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"Identification and evaluation of alternatives to Unity which are not under U.S. Sanction lists" Untertitel der Arbeit

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Declaration of Authorship

I, Nipun Sharma, hereby certify that WPM-Projekt titled "Identification and evaluation of alternatives to Unity which are not under U.S. Sanction lists" and included practices are my original work except where otherwise indicated. I am aware of the University's regulations concerning plagiarism, including those regulations concerning disciplinary actions that may result for plagiarism. Any use of the work of any other author, in form, is properly acknowledged at their point of use.

Signed:

Date: 27/082/021

Content

1 Introduction

1.1 Abstract for the project

When it comes to education/learning there should be no restriction on anyone, no matter whatever homeland is. However, this doesn't work in the case if a student from a country in the sanction list of U.S. wants to become an application developer of Unity. A similar situation was seen while students who were interested in opting AR/VR basics course could not do so as Unity is used as environment in the course for developing many applications which could enhance real-life experiences and solve a lot of problems which can be simulated virtually. This major drawback should be resolved by finding an alternative software which has similar output to that of Unity, similar compatibility with hardware, easy to use and especially having no restrictions for a student of any nationality. Although, Unity as platform is having very large community of developers where a tremendous amount of resources can be if found if someone is having any issues with the software. This thing should also be a considerable as for learning new software we need some good amount of resources. If the software is open-source it could a really nice add-on.

1.2 Approach/Methodology

As initial approach, after a lot of research through web a comparison table with all other alternatives available having filtering parameters like simplicity, performance, tutorials available, XR support and much more would be made and after a discussion with the concerned professor, a right alternative would be selected. After this, at the end to check that whether the problem introduced in the beginning was solved or not, a Biomedical teaching sample consisting of an Interactive 3D model and an XR application based upon carboardSDK would be made on different selected alternatives. At last, these developed applications will be tested with the similar application made on Unity, so that it can be decided whether the desired outcome has reached or not.

2 Literature Research

Looking at the past work done on similar experimentation which was at University of Louisiana, U.S.A. January 2015, In this study the instead of comparing gaming platforms, the toolkits available for Unity gaming engine were compared which were getReal3D, MiddleVR and Reality based User Interface System (RUIS) for projecting in immersive environment like Cave Automatic Virtual Environment(CAVE). It was found that the filtering characteristics of the software's were somehow identical. It was stated that the cost has been one of the major factors for popularity of VR, the more things came affordable then more the people started developing applications on it **[1]**.

Other parameters listed below were also considered.

a) User friendliness,
b) menu selection,
c) form filling
d) Object manipulation
e) Support for VR devices

Talking about the second study that was performed at Iowa state University in 1998, here they discussed that as number of VR development environment is increasing what should be the right way to choose it **[2]**. Here they had 3 basic requirement performance, ease of use and flexibility, adding more to this they had many more parameters too. A different thing from the current research that was performed by us was they also counted non-standalone VR development applications like VR juggler etc. At last, they tested each and every application and wrote the report stating how each of them performed in different parameters and they listed out the pros and cons of each software, as a result of there study they selected VR juggler as best out of all platforms that were available in that time.

Furthermore, one more interesting research was performed by Shaun Bangay at Rhodes University, South Africa , 1994 where he compared his own created virtual reality platforms with other that were available in the market. The parameters that were used to compare were like level of support, Object implementation, complexity which were also quite similar to parameters that we used**.[3]**

After our literature research, our experimentation was further proceeded which is finding the current available alternatives

3 Experimentation

3.1 Finding and analysing alternatives

Through a research through internet a lot of gaming engines were found on the various websites. All them are listed below in fig: 1, some more alternatives were found from some presentations of the students of the AR/VR course listed in table 2.

After listing down the name of gaming engine, the filtering parameters were needed to be decided that on what parameters we will compare them to Unity. First looking at the parameters starting from:

a) **XR support**- it is the first basic parameter because the course that is taught to students is based on XR.
b) **Paid/opensource**- it would be a very nice add-on if no license is required, so the department doesn't need to purchase any license.
c) **Pricing**- if we need to use the software then we need to know how expensive it is. If it is very expensive then it marked as red.
d) **Restricted with U.S. sanction list**- it is the most important parameter, that's why this project is started. We use this parameter that indicate that whether that software is having restricted use with U.S. sanction list.
e) **Compatibility (Android/PC/IOS)**- once we develop the application, we need to deploy it different platforms so that we can use the application everywhere. Just like Unity, the software should have support for various major platform.
f) **Simplicity**- If someone is beginner to the AR/VR course. The one of most important things comes that he/she should be able to grasp the software easily, get to know with the functions quickly. Not only the simple interface, one should be able to develop the application in least complex way.
g) **Documentation availability**- In the previous point we talked about the learning, So just like w e buy some goods from market, there is always a documentation available with that "which tells you how to use it"? In similar way the documentation of the software is needed that would help a beginner to understand the software.
h) **Community**- Now there comes a point where go through manual and sometimes you are still not able to solve the problem while developing application. Then, we look towards the community of that particular software. There might experts or professional developers who might answer your questions.
i) **Tutorials/Resources**- Further to improve your learning and development, one needs more tutorial and resources to play around with software. Furthermore, to get to know with all of available functions of the software.
j) **Performance quality**- finally, comes the output quality of the application that is developed. That whether the software produces same quality of graphics as compared to Unity?

3.2 Filtering Parameters

On the basis the above listed parameters the below listed table was made. The colour coding of the is listed below table: **[4] – [16]**

	A	B	C	D	E	F	G	H	I	J	K	L
1	Project AR/VR	SoSe 2021										
2	Name- Nipun Sharma		AR/VR gaming engine comparison Sheet									
3												
4			Filtering Parameters									
5		XR Support	Paid/ opensource	Pricing	Restricted with US sanction list	Android/IOS/PC/ Mac compatibility	Simplicity	Documentation availability	Community	Tutorials/Resources	Performance/ Output quality	Selected alternatives
6	Name of Gaming Engine											
7	Cryengine	yes*(AR not)	opensource	Free	NO(European)	ALL	ok(*complex functions)	yes	yes	yes	high	✔
8	Unigine	yes	opensource	Free	NO (European)	ALL	ok(*complex functions)	yes	yes	yes	high	✔
9	Unreal Engine	yes	opensource	Free	YES	ALL	ok(*less complex)	yes	yes	yes	high	X
10	3ds max	yes	paid	1year free	YES	Win	easy	yes	yes	yes	high	X
11	Blender	yes	opensource	Free	NO	Win,Mac	easy	yes	yes	yes	high	X
12	KeyVr(Keyshot)	Yes (AR not on android)	paid	95$ per system (1995$ for 30 pc)	NO(https://www.keyshot.com/terms/)	Win	easy(less coding) * but not much complex scene	YES	not much	not much	high	X
13	Maya	yes	paid	1year free	YES	MAC,Win	ok	YES	yes	yes	high	X
14	apertusVR	only VR	opensource	Free	NO	no clear information	nothing available	not much	not much	not much	good	X
15	Godot	yes	opensource	Free	$1/do-international-	ALL	easy to use	YES	yes	yes	good	✔
16	Appgamekit	yes	paid	60$(60%off for students)	NO	ALL	not easy(no live view)	YES	yes	not much	low	X
17	Cinema4d	NO	paid	on Request	NO (European)	Win,Mac	easy to use(less coding)	yes	ok	yes	high	X
18	Lumberyard by amazon	yes	opensource	Free	Yes(https://aws.amazon.com/agreement/)	Win,Xbox,PS4	ok(*nothing found for vr)	YES	yes	yes	high	X
19	Wave engine	yes	opensource	Free	NO (European)	ALL	ok	not much	not much	not much	high	X

Fig: 1

Color Coding	
	This color indicates surity 100%
	This color indicates only 50% yes
	This color indicates no
	This color indicates that we cannot proceed with it as it is the main filter

Furthermore, the gaming engines were found but further research was not performed** **[17]-[24]**

Other Engines suggested but not worth it.	**Further research on the engines listed below was not performed as they didn't fullfiled the basic criteria of the requirement. As we need a 3D gaming engine which supports XR
Coronalabs	2D gaming engine
monogame	2D gaming engine
torque 3d	No XR Support
lib gdx	2D gaming engine
jmonkeysalad	2D gaming engine
gamesalad	2D gaming engine
hero engine	No XR support
gamemakerstudio	2D gaming engine

Fig: 2

Then on the basis of table figure:1. The three alternatives with most greens are:

a) Godot
b) CryEngine
c) Unigine

Now as alternatives are selected, we can proceed with making the Biomedical applications.

3.3 Procedure for development of the application

a) Set-up the scene
b) Import the object
c) Set-up the environment
d) Choose the properties of imported object
e) Scale the object
f) Attaching script to the object
g) Developing the Hands that will interact the with object
h) Again, attaching the script to hands
i) Connecting the VR headset, installing the required Add-on
j) And finally running the scene

The procedure may vary from application to application, the steps might be in different order or may be addition of new steps like adding of sound effects, adding of 2-D elements and graphics, importing prefab models from websites like sketchfab or turbosquid. If a user wants a custom model then one can design it in blender and import in the software. Last but not the least, the most important step that has to be mentioned in the beginning for all experimentations is idea generation that will through looking videos from internet and looking at other resources online**.[25]**

4 Elaboration on short-listed alternatives

a) **CryEngine-**
CryEngine is developed by Crytek a German game developer. This software is also open source until someone wants to publish a game developed on it, then there is some royalty fees on revenue from the game. A very popular game
Far Cry was developed in CryEngine.

b) **Unigine-**
Unigine is gaming platform developed by Russian software company called Unigine Corp. it also supports variety of cross platforms like IOS, android, windows and also having a great advantage of being open source. Not only this, this is also a big name in gaming engines.

c) **Godot-**
Godot is open source gaming engine under MIT license which has 2 versions available that are:
Mono: supports C# script for which Visual studio needed to be installed
Stable: supports gd script
As a prerequisite SteamVR needed to be installed.

As a test sample in the beginning a .obj file was made from DICOM file (CT scan) of lung and ribs. This .obj file is used in all the selected gaming engines, so that the comparison becomes easy. Which one appears to be simplest in handling the same file. In addition to this a similar tutorial would be also made on the Unity, so, we have a base to compare with.

5 Application Development

5.1 Unity-

In fig: 3, the layout of Unity can be seen. On the scene 3 objects can be seen that were deduced out of DICOM file. These objects were imported into the scene, physics and the scripts were added to respective objects. Moreover, MRTK from Unity asset store was also added here to let it work with Microsoft HoloLens 2.

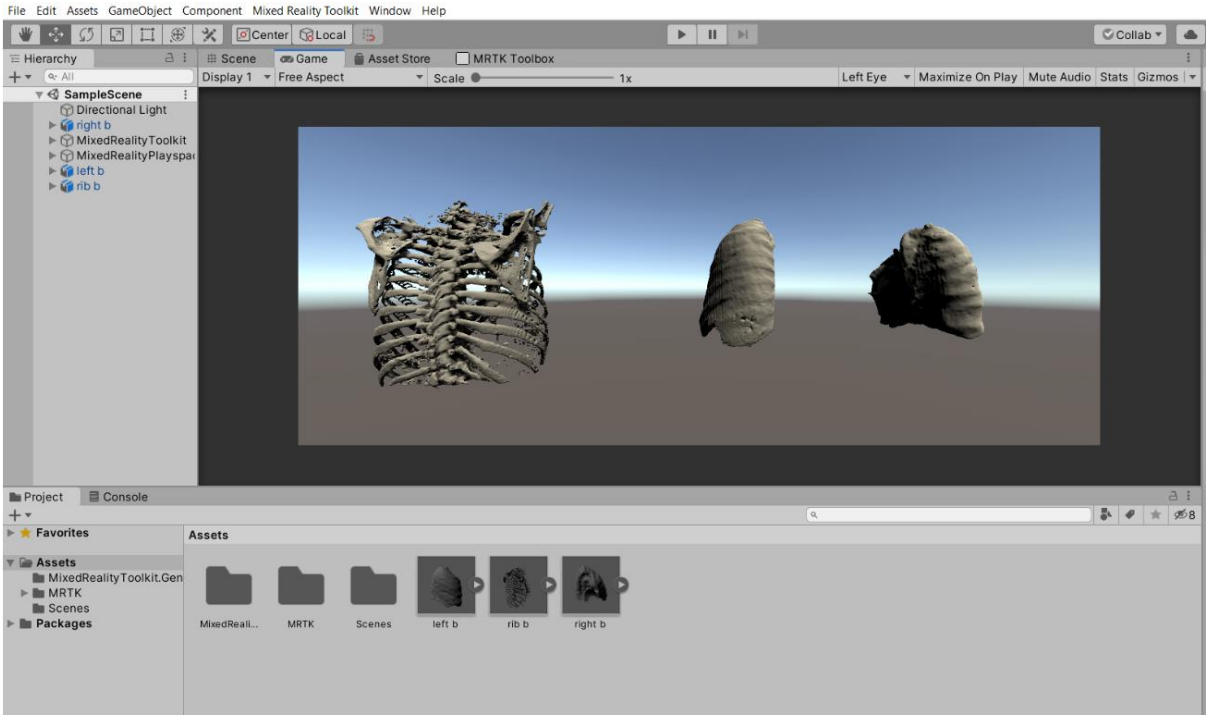

Fig: 3

Once we click on the play button on the top, then we can see the virtual hand that appears on the scene. If we look at the Fig:4 that virtual hand can be seen that pinches with click of the button.

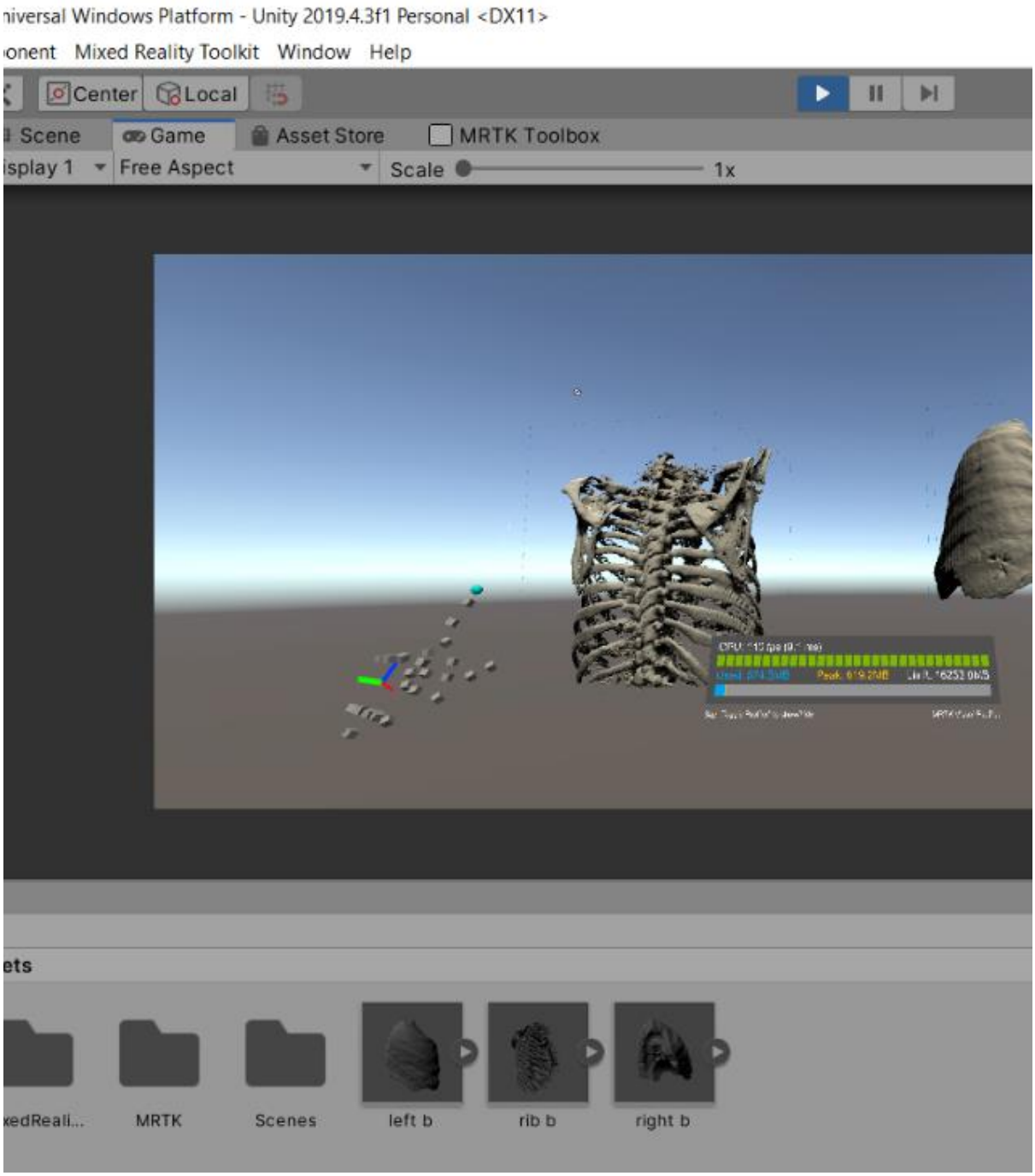

Fig: 4

And here in the Fig: 5 the interaction of the virtual hand with the lungs can be seen where it is resizing the organ. Also panning and tilting could be performed. Overall, it was easy to understand the tutorials from the internet and now considering this experimentation as base we will compare this development of application in other selected alternatives.

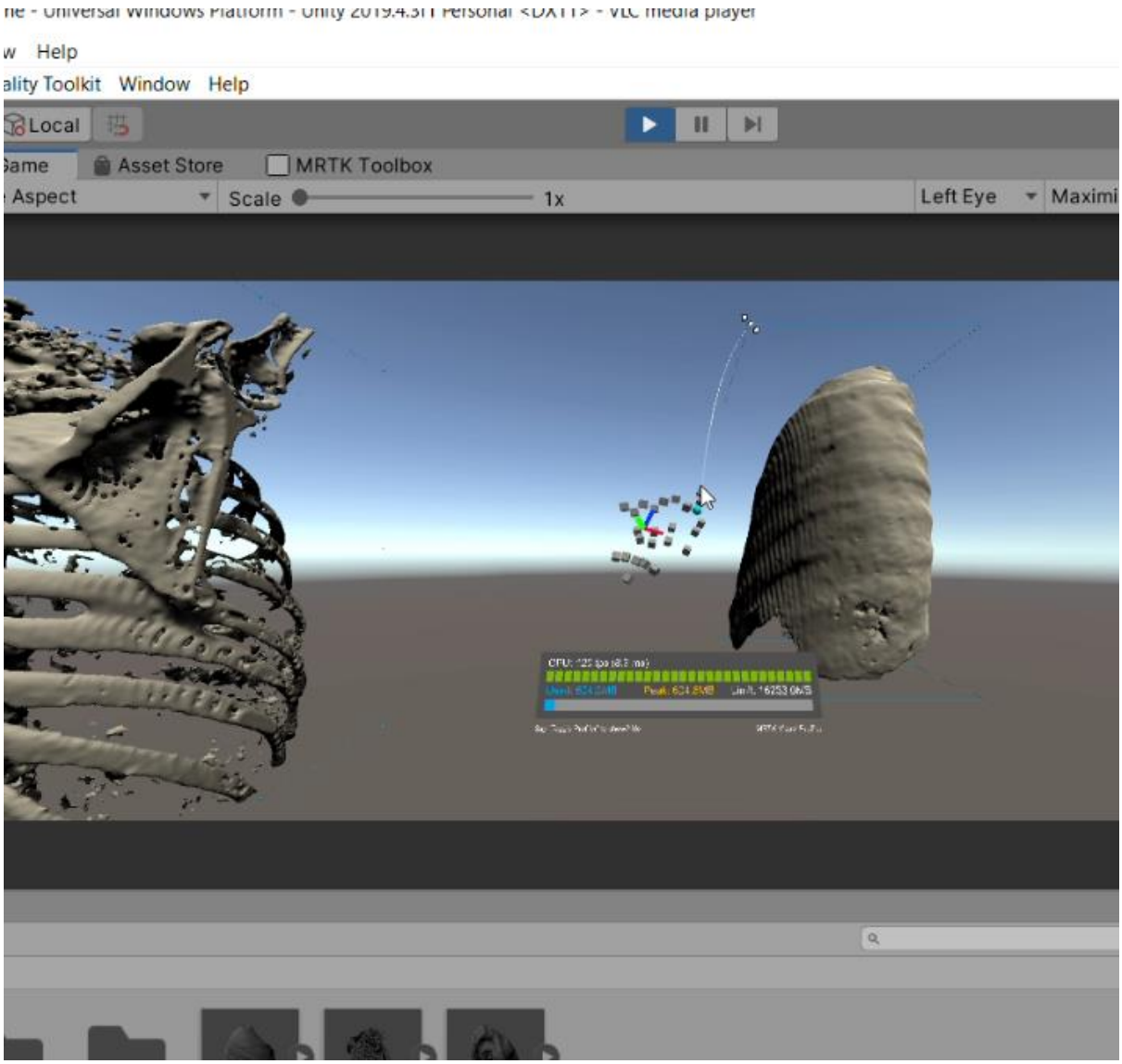

Fig: 5

5.2 Godot

In Fig: 6 the layout of Godot can be seen which quite similar to Unity. Talking about the following the documentation and tutorials was quite easy. In the scene the same organ and ribs can be seen.

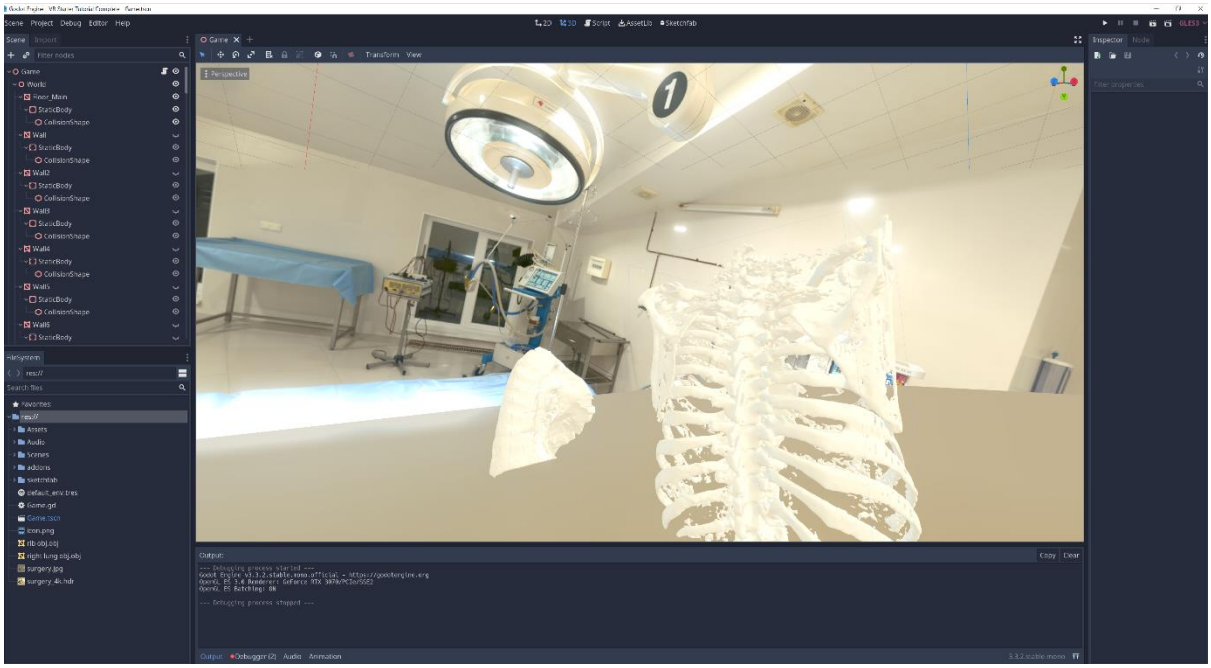

Fig: 6

Fig: 7

Again, when the scene in initiated then virtual hands appear in the screen, the background of the scene which is ICU makes the experience more mesmerising. Which can be seen in fig: 7.

Talking about the interaction, below in Fig: 8. It can be seen that ribs are being moved around in the environment and same in done with lung. All in all, it was easy to grasp.

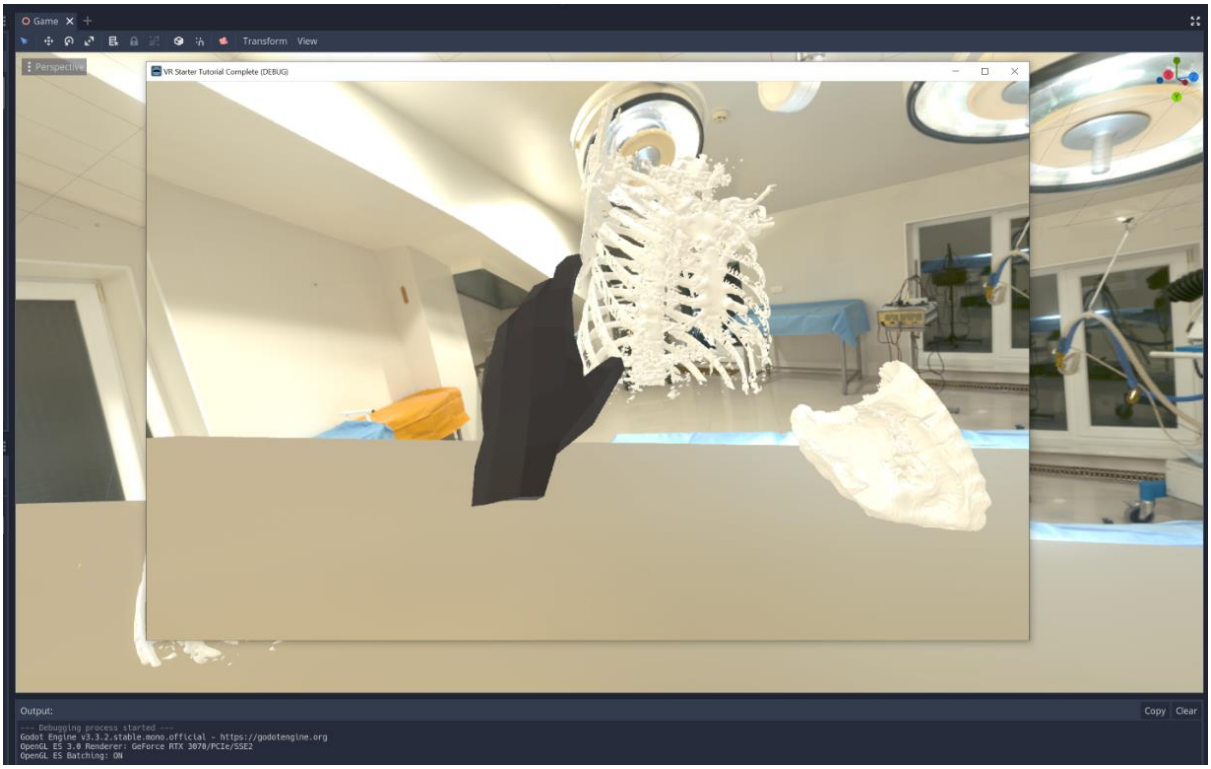

Fig: 8

5.3 CryEngine

Talking about CryEngine, the predicted level of application was not achieved because the tutorials of the software were outdated. The version of current software had a different UI, where many of the function buttons were misplaced as compared to tutorials. Coming to forums, there was less content related to VR as compared to general discussion and similar things were seen in the documentation. So, looking at the UI first in Fig: 9 seems to be a bit complicated.

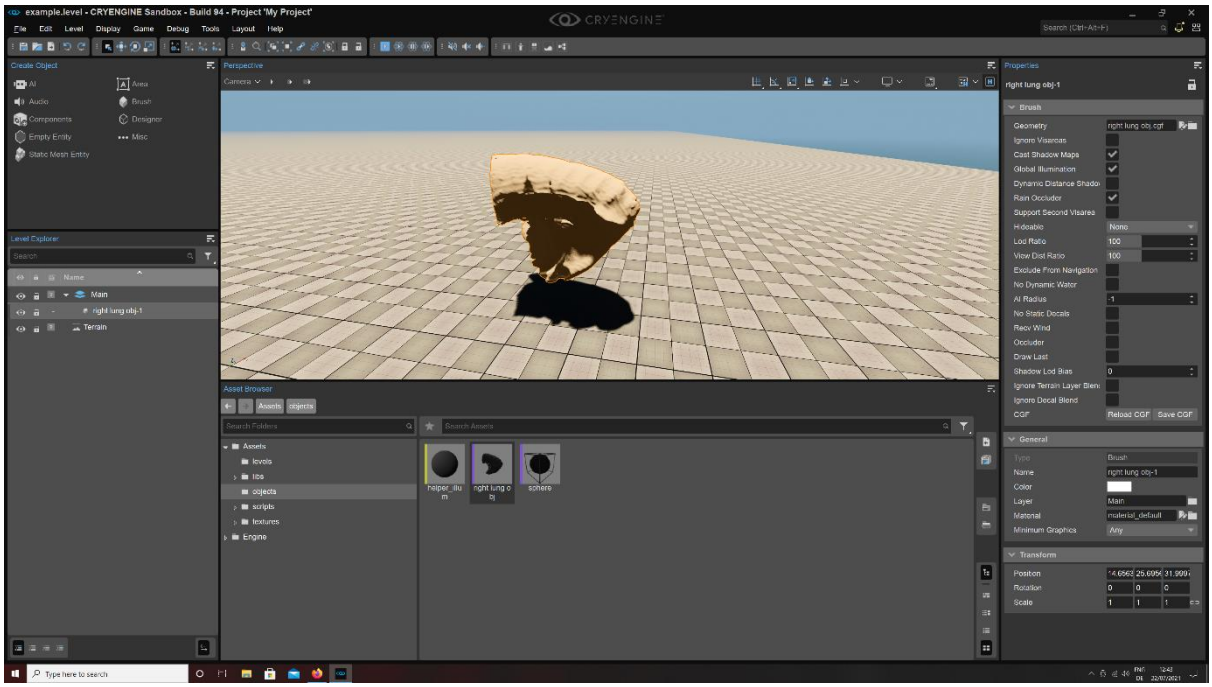

Fig: 9

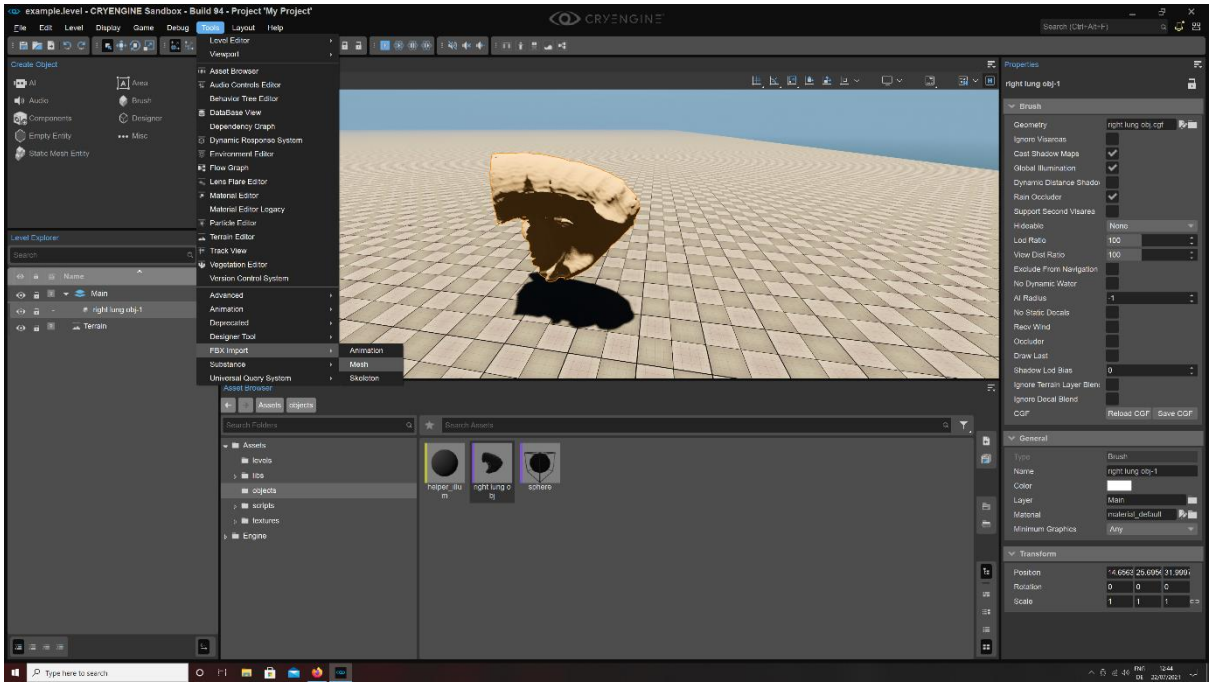

Fig: 10

By looking at fig:10 one can get the idea of importing the .obj file. A pop up screen appears where we have to select the target location of the file and then we can change some properties like scale, orientation, texture. After this nothing was achieved because no content related to AR/VR was found.

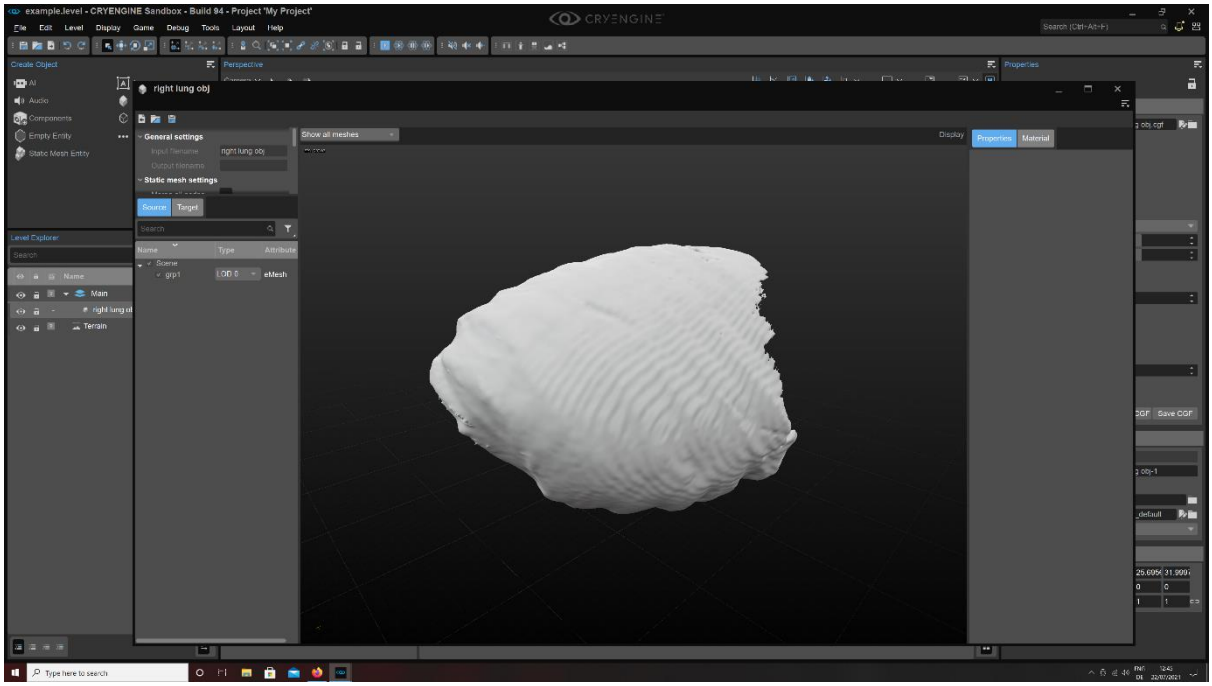

Fig: 11

5.4 Unigine

Results of Unigine were quite similar to CryEngine because the same issue was observed with both of them, complicated UI, less resources for development of AR/VR application. Also, there was problem with attaching the scripts to the objects. As a beginner, to understand the application was quite difficult. Also, I tried to attach to object of pre-made scene but it was not working. Not only this, it supports HTC Vive and Oculus Rift but there are problems for WMR. There were also a lot of bugs in software. The imported object can be seen in Fig:12.

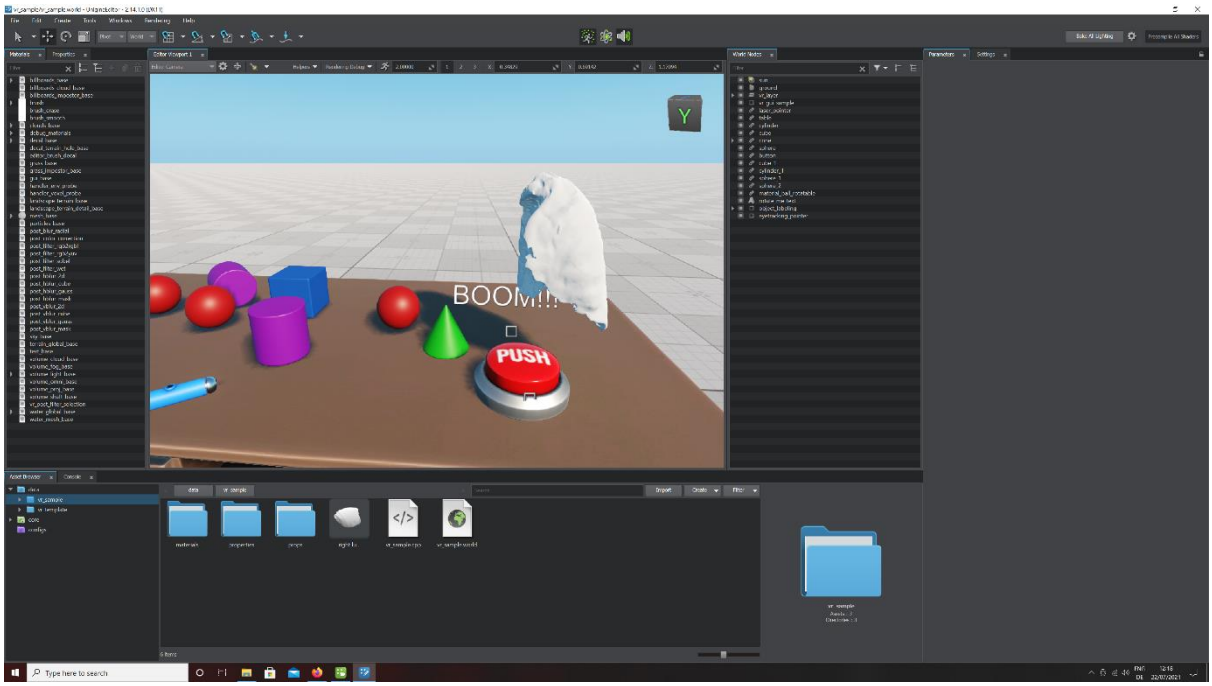

Fig: 12

And in the fig:13 it can be clearly seen that when the scene was initiated the all of the other objects were working but not the organ.

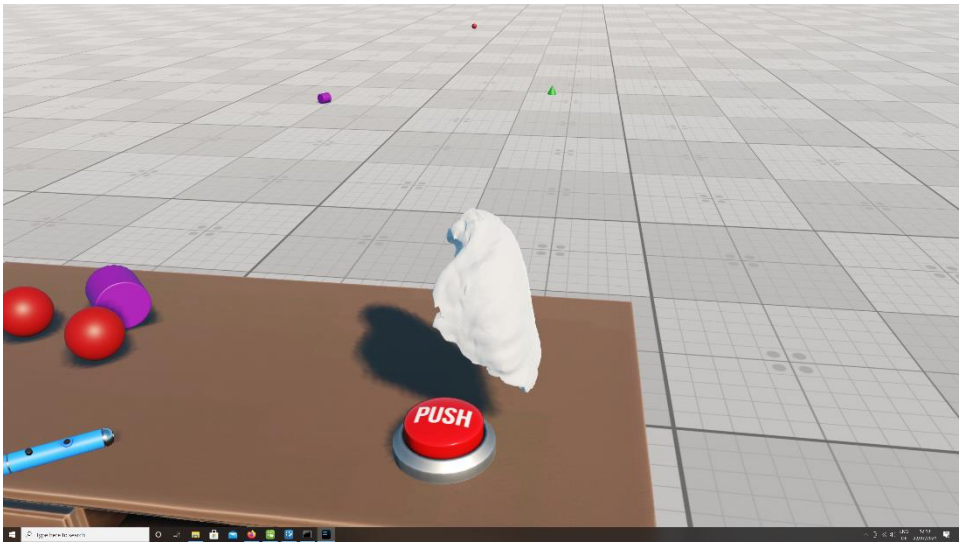

Fig: 13

6 Conclusion

A table below is made to make a quick comparison of the of the experimentation done, so that it can be easily deduced that which software was comparable too Unity.

S.No.	Tasks	Unity	Godot	CryEngine	Unigine
1.	Importing the object	✔	✔	✔	✔
2.	Attaching the script to object	✔	✔	X	X
3.	Connecting Software with VR headset	✔	✔	X	X
4.	Follow-up tutorials	✔	✔	X	X
5.	Designing the environment	✔	✔	X	X

At last, results from the table are quite surprising that 2 big giant gaming engines (CryEngine, Unigine) didn't performed as expected as they famous companies for developing vast variety of games. Whereas, Godot which is an entry level software performed better than both of them. In the end it can be said that Godot was the comparable alternative Unity. I don't say its 100% comparable to Unity but yes it gives the similar amount of performance to Unity and as a beginner student who doesn't have any background of AR/VR application development, Godot was quite understandable like Unity.

7 References

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[2] Bierbaum, Allen, and Christopher Just. "Software tools for virtual reality application development." Course Notes for SIGGRAPH 98 (1998).

[3] Bangay, Shaun. "A Comparison of Virtual Reality Platforms." Unpublished paper, available via anonymous ftp from cs. ru. ac. za as/www/vrsig/SDB04. ps. Zi (1994).

[4] https://www.CryEngine.com/

[5] https://unigine.com/

[6] https://www.unrealengine.com/en-US/

[7] https://www.autodesk.com/products/3ds-max/overview

[8] https://www.blender.org/

[9] https://www.keyshot.com/keyvr/

[10] https://www.autodesk.com/products/maya/overview

[11] http://apertusvr.org/

[12] https://godotengine.org/

[13] https://www.appgamekit.com/

[14] https://www.maxon.net/en/cinema-4d

[15] https://aws.amazon.com/lumberyard/

[16] https://waveengine.net/

[17] https://coronalabs.com/

[18] https://www.monogame.net/

[19] https://torque3d.org/

[20] https://libgdx.com/

[21] https://jmonkeyengine.org/

[22] https://gamesalad.com/

[23] https://www.heroengine.com/

[24] https://www.yoyogames.com/en/gamemaker

[25] https://www.vrdirect.com/blog/vrdirect-products-news/20-free-resources-to-help-you-create-an-interactive-vr-experience/