural waste, are utilized[2].

2.4 Disinfectant for Hospital (Surface)



Figure 4 Disinfectant for Hospital

(Source: GH Bioscience Malaysia)

This liquid for disinfection of medical equipment and surface and suitable for a medical equipment that have always to keep hygiene.

Dilute Global Health Surface Disinfectant in the proportion of 1:50 by water and utilize the weakened answer for wipe or douse restorative gear and articles[5]. It is very protected and helpful to be utilized as a part of the restorative condition since it isn't destructive against therapeutic gear. For sterilization of materials. No blanching, solidness, erosion or build-up[5].

Dilute Global Health Surface Disinfectant in the proportion of 1:50 by water, at that point drench cleaned medicinal instrument, staff's garments, sickrooms' merchandise and drapes in the dilute solution. The disinfectant can successfully execute a wide range of microscopic organisms, infections and growths, and won't make unsafe microorganism to create protection[5].

CHAPTER III

METHODOLOGY

3.1. Introduction

This area depicts the investigative concentration, investigate strategy and techniques utilized as a part of this examination. The system utilized was a blended technique inquire about structure enveloping both quantitative and qualitative strategies and measures. It's also part of study an information and requirement, such as hardware and software. After that, the data will collecting by the questionnaire that will two times, at the first-time data will collect at the Bachelor of Electronic Medical student. Then, the last one data will collect with patient who have and the Physiotherapy Unit and Nurse Staff.

3.2. Planning

In this part, arranging must be in a legitimate way in the method for recognizing a data and necessity, for example, equipment and programming. Arranging is additionally at some point can be the path for examiner to recognize the issue explanation as motivation to continue with the examination. For this task arranging stage are finished by information accumulation and necessity of equipment and programming. Normally for this beginning time, the strategy for arranging was by essential accumulation, which is more to meeting and meeting with outcast to get data.

3.2.1 Data collection

The questionnaires of data collection are distributed to the 50 respondent and one Doctor from Clinic. By information gathering, prerequisite for equipment and programming can be design also. At this stage, project resources and requirements, literature studies and schedule to get more data in this study are arranged. All materials are collected from journal, internet, research paper, and text books.

Refer appendix for questionnaire form

3.2.2. Study of Population

In this study, the respondents are consisting of public with or without respiratory disease for the usability test. The population of respondents are among the Politeknik Premier Sultan Salahuddin Abdul Aziz Shah Alam, focusing in Electrical Engineering Department. For recommendation, the data collect from Poliklinik An-Nisa' TTDI Jaya.

3.2.3. Sample Size and Sampling Technique

In this study, Krejcie and Morgan theory has been used to determine the sample size. The population of limitation for this study is 50 respondents, so that the sample size will be 44 respondents excluding 1 recommendation from clinic.

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

Note.—N is population size.
S is sample size.

Table 3 Krejcie and Morgan Table for determine Sample Size

3.2.4 Requirement of Hardware and Software

In this session, investigator will decide the components to use inside the board. To do this planning, hardware was designed by using SketchUp and software designed by using Sketch Up application, Rhino 3D Model and 3D object application are used for 3D printing for casing HMP. The purposes of doing product design are to get the better output if we planned well besides to save cost by just run the circuit by using application software.

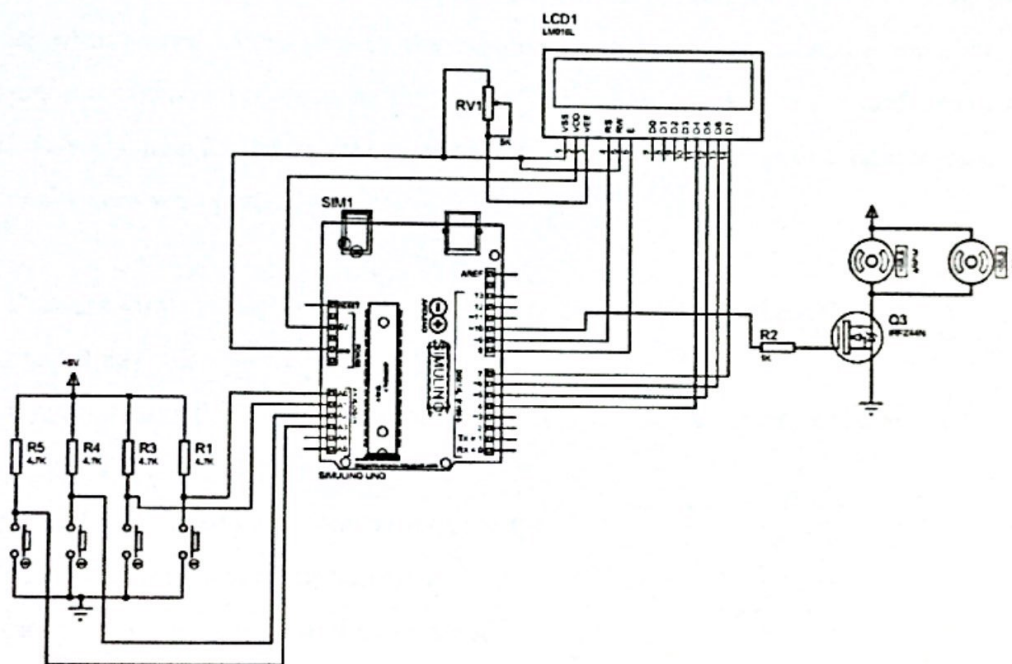


Figure 5 Schematic Diagram for main board of HMP

3.2.5 Informed Consent Process

Doctors at the clinic are given a consent form that a clinical test will be performed there. Description of HMP is done then the Doctor also try to use the HMP. She gave a recommendation on HMP.

Refer appendix for the consent form.

3.2.6 Ethics of Study

The basic concept and fundamental principles of decent human's conduct. It includes study of universal values such as the essential equality of all men and women, human or natural rights, obedience to the law of land, concern for health and safety and increasingly, also for the natural environment. In this study, things to consider regarding ethical issues with participants are:

- a) Consent forms (which state overall purpose and any risks or benefits of participating).
- b) Potential risks that could be involved in any questioning (emotional distress, dignity).
- c) Confidentiality of participants (anonymity).
- d) Feedback of results to participants.
- e) Indebted reciprocity should be reasonable

3.3. Gantt Chart

Task	Sept-17	Okt-17	Nov-17	Dis-17	Jan-18	Feb-18	Mac-18	Apr-18
Project Title Agreed By Supervisor								
Complete Project Qeustionnaire								
Identfy The Material And Cost								
Collect Article And Journal About Project								
Present Initial Presentation								
Submint Initial Report								
Design Layout Product								
Dsign PCB Board Circuit								
Design Product (Software And Hardware)								
Writing Proposal								
Submint Proposal								
Defend Proposal								
Survey								
Collecting Data								
Test Product								
Writing Thesis								
Analyze Data And Result								
Submit Thesis								
Persent Viva								

Table 4 Gantt Chart of the whole Project

3.3.1 Gantt Chart First Semester

Progress	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Choose Project Title															
Make Research															
Initial Proposal															
Development of the Device															
Defend Proposal															
Log Book															

Table 5 Gantt chart of the project for semester I

It is a plan to conduct on this project. On first week and second week the project progress was choosing the title of project and write the report in log book. On third week until fourth week is the time to make a preparation for initial proposal also make a research about this title and write the report on log book. On seven weeks until 13 weeks was planned for a defend proposal.

3.3.2 Gantt Chart First Semester

Progress	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Development of the Device															
Collect Data															
Thesis Writing															
VIVA															
Log Book															

Table 6 Gantt chart of the project for semester 2.

It is a plan to conduct on this project. On week 1 and 6 the project is development of device and write the report in log book. On week 4 until 8 is the time to collect the data from surveying questions and write the report on log book. On week 7 until 14 was planned for a thesis writing. On week 12 and 13 is a VIVA presentation.

3.4. Block Diagram

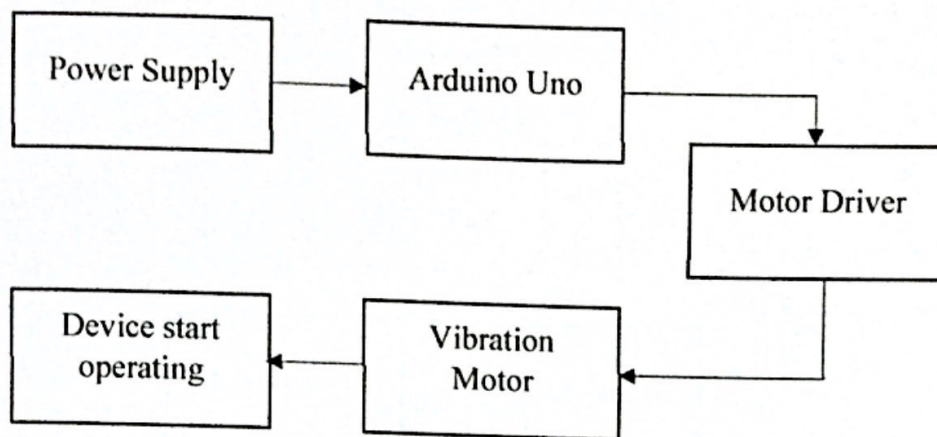


Figure 6 Block Diagram of HMP

3.5. Flow Chart of SOP HMP

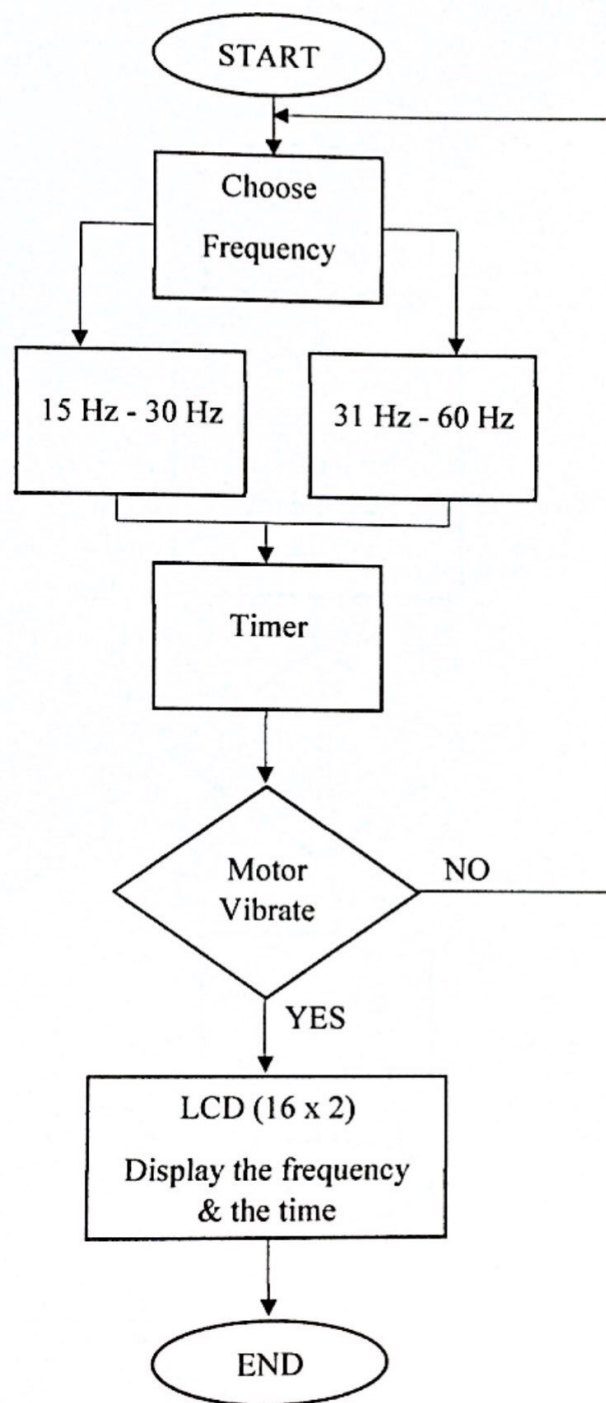


Figure 7 Flow Chart of SOP HMP

3.6. Flow Chart of HMP Design

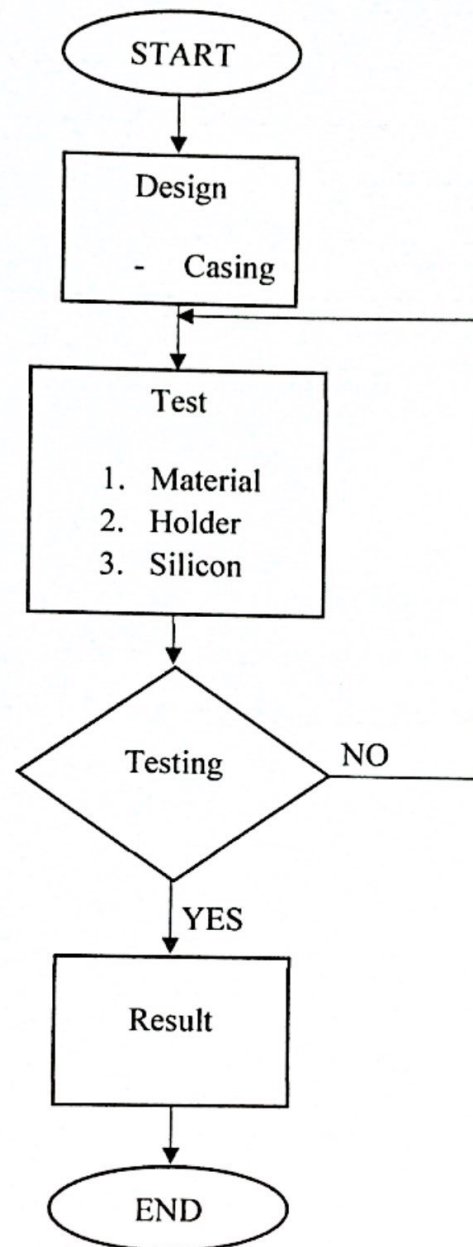


Figure 8 Flow Chart of HMP Design

3.7 Material

Arduino Uno	ABS Casing
4 x Rechargeable Batteries 3.7V	Vibration Motor
LCD (16 x 2)	Driver Motor
2 x Spring	4 x Switch Button

Table 7 Material that was used in HMP

3.8 Implementing

This phase is where the making of hardware and software happened. The making up of HMP are including some steps which is, etching, soldering, welding, etc. After hardware and software done, it will be test on the material that casing used and others part on casing.

3.8.1 Hardware

3.8.1.1 Vibration Motor



Vibration motor is a compact size coreless DC motor used to informs the users of receiving the signal by vibrating, no sound. Vibration motors are widely used in a variety of applications including cell phones, handsets, pagers, and so on. The main features of vibration motor are the magnet coreless DC motor are permanent, which

means it will always have its magnetic properties (unlike an electromagnet, which only behaves like a magnet when an electric current run through it); another main feature is the size of the motor itself is small, and thus light weight. Moreover, the noise and the power consumption that the motor produce while using are low. Based on those features, the performance of the motor is highly reliable. The vibration motors are configured in two basic varieties: coin (or flat) and cylinder (or bar). There are some components in both of their internal constructions.

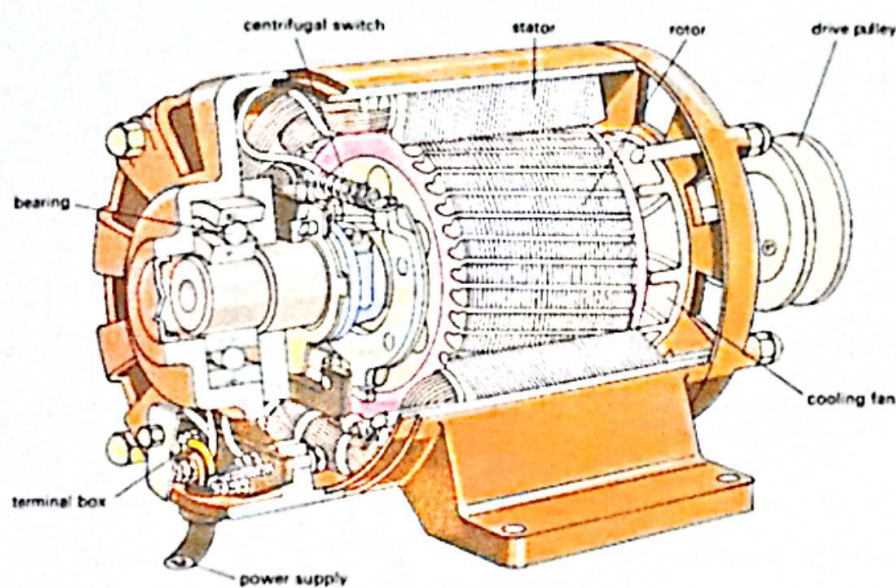


Figure 9 Inside the Vibration Motor

- ❖ Rotor: The rotor is the non-stationary part of a rotary electric motor. The wires and magnetic field of the motor are arranged so that a torque is developed about the rotor's axis. In some designs, the rotor can act to serve as the motor's armature, across which the input voltage is supplied.
- ❖ Stator: The stator is the stationary part of a rotary electric motor. It could be worked as the magnet field and interact with the armature to create motion. Another function of the stator is it could act as the armature, which receives its influence from moving field coils on the rotor.

- ❖ Commutator: A commutator is a rotary electrical switch in certain types of electric motors or electrical generators that periodically reverses the current direction between the rotor and the external circuit. In a motor, it applies power to the best location on the rotor, and in a generator, picks off power similarly. As a switch, it has exceptionally long life, considering the number of circuit makes and breaks that occur in normal operation.
- ❖ Armature: The armature in this motor is a set of thin metal plates stacked together, with thin copper wire coiled around each of the three poles of the armature. (How the electric motor works) The main function of the armature is to convert the magnetic energy into the kinetic energy.
- ❖ Windings: Windings are consisted with some turns of coils. These coils are assembled to generate a magnetic field once electricity goes through them.
- ❖ Weight: In order to make a vibrating alert, a weight mass need to be attached to the shaft. Through the high-speed displacement of weight, the vibration can be achieved. Moreover, the magnitude of the force can be controlled and adjusted, and the factors that could affect it will be discussed below.
- ❖ Brushes: In motor's shaft, the brushes conduct the current between stator and coils. The life of the motor depends on when the brushes will be worn out. Based on this factor, brushless dc motor, which is also called BLDC, is used to extend the life of motors.

3.8.1.2 Bar Type Vibration Motor Construction

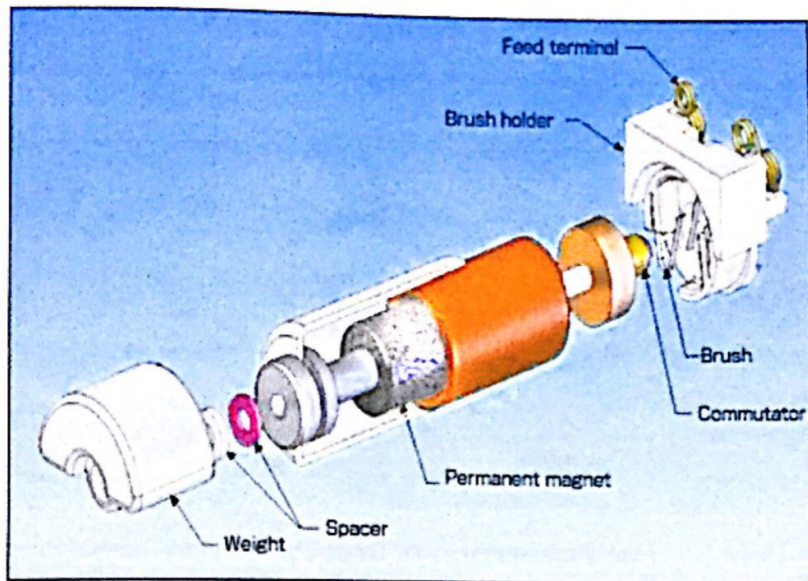


Figure 10 Inside the Bar Type Vibration Motor

The cylinder shape is also called bar-type vibration motor. This vibrating motor is essentially a motor that is improperly balanced. In other words, there is an off-centered weight attached to the motor's rotational shaft that produces a centrifugal force while rotating. This unbalanced force displaces the motor. Its high-speed displacement makes the motor to wobble, which is known as the "vibrating". The wobble can be changed by the weight mass you attach, the weight's distance to the shaft, and the speed at which the motor spins.

What's more, the centrifugal force, which is generated by the rotating an unbalanced weight, causes the motor to vibrate in 2 axis (Z axis and X axis). Besides, the centrifugal force can be calculated through the equations on Equation below. According to the relationship of each components in this equation, it is easy to tell that a larger weight mass with a bigger offset from the shaft will produce more force and hence more vibration amplitude. Moreover, increasing the voltage supplied to the motor will increase its speed, and therefore the vibration frequency, as well as the vibration amplitude.

Frequency

$$f_{\text{vibration}} = \frac{(\text{Motor RPM})}{60}$$

Equation 1 Frequency

Force

$$f_{\text{vibration}} = m \times r \times \omega^2$$

Equation 2 Force

m = the mass of eccentric weight

r = mass offset distance

ω = speed of the motor (rads^{-1})

Speed of the motor

$$\omega = 2\pi f$$

Equation 3 Speed of the motor

3.8.1.3 Motor Selection

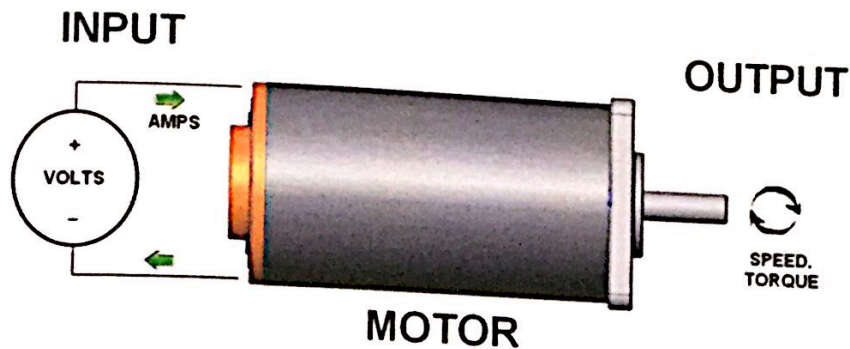


Figure 11 Motor Selection

Figure 10 is a diagram that shows the role of motor in the operating system. Selecting a DC motor for an application, some factors need to be considered and clarified: How much power is needed, how much electrical power is available, the space capacity, and so on.

- Load:
 - Load is defined as the output of a circuit connected to the device. In motor selection, load can be defined as the torque needed to operate the whole system. The magnitude of load can be a constant, or it can be varied by time.
- Power:
 - Power is the product of speed and torque. The maximum power of a DC motor is produced at the operating point that is defined by operation at half the no-load speed and half the stall torque.

- Torque:
 - The relationship between torque and speed is called a characteristic of the operating system. This DC motor's characteristic varies based on three different magnetization sources: separately excited field, self-excited field or permanent field, which is used selectively to control the motor over the mechanical load's range.

3.8.2 Motor Driver

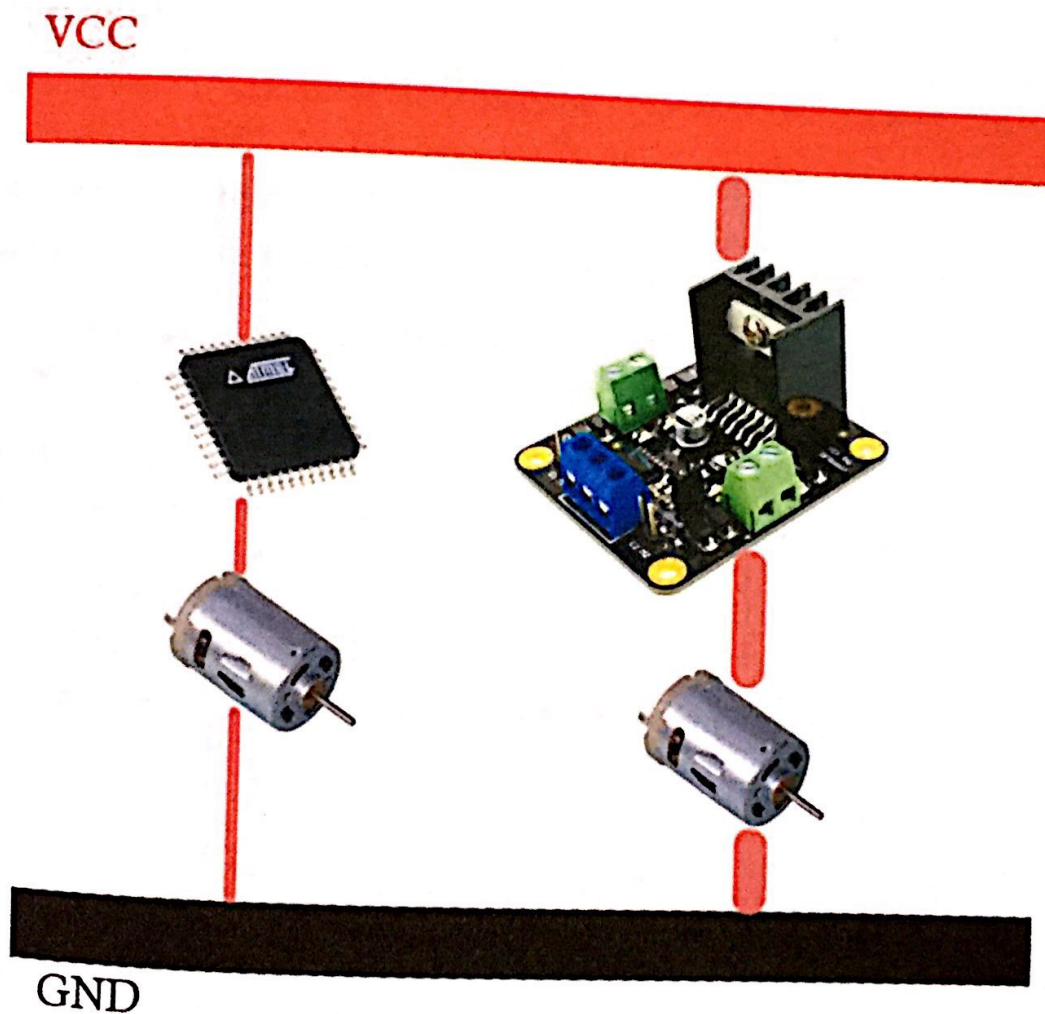


Figure 12 Motor Driver connecting with Vibration Motor

A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

Types of Motor Drivers

There are many kinds of motor drivers. The most common types categorized by maximum supply voltage, maximum output current, rated power dissipation, load voltage, packaging type and number of outputs. The parametric filters on our website can help refine your search results depending on the required specifications.

The most common values for maximum supply voltage are 36 V and 52 V. The carry motor drivers with supply voltage up to 450 V. The number of outputs can be between 1 and 12, with the most common motor drivers having 1, 2 or 4 outputs.

Motor Drivers has a full programmable motor driver selection from several chip manufacturers that can be used for a motor driver IC (integrated circuit), bipolar stepper motor driver, H bridge motor driver, servo motor driver, DC motor driver, brushless motor driver or for any circuit that may require a motor driver.

Applications for Motor Drivers:

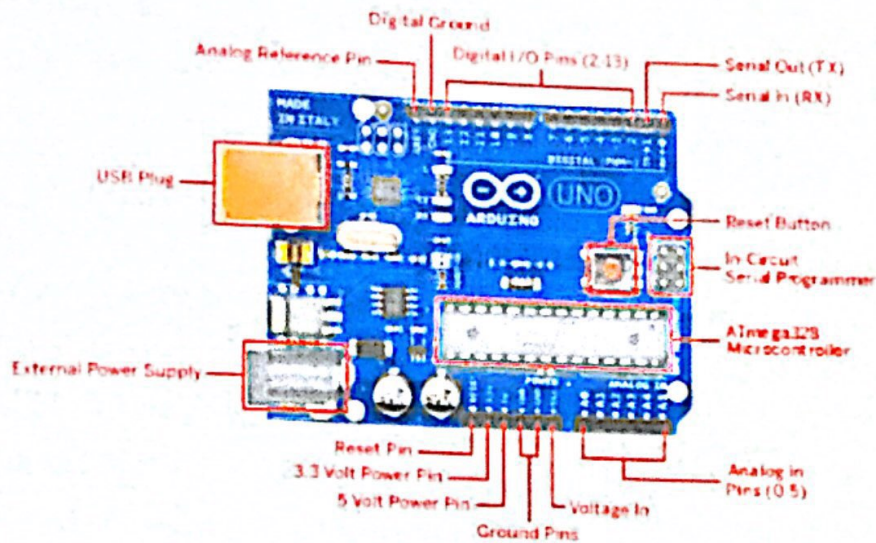
Motor drivers can be found in a wide array of applications including:

- ❖ Relay and solenoid switching
- ❖ Stepping motor
- ❖ LED and incandescent displays
- ❖ Automotive applications
- ❖ Audio-visual equipment
- ❖ PC Peripherals
- ❖ Car audios
- ❖ Car navigation systems

Inside the HMP motor driver used for relay and solenoid switching.

3.8.2 Software

3.8.2.1 Arduino Uno



Arduino is an open-source stage utilized for building and programming of electronics. It can get and send data to most gadgets, and even through the web to command the particular electronic device. It utilizes an equipment called Arduino Uno[6] circuit board and programming programme (Simplified C++ [1]) to program the board. In these present day, Arduino are utilized a lot in microcontroller programming in addition to other things because of its easy to use or simple to utilize setting,[7] similar to any microcontroller an Arduino is a circuit board with chip that can be modified to do various number of assignments, it sends data from the PC program to the Arduino microcontroller lastly to the particular circuit or machine with different circuits keeping in mind the end goal to execute the particular command. An Arduino can enable to peruse data from input gadgets, for example, e.g. Sensors, Antenna, Trimmer(potentiometer) what's more, can likewise send data to yield gadgets, for example, LED, Speakers, LCD Screen, DC engine[8].

ARDUINO BOARD

The Arduino stage has turned out to be very much familiar with individuals into gadgets. Not at all like most past programmable circuit sheets, the Arduino does not have a different piece of equipment to stack new code onto the board, it can basically utilize a USB link to transfer, and the product of the Arduino utilizes a disentangled adaptation of C++, making it less demanding to figure out how to program, and it gives a simpler domain that sidestep the elements of the smaller scale controller into a more available bundle[6].

An Arduino Board can be grouped into two sections:

Hardware: The Arduino board hardware consist of many components that combine to make it work, but we are going to discuss the main component on the board such as follows:

- ✓ USB Plug: This is the first part of the Arduino because it is used to upload a programmed to the microcontroller and has a regulated power of 5volts which also power the Arduino board.
- ✓ External Power Supply: This is only used to power the board and has a regulated voltage of 9 to 12 volts, mostly if the USB plug does not provide sufficient power for whatever you have programmed it to do.
- ✓ Reset button: This button resets the Arduino when it when its pressed in case you have uploaded another command and want the Arduino to do it.
- ✓ Microcontroller: This is the device that receive and send information or command to the respective circuit.
- ✓ Analog Pins(O-5): This are analog input pins from AO to A5.
- ✓ Digital I/O Pins: This are the digital input, output Pins 2 to13.
- ✓ In-Circuit Programmer: This is another source to upload or programmed your programmed, it can also be done using "TX-1,I" output and "RX-1,O" input.
- ✓ Digital and analog Ground pins
- ✓ Power Pins: we have 3.3 and 5 volts power pins etc.

3.8.2.1.1 Coding of the Project by using Arduino Uno

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(8, 9, 4, 5, 6, 7);
#define SW1 A0
#define SW2 A1
#define SW3 A2
#define SW4 A3

#define Out 10
#define BL 11

int SF=0;
int Min=0,Sec=0;
float Freq=100; //starting frequency
int MODE=0;
int Timer=0;
int DefTimeS=900; // for 15min
float PlusFreq=0;
float TargetTime=0;
int DefTimeM=15; // for 15min
int NowTime; // for 15min
int Counter=0;
float PWM=0;
float NowPWM=0;

void setup()
{

  Serial.begin(9600);

  pinMode(BL,OUTPUT);
  pinMode(Out,OUTPUT);
```

```

pinMode(SW1,INPUT);
pinMode(SW2,INPUT);
pinMode(SW3,INPUT);
pinMode(SW4,INPUT);

digitalWrite(BL,LOW);
lcd.begin(16, 2);
lcd.clear();
lcd.print("  WELCOME");
lcd.setCursor(0,1);
lcd.print(" -----");
delay(2000);
digitalWrite(BL,HIGH);
}

void loop()
{

if (MODE==0){
  analogWrite(Out,0);
  lcd.clear();
  lcd.print(" Sleep");
  lcd.setCursor(0,1);
  lcd.print(" -----");
  if (digitalRead(SW1)==0 ){
    MODE=1;
  }
  if (digitalRead(SW2)==0 ){
    MODE=2;
  }
  if (digitalRead(SW4)==0){
    digitalWrite(BL,LOW);
    lcd.clear();

```



```

    lcd.print("Ready to start");

    MODE=3;
    NowTime=DefTimeM *60;
    TargetTime=NowTime;
    lcd.setCursor(0,1);
    lcd.print(NowTime);
    if (SF==0){
        PlusFreq=15/TargetTime;
        Freq=15;
    }
    if (SF==1){
        Freq=31;
        PlusFreq=30/TargetTime;
    }
    delay(2000);
    PWM=15/499*255;
    NowPWM=PWM;
    }
    delay(100);
}

//-----
if (MODE==1){
    digitalWrite(BL,LOW);
    lcd.clear();
    lcd.print("SET TIMER");
    lcd.setCursor(0,1);
    lcd.print(DefTimeM);
    lcd.print("min");
    delay(100);
    if (digitalRead(SW1)==0){
        if (DefTimeM > 0){
            DefTimeM--;

```

```

    }
}
if (digitalRead(SW2)==0){
    DefTimeM++;
}

if (digitalRead(SW4)==0){
    lcd.clear();
    lcd.print("SAVE TIMER...");
    delay(2000);
    MODE=0;
    digitalWrite(BL,HIGH);
    NowTime=DefTimeM *60;
}

//-----

}

//-----

if (MODE==2){
    digitalWrite(BL,LOW);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("Set frequency");
    lcd.setCursor(0,1);
    if (SF==0){
        lcd.print("Freq1(15hz-30hz)");
    }
    if (SF==1){
        lcd.print("Freq2(31hz-60hz)");
    }
}

```



```

delay(100);
  if (digitalRead(SW1)==0){
    if (SF> 0){
      SF--;
    }
  }
  if (digitalRead(SW2)==0){
    if (SF<1){
      SF++;
    }
  }

  if (digitalRead(SW4)==0){
    lcd.clear();
    lcd.print("SAVE FREQ...");
    delay(2000);
    MODE=0;
    digitalWrite(BL,HIGH);

  }

//-----

}

//-----

if (MODE==3){
  lcd.clear();
  NowTime--;
  lcd.print("TIMER:");
  analogWrite(Out,NowPWM);

```

```

    if (Min <10){
        lcd.print("0");
    }
    lcd.print(Min);
    lcd.print(":");
    if (Sec <10){
        lcd.print("0");
    }
    lcd.print(Sec);

    Sec++;
    if (Sec>=60){
        Min++;
        Sec=0;
    }

    lcd.setCursor(0,1);
    lcd.print("Freq(Hz:");
    lcd.print(Freq);

    Freq=Freq+PlusFreq;
    NowPWM=((Freq+100)/499)*255;
    delay(1000);

    if (NowTime <=0){
        lcd.clear();

        lcd.print("Completed");
        delay(2000);
        digitalWrite(Out,LOW);
        MODE=0;
        digitalWrite(BL,HIGH);
    }

```



```
if (digitalRead(SW4)==0){  
  analogWrite(Out,0);  
  lcd.clear();  
  lcd.print("STOP...");  
  delay(2000);  
  MODE=0;  
  
  }  
  Serial.print("Now PWM:");  
  Serial.print(NowPWM);  
  Serial.print(" Now Time:");  
  Serial.println(NowTime);  
}  
//-----
```

3.8.2.2 SketchUp

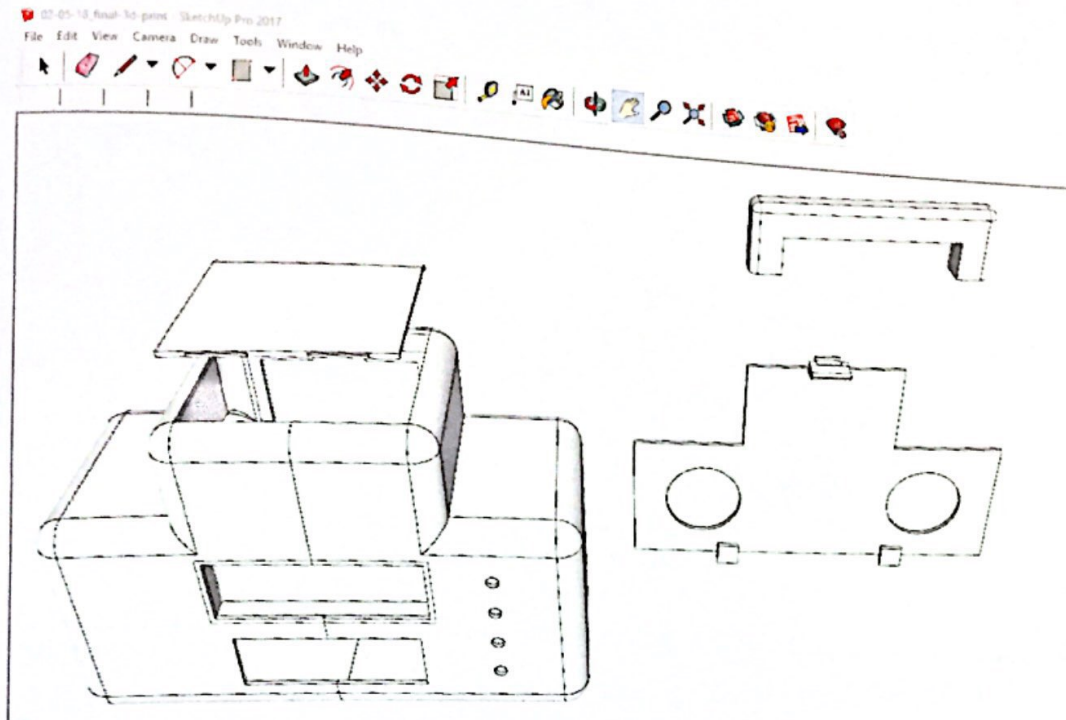


Figure 13 3D Design by using SketchUp

SketchUp was made for those needing to create 3D questions in a quick, simple, and natural way. The program accompanies an abnormal interface, in which the creation, control, and altering of components is done in a way that is not quite the same as some other programming. Given its one of a kind quality, it doesn't fall into the classification of CAD programming (like Vector works, ArchiCAD, or then again Revit, for instance), or in that of conventional 3D programming (3D Studio, Maya, Cinema 4D, and others); and that is the thing that makes it such an uncommon program.

3.8.2.3 3D Object

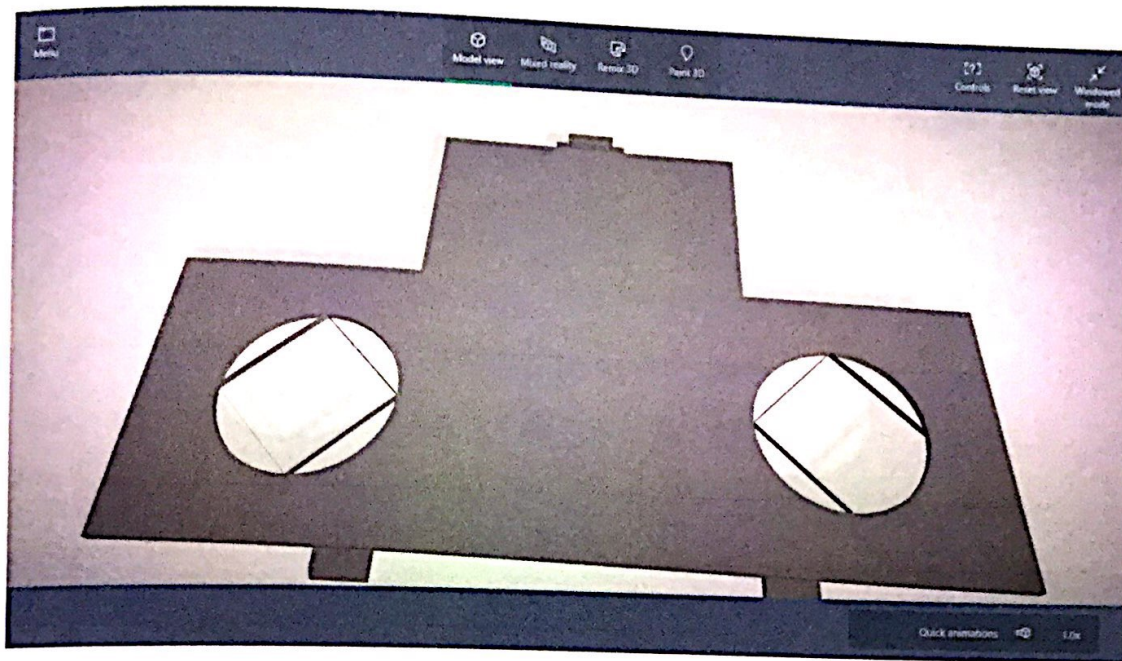


Figure 14 3D Design by using 3D object

3D printing is essentially an assembling system that incorporates objects development by keeping or combining materials, for example, fluids, plastic, powders, metal, earthenware production, or even living cells in layers to create a 3D object[9].

It is likewise meant as quick prototyping, strong free shape, PC mechanized or layered fabricating relying upon the sort of creation strategy utilized. Fast prototyping rule is to reproduce 3D physical model with expansion of material layers by utilizing 3D PC models. Through writing audit on 3D printing, it is seen that all sources share the common qualities of giving a definition. Extreme thoughts may differ among sources, however most of them conceded to one thought that 3D printing comprises of exchanging a unique PC record or on the other hand a plan to a printer equipped for printing 3D questions through added substance process that prints layers of material[10].

3.8.2.4 Rhino 3D Model

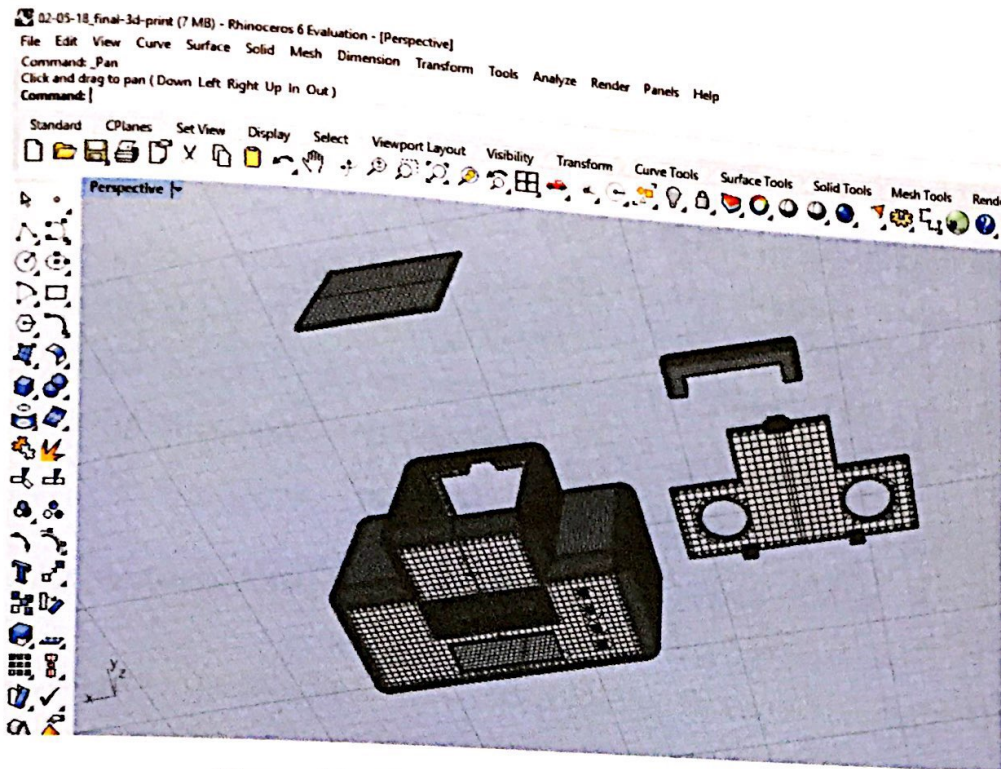


Figure 15 3D Design by using Rhino 3D Model

Rhino can create, edit, analyse, document, render, animate, and translate NURBS curves, surfaces, and solids with no limits on complexity, degree, or size. Rhino also supports polygon meshes and point clouds. Its accuracy and flexibility make it possible to students to explore and build their ideas without having to spend much time learning "CAD".

Also, any geometry created in Rhino can be exported to laser cutters, milling machines or 3D printers, and this is really what makes Rhino different from general 3D modelling tools based in polygons, where can create great images, but without manufacturing precision.

Rhino's open architecture allows using also Rhino as a development platform: a C++ SDK and a series of scripting methods (Rhino Script) allow programmers of any level of expertise customize and automate Rhino and extend its capabilities. Today, there are dozens of commercial plug-ins for Rhino for nesting, terrain creation, parametric architecture, rendering, animation, CAM, subdivision modelling, jewellery, mold design, etc.

3.9 Data Analysis

After the implementing phase done, data analysis is the last phase to process. Which all the findings during the study must analyse to get results and to measures the successful of the study. In this phase there another type of software application that has been used, which are Statistical Package for Social Science (SPSS). Data are provided from the 50 respondent and one Doctor from clinic. Analysis divided into two parts, which is clinical test and technical test. Clinical test is performed by the Doctor, Doctor was trying used this HMP and Doctor give the recommendation for HMP. Technical test is referring to comfortableness, material and effectiveness.

3.9.1 Statistical Analysis Plan

Data analysis will be done by using Statistical Package for Social Science (SPSS). The data collection will be done by doing testing on a public. For evaluation form, there are 3 main things to analysis, which is comfortableness, the material of HMP and the effectiveness of HMP.

3.9.2 SPSS

It is a standout amongst the most mainstream factual bundles which can perform profoundly complex information control and investigation with basic direction. SPSS work as an application to help in delivering measurement for assessment test by the subjects.

Through SPSS likewise, specialist can do graphic and investigation straightforwardly directly after key in the information. This technique additionally demonstrates the shortcoming of our examination by demonstrating the scope of adequacy, in other way, it is useful to enhance our investigation.

CHAPTER IV

DATA ANALYSIS

4.1 Introduction

This section shows the consequences of the investigation that were directed considering the strategy portrayed in Chapter 3. The information acquired all through the examination were investigated and translated. Synopses of results are for the most part displayed in figures. Typical graphs and tables relating to the experiments will be provided in this chapter. This chapter describes the analysis of data followed by a discussion of the research findings. The discoveries identify with the examination addresses that guided the investigation.



Figure 16 Final output in front of HMP

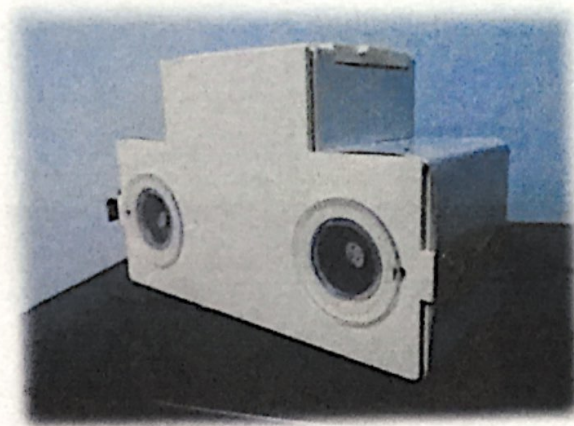


Figure 17 Final output behind of HMP

4.2 Project Costing

ITEMS	PRICE(RM)	UNIT	TOTAL(RM)
Vibration Motor	99	2	198
Driver Motor	100	1	100
Arduino UNO	30	1	30
Rechargeable Batteries (3.7V)	2	4	8
Charger Rechargeable Batteries	5	1	5
Classic Neck Silicone	2	2	4
ABS 3D Printing	100g=RM100	1	310
LCD Screen	30	1	30
Switch Button	2	5	10
GP Sealant-Acetic Silicone	20	1	20
Others component	100		100
TOTAL(RM)			815

Table 8 Project Costing

4.3 Evaluation test referring to Comfortableness

Comfortableness	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
a)	10	38	1		
b)	12	36	2		
c)	8	39	3		
d)	18	27	5		
e)	18	25	7		

Table 9 Evaluation test referring to Comfortableness

NOTES:

- a) This Hygienic Mechanical Percussor (HMP) is easy to used and friendly.
- b) HMP need to be light and easy to carry where to go.
- c) HMP should be portable to use at home.
- d) HMP use rechargeable battery helps reducing the environment damage.
- e) HMP should be comfortable when use in long time used.

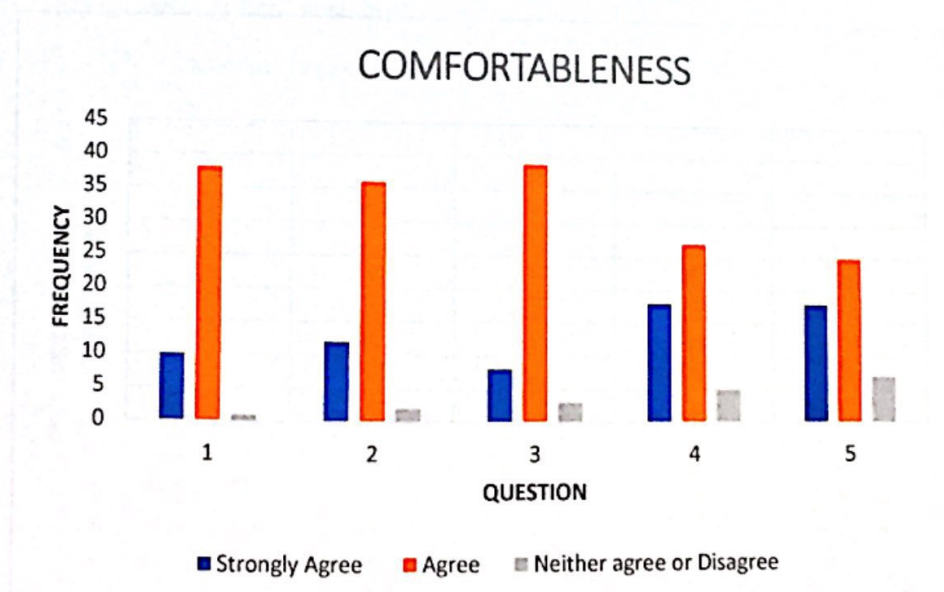


Figure 18 Evaluation test referring to Comfortableness

4.4 Evaluation test referring to Material

Comfortableness	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
a)	18	25	7		
b)	14	27	9		
c)	14	32	4		
d)	22	25	3		
e)	14	32	4		

Table 10 Evaluation test referring to Material

NOTES:

- a) ABS material used by HMP are easy to maintain it clean. HMP need to be light and easy to carry where to go.
- b) It's easy to keep it clean with only wipe the HMP after used by using alcohol pad or disinfectant solution.
- c) HMP material are light and easy to carry it. HMP should be comfortable when use in long time used.
- d) This material is heat resistant.
- e) This HMP material is comfortably used in patients.

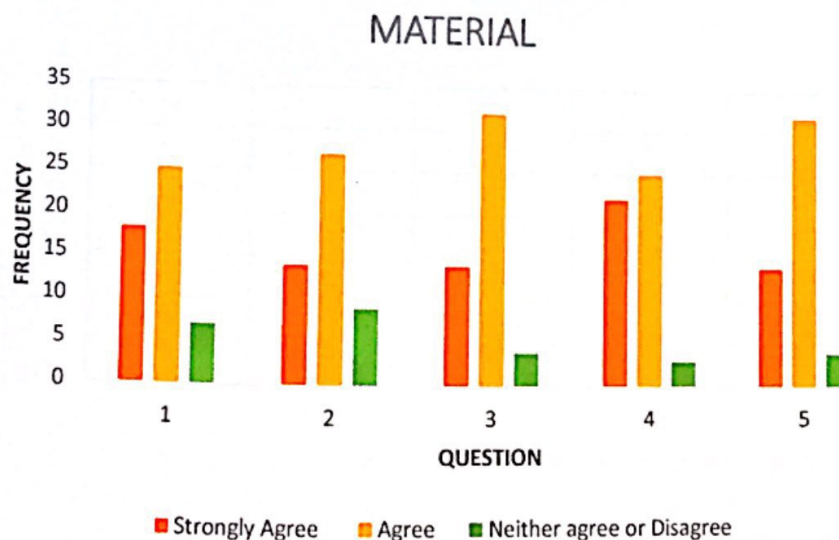


Figure 19 Evaluation test referring to Material

4.5 Evaluation test referring to Effectiveness

Comfortableness	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
a)	18	25	7		
b)	14	27	9		
c)	14	32	4		
d)	22	25	3		
e)	14	32	4		

Table 11 Evaluation test referring to Effectiveness

NOTES:

- a) This HMP very importance to respiratory problem.
- b) There should be a suitable respiratory therapy device that could be used anywhere.
- c) HMP therapy is easier than Conventional Chest Physiotherapy.
- d) HMP helps an individual to fasten the recovery time.
- e) HMP suitable for reduce respiratory problem.

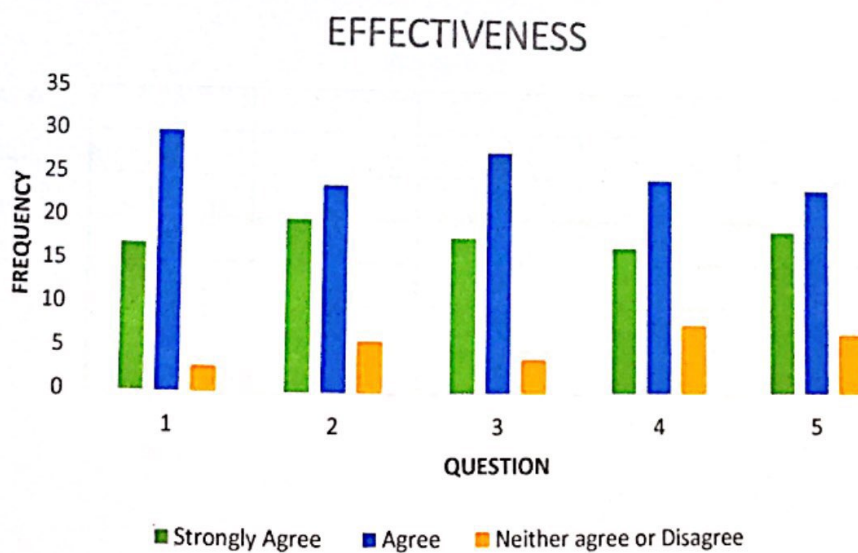


Figure 20 Evaluation test referring to Effectiveness

CHAPTER V

CONCLUSION AND RECOMMENDATION

In conclusion, most of the objective in which is 90% of this project was achieved. At the end, the innovation of this project may help to make the Mechanical Percussor always keep it hygiene. Then the problem on the MP holders who also vibrate on the hands of respiratory therapists will settle with put the spring on the HMP. The design of HMP suitable for machine that can easy to open it and the material that was used are suitable for cleaning process.

As a recommendation for future, the frequency must be increasing than 15 Hz until 30 Hz for adult user. In addition, the design of Hygienic Mechanical Percussor also can be improve so that it will look more interesting in feature. This product is made up of moderate costing but good quality, so that the price would be affordable for user to buy to be use at home.

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Tarikh:

Appendix A

Kepada Berkenaan,

Tuan,

KEBENARAN UNTUK MELAKSANAKAN PROJEK TAHUN AKHIR DILUAR

Dengan segala hormatnya adalah disahkan bahawa pelajar-pelajar berikut merupakan pelajar Jabatan Kejuruteraan Elektrik, Politeknik Sultan Salahuddin Abdul Aziz Shah bagi Program Ijazah Sarjana Muda Teknologi Kejuruteraan Elektronik (Elektronik Perubatan), semester enam.

BIL	NAMA	NO.MATRIK
1.	Nurul Syazwani Binti Mohd Zaidi	08BEU16F3014
2.		
3.		

Pelajar-pelajar tersebut dikehendaki menyiapkan kajian dan projek berkaitan dengan kursus seperti yang dinyatakan di bawah:

TAJUK PROJEK: Development of Hygienic Mechanical Percussor For Respiratory Therapy

2. Sehubungan itu, kerjasama tuan adalah dipohon untuk membenarkan pelajar-pelajar tersebut mendapatkan maklumat yang berkaitan daripada organisasi tuan. Sekiranya terdapat sebarang pertanyaan, tuan boleh menghubungi **Dr. Hj. Zunuwanas Bin Mohamad** di talian 013-3896812

3. Segala kerjasama dari pihak tuan didahului dengan ucapan ribuan terima kasih.
Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menurut perintah,

(HANIZAH BINTI ANAITULLAH)

Ketua Jabatan
Jabatan Kejuruteraan Elektrik



Development of Hygienic Mechanical Percussor for Respiratory Therapy

In the questionnaire we ask you about hand support and therapy device. The questionnaire itself has two parts. In the first one consists demographic questions and second is the hand support and therapy device. We assure complete anonymity of the gathered data. Please provide answers on all questions even though you feel that they repeat themselves occasionally. This is the only way we can assure statistical validity of the questionnaire.

SECTION A: DEMOGRAPHIC

This section relates with your background in brief. Please tick your answer (✓) and your answer will be kept strictly confidential.

1. Age
- | | |
|--------------------------|---------------|
| <input type="checkbox"/> | 20 - 30 years |
| <input type="checkbox"/> | 31 - 40 years |
| <input type="checkbox"/> | 41 - 50 years |
| <input type="checkbox"/> | > 51 years |

2. Gender

<input type="checkbox"/>	Male
<input type="checkbox"/>	Female

3. Education

<input type="checkbox"/>	Student
<input type="checkbox"/>	Worker
<input type="checkbox"/>	Unemployed

SECTION B: DEVELOPMENT OF HAND SUPPORT AND THERAPY

Please read carefully, please tick (✓) based on your understanding and evaluate.

No.	Item & Elements	Strongly Disagree	Disagree	Neither agree or Disagree	Agree	Strongly Agree
1	COMFORTABLENESS					
	a. This Hygienic Mechanical Percussor (HMP) is easy to used and friendly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	b. HMP need to be light and easy to carry where to go.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	c. HMP should be portable to use at home.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	d. HMP use rechargeable battery helps reducing the environment damage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	e. HMP should be comfortable when use in long time used	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	MATERIAL a. ABS material used by HMP are easy to maintain it clean. b. It's easy to keep it clean with only wipe the HMP after used by using alcohol pad or disinfectant solution. c. HMP material are light and easy to carry it. d. This material is heat resistant. e. This HMP material is comfortably used in patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	EFFECTIVENESS a. This HMP very importance to respiratory problem. b. There should be a suitable respiratory therapy device that could be used anywhere. c. HMP therapy is easier than Conventional Chest Physiotherapy. d. HMP helps an individual to fasten the recovery time. e. HMP suitable for reduce respiratory problem.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



POLITEKNIK

Jabatan Pengajian Politeknik



Development of Hygienic Mechanical Percussor for Respiratory Therapy

Thank you for taking time to fill in this questionnaire, you will remain anonymous. The goal of this questionnaire is to get some data through the range of instrument usability about Hygienic Mechanical Percussor (HMP). Please indicate the extent to which you choose with the following statements by putting a \checkmark in the appropriate box by following the range.

Age: 18-22 ☐ 38-42 ☐
 23-27 ☐ 43-47 ☐
 28-32 ☐ 48-52 ☐
 33-37 ☐

Gender: F ☐ M ☐

Occupation: _____

Do you having facing this problem? : _____

If you have someone facing this condition, what is the cause? : _____

What kind of the treatment used? : _____

How many times that therapy used in a week? : _____

No.	Item & Elements	Strongly Agree	Agree	Neither agree or Disagree	Disagree	Strongly Disagree
1	COMFORTABLENESS a. I was found this Hygienic Mechanical Percussor (HMP) is easy to used and friendly. b. HMP was modified from the original and has been added the spring on the holder, the design is suitable and comfortable. c. During therapy session, the position of HMP is consistence while vibration. d. During therapy, HMP did not give me pain. e. I'm comfortable using HMP.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	FREQUENCY a. Frequency 15Hz until 30Hz help me in this therapy. b. Frequency 31Hz until 60Hz help me in this therapy. c. The frequency and 15 minutes therapy are enough. d. HMP frequency suitable for the purpose of reduce respiratory problem. e. Frequency is safe for use in human lungs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	MATERIAL a. HMP are easy to maintain it clean. b. I can wipe the HMP after used by using alcohol pad or others way to make HMP hygiene. c. HMP safely to use to all respiratory problem user. d. This material is suitable for 100° Celsius. e. This HMP material is comfortably used in patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

EFFECTIVENESS

- a. I think that I would like use this product to respiratory problem.
- b. I think that I would need support of a technical person to be able to use this product.
- c. I found that some additional functions in the product were well integrated.
- d. I imagine that most people would learn to use this product very quickly.
- e. HMP suitable for the purpose of reduce respiratory problem.

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

