DESIGN AND DEVELOPMENT OF 3D FOOT SCANNING RIG

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MUHAMMAD SHAHIRUDDIN BIN ALIAS

Report submitted in partial fulfilment of the requirements for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering

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JUNE 2013

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
Name of Supervisor:
Position:
Date:

STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ACKNOWLEDGEMENT

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ABSTRACT

This research is about design and development of 3D foot scanning rig. In 3D scanning industries, there are two mains applications that were used. There are David Laser Scanner and Kinect. For this research, it more focused into Kinect. Kinect is a motion sensing input device that can scan a subject and change to 3D image in Skannet's software. Until todays, there is no rig that had made for kinect. The significant to develop kinect's rig is to make the scanner easy to scan and can produce an accurate 3D image in the software. The objectives of this research are to design and fabricate the portable 3D foot scanning rig and to design a scanning rig that can get a constant radius when circulate a subject. In this research, there are two methodologies that are used. Firstly, design and fabricate the rig. The fabrication process included in this project is cutting of material, machining, drilling and finishing. The selection of the materials and the reason behind the selection are shown based on criteria predetermined. Second methodology is testing the rig. A kinect is attached to the rig and it circulates the subject. The scan result or the 3D image of the subject is shown in Skannect's software. Modification process is done after the testing. From this rig, an excellent result had been produced. The rig can capture the subject's image accurately and sharp in short time. It shows the rig can be used in future.

ABSTRAK

Kajian ini adalah mengenai reka bentuk dan pembangunan imbasan kaki 3D. Dalam industri imbasan 3D, terdapat dua aplikasi utama yang telah digunakan. Terdapat David Laser Pengimbas dan Kinect. Untuk kajian ini, ia lebih tertumpu pada Kinect. Kinect adalah gerakan penderiaan peranti input yang boleh mengimbas subjek dan menukar kepada imej 3D dalam perisian Skannet ini. Sehingga hari ini, tidak ada alat yang telah dibuat untuk Kinect. Yang ketara untuk membangunkan alat pembantu imbasan Kinect adalah untuk membuat pengimbas mudah untuk mengimbas dan boleh menghasilkan imej 3D yang tepat dalam perisian. Objektif kajian ini adalah untuk mereka bentuk alat mudah alih mengimbas dan untuk reka bentuk alat pembantu imbasan yang boleh mendapatkan radius malar apabila mengedarkan subjek. Dalam kajian ini, terdapat dua kaedah yang digunakan. Pertama, reka bentuk. Proses fabrikasi termasuk dalam projek ini adalah memotong bahan, mesin, penggerudian dan penamat. Pemilihan bahan-bahan dan sebab di sebalik pemilihan ditunjukkan berdasarkan kriteria yang telah ditetapkan. Kaedah kedua menguji alat pembantu imbasan ini. Kinect digabungkan ke alat dan ia akan mengedarkan subjek. Hasil imbasan atau imej 3D subjek yang ditunjukkan dalam perisian Skannect ini. Proses pengubahsuaian dilakukan selepas ujian. Dari alat pembantu imbasan ini, keputusan yang cemerlang telah dihasilkan. Alat pembantu imbasan ini boleh menangkap imej subjek tepat dan tajam dalam masa yang singkat. Ia menunjukkan alat pembantu imbasan yang boleh digunakan pada masa depan.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

This project is about to design and development a 3D foot scanning rig that is suitable for an optical instrument which is to records images or photo. Rig is a thing that helps a particular gadget to archive its main function. In film or photographer industry, rig is the most common gadget that helps the high technologies camera to produce or capture an excellent photo. There are many types of rig that were used in industry nowadays. For examples there are moveable platform, tripod, shoulder rig and many more. For this project, the main scope is more towards 3D scanner rig. 3D Scanner is a device that analyse a real world object and generates a point cloud. Applications for 3D scanning are available in many fields, from architecture to art preservation, movies and video games, object recognition and many more. The most famous scanners are David Laserscanner and Kinect (Skanect). However, Kinect comes with its own set of challenges, such as lower resolution textures and there is no rig that can help to obtain a complete 360˚ degree 3D scanning result. So, that's the main problem. At this moment, there is no rig created for Kinect.

1.2 PROBLEM STATEMENT

For this project, Stereoliptography, Kinect was chosen to be improved. Kinect is a good 3D scanner. It can scan object sharply and accurate if it get a constant radius from the subject. So, to overcome this problems a rig for Kinect must be made or improved. The first problem for Kinect is there is no suitable rig that can ease the 3D foot scanning process. Secondly, the conventional method or using hand can cause vibration, user fatigue and inconstant scanning radius during scanning 360˚ of the object.

1.3 OBJECTIVES

The objectives of this project are to design and fabricate the portable 3D foot scanning rig and to design a 3D foot scanning rig that can get a constant radius or to circulate the object that to be scan.

1.4 SCOPES

The project scope is as followed:

i. To proposed 3D foot scanning rig that can be used in particular radius, time range and can control the speed of the movement.
ii. Fabricate the portable rig which can get the accurate image.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter gives a brief explanation about 3D scanning tools and software that were used nowadays. It describes about Stereolitography and the rig. It will describe about the rig that was had in the market.

2.2 GENERAL 3D SCANNING

3D is a short name for 3-dimensional. Physical environment is three-dimensional. Human have two eyes which are about 2 inches apart which able human to perceive the spatial relationship between the things just by looking at them. Thus human see the surroundings objects from two different perspectives which will be processed together in the brain and generate the sense of depth for a 3D visual experience.

In early 80s, research and development of 3D mostly around the world were trying to development a scanner for 3D. 3D scanner is a device that analyse a real world object and generates a point cloud. With the advent of computer it was possible to build

up a highly complex model. In the eighties, the research and the development for 3D scanner is mostly success but it was too slow. So to solve these problems, experts started developing optical technology. By using light much faster that a physical probe. It also allowed scanning of soft objects. There are two types of optical technology were development:

i. Point

   Point is similar to a physical probe in that it uses a single point of reference, many times. This was the slowest approach as it involved lots of movement

ii. Stripe

   Stripe was found to be faster than point as it used a band of many points to pass over the object at once. It was accurate too. So it matched demands for speed and precision.

So, the stripe type was chosen. To capture an object in three dimensions, the sensors would make several scans from different positions. The challenge is to combined those picture together and remove the unnecessary or duplicate the data. The big problems came out when to collect million points of data at once in limit time.

In the eighties, Cyberware Laboratories of Los Angeles was capturing or use humans for their animation industry. In the mid-nineties they had developed into a fully body scanner. In 1994, 3D Scanners launched REPLICA which allowed fast, highly accurate scanning of very small or detailed objects. REPLICA marked serious progress in laser stripe scanning. Some of the scanner able to capture object colour too (Daniel Tenedorio, 2012).

But nowadays, on 20th centuries, there are lots of 3D scanners that were development by the research and development team in industries. Before these, 3D scanners just only use for photographer, designer, craftsmen or artist which to produce their design or capture the myriad abstractions of nature. But today, the applications for 3D scanner are present in many fields, from architecture to art preservation, movies,

medication, video games, object recognition and many more. There are two scanners that are famous today. There is Laser Scan (David Laserscanner) and Stereolitography (Kinect). For this study, the Stereolitography, Kinect was chosen to be improved.

2.3 KINECT AND RIG

Kinect is a motion sensing input device that had been introduced by Microsoft for the Xbox 360 video game console and Windows PCs. This thing, Kinect enables users to control and interact with the Xbox 360 without need to touch a game controller but only by using gestures and spoken commands from the users. Firstly, this project is aimed at broadening the Xbox 360's audience beyond its typical gamer base. Kinect competes with the Wii Remote Plus and PlayStation Move with PlayStation Eye motion controllers for the Wii and PlayStation 3 home consoles, respectively.

Kinect was invented by Zeev Zalevsky, Alexander Shpunt, Aviad Maizels and Javier Garcia in year 2005. It was first announced on June 1, 2009 at E3 2009 under the code name "Project Natal". Following in Microsoft's tradition of using cities as code names, "Project Natal" was named after the Brazilian city of Natal as a tribute to the country by Brazilian-born Microsoft director Alex Kipman, who incubated the project. The name Natal was also chosen because the word *natal* means "of or relating to birth", reflecting Microsoft's view of the project as "the birth of the next generation of home entertainment". The main application for Kinect is for games. But numerous developers are researching possible applications of Kinect that go beyond the system's intended purpose of playing games. The examples of the application that were used Kinect nowadays are quadrocopters, smart shopping, body scanner, medical application, gesture based computer interaction, 3D scanner and many more (Stefan Boeykens, 2012).

The most famous application of Kinect is 3D scanner. In 3D scanner, mostly people use Skanect's software to get the image that was captured or scan by the kinect. It is the software that allows users to capture a full colour 3D model of an object, a person or a room by using kinect. When the Kinect is moved around, it will captures new views of an object or a room and automatically computes a metric 3D model into the skanect's software. Skanect can detect planes, such as floors and walls, and perform automatic ground alignment. Skanect's output can be imported into popular 3D software further examination, measurement and refining. The main problems for both of these devices are they need a constant radius or constant circulate the object that to be scan. The development for Kinect's rig must be done to solve the problems.

Figure 2.1: Kinect

Source: https://commons.wikimedia.org/wiki/File:KinectSensor.png, 14 March 2013

Rig is a thing that helps a particular gadget to archive the main functions. Most gadgets nowadays need a rig to help or to solve their problems to achieve it main function. For the simplest gadget that was used rig is photography. In photography industries or film industries there are lots of rigs that were used. The main function of a rig in photography is to help the camera to produce or capture a fantastic picture. A company in UK which is The Moving Picture Company is the first company produce a practical control rig. They make this rig for the gadget just to produce an excellent image or photo. There are many types of rig in these industries. They are moveable platform rig, tripod, camera track, motion control rig, automotive rig, laser shutter rig, dolly and many more. Each of them wants to produce the fantastic image or photo.

For this project, photography's rig is the most suitable rig that can be related or can be an idea to this project, 3D Scanning rig. This is because both of these were involved in same function which is to produce an excellent image or photo.

Figure 2.2: Automotive rig

Source: http://photography-on-the.net/forum/showthread.php?p=11041185, 13 March 2013

Figure 2.3: Camera track

Source: http://www.mattjackson.tv/equipment.html, 14 March 2013

Figure 2.4: Shoulder rig

Source: http://www.diyphotography.net/diy-dslr-pvc-shoulder-rig, 14 March 2013

2.4 SUMMARY

Chapter 2 has been discussed generally about the software that was used in 3D scanner which is stereolitography, Kinect. It also discussed about the types of rig that will used in these project. This chapter is as a key for this project.

CHAPTER 3

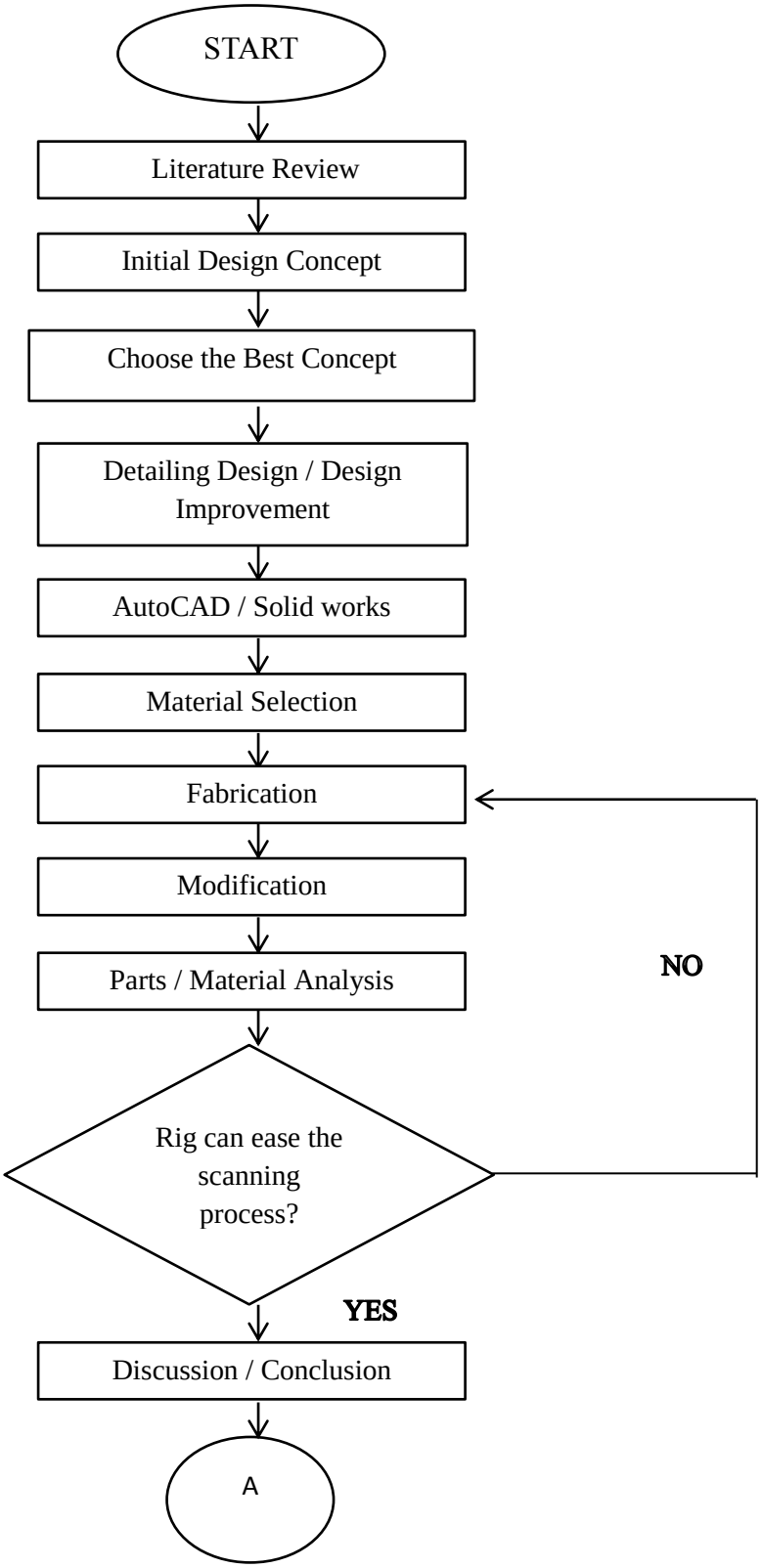
METHODOLOGY

3.1 INTRODUCTION

This chapter discuss about process flow, the equipment and the material that will use and the steps of fabricate. It also described about the design of the rig that will be create. This is very important to determine the best and excellent result for this project.

This research study was conducted based on the methodology. This chapter plays an important role in development and implementing this project accordingly. The details are explained in this chapter.

3.2 FLOW CHART PROCESS



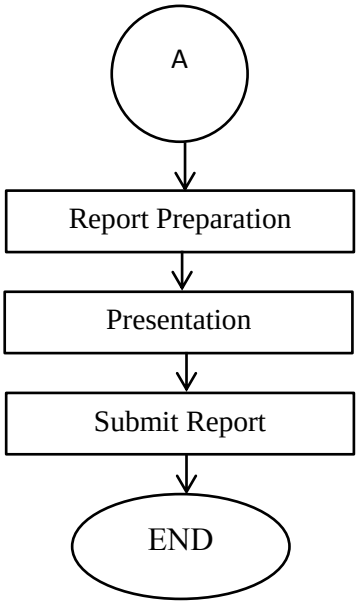


Figure 3.1: Methodology Process

This flowchart had been created before the project was start. This flow chart is to show the steps in a making these project. It makes the process work more clearly and done in time. For this project, these are the several steps that need to achieve the objectives successfully.

These project starts with understanding the program that will use which are Kinect and Skanect. Observe and identify their advantages and disadvantages to understand about the concept of the rig. After that, concept design is carry out. In this project, 4 concept designs have been sketch out and an evaluation is carried out. Concept screening is the method of evaluation that are being carry out to design out the finalize design concept of the rig.

After finalize the concept, next process is material selection. Next, the fabrication process is carried out. Here several of tool and machining process like cutting, drilling, turning and much more is carry out. After that, the rig had been through an experiment or testing for identifying whether the rig achieved the objectives or not. If there are problems, modification and improvement must be done to make sure is objectives achieved. Lastly, after done all the steps a complete rig has been produced.

3.3 DESIGN CONCEPT

3.3.1 Concept A

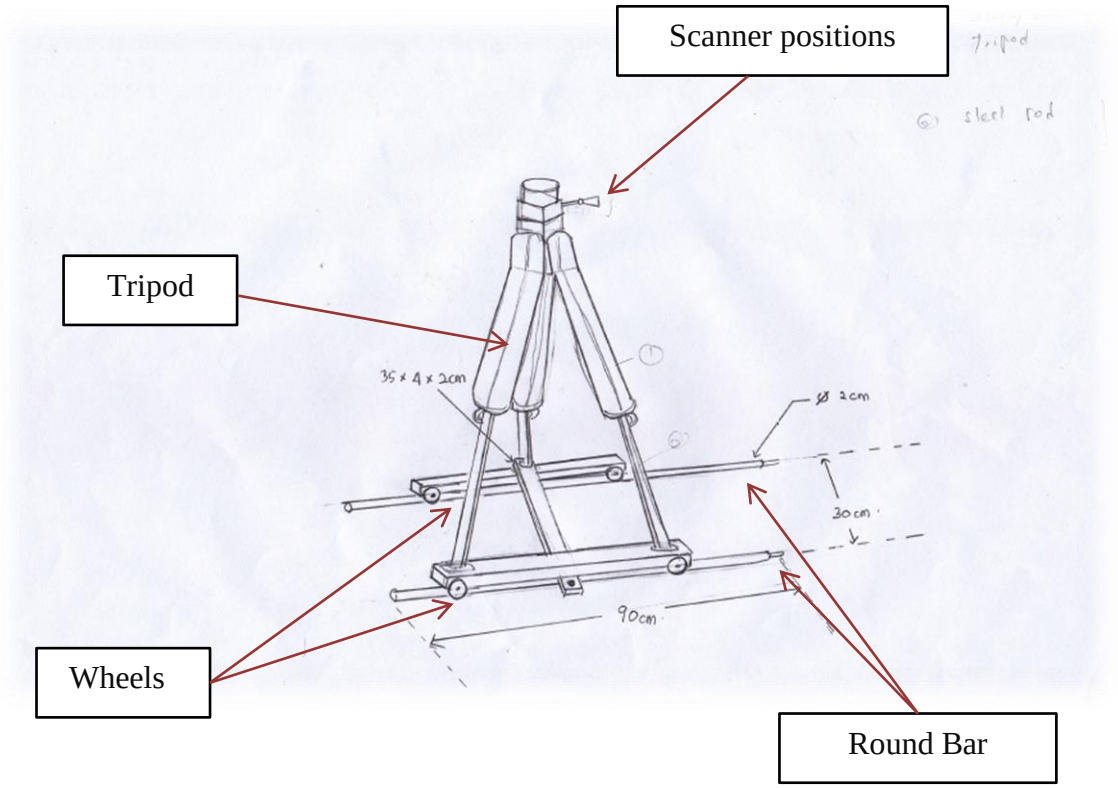


Figure 3.2: Concept A

Figure 3.2 shows the first concept or the concept A that had been made for the rig. For this concept, it can get a constant radius from the subject. Furthermore, the radius can be adjustable. The concept is similar to camera track. The track can be combined by bolt and nut. So, if the user wants large radius or long track the users can add more round bar which is easily coupling. The disadvantages of this concept are, it needs a high cost to build it and it is not suitable for a small subject. Besides that, this concept is difficult to use for users.

3.3.2 Concept B

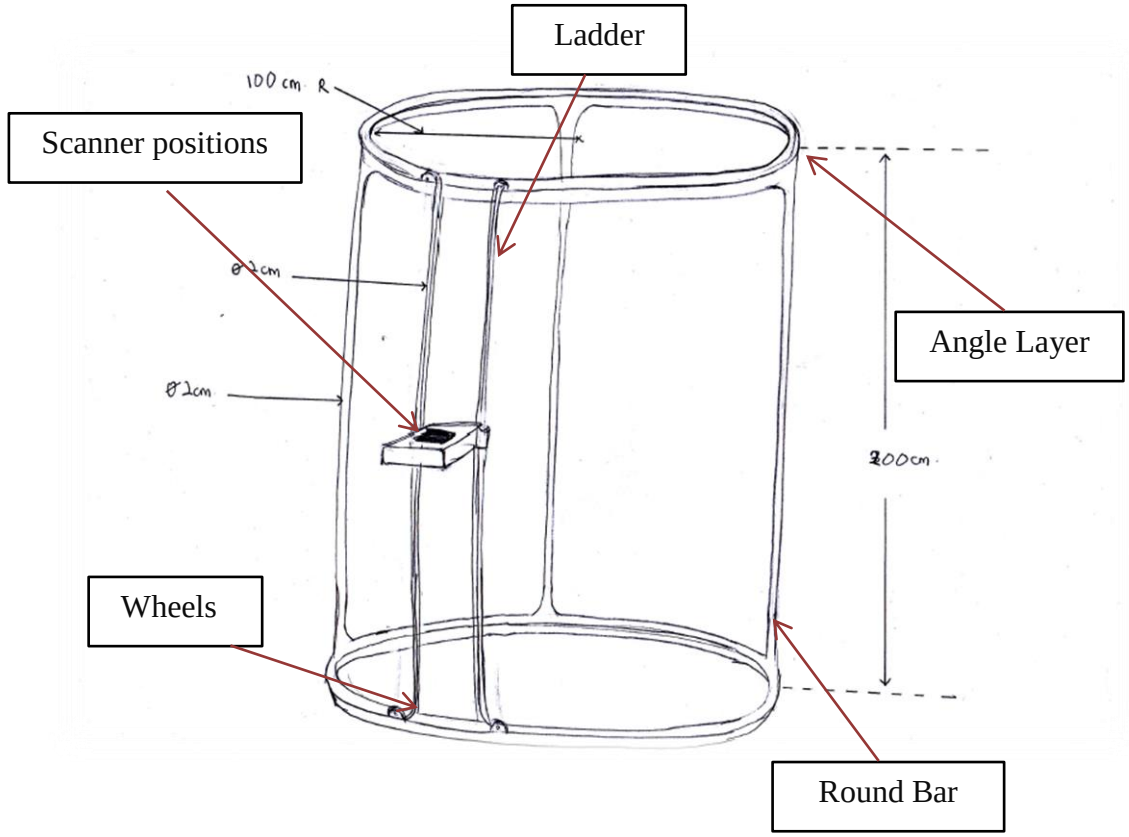


Figure 3.3: Concept B

Figure 3.3 shows the Concept B. In this concept, there is a ladder that attached to the main circle. The ladder will move around follow the shape of the circle. It will easily circulate the subject without radius problem. Advantages of this concept, the radius will be constant and can produce an accurate scan to the subject. It is easy because the subject stay static in the centre and the ladder will move around. The disadvantage of this project is, it is not suitable for a small subject. Furthermore, this concept is highly cost and it requires large space to use it. Besides that, this concept is too massive.

3.3.3 Concept C

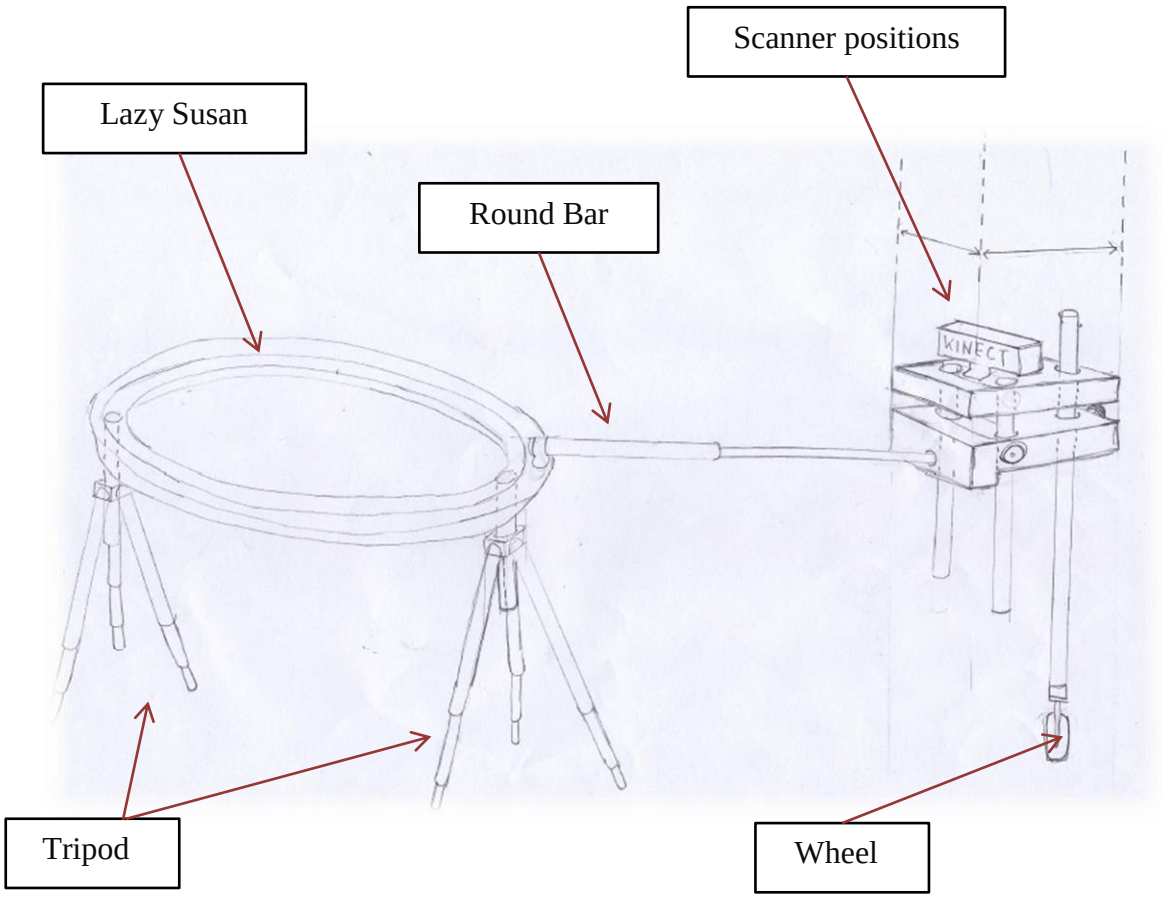


Figure 3.4: Concept C

Figure 3.4 shows the concept C. For this concept, a lazy susan was used. Lazy susan is the mechanism that was used in the round table. The scanner will circulate the subject around the lazy susan which attached by a round bar to them. The advantages are it can get a constant radius and the cost is low. This concept is simple and easy for the user to use. The disadvantages are it needs a large space for the scan move around the lazy susan and the size of the lazy susan it's too small which can affect the size of the subject.

3.3.4 Concept D

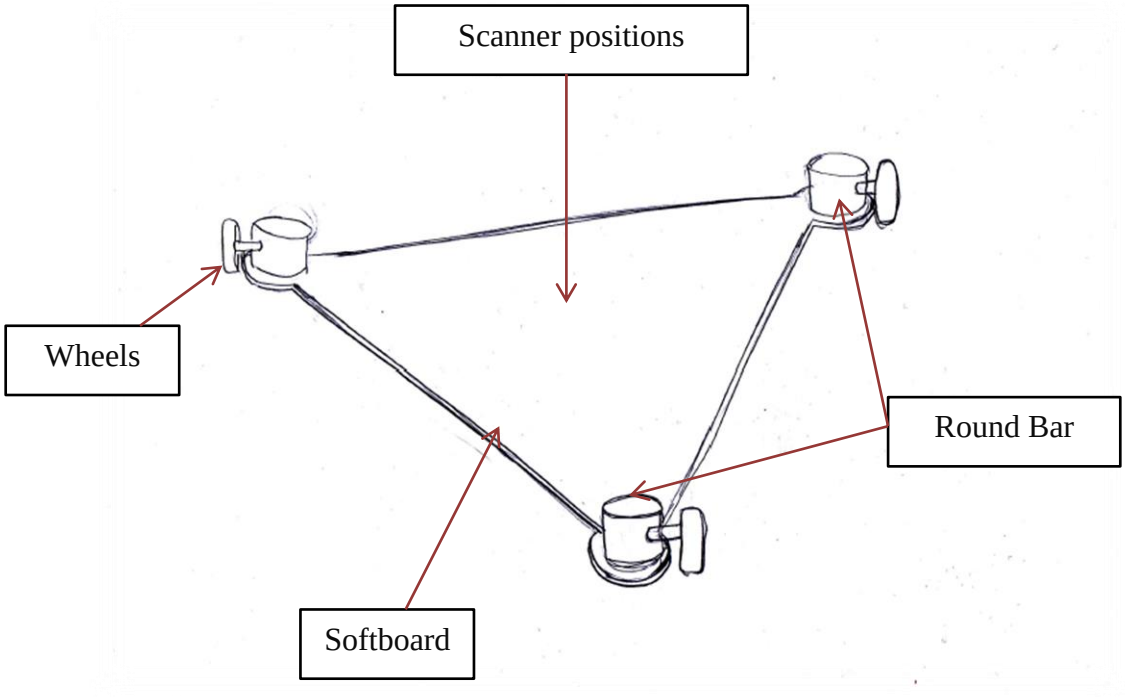


Figure 3.5: Concept D

Figure 3.5 shows the concept D. This design is the simple and easy to handle. There is one wheel that stays static and the others two wheels can be adjusted. The user can adjusts the two wheels to any radius which can make the rig move circle or forward. It can produce a constant radius from the subject. It is also a low cost concept. The disadvantages of this concept are it needs a constant radius to push it or move it around.

3.4 EVALUATION PROCESS

After four concept designs were sketch out, the next process is the evaluation process to sort out the criteria of each concept. Screening concept will be carry out in this section. The process will determine which concept or design will be developed.

3.4.1 Concept Screening

Table 3.1: Concept Screening

	CONCEPT VARIANTS			
SELECTION CRITERIA	**A**	**B**	**C (ref)**	**D**
Ease of operating	-	-	0	+
Multi-user	+	+	0	+
Space that needed	-	0	0	+
Ease of manufacture	+	-	0	+
Cost production	-	-	0	+
Constant radius	0	0	0	0
PLUSSES	2	1	0	5
SAME	1	2	6	2
MINUS	3	3	0	0
NET	-1	-2	0	5
RANK	3	4	2	1
CONTINUE?	NO	NO	NO	YES

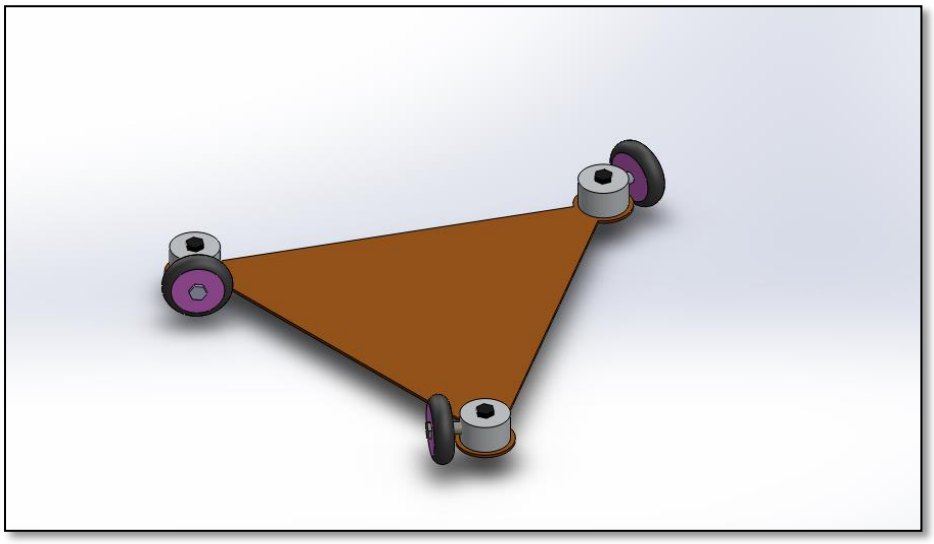
Table 3.1 above shows the concept screening process. Each concept design will be evaluated according to the selection criteria which ease of operating, multi-user, space that needed, ease of manufacture, the cost production and a constant radius. Concept C is taken as the reference in screening out the design concept. Design concept that has the same selection criteria to the reference will be given a (0) sign, (-) is given to the design that has bad criteria than the reference and (+) is given to the design that has better criteria than the reference. Then the sum of (+), (-) and (0) is calculated. Net score is obtained by minus away the (+) sign with the (-) sign then the concept is ranked. Here concept D ranked the first followed by C, A and B. Concept D is the designed that will be continuing and development.

3.5 FINALIZE CONCEPT

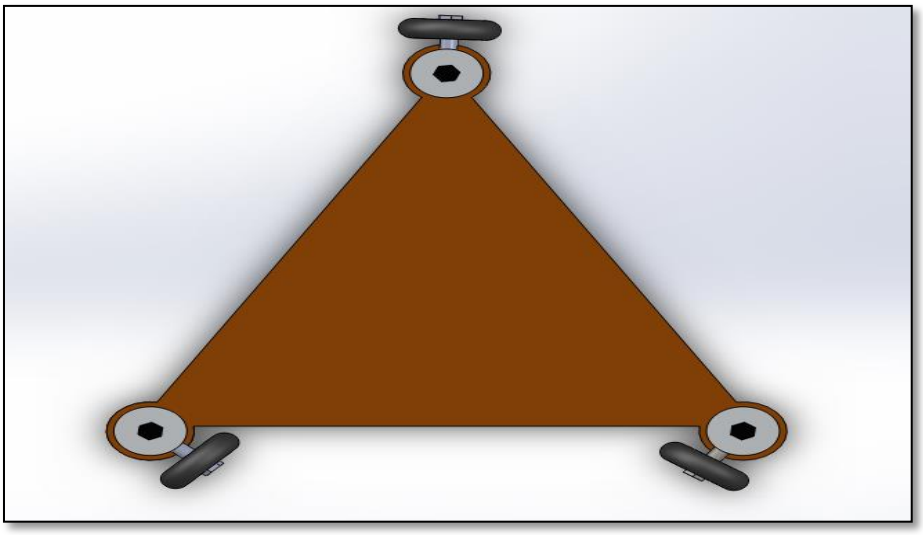
After the concept screening, concept D was chosen for the final concept. Concept D had been made in Solidwork. Solidworks is a 3D mechanical CAD (computer-aided design) program. It helps mechanical engineers design products. It makes the designer easy to visualize and communicate a 3D concept. The designer can make changes to the design, validate the design against requirements, and prepare the design for production in manufacturing. It uses a mouse-driven graphical user interface to enable engineers and designers to visualize and communicate 3D models of manufactured objects. Solidworks works extremely well for mechanical design and similar industries requiring precise definition of 3D shapes and their design intent.

Parts of the rig are made one by one before assembly it according to actual size. Then, all the parts were assemble together to produce a complete design. The complete design is shown in Figures 3.6 below.

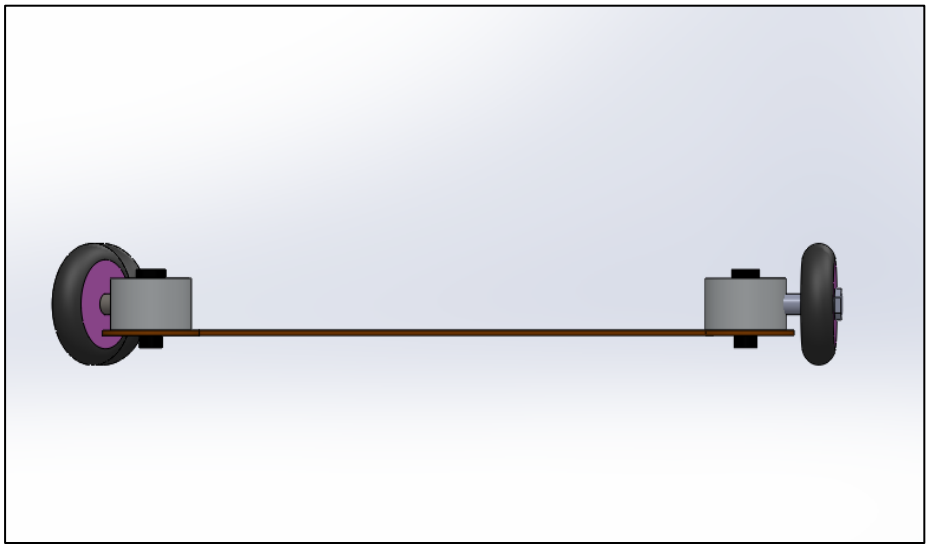
Figure 3.6: The rig design in Solidworks



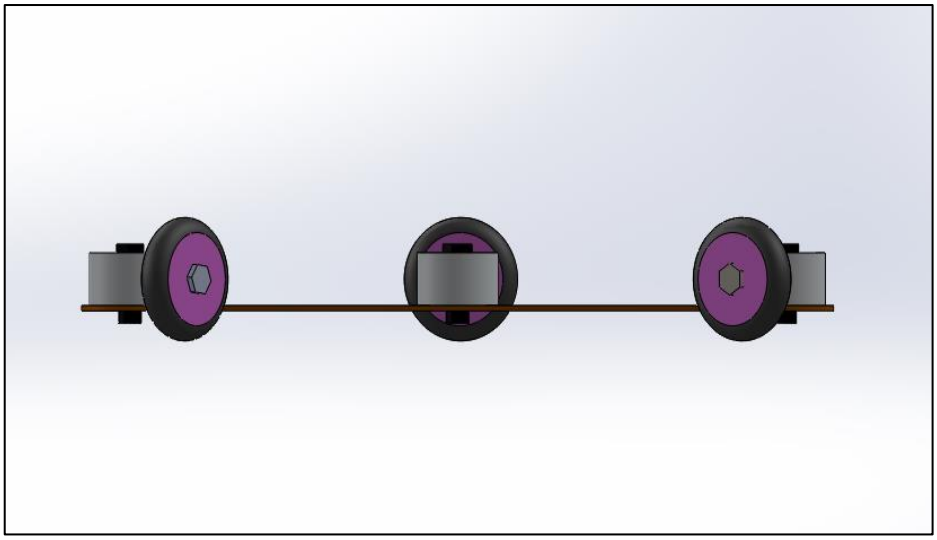
(a) Isometric View



(b) Top View



(c) Side View



(d) Front View

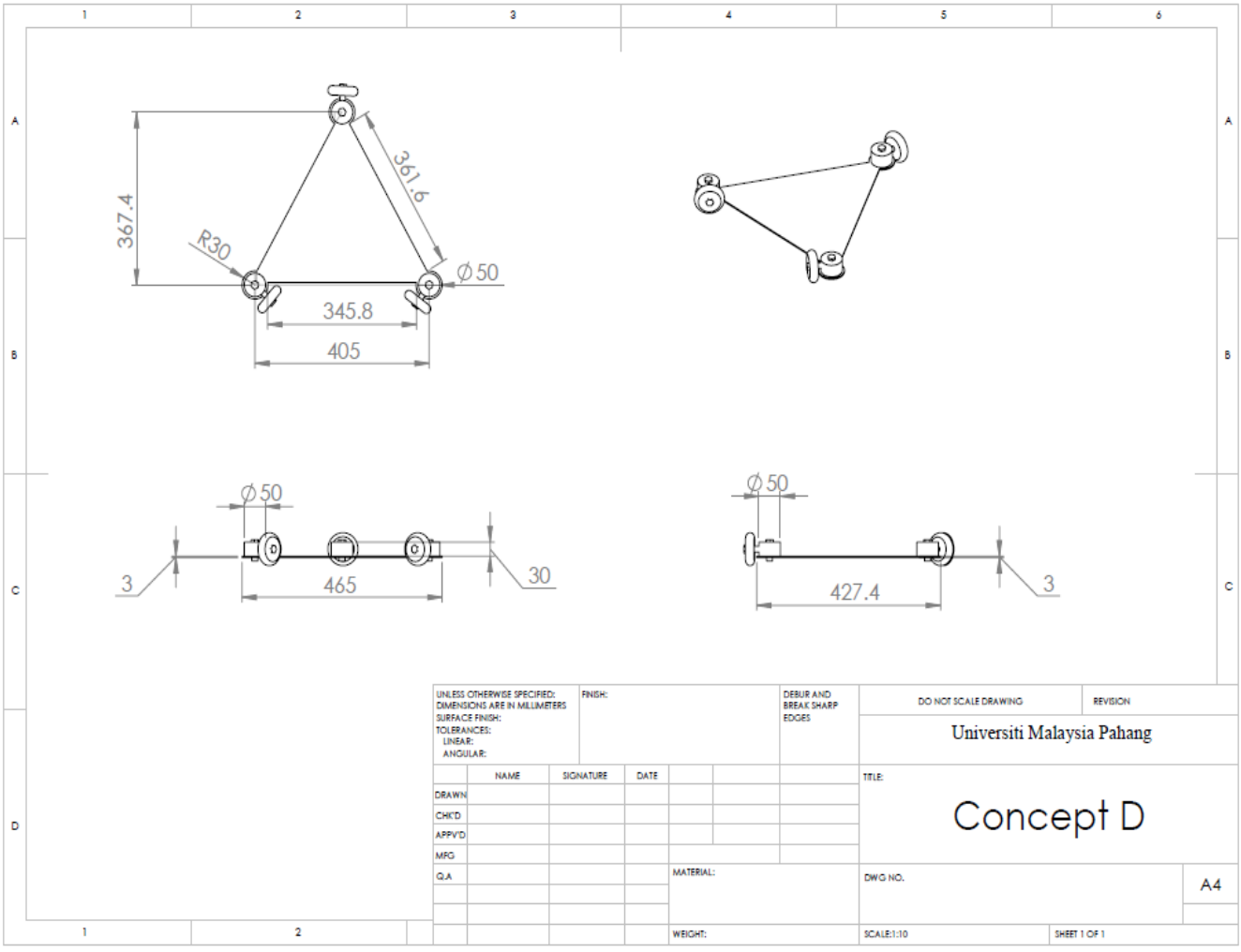


Figure 3.7: Drawing in Solidwork with dimensions

3.6 HOW IT WORKS

For this concept, there are two ways to move. Firstly, it can move forward or backward. Secondly, it can move circle with any radius that user want by adjusting two wheels of the rig. One wheel at the back will stays static and the other two wheels are the adjustable wheels. The adjustable wheels are the wheels which decide the radius of the circle. User can change to any radius that the user desired by turning it. Figures below shows how it moves forward or backward and circle.

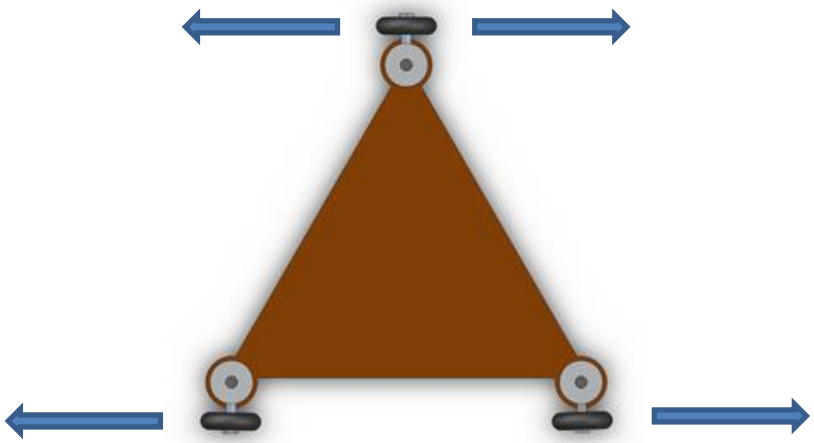


Figure 3.8: The rig can move forward or backward

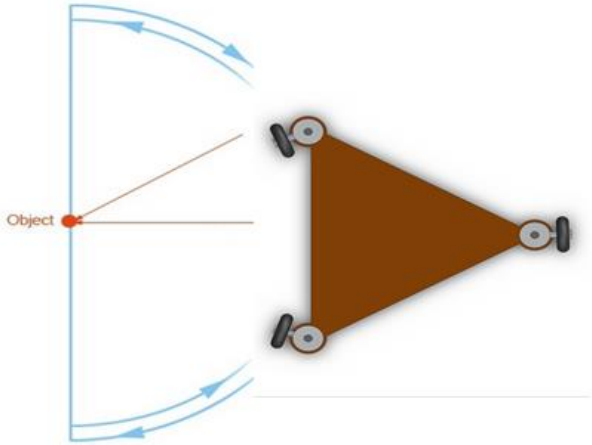


Figure 3.9: The rig can move circle by adjust the two in front wheels

3.7 MATERIAL SELECTION FOR RIG

Material selection is a process which is performed to select the best materials which may have the potential to perform well both in industrially and commercially. It is important to choose the suitable materials to build the rig because it will affect the result of the project.

3.7.1 Three Wheels

When the platform is move, the friction and vibration between the wheels and the ground will totally affects the result. Therefore, the materials or types of the wheels should have good ability to absorb or reduce the friction and vibration among them. So, the rollerblades wheels had been choosing for this project than others. It is more stable. Besides, the outside part of the wheels is made of rubber which make it works fine and smoothly in flat surface. It can reduce friction among them. Furthermore, inside the rollerblades wheels have hollow which can reduce the vibration. The size of these wheels also was identified. For rollerblades wheels the size is only 7 cm diameter which is the suitable size for the rig. Before choosing rollerblades, an observation was made to scooter wheels. Scooter has a large size of wheels, 10 cm diameter which is too large for a small rig. So, after observe all the points the rollerblades wheels had been choose.

Figure 3.10: Rollerblade wheel that have a hollow inside it

Source: http://www.prophotographygear.com/table-top-dslr, 13 March 2013

3.7.2 Platform

Softboard is used for making the platform of the rig because it is light. It will make the users easy to bring the rig anywhere. Furthermore, softboard is easily to cut into shapes. If the platform was used by other materials like steel or galvanized iron, they are very hard to cut into shapes. So, softboard had been select for the platform.

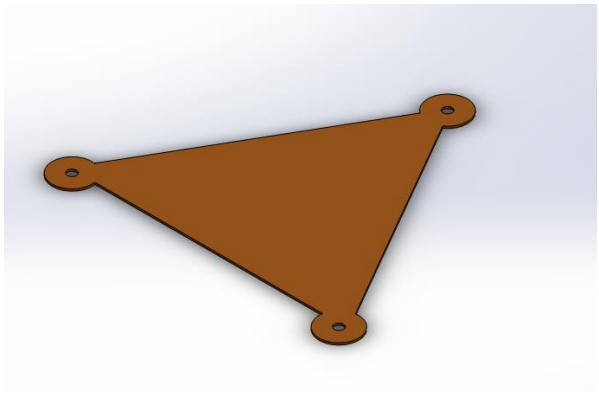


Figure 3.11: Softboard platform

3.7.3 Round Bar

For the three round bars that attached to the wheels, aluminium was chosen. This is because aluminium round bar has a light weight than others materials. It can reduce the downwards force or the pressure that had been applied to the platform. If the round bar was made from steel, the force or the pressure that had been applied to the platform will increase and affect the softboard platform. It will cause the platform to bending. So, the aluminium round bar had been select for these project.

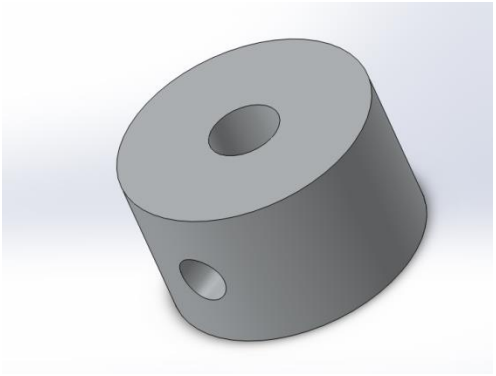


Figure 3.12: Aluminium round bar

3.7.4 Scanner Stand

For the stand to support the scanner, Kinect, tripod had been select. Tripod is a portable three-legged frame that can support the scanner weight and can maintaining the stability of the scanner. The positioning of the three feet away from the vertical centre makes or allows the tripod better leverage for resisting lateral forces. Furthermore, tripod is more stabilize than monopod which has only one leg. So, to obtain the excellent result tripod had been select to support or to stand the scanner, Kinect.

Figure 3.13: Tripod

Source: http://www.meritpower.com.my/products/digieye, 13 March 2013

3.8 BILL OF MATERIALS

Table 3.2: Bill of Materials

No	Types	Thickness	Size	Quantity
1.	Softboard	10mm	400mm x 400mm	1
2.	Aluminium Round Bar	30mm	50mm diameter	3
3.	Rollerblade Wheels	-	70mm diameter	3
4.	Bolt and Nut	50mm	M6 x 1 (6mm diameter)	3

3.9 FABRICATIONS PROCESS

Fabrication process comes after designing and selected materials phases were done. The objectives of this process are to produce or fabricate the product based on the design and the dimensions from the final concept. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product compared to manufacturing process which is to process a large number of productions. Fabrication process was used at the whole system production.

3.9.1 Process Involve

In order to make the design come to reality, fabrication process needs to be finished. The fabrication process starts from dimensioning the raw material until it is finish as a desired product. The processes that involved are:

i. Measuring: Materials are measured to desired dimensions or location.
ii. Marking: All measured materials need to be marked to give precise dimension.
iii. Cutting: Marked materials are then cut into pieces.
iv. Turning: Use lathe machine or turning machine to make round shaft or bar
v. Joining: Materials joined by the method of screw and bolt.
vi. Drilling: Marked holes are then drilled to make holes for mount the round bar with the bolt and nut
vii. Finishing: Any uneven and rough surface was flattened by using steel files to give smooth and safe surface. The surface of the product also colour by spraying.

3.9.2 Steps to Fabricate the Rig

There are several steps to fabricate this rig. Firstly, make the platform or the base according to the design and dimensions. For this project, it used softboard for the base. The softboard was cut easily with a jig-saw. The hole at the platform was drill with hand drilling.

Figure 3.14: Cutting the softboard with Jig-saw

Figure 3.15: Drill the holes with hand drill

Secondly, proceed with the aluminium round bar. Lathe machine was used to cut and create the aluminium round bar according into their desired size. A through hole at the centre of the round bar was drill by the lathe machine too.

Figure 3.16: Cut the round bar by Lathe Machine

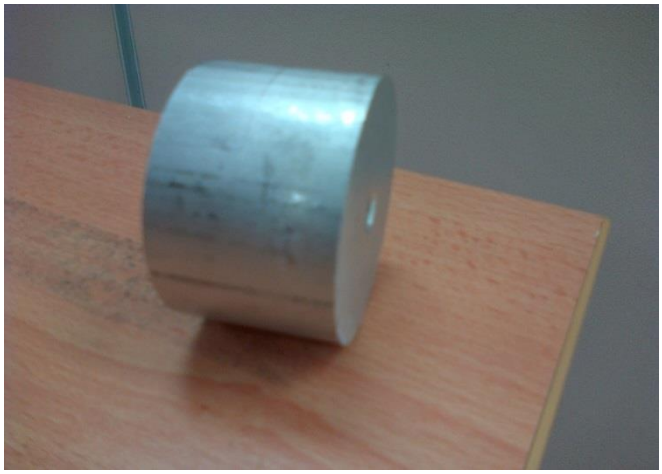


Figure 3.17: The aluminium round bar had been cut

Third step is focusing into the wheels part. Assemble all the aluminium round bar with wheels by using bolt and nut. The size that was used must same and suitable to the hole that was made at the round bar. For this project, bolt and nut size M6 were used to attached or combine both of them.

Figure 3.18: The combination between the wheel and the round bar

Lastly, combine all the part together according to the design. The tripod also had been attached with the platform. Figure 3.19 below showed the combination.

Figure 3.19: Assembly all parts

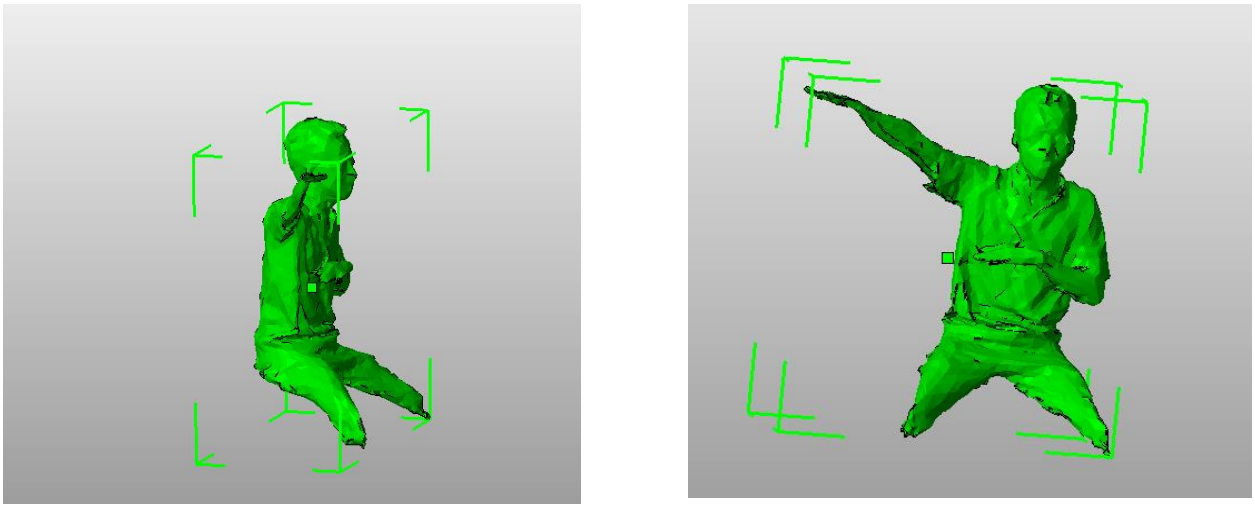
3.9.3 Project Experiment

After the fabrication process, the rig had been experiment to check whether it's achieved the main objectives of this project or not. There are two experiments were conducted to the rig.

The first experiment is about the movement. It is to check whether it can circulate 360˚ accurately and move straight or not. For the straight movement, a black tape was tape on the floor in a straight line. The rig will move from the beginning until the end of the tape. For this test, the rig was moved straight follow the tape line and it passed the test. For the circle movement, a large round circle had been created on the floor. The rig will move according to the shape. If the rig can stop where it was start, it shows that it can circulate 360˚ accurately. For the circulate movement, this rig was passed too.

Second test is about the scanner result. It is to check whether this rig can be used with the scanner or not. The rig was attached with the scanner, Kinect on the tripod. A student had been select to be the subject for this experiment. The rig will circulate 360˚ and scan the student. The result of the experiment will show in Skanect software. For these testing, the rig was done successfully. An excellent result was produce in the software. Figure 3.20 below shows the result.

(a) Subject in normal camera



(b) The result of the subject in the software

Figure 3.20: Result from the rig

3.10 MODIFICATION AND IMPROVEMENT

After testing the rig, there are several problems and difficulty was found. The first problem is a constant force must be applied to the rig to get an accurate result. If there are inconstant force, the rig must not circulate 360˚ accurately which will affect the result of the subject. Second problem is the round bar. It is hard to make both of the front wheels have a same direction together. For the third problem, the softboard will not be a long lasting if there are no other materials to support them.

So, modification and improvement was made to the rig to solve the problems. For the first problem, the present of DC motor with a remote control had solved it. When there is a motor and controller, the rig will move automatic and a constant force can be applied to move the rig. The specification and the characteristic of the motor was determined and calculated to get an excellent result. This is the type of motor that was select.

Table 3.3: Characteristic of the motor

Parameters	Specification
Rated voltage	12 VDC
Output power	1.1 Watt
Rated torque	1176 mN.m
Rated current	410 mA
Rated speed	12 RPM

After select the types of motor, the time taken that need for the rig to circulate a subject was calculated. The minimum radius of the circle, 63cm was taken for the calculation. These are calculations.

The circumstances of the circle = 2 π r = 2 x π x 63cm = 395.84cm

The circumstances for wheel = 2 π r = 2 x π x 7 = 21.99cm

$$\frac{\text{Circle Circumstances}}{\text{Wheel Circumstances}} = \frac{395.84}{21.99} = 18 \text{ times for 1 complete rotation}$$

If use 12 rpm motor,

$$\frac{12 \text{ rpm}}{60\text{s}} = 0.2 \text{ rps}$$

$$\frac{18}{0.2} = 90\text{s for 1 complete rotation}$$

As shown above, the time taken for the rig to circulate a subject with 63cm radius is 90 seconds. It is the suitable time taken to scan because when the time taken to scan is increase or longer more focus the scanner to the subject. Besides, it can produce an excellent image in the Skanect. A circuit with switch on/off and transmitter had been attached to the platform to control the rig by remote control. Figure 3.21 below shows the circuit while Figure 3.22 shows the motor that had been attached.

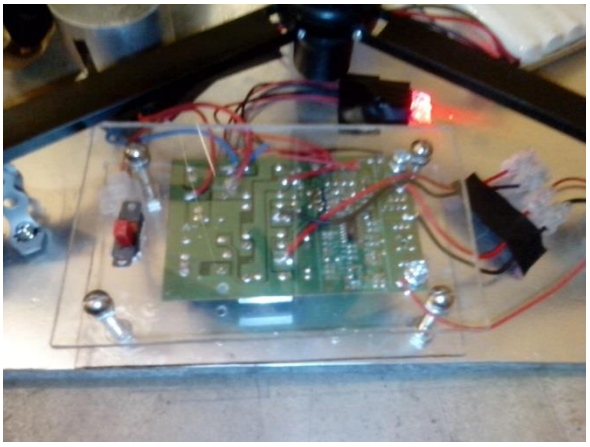


Figure 3.21: A circuit had been attached to the platform

Figure 3.22: The motor that been attached to the platform

For the second problem, a marked on the platform and on the round bar had been made. This method can make the movement of both wheels in same direction even though they circulate or move straight.

Figure 3.23: A mark had been made on the platform and the wheels

For the last problem, an aluminium sheet metal had been made to support the softboard platform. It also can make the softboard more long lasting. Aluminium will cover the softboard to avoid any others problem that will affect the softboard.

Figure 3.24: Adding of aluminium

3.11 SUMMARY

This chapter present on how the rig is being fabricated from the beginning. It describes the steps and the modification that had been made to the rig to achieve the main objectives of this project. The calculations of the motor that want to use also had been showed and calculate. As conclusion, Chapter 3 is another main point of this project for design and fabricating the 3D foot scanning rig.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

For chapter 4, it will describe about the result of the fabrication process which develop in Chapter 3. It also will describe the result from the scanner and the rig. This chapter will show whether the rig is achieved the objectives successfully or not. It is the key chapter of the rig and this project.

4.2 RESULT AND DISCUSSION

Figure 4.1 below shows result of the fabrication and improvement that had been proceed in chapter before. The final product was successfully done according to the design and the dimensions.

Figure 4.1: The rig or the final product

After done with the fabrication process, a test or an experiment was been conduct to see if the rig can achieve the main objectives of this project successfully or not. A foot of a student was select for this final experiment. The student will sit on a table at the centre and his leg will hang on. Figures 4.2 below show how the foot of the student was hang on from the table.

Figure 4.2: A foot as the subject

The rig will circulate the subject 360˚ with scanner, Kinect that attached on it. It will move around automatic under the table by using the remote control. The rig will smoothly scan the foot and transfer the data into the Skanet's software. Figure 4.3 shows the data or result that gets from the scanner and the rig

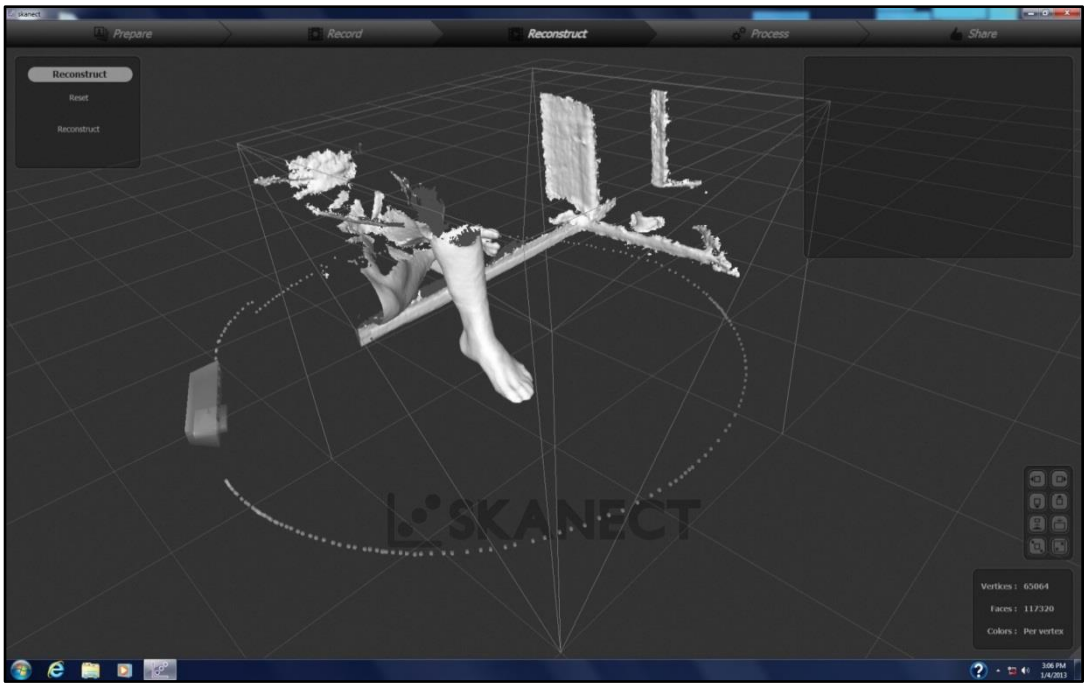


Figure 4.3: The result in the Skanect

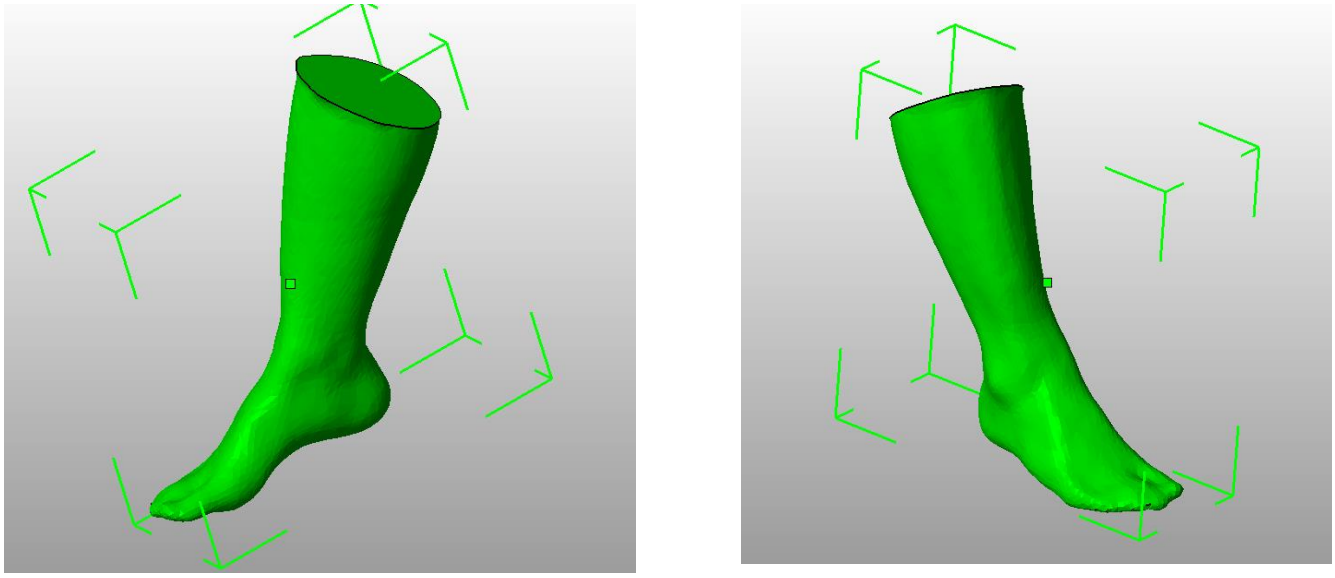


Figure 4.4: An accurate 3D scan foot result

Figure 4.4 above shows the result that the Skanect get from the scanner, Kinect with the help from the rig. It shows an accurate and sharp image had been captured. There is no damage axis that the scanner was scan. It shows that the scanner was captured all parts of the foot according to their axis smoothly and nice. It also shows that the rig that was made is the suitable rig for the scanner.

4.3 SUMMARY

This chapter present the result that get from the fabrication process. It also described about an experiment that was done for testing the rig and the scanner. The result of the experiment will determined whether the rig had achieved the objectives of this project easily or not.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The objectives of this project which are to design and fabricate the portable 3D foot scanning rig were successfully accomplished. The 3D scanning rig is capable to get a constant radius and circulate the foot. The subject or foot of this project was easily scans without any problems. A 3D image of the foot was produced less than 2 minutes. This rig can make the kinect's users achieve a quality 3D image. In future, this rig will be the important things in development of 3D scanning rig.

5.2 RECOMMENDATIONS

Even though, this final product was successfully done, there is also weakness that needs to be improved for future.

5.2.1 Platform

For this project, softboard was used for making the platform. For future planning, the recommendations is change the platform into some material that are strong and light which can make the rig easily to bring anywhere. Plastic is another material that had been suggest if want to change the platform. Select a material that has less thickness which cannot effect the movement of the rig with the floor.

5.2.2 Motor

In this project, a motor with 12RPM had been used. It needs 90seconds for the scanner to circulate the subject. For future planning, increasing the RPM is the recommendations. 54 RPM is the suitable motor that can be used. It takes only 60 seconds for the rig to scan if 54 RPM is used. It can reduce the time taken for the rig to circulate a subject.

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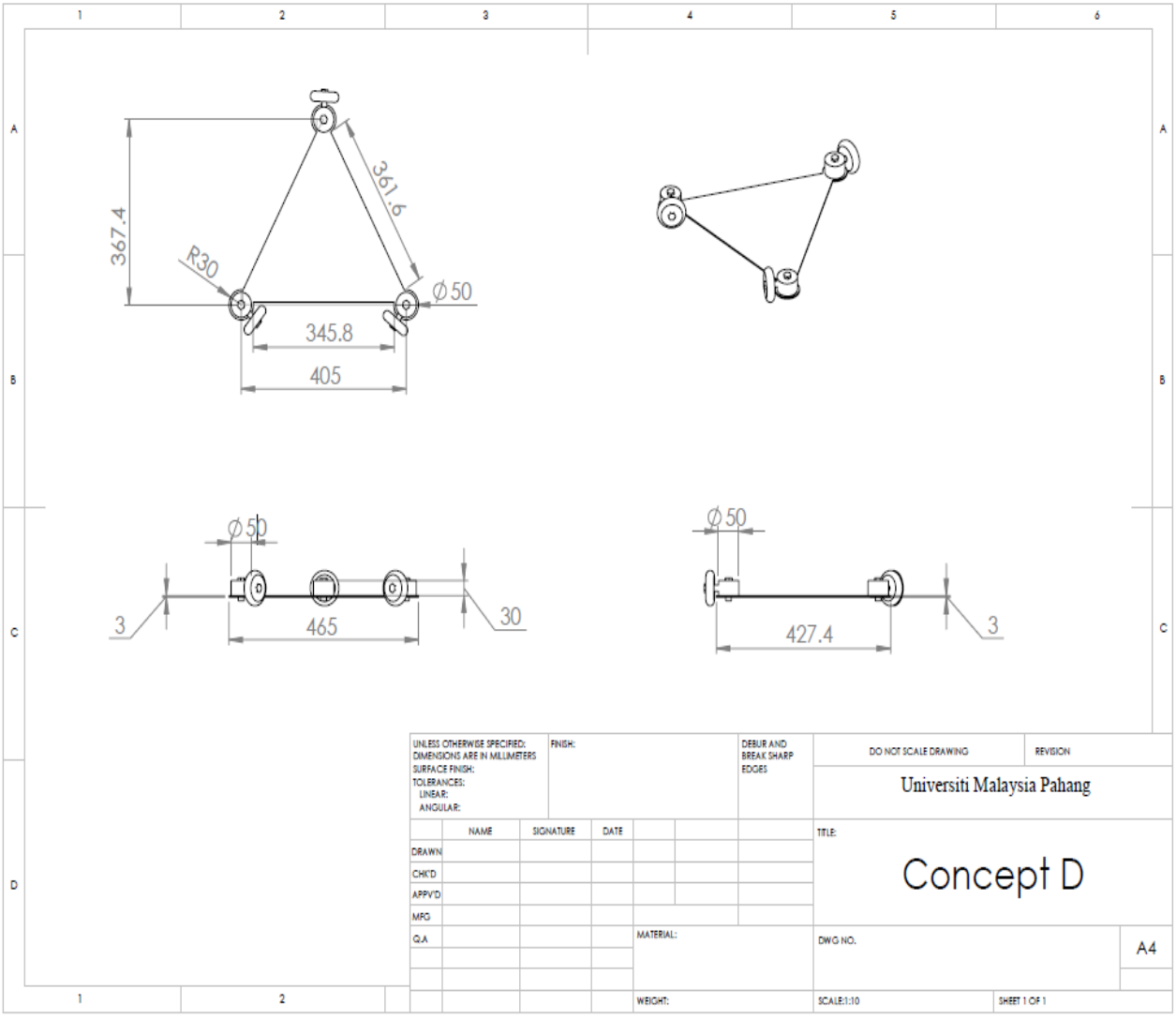
APPENDIX A

Gantt Chart

PROJECT ACTIVITIES	WEEKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Literature Review And Gather Information	PLANNING														
	ACTUAL														
Sketching 4 Concepts	PLANNING														
	ACTUAL														
Develop in Solid Work	PLANNING														
	ACTUAL														
Show Progress Report To Supervisor and Present Current Progress	PLANNING														
	ACTUAL														
Set Material and Start Fabricate	PLANNING														
	ACTUAL														
Testing and Identifying	PLANNING														
	ACTUAL														
Modification	PLANNING														
	ACTUAL														
Report Presentation	PLANNING														
	ACTUAL														
Final Presentation	PLANNING														
	ACTUAL														

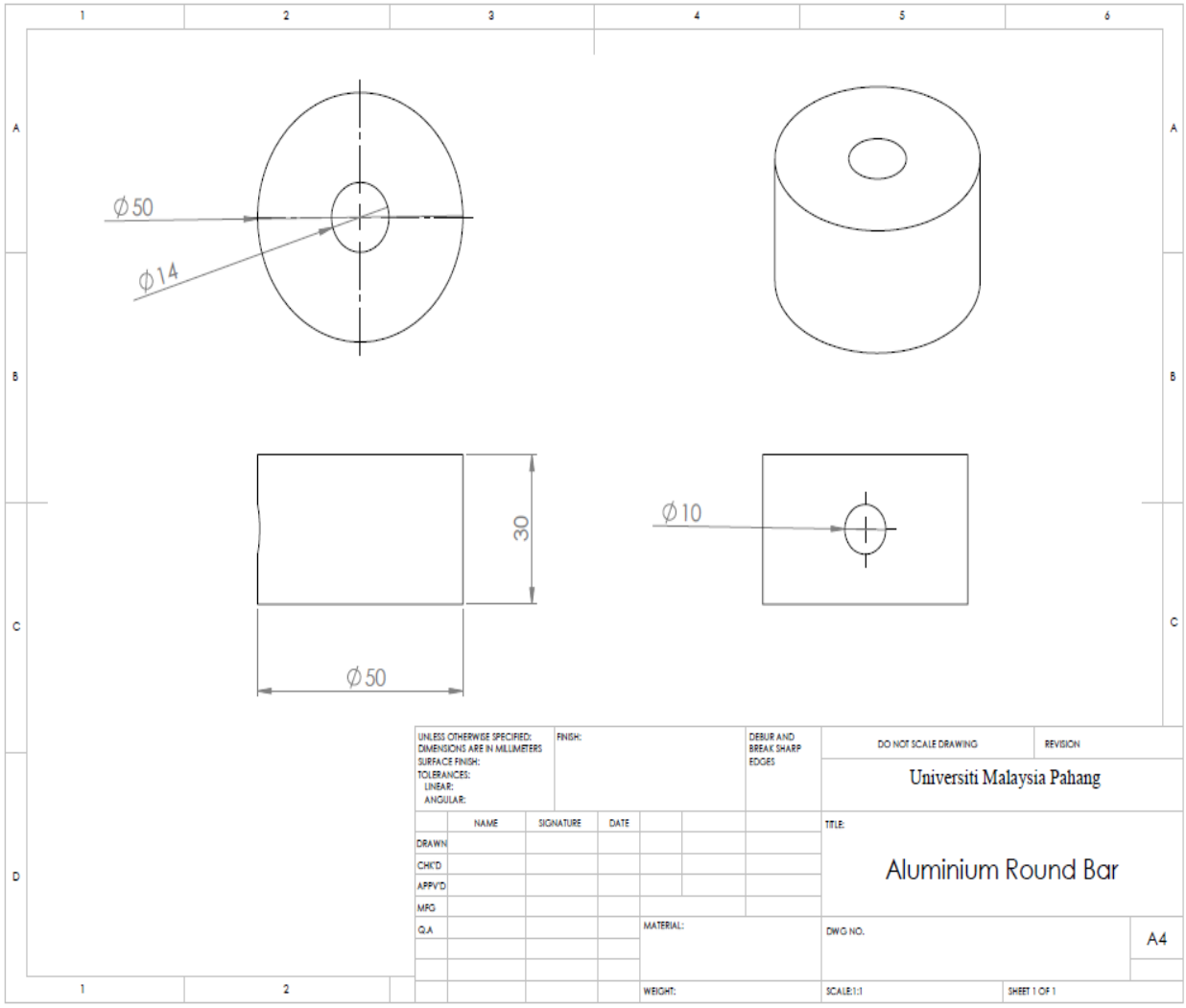
APPENDIX B

Design Concept D in Solidwork



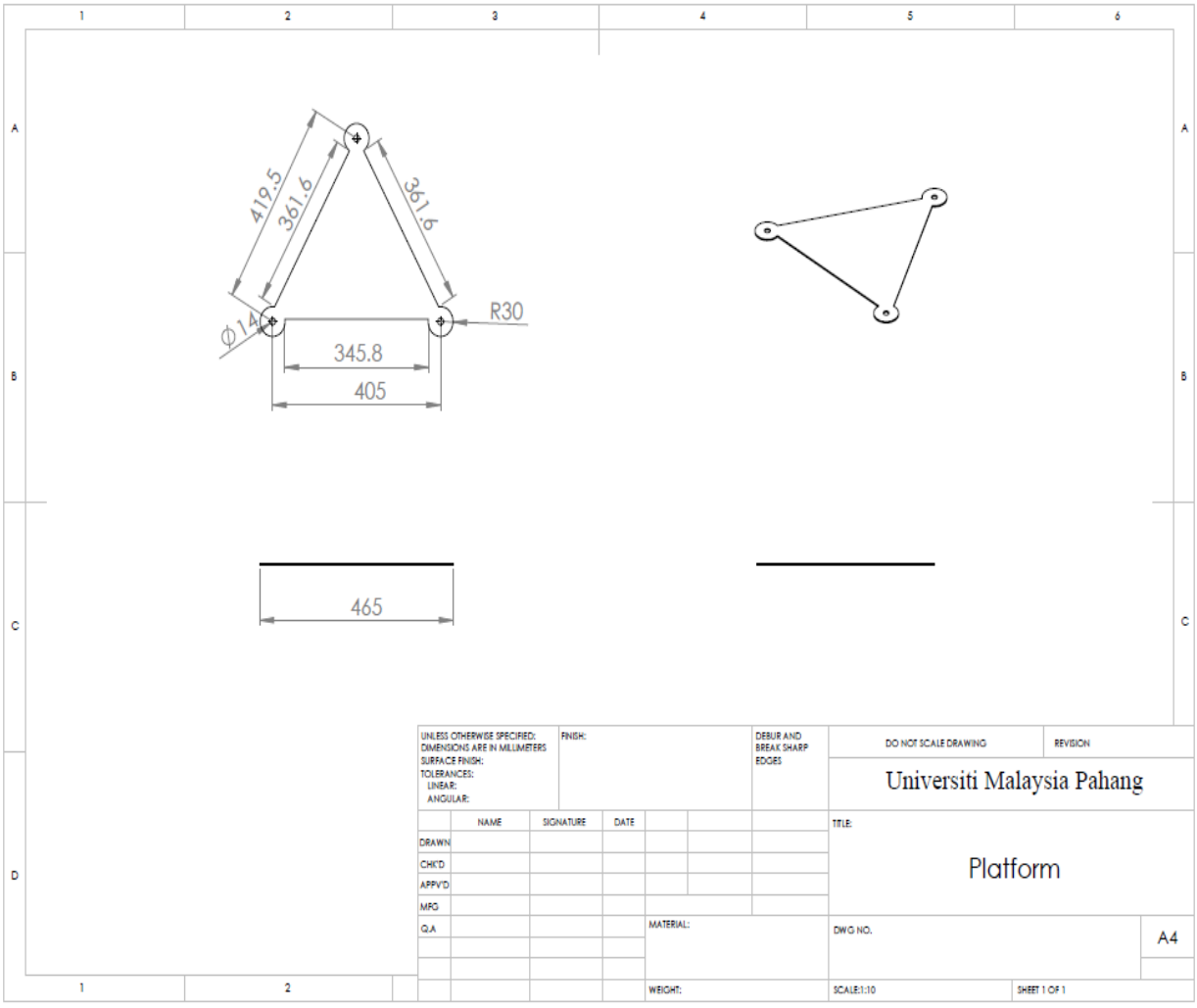
APPENDIX C

Design Aluminium Round Bar in Solidwork



APPENDIX D

Design Platform in Solidwork



APPENDIX E

Price of Materials

NO	QUANTITY	MATERIAL	PRICE (RM)
1.	2 set (4 wheels)	Rollerblade wheels	48.00
2.	1	RC circuit	80.00
3.	1	Silver Spray	15.00
4.	1	DC Motor	60.00
		TOTAL	**RM 203.00**