

Development of Virtual Reality simulator, TEVS for Turbine education

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Abstract : The Turbine Engine Virtual Simulator (TEVS) was created for students in Politeknik Banting Selangor since students are difficult to access to a real turbine engine. The real turbine engine is expensive for study purpose and it is dangerous for the students since it is too complex for the students to do practically. Therefore we would like to propose our project which is Turbine Engine Virtual Simulator to overcome this current problem. The real environment of study about turbine engine is complex and hard for the students, so we created a virtual environment for the student to learn more detail about turbine engine. This project is using SteamVr and Unreal Engine 4 to handle the Virtual Reality environment and Oculus Rift is used for the controlling purpose of movement in the program. The project can make student feel like being in an environment consist of hangar, aircraft, tools crib and others that will allow the users to do practical learning in inspection room and theory learning in virtual class. Our goals are the student learns new information and develops skills. TEVS gives a learner a stake in the outcome by putting the learner into the shoes of a character who needs to overcome a real turbine engine scenario. TEVS can transform the way educational content is delivered. Students can learn from realistic scenarios without the risk of practising an unfamiliar skill in an uncontrolled real-life situation. Furthermore, this innovation is in line with IR4.0 to enhance the learning process. The technological advancements in IR4.0 consist of 3D Printing, augmented reality, virtual reality, cloud computing, hologram, biometrics, multi-touch LCD screen, internet of things, artificial intelligence, big data and QR-code for educational purposes.

Keywords: Virtual Reality

1. Introduction

Turbine Engine Virtual Simulator (TEVS) is invented to help the students in studying and learning the fundamental of Turbine Engines including the theory and practical task. The advantages of TEVS

come as the student learns new information and develops skills. This TEVS gives the learner a stake in the outcome by putting the learner into the shoes of a character who needs to overcome a real turbine engine scenario. TEVS can transform the way educational content is delivered. It allows students not only to see it but also interact with it. TEVS immerses the students by making them feel like they are experiencing the simulated reality first-hand, primarily by stimulating their vision and hearing. The students can learn how to change turbine engine parts in a virtual environment. This will allow them to develop their passion and skills sooner and more quickly. Through TEVS, students can develop dexterous skills at an early stage. VRTET able to help students learn practical skills, and one of the biggest benefits to training people in this way is that students can learn from realistic scenarios without the risk of practising an unfamiliar skill in an uncontrolled real-life situation. The students are able to do those things in a much faster, more efficient, and extremely accurate way because so much of this content is created with support from the industry. This TEVS puts them at a huge advantage over a student who is still doing it the traditional way. TEVS want them to have some fundamental skills they're comfortable with, and working in a virtual reality environment is one of those skills.

2. Materials and Methods

2.1 Materials

Equipment used for making Virtual Reality game:

- Computer
- HTC VIVE Headset (testing)
- HTC VIVE Controller (testing)

Software used for making VR game:

- SteamVR
- Unreal Engine 4
- SketchUp Pro

2.2 Methods

2.2.1 Visual Scripting (Coding and Programming)

TEVS is using Unreal Engine 4 which is software to engineer gaming and programming in a simpler way (refer **Figure 1**). Unreal Engine 4 has Blueprint Visual Scripting features, which functions as coding but in a more visual way. The Blueprint Visual Scripting system in Unreal Engine is a complete gameplay scripting system based on the concept of using a node-based interface to create gameplay elements from within Unreal Editor. As with many common scripting languages, it is used to define object-oriented (OO) classes or objects in the engine. As you use UE4, you'll often find that objects defined using Blueprint are colloquially referred to as just "Blueprints."

This system is extremely flexible and powerful as it provides the ability for designers to use virtually the full range of concepts and tools generally only available to programmers. In addition, Blueprint-specific mark-up available in Unreal Engine's C++ implementation enables programmers to create baseline systems that can be extended by designers.

Next, Blueprint Visual Scripting consists of nodes that power the coding throughout the gameplay. **Nodes** are objects such as events, function calls, flow control operations, variables, etc. that can be used in graphs to define the functionality of the particular graph and the Blueprint that contains it. Each type of node performs a unique function; however, how nodes are created and used is common

to all nodes. This helps to make for an intuitive experience when creating node graphs. New nodes are added according to the project’s purposes and the nodes are also adjustable for their proper use.

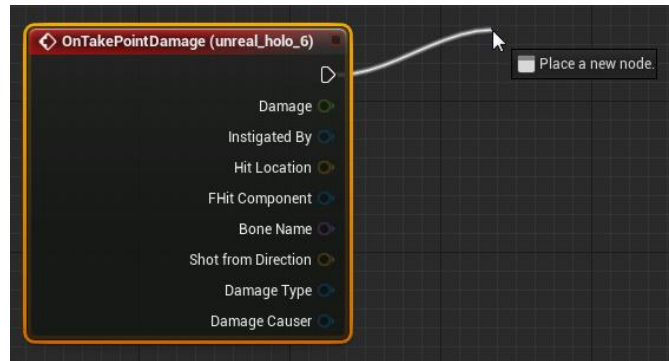


Figure 1. Example of nodes scripting in UE4

In TEVS, the Blueprint Visual Scripting is based on UE4 starter content nodes which apply to character movement, movement speed, player start and etc.

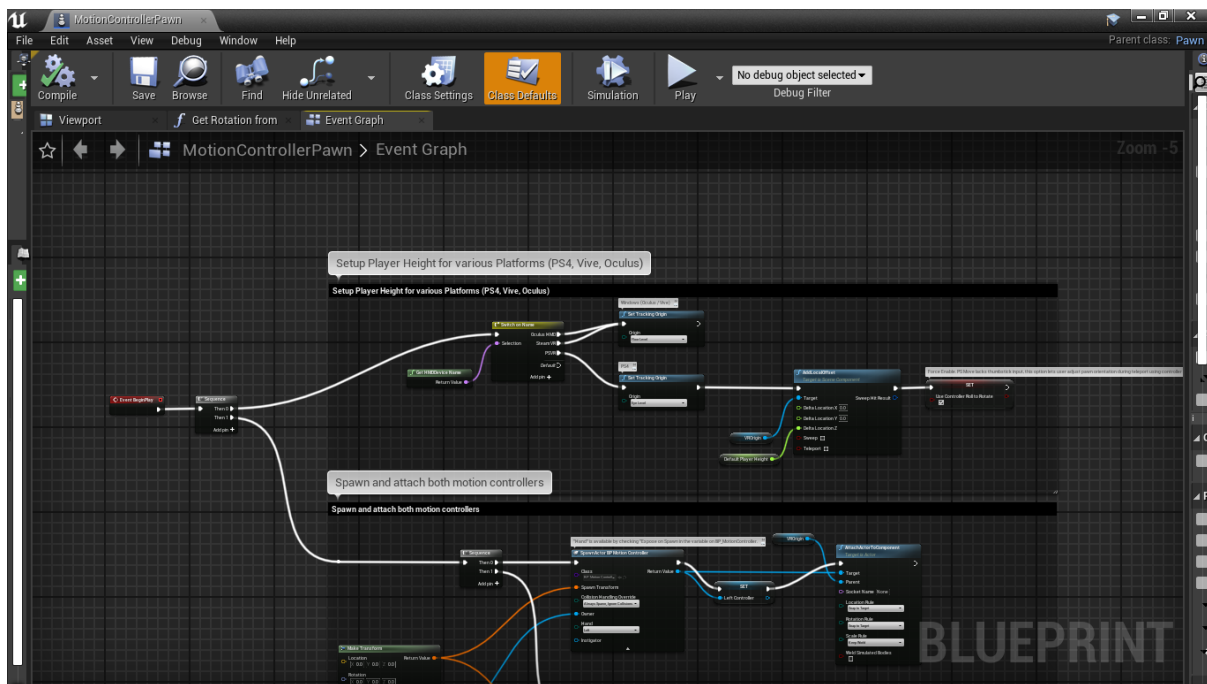


Figure 2. Player Setup nodes scripting

In the **figure 2**, “Setup Player Height for various use” is the visual scripting for the player start. The sequence start from nodes Event Begin Play and proceed to selection of VR equipment, which then moves to Set Tracking Origin which provides the eye level for various type of VR equipment selection start.

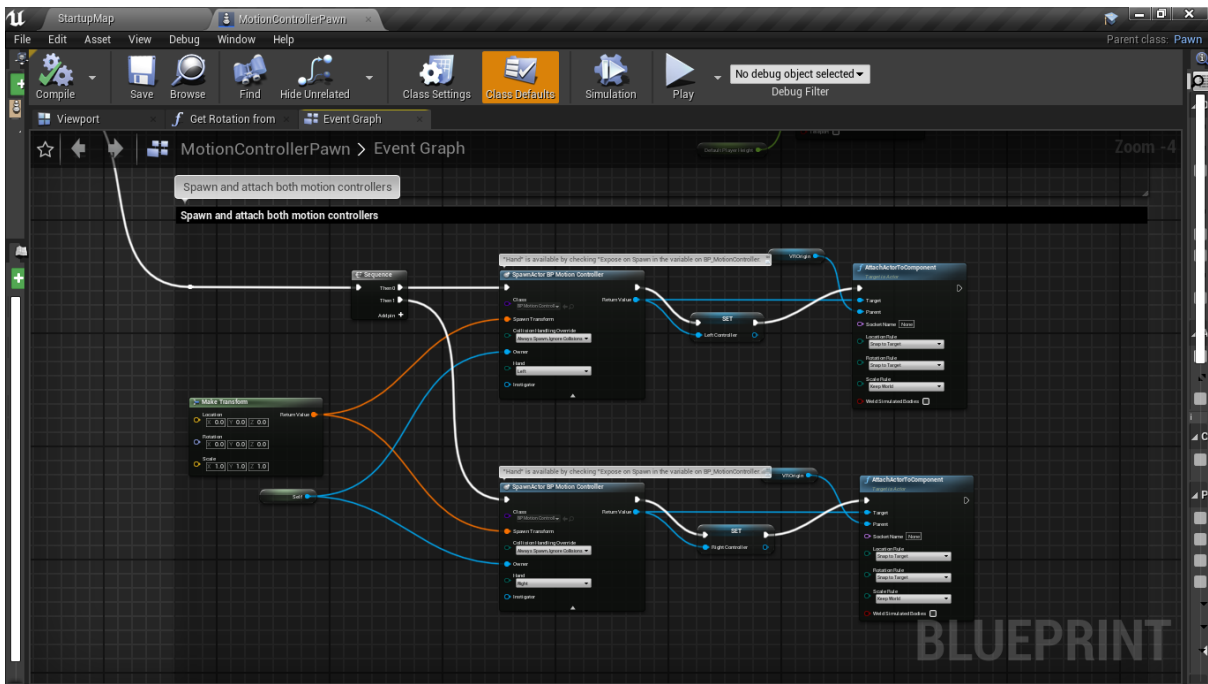


Figure 3. Motion Controller Pawn nodes scripting

In this area (refer **Figure 3**), the nodes are focus on character’s motion controllers, meaning the character pawn will be full-equipped such as left and right motion controller, camera and character speed. In simpler words, the character physics.

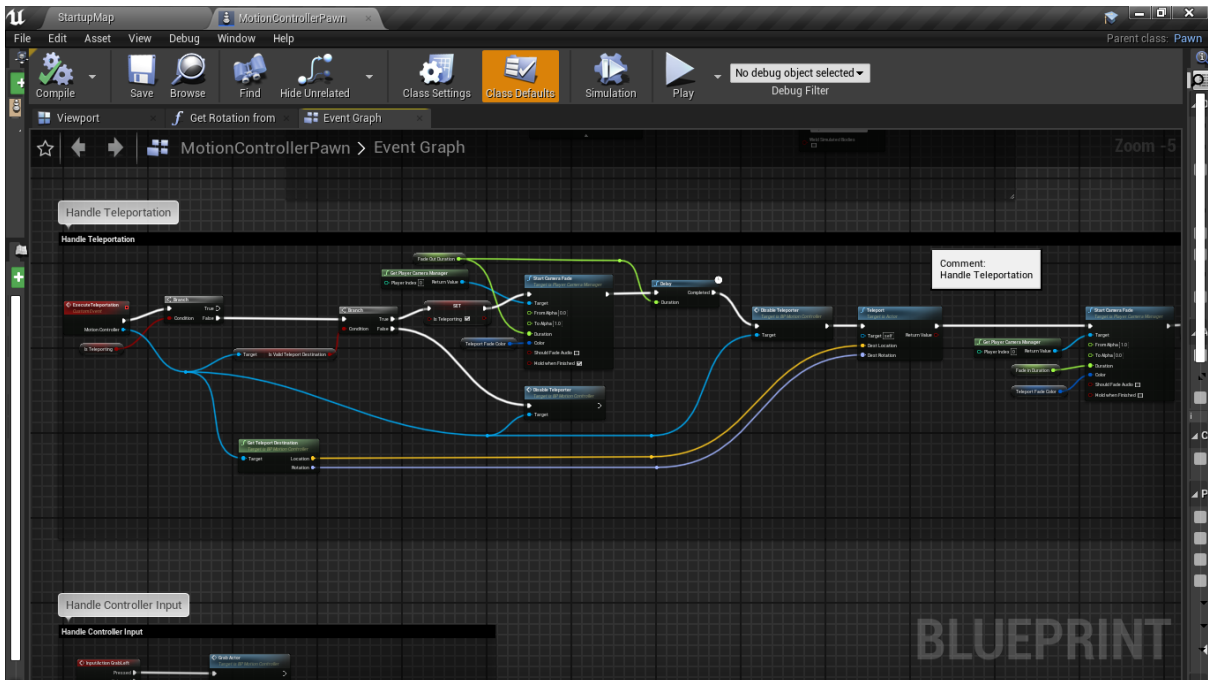


Figure 4. Handle Teleportation nodes scripting

In this area (refer **Figure 4**), the character teleportation’s is handled with teleportation’s target, camera management and also end of teleportation’s destination. To put in a simple word, the scripting is for character’s movement.

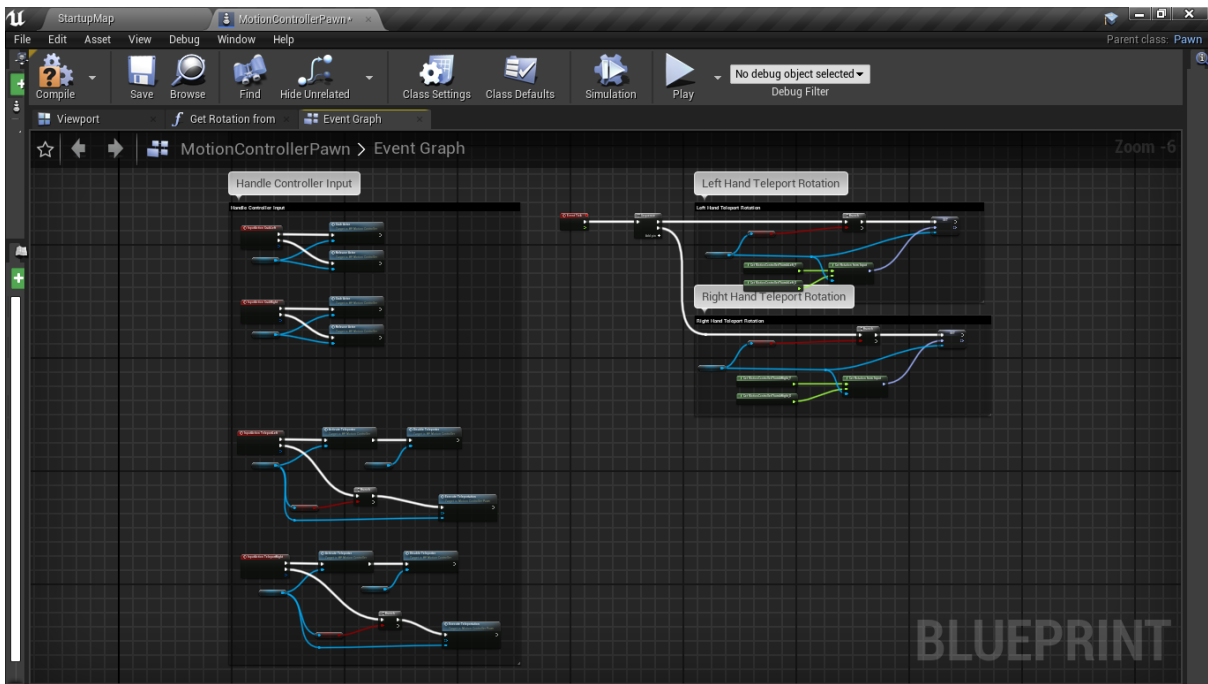


Figure 5. Handle Controller Input nodes scripting

For the Handle Controller Input (refer **Figure 5**), the scripting have covered the user’s control interface, character teleportation and character’s movement for limitation. This scripting is focused on the character’s interaction via VR remotes.

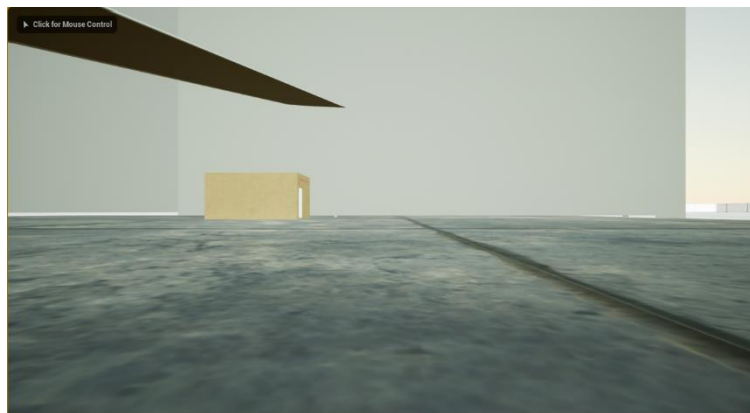


Figure 6. The starting point of the TEVS

TEVS will allow user to perform certain action such as pick an item. Some tasks will required user to use certain items such as holding a torchlight to perform inspection (refer **Figure 6**).



Figure 7. Tool crib in the TEVS.

This product can also bring user to another room to see the exploded view of the turbine engine (CFM-56) (refer **Figure 7**). While in the room, TEVS can explain some theory learning such as what type of compressor does the turbine use, the air flow inside the turbine and more.

3. Results and Discussion

3.1 Product Features and applicatons

3.1.1 Hangar Level

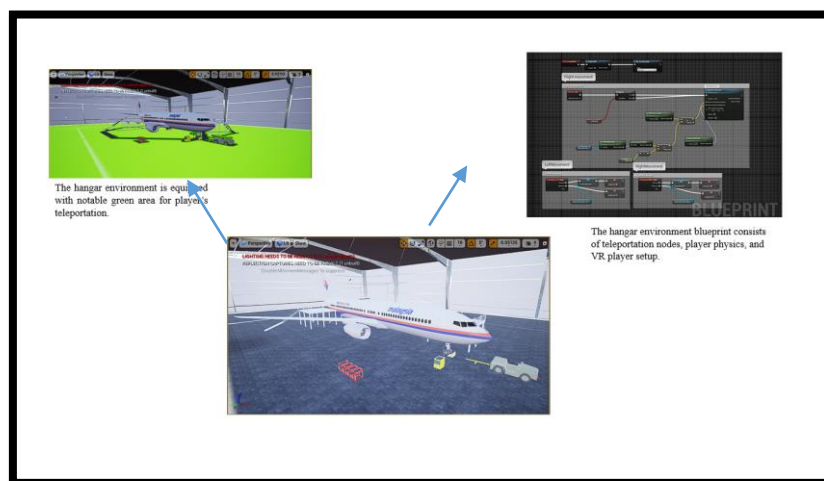


Figure 8. Hangar level environment

The Hangar environment (refer **Figure 8**) contains the basic layout of a hangar completed with a Boeing 737-400, tow truck, tool cart, and aircraft jack. The hangar environment is supported by visual scripting for user teleportation, player start, and teleportation to other room.

3.1.2 Tool Crib

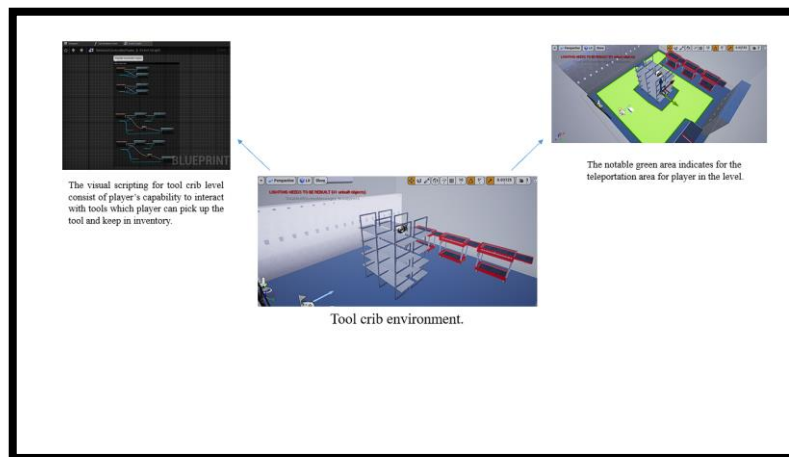


Figure 9. Tool crib level environment

In the tool crib environment (refer **Figure 9**), player can pick tools and keep in their inventory to do some tasking in the turbine room environment. The tool crib level is supported by player teleportation nodes, pick up interaction nodes, and inventory nodes.

3.1.3 Turbine Room

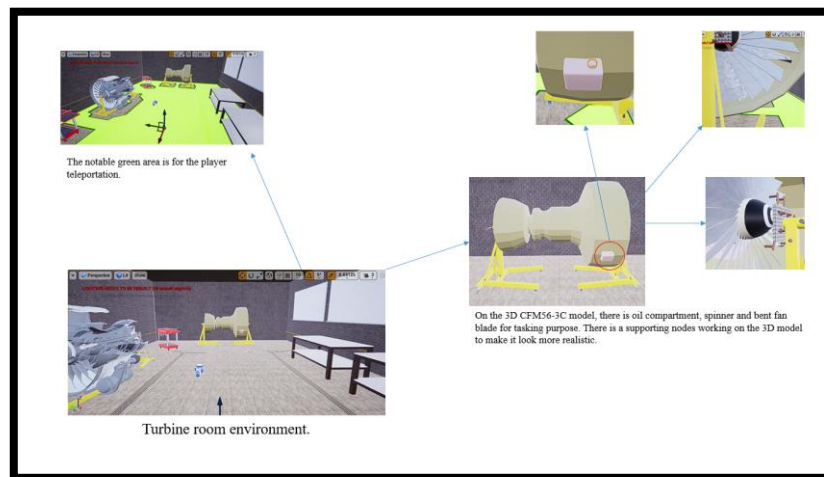


Figure 10. Turbine room level environment.

In the Turbine room level (refer **Figure 10**), there is a CFM56-3C turbine engine with bent fan blade, crooked spinner and oil compartment for tasking purposes. The model is supported by few working nodes to make the turbine appear more realistic.

3.1.4 Classroom

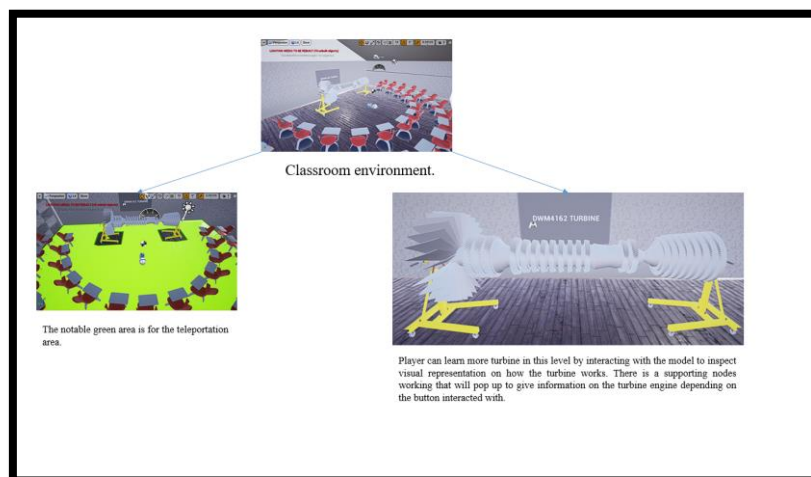





Figure 11. The classroom level environment.

In the classroom (refer **Figure 11**), there is another turbine engine equipped with buttons for interaction; pop ups. Player can interact with the buttons to learn about the turbine engine such as how the compressor works, and so on. The level is completed with working nodes of teleportation, interaction and information pop ups.

Table 1. Products features and applications

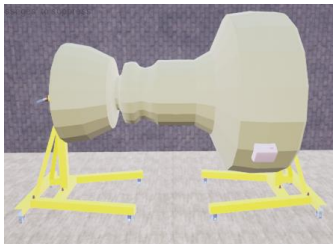
PART DIAGRAM	FUNCTIONS
	<p>VR headset help users to replace the normal view with Virtual field view. VR Headset is integrated with motion features to enhance user's experience on replacing normal view to virtual view.</p>
	<p>VR remotes is an extension use of VR equipment mainly for ease interaction such as picking up things or teleportation.</p>
	<p>VR Base Station create room immersion by scaling up the room for user's location and safety use. Some VR equipment does not use Base Station such as Oculus Rift and Oculus Quest.</p>



Unreal Engine 4 is one the latest game engine completed with editors to build a game. UE4 is thorough starting from building a character to creating its physics.



Steam VR software enhancing the user experience for VR content.



3D model of CFM56-3C consists of oil compartment, bent fan blade and spinner part.

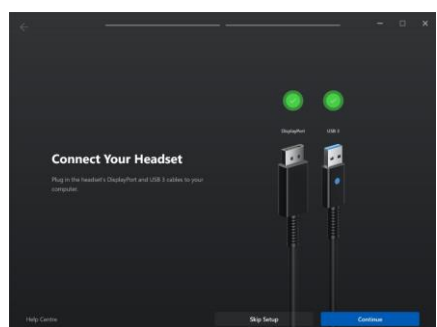
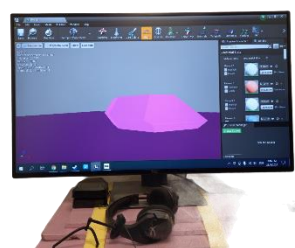
3.2 Operation of the Product

This TEVS software consists of a 3D turbine model of CFM56-3C which is completed with a bent turbine fan blade for inspection purposes, empty oil can for oil inspection and changing purposes, and a crooked spinner for uninstalling and reinstalling purposes. Throughout the gameplay, the user (students or lecturer) can free roam in the environment at will. This project is VR-based which means there is a controller support system like a VR headset to replace the user's natural environment with virtual reality content, and VR remotes for interactions in the game (refer **Table 1**).

In addition, this TEVS software consists several VR environment; tool crib, task room, and classroom which will enhance the user experience. There will be a task room, in which the user will take a task card to review the user's mission that comprises three tasking. Then, the user will teleport into the tool crib to get prepared to do a certain task. Lastly, there is a classroom environment, users can learn more about turbine engine more with additional information that was given in the environment (refer **Table 2**).

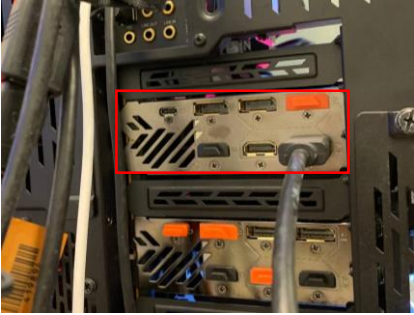
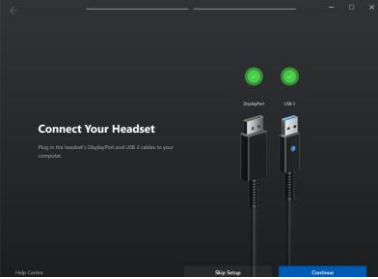
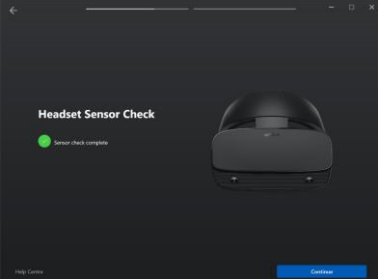
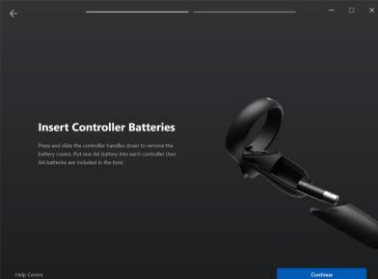
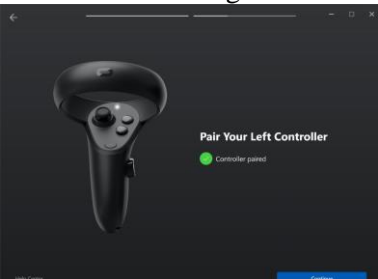
3.3 Working Procedure

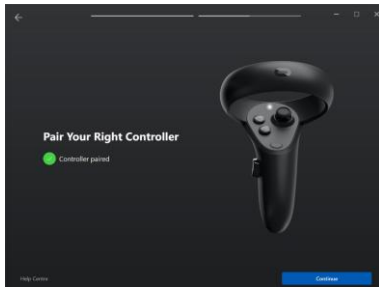
Table 2. Working procedure for TEVS

No.	Procedure	Explanation
1.	Turn on the Personal Computer (PC).	Turn on the PC to run the software which is Steam VR and Unreal Engine 4.
		
2.	Setup VR equipment on the PC	Setup the necessary equipment for the VR; calibrate the VR Headset motion, player boundary and VR Controller battery.
		
3.	Run the TEVS software.	Run the software and play the game.
4.	Run the Unreal Engine 4 software to view the VR view of the user.	In this software we are able to see the user's view display on the monitor.
		
5.	The user need to follow the instructions given in the TEVS to finish the learning.	The user are able to experience TEVS and able to finish all the task.
6.	Finish.	The user will get some knowledge, and experience when use this project which is TEVS.

3.4 User guide for VR equipment setup (Oculus Rift).

Table 3. User VR equipment setup

No.	Procedure	Description
1.	Connect the HDMI and USB to the PC.	For the wiring setup, make sure the HDMI cable is connected to the Graphics Card slot, otherwise the display will not appear.
		
2.	Do device setup.	Open Oculus application and do Device setup, follow the instruction.
	i. Check for wiring setup.	
		
	ii. Check for Headset setup.	
		
	iii. Check for VR Controller battery.	
		
	iv. Pair Left and Right Controller.	
		



3. VR device is ready to use.



Your device is now ready to use.

4. Conclusion

In this project, TEVS (refer **Table 3**) was developed to overcome the current problems and students able to do those things in a much faster, more efficient, and extremely accurate way because so much of this content is created with support from the industry. Furthermore, to address the needs of industrial revolution 4.0 (IR4. 0) in education, higher learning institutions must keep on integrating an innovative method to enhance the teaching and learning process [2] .

Acknowledgement

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