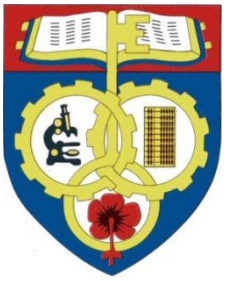

Tunku Abdul Rahman University College

BACS2173
Graphics Programming

Robot Prototype

Programme : RSF2S2G1

Tutorial Group : Group 1

Date Submitted to Tutor : 14th April 2022

: Ms. Chai Foong Theng

Team Members:

No	Student Name	Student ID	Contribution (%)	Signature
1.	Hii Puong Hou	19WMR12034	33.3	
2.	Tang Hang Rong	20WMR11779	33.3	
3.	Desmond Lim Chiang Shen	20WMR12176	33.3	
		Total	**100**	

No.	Team Member	Task(s) Allocated
1.	Hii Puong Hou	-Shoulder and hand -Skybox -Animation -Weapon -Projection -Interaction Key
2.	Tang Hang Rong	-Leg and feet -Animation -Weapon -Texture -Interaction Key
3.	Desmond Lim Chiang Shen	-Head and Body -Animation -Weapon -Lighting -Interaction Key

Declaration

We confirm that we have read and shall comply with all the terms and conditions of TAR University College's plagiarism policy.

We declare that this assignment is free from all forms of plagiarism and for all intents and purposes is my own properly derived work.

Signature :			
Name :	Hii Puong Hou	Tang Hang Rong	Desmond Lim Chiang Shen
Date :	13/04/2022	13/04/2022	13/04/2022

Assessment Rubrics

No	Student Name	Programme and Year of Study	Tutorial Group	Total Mark
1	Hii Puong Hou	RSF2S2	G1	
2	Tang Hang Rong	RSF2S2	G1	
3	Desmond Lim Chiang Shen	RSF2S2	G1	

CLO3: Create a 3D interactive graphics application using an appropriate graphics API in a team. (A4, PLO4).					
Criteria	**Marks**	**Very Poor**	**Rating Very Poor to Excellent**	**Excellent**	**Comment**
Teamwork & Completeness	10	Fail to work in a team and fail to integrate the application. Final model is incomplete and lots of bugs.	1 2 3 4 5 6 7 8 9 10	Able to work in a team to product a complete application. Final model is fully work and less bugs. Overall is well prepared.	
Techniques Applied	10	No technique applied.	1 2 3 4 5 6 7 8 9 10	Complete techniques applied include texture and lighting.	
Interactive Features	10	Model has no or limited interactive feature.	1 2 3 4 5 6 7 8 9 10	Model is very flexible. All parts are moving freely.	
Viewport/ Projection	10	Only one default projection with no transformations.	1 2 3 4 5 6 7 8 9 10	Complete viewport with orthographic and perspective projections. Fully transformations for both views.	
Animations	10	No animation or only one animation with very simple movement.	1 2 3 4 5 6 7 8 9 10	Good animation and complicated movement.	
Model Design	10	Simple design with only using quadric.	1 2 3 4 5 6 7 8 9 10	Complicated design with variety of geometric primitives.	

Complexity/ Primitive Count	10	Simple model with less than 200 polygon count.	1 2 3 4 5 6 7 8 9 10	Complex model with more than 500 polygon count.	
Specific Features	10	Model has no specific features /customization and without weapon.	1 2 3 4 5 6 7 8 9 10	Model has a lot of specific features/customizations and weapons.	
Documentation	10	Incomplete documentation.	1 2 3 4 5 6 7 8 9 10	Complete document with detail information	
Personal appraisal / Presentation **(Individual)**	10	Simple personal appraisal and poor presentation skill which unable to demonstrate the model clearly.	1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10	Detail personal appraisal and good presentation skill which able to demonstrate the model clearly with complete explanation.	
				Total [100]	

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1.0 Introduction

In this assignment, the director of the “Pacific Rim Uprising” movie decided to have some giant robot for the upcoming sequel. He wishes to see the new design robot with some interactive features and some basic customization options. Therefore, we had designed our rebot by referring to a video game named “Apex Legend” which is a first-person shooter (FPS) game . The robot from Apex Legend which inspired us is the character named “Revenant”. We had modified the design from character and builded in our project. The robot was named a first-person shooter (FPS) robot. The robot has two hands which can hold any kind of weapon such as a laser gun, sword, pistol and shield. We customize the colour of the robot’s body which consists of black , yellow and orange.

Besides referring to the first-person shooter (FPS) robot that we have chosen, we have also done some modification on the robot. As mentioned earlier, there are interactive features included in our robot which are walking, running, shaking head and making various posts. As for our robot’s attack interactive, it includes 3 different attacks which are sword swinging styles, shooting and shielding. There are also some combinations of interactive features such as using a sword, laser gun and shield at the same time and using shield and sword at the same time. Defensive interaction such as deflecting bullets is also included. Furthermore, the FPS robot also includes light source transformation such as moving the light source left, right, forward and backward.

2.0 System Specification

To develop the robot, we used some tools which we learned from our tutor. The first tool is Microsoft Visual Studio 2019. Microsoft Visual Studio 2019 is an integrated development environment from Microsoft. The software is allowed to add, edit and delete our code during development. Furthermore, it also allows us to code our designed robot and weapon in 2D and 3D models.

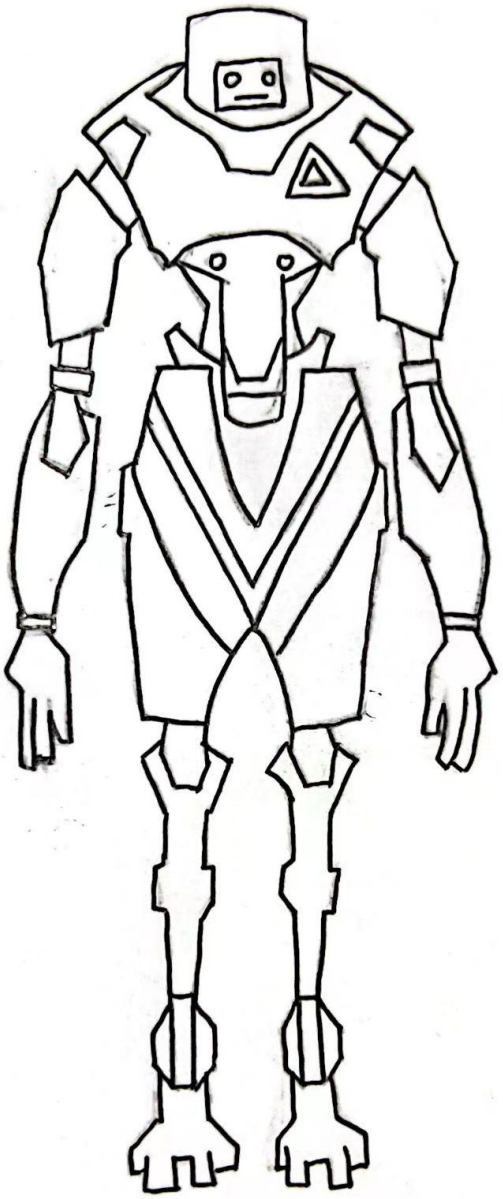
The second tool is OpenGL. OpenGL is a cross-language, cross-platform application programming interface for rendering 2D and 3D vector graphics. The API is typically used to interact with a graphics processing unit, to achieve hardware-accelerated rendering.WIth OpenGL API library, we are allowed to code 3D models with Cylinder, Cube, Sphere and Quads. Furthermore, the texture and lighting also can be applied on our robot by using OpenGL API in order to enhance the visual delight of the robot. Not only this, to render the polygon, we had applied the GLU library from Microsoft Visual Studio 2019 into our robot.

The third tool that we've used to assist to capture and locate all the precious coordinates of all geometry objects is by using GeoGeBra.org. It is a free source calculator that we used to plan out all the coordinates before we implement it with other tools. It is also crucial to us to obtain the coordinates after an interaction event.

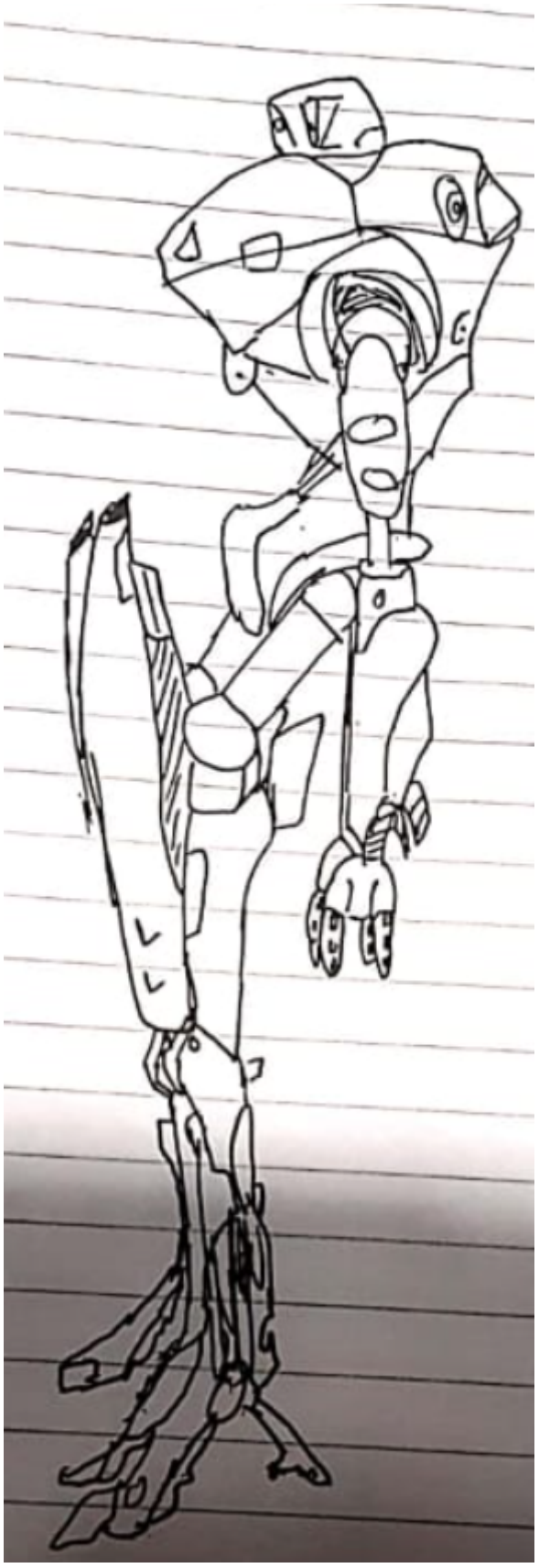
The fourth tool is GitHub. GitHub is a repository of source code and allows us to track changes to code versions. After doing the above work, we will use paint to convert a PNG texture to a BMP texture image, because the color of the BMP texture image will be closer to the real color so it is more suitable for texturing our robot.

3.0 Design Concept

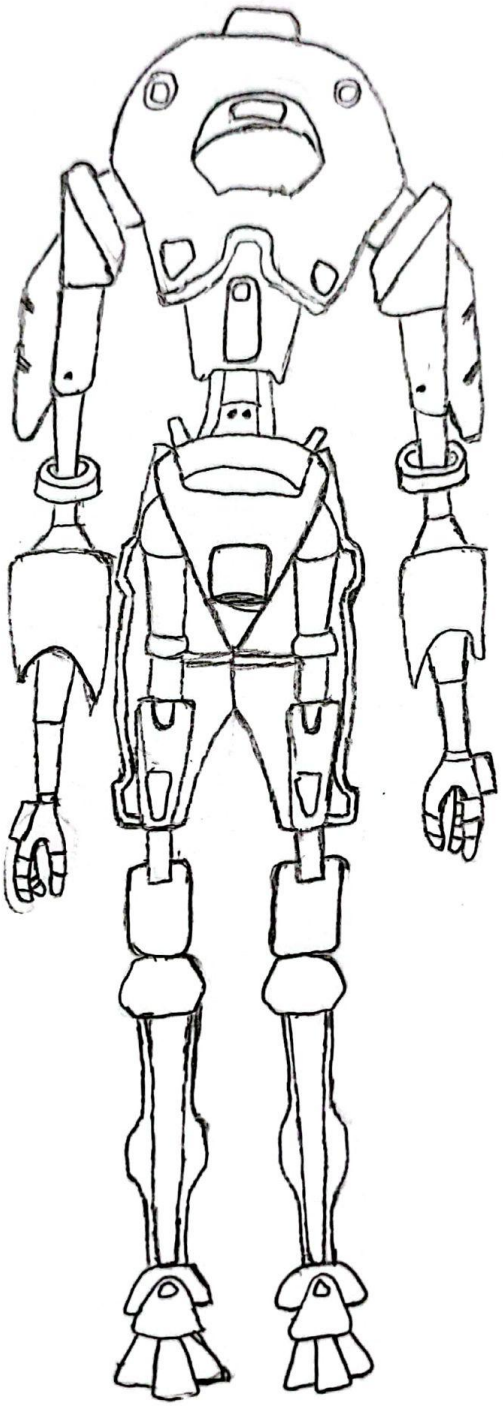
3.1 Front View



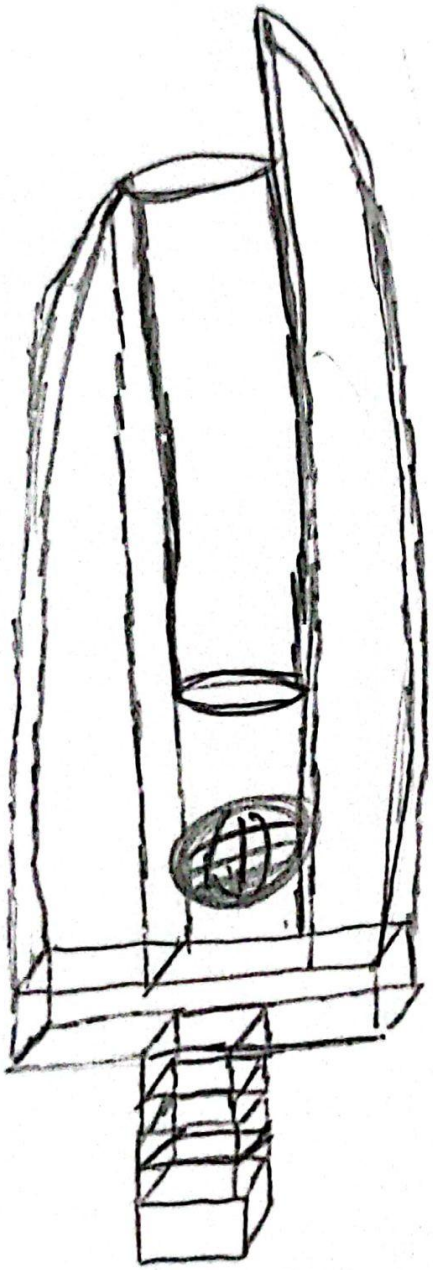
3.2 Side View



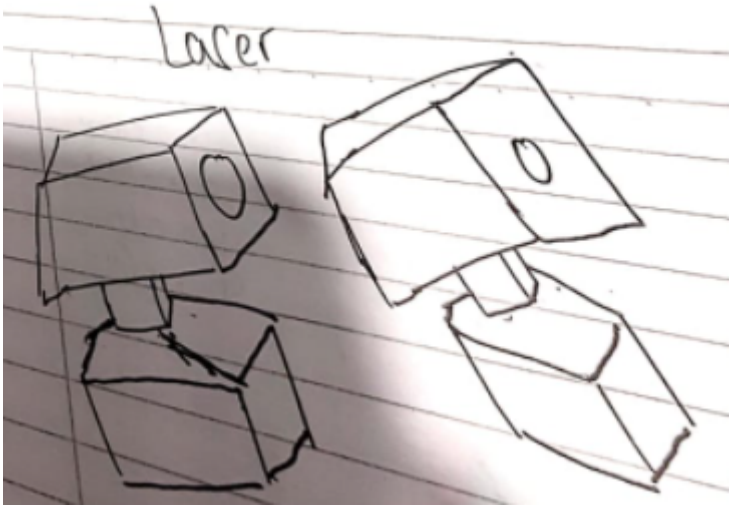
3.3 BackView



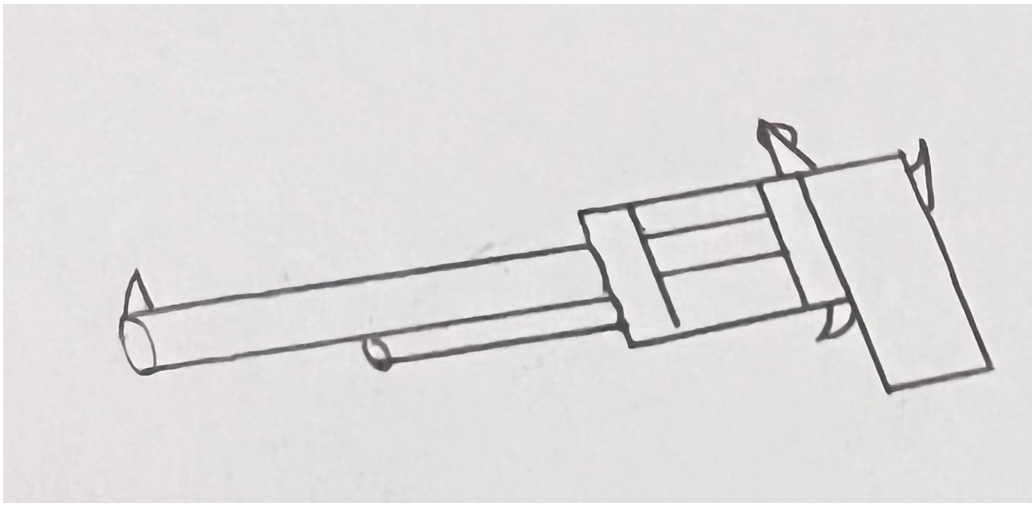
3.4 Weapon (Sword)



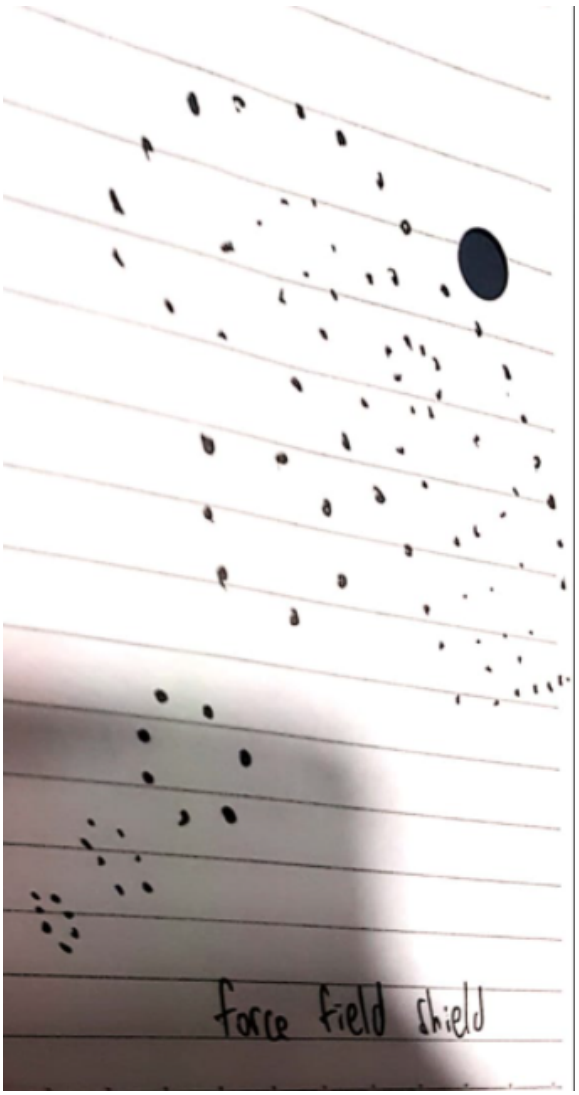
3.5 Weapon (Laser Gun)



3.6 Weapon (Pistol Gun)



3.7 Weapon (Shield)



4.0 Polygon Counts

Polygon Count	Quads	Sphere	Cylinder	Cone	Triangle	Lines	**Total**
Head	54	4	2	-	-	-	60
Body	43	-	3	-	4	-	50
Left Arm	72	3	6	-	4	15	100
Right Arm	72	3	6	-	4	15	100
Left Leg	87	5	6	2	6	-	106
Right Leg	87	5	6	2	6	-	106
Sword	66	1	1	-	4	-	72
Pistol Gun	48	1	2	-	8	-	59
Laser	60	-	-	8	-	-	68
Shield	-	-	-	4	-	-	4
Total	589	22	32	16	36	30	**725**

5.0 User Manual

Sections		Action	Key
Head		Look Up	Z
		Look Down	X
		Look Left	C
		Look Right	V
Body		Turn Body Left	B
		Turn Body Right	N
Arms	Left Arm	Lift Left Arm Up	Q
		Lower Left Arm Down	A
	Left Lower Arm	Lift Left Lower Arm Up	W
		Lower Left Lower Arm Down	S
	Right Arm	Lift Right Arm Up	E
		Lower Right Arm Down	D
	Right Lower Arm	Lift Right Lower Arm Up	R
		Lower Right Lower Arm Down	F
Legs	Left Leg	Lift Left Leg Up	T
		Lower Left Leg Down	G
	Left Lower Leg	Lift Left Lower Leg Up	Y
		Lower Left Lower Leg Down	H
	Right Leg	Lift Right Leg Up	U
		Lower Right Leg Down	J
	Right Lower Leg	Lift Right Lower Leg Up	I
		Lower Right Lower Leg Down	K
		Equip Sword	F1

Weapons (Display Only)	Equip Laser	F2
	Equip Pistol Gun	F3
	Shield	F4
Animation	Nod Head (Hold Key)	Number 1
	Shake Head (Hold Key)	Number 2
	Walk	Number 3
	Run	Number 4
	Swing Sword	Number 5
	Use Shield	Number 6
	Shoot Laser	Number 7
	Reload Laser	Number 8
Rotation	Rotate Robot Left	F5
	Rotate Robot Right	F6
Projection	Orthographic Projection	O
	Perspective Projection	P
Camera	Look Up	Up Key
	Look Down	Down Key
	Look Left	Left Key
	Look Right	Right Key
	Look closer	Page Up
	Look Further	Page Down
Texture	Change Robot Texture	F7
	Reset Robot Texture	F8
Lighting	Open/Close Lighting	SPACE
	Change Lighting Type	F9
	Move left	M
	Move right	,
	Move forward	.

	Move backward	/
Reset Weapon		Number 0
Reset Whole Setting		L
Reset Whole Animation Setting		Number 9

6.0 Personal Appraisal

6.1 Peer Assessment Statement (Hii Puong Hou)

6.1.1 Learning outcome

Throughout this 14 weeks of long semester course, BACS2173 Graphic Programming, I have definitely learnt a lot and developed a lot of interest in this specific course. I found out that the assignment of this course is very interesting, which is developing an Interactive robot model. In order to be able to fully understand all the knowledge required, I have attended all of the classes including lecturer, practical and tutorial class.

Chapter 1 and chapter 2 gives a brief overview of what this course is about and the fundamental and theories behind graphic programming. It allows me to get familiar with OpenGl libraries and Microsoft Visio Studio 2019. Chapter 3 is a crucial and important to me as I have learned most of the different types of geometric primitives including unfilled geometric object such as lines, lines strip, line loop, points, and filled geometric object such as quads, quads strip, quads loop, triangle, polygons and many more. At this stage I'll be able to plan the assignment robot model together with my assignment group mate after learning how to plot the coordinates of the geometry using "glVertex2f" for 2d geometric objects and glVertex3f for 3d geometric objects in week 3 and 4 of the semester. Chapter 4 and 5 both are also important chapters as I have learnt to perform transformations to the geometric object such as translation, rotation and scaling. With the combination of all transformations using push and pop matrix, I am able to create complex animation on the assignment robot model by week 7 and 8.

In order to make the environment and the geometric object look more realistic, I have spent extra time on learning on projection, lighting and texture which enable me to change the projection view, apply different lighting effects and map different textures to the entire object. For example, I am able to switch the projection view from orthographic view to perspective view and vice versa without affecting the primitive object itself. The mapping of the texture to the object requires pinning the coordinates using glTexCoord2d.

With all that I have learned from this course, I am able to complete my assignment on time by applying everything that I have learned.

6.1.2 Problem face and solution

Throughout this course, there are definitely a lot of difficulties and challenges that I have faced. Of course with strong determination to solve the problem, I have managed to come up with a solution. The first challenge that I have encountered is when completing the practical 4 questions where it requires us to create two rectangles that represent upper and lower limbs which are able to perform rotation. At first, I used only one rotating variable for both rectangles to rotate the x and y axis with only the second cube rotating the z axis. However, I found out that it's not gonna work with only one rotating variable. Fortunately, I am able to quickly figure out how to use two different rotating variables, each one for each rectangle. And together with glPushMatrix and glPopMatric, finally I'm able to achieve the practical question requirement of rotating both rectangles on the x and y axis with only the second rectangle rotating on the z axis.

Besides that during assignment, my biggest challenge that I have faced is definitely when dealing with both orthographic view and perspective view. Af first when I've

implemented the perspective code, and by the time when I switch from orthogonal view to perspective, the constructed robot model looks distorted. I panicked for a while and after countless hours of debugging together with 2 of my assignment group team mates, we found out that the value of fovy and both near and far value was wrong. After fixing it, the robot itself finally looks like how it shall be. Million thanks goes to both of my 2 group mates to solve this problem together as a team.

Another difficulty that I have faced was when I am setting up for the camera such that it can perform transformations including translation and rotation. When rotating the camera, everything inside the view which includes the robot model and skybox was greatly affected. Everything will look distorted when performing rotation on camera along y axis and this has been going on for 2 days. Until I had almost given up, I managed to solve this problem. I tried to add in another function which called the projection method and added a glLoadIdentity in it. As a result, everything looks normal when rotating along the y-axis and I'm glad that I am determined enough to solve the problem.

Last but not least, another difficulty that I have encountered is when creating the animation of the robot model. Initially everything goes as smooth as better until when I've decided to automate every single animation with each of their assigned keys. After I have pressed on any key to perform an animation, The animation can't be reset by pressing the reset key as it shall be. After hours and hours of configuring and adjusting the reset code, I found out that, everytime after the reset key is pressed, another redundant code in the void display function will keep it running the animation non stop. This problem finally is solved after removing and replacing the code.

6.1.3 Future enhancement

After the completion of this course of BACS2173, I definitely have not only enjoyed myself along the learning experience, I found that I have also developed a very high interest in graphic programming. I have also had a lot of fun when creating the robot model during the assignment together with 2 of my beloved team mates. That said, in my upcoming schedule in the future I would definitely attend some other classes that are related to graphic design and programming in order to further enhance my graphic programming skills and knowledge.

Besides that, by any chance after my degree course, in the future I would definitely look out for more courses and workshops that are related to graphic programming courses if I have available time slots. I would also definitely recommend this course related to graphic programming to all my friends and relatives who are also interested in it in the future.

6.2 Peer Assessment Statement (Tang Hang Rong)

6.2.1 Learning outcome

For the BAC2173 Graphic Programming Assignment. I have learnt a lot of programming and theoretical skills from lectures, tutorials and practical classes. This subject is very interesting. I had applied all the skills I had leant in developing a robot model for the assignment.

From this assignment, I have learnt how to build a robot model from nothing to a robot model by using OpenGL API with Microsoft Visual Studio 2019 software. Furthermore, There are some types of geometric primitives I have learned from this subject. It consists of quads, sphere, cylinder, cone, triangle, lines and more. I applied the primitives by using the “glVertex2f” and “glVertex3f” commands in order to build a 2D model and also applied them on my robot model in 3D. In addition, I learned about the transformation for geometric primitives. It consists of “glRotatef”, “glScalef” and “glTranslatef”. By using these transformations, by using the “glRotatef” command, I can rotate the object to the direction and angle I want. Then, by using the “glScalef " command, I can resize the object to the size I want while using “glTranslatef” I can translate the object to left, right, up, down, front and back. The next command will be “glPushMatrix", “glPopMatrix” and “glLoadIdentity” which is very important for me to reset a matrix and separate the code. For “glPushMatrix” and “glPopMatrix” is used the most in the assignment because it enables the function code to be independent.

Furthermore, I had used the “glTranslatef” and “glRotatef” to perform the animation for the robot model. This is because it allows the polygon to be animated. In order to use these functions, we have to add the interactions with the robot model. Then I applied the texture and lighting I learned from the class to enhance the appearance of our robot model while using lighting to light the robot up. Lastly, I learned about the proper way to apply the orthographic and perspective view. It allows the robot to be viewed from a different angle of view and the most important is to let the user view our robot in detail.

6.2.2 Problem face and solution

At the beginning of this semester, I had no clue about where to start the assignment. I had a lot of issues with coding the polygon at the correct coordinates. But after some practical classes, I learned how to code the object from the tutor and was able to solve my personal problem after the tutor explained it. Furthermore, the next problem will be the way to translate and rotate the object. This is because I always rotate and translate the object to the wrong direction from the wrong origin. Thanks to Ms. Chai for always explaining the details clearly and recording class every time. Therefore, I can rewatch the recording from the Google calendar to solve my problem.

The other problem I faced in this assignment is to make the robot model to animate. This is because animation will require the logic of how to rotate and translate the object. For example, when we applied the animation for the robot model to run, the leg of the robot would always rotate with a 360 degree angle and make it seem illogical. After searching and understanding the lecture note which was provided by Ms. Chai, I am able to understand the logic of making the robot animate by using the “glTranslatef” and “glRotatef” commands. Lastly, the problem I faced is applying the photo to the texture and also the background of the

robot model. Firstly, I am having trouble finding a website which provides the correct resolution, size and type of photo. After that, Ms. Chai had suggested a recommended website for our class to get the photo we want and also guide us the way to apply the texture in detail.

6.2.3 Future enhancement

From this the Graphic Programming assignment. I had learned a lot of programming logic and also having fun after successfully developing my own robot model with animation. I would be interested in enhancing my programming skills in Graphic Programming because I like to design and develop my own creative thing and make it look realistic.

In future, I would like to enhance my programming knowledge by attending workshops and any programme which is similar to Graphic Programming. Furthermore, I will be searching for more information about the programming language and skills about Graphic Programming during sembreak after this semester.

Lastly, I would like to take an extra course similar to Graphic Programming in order to learn more about it.

6.3 Peer Assessment Statement (Desmond Lim Chiang Shen)

6.3.1 Learning outcome

In this course, I learned a lot of programming and theoretical skills from lectures, tutorials, and practical class During my first 2 weeks, I learned Chapters 1 and 2 which give a brief overview of the content of this course and the fundamentals and theory behind graphics programming. When I got to Chapter 3, it was very new to me, because I just learned that Microsoft Visio Studio 2019 can add OpenGL for 2D geometric and 3D geometric . Learn how to program points, lines, quads, triangles and polygons from this practical class. And can carry out a certain creative design, which makes me feel very useful. While studying Chapter 4, I was interested in being able to transform geometric objects, such as translate, rotate, and scale. In Chapter 5, I learned to use the combined push and pop matrix. For example, when I convert geometric objects in push, the geometric objects in push matrix will be converted accordingly. Over the course of the following few weeks, I learned more programming and theoretical skills such as projecting, lighting and texturing geometric objects. The programming and knowledge I learned from the above has been very helpful in my assignment robot model and helped me to complete the robot model I think is quite complete.

In this robot model, I used a lot of glVertex3f to construct the main parts of my head and body, and added some three-dimensional shapes such as cylinders and pyramids to decorate it. Because I personally like the cute details of the robot under the fierce shape, I did some animations for the head such as nodding and shaking his head, which made my robot look very happy. And I chose a launcher for the robot that will emit laser balls, and added it on the robot's shoulders, so that the robot can launch laser balls anytime, anywhere. When the robot is not using the weapon, the weapon will be attached to the back of the robot. When we choose to use the weapon, the weapon will stand on the shoulder for a moment to launch, but we need to add bullets to launch. I also added a lighting effect to this model, which will turn off the lighting of all objects in our model when I press SPACE, and I also added an option to switch the lighting color, and my teammates also added it to the robot Many designs that I find very ingenious and are happy to share with me so I can learn.

6.3.2 Problem face and solution

At the beginning, I encountered a lot of problems, which was a challenge and learning opportunity for me. The first problem I encountered was the windmill assignment of the practical class. The teacher asked us to accelerate and transform the windmill, and add 2 additional functions. When I started this assignment, I didn't know how to use rotate to make my windmill blades rotate. So I went to review the recording and did some experiments with rotation. It is found that the direction of rotation is to rotate according to the origin, which means that when I draw geometric objects, I try to design in the direction of rotation that I want. For example, the blades of a windmill, I designed 4 pieces, so I only need to extend up, down, left, and right in the x, y axis (0, 0) to achieve the effect of rotation in the middle, assuming we Use translate to translate, and the origin will not change.

Other than that, the biggest challenge for me was the robot model for the assignment. Because we need to create a humanoid robot model and need to have 2 animations. So when I have the biggest challenges of this kind, I'm more willing to go online for inspiration and research how the robot should move and so on. After completing a certain robot appearance, I found that the most difficult thing is that the size of the robot is different between teammates, so it is necessary to use rotate, translate, scale and other operations to make subtle adjustments. This process is not difficult but requires patience to find out whether each side is aligned with the x-axis, y-axis and z-axis. Because I am now transforming geometric objects, I have accumulated a certain amount of experience. After completing the combine, I faced another problem that the buttons are too mixed, so when we add new functions, we need to check whether the button has been used one by one. Therefore, my suggestion is to clearly plan the use range of the buttons when starting to place the buttons. For example, the moving buttons of the head are planned in Z, X, C, V, etc., so that they will not be found when you want to use them. After I completed the above challenge, I came across the challenge regarding animation. At the beginning we set if else in wParam but the effect is not good, we need to keep pressing the button action to be able to continue. But then I thought and discussed with my teammates and found that I only need to add to the display part to open an if else and let it loop, which solves the problem of needing to keep pressing to have animation.

6.3.3 Future enhancement

After completing this course, I am very happy and enjoy learning programming, no longer afraid of programming but to study harder. I work hard to program better work than before, and I also hope to bring this programming skill to my future workplace. If there are more opportunities to learn more programming skills in the future, I will participate and work hard to bring programming skills and knowledge to my important skills. Because my goal is to develop into video games, programming is very important to me so I hope I can continue to improve on programming. To contribute to the future society, I will also try to join a world-renowned software company to learn more internships after the opportunity.