Modeling and Simulation - Virtual

Peter Leroy Santana-Rodríguez
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NASA KSC Intern Final Report – Modeling and Simulation - Virtual

Peter Leroy Santana-Rodríguez[1]

University of Puerto Rico – Mayagüez, PR, 00682

Nomenclature

VR	=	Virtual Reality
AR	=	Augmented Reality
GE	=	Game Engine
MR	=	Mixed Reality
CS	=	Computer Science
PLL	=	Programming Language Library
KSC	=	Kennedy Space Center
MCT	=	Motion Capture Technology
HMS	=	Human Modeling Software
EST	=	Engineering Simulation Tool

I. Abstract

The purpose of this report is to describe the body of work I have produced as a NASA Office of Science Technology Engineering and Math (OSTEM) intern in the Fall 2020 semester. My mentor during this session was Antonio Pego and my main task was to research and develop solutions in augmented and virtual reality technologies for use in training simulations. A main focus of this project was the development of human models for use in the game engine, with the purpose of creating simulations that would help with realistic analysis of tasks that will be performed by personnel. A steep learning curve had to be tackled in order to learn and catch up with current MR technologies. Along the way I created documentation of the different techniques utilized to support future continuation of the project.

[1]NIF Intern, NEX-O, KSC, University of Puerto Rico - Mayagüez.

II. Introduction

Covid-19 has proven the necessity for NASA to shift their training and focus on different technologies that allow training to be done while fulfilling social distance and safety parameters. VR and AR are two technologies that have proven to be able to immerse the user in different activities that enhance education and training experiences. Exploring the full capabilities of this emerging and evolving technology is something that NASA has decided to shift its focus to. The GE was a complete suite of creation tools for game development, architectural and automotive visualization, linear film and television content creation, broadcast and live event production, training and simulation, and much other real-time applications. The GE is capable of developing environments that can be interacted with in the VR, AR and MR headsets that are available in the market. For this internship, I was part of the modeling and simulation team on the Spaceport Command & Control System at NASA – KSC. Specifically, I worked on the research and development of different AR and VR solutions available for use in training simulations. My particular assignment was researching the VR equipment available in the market, developing an understanding of how to maximize the use of the equipment for training simulations, creating documents that explain and convey the operations and procedures concerning the development of the simulations, and creating simulations that had realistic human factors. Over the course of this internship, I outlined and learned essential procedures for development of VR/AR/MR environments, solved technology problems that arose (from the software used and from the problems that came from working virtually), and learned a lot about this emerging trend in tech that is revolutionizing learning as we know it.

III. Educational Achievements

A big component of my internship was the dynamic system I established for myself to learn VR/AR/MR development with experimentation on different software. My first particular task was to research the different headset solutions that were available in the market and were used in the industry, with the purpose of knowing the possibilities and limitations with current technologies. Coming from a CS background, VR, AR and MR technologies had been something I had already been keeping my eye on. Using PLL, learning how to tackle and create environments in the GE helped flatten the steep learning curve into the world of VR, AR and MR. PLL is a programming language library based on blocks or nodes that contain basic commands from commonly used programming languages. The combination of the GE and PLL helps close the gap between designs and interaction with a simple yet challenging toolset.

Another big aspect of my internship was the need to create human models that were able to be used in conjunction with MCT. The software that was being utilized before did a good job of creating human models and analyzing them but did not offer the possibility of creating a whole interactive environment in it. For this problem, I researched different software that was being used in the industry and experimented with them focusing on simplicity and utility. A big aspect of what I was looking for was the skeletons inside the human models, which is the factor that allows us to analyze the movements done by the user in real life. I found a reliable third party software solution for having the ability of designing humans with different aspects, skeletons and was compatible with my GE. With the modeling software, I was able to create a human model from scratch assigning weight, height, race, age, gender, proportions while still being able to edit specific parts of the body such as hands, fingers, legs and torso. The HMS also allowed me to import my own human skeletons to be incorporated into the human model I was going to be designing. This opened up the possibility of analyzing movement in specific parts of the body when used in conjunction with training simulations in the GE.

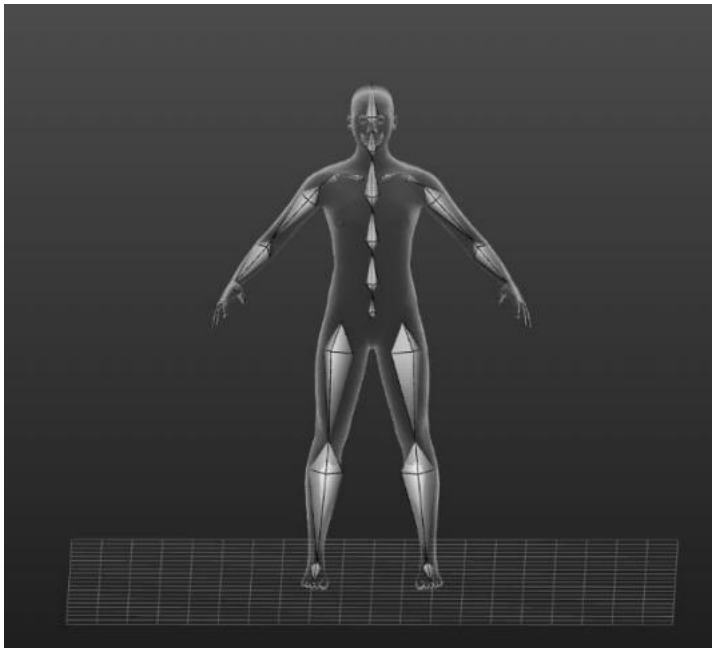

Figure 1: Human Skeleton model

The inclusion of Computer Aided Design (CAD) models of tools in the simulations is crucial to reach submersion and increase training capacity of the users. For this, I experimented with importing different CAD models and experimented with the EST. The EST allowed me to separate the CAD model into different parts in an animated way, which open up a lot of possibilities when it comes to the different trainings that can be done in the GE.

IV. Proof of Concept

As a proof of the capabilities and the work done in this internship, I decided to create a simulation of repairing a turbo jet engine.

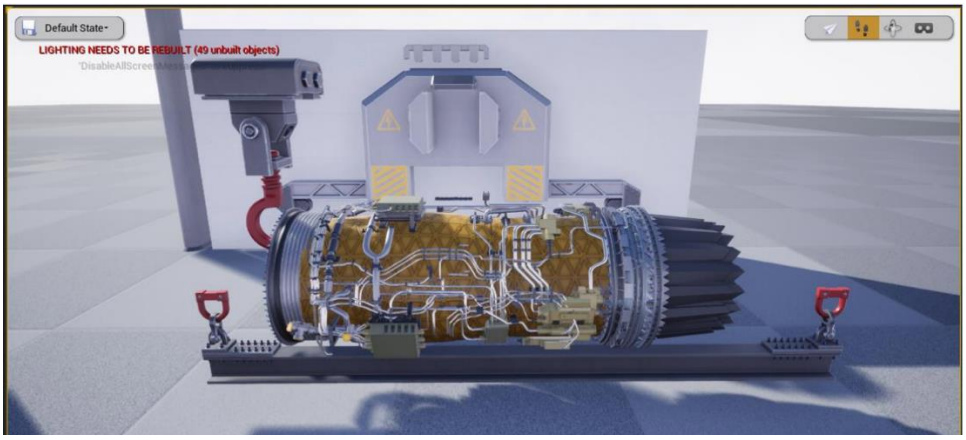

Figure 2: Turbo jet engine in the GE

The simulation's purpose is to showcase the turbo jet engine with the an AR/VR headset and will include EST and different multimedia elements to ensure that the ability to create training experiences with the software mentioned is demonstrated.

V. Conclusion

For this internship session, I was specifically responsible for: learning VR and AR technologies; designing Human Models and their skeletons (rigs); researching software utilized in the industry; researching hardware solutions available to fit the needs of the team; and creating documentation of the techniques used to create and design these environments with the purpose of the continuation of the project. In between tasks, my mentor also assigned personal and career growth material as well, with the purpose of rounding out my learning experience. Overall, I helped build the base needed to switch the software used to analyze human movement and incorporate VR, AR and MR technologies into it.

Acknowledgments

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References

[1] *"Human Centered Hardware Modeling and CollaboraHon" Document ID 20130012553. Report/Patent number KSC-2013-058*

[2] *Chen, Xiaowei & Wang, Meihong & Wu, Qingfeng. (2017). Research and development of virtual reality game based on unreal engine 4. 1388-1393. 10.1109/ICSAI.2017.8248503.*

[3] *Ekströmer, Philip & Wever, Renee & Andersson, Patrik & Jönsson, Johan. (2019). Shedding Light on Game Engines and Virtual Reality for Design IdeaHon. Proceedings of the Design Society: InternaHonal Conference on Engineering Design. 1. 2003-2010. 10.1017/dsi.2019.206.*

[4] *Checa, David & Gago, Carola & Cisternino, Doriana & De Paolis, Lucio & BusHllo, Andrés. (2020). A Framework for EducaHonal and Training Immersive Virtual Reality Experiences. 10.1007/978-3-030-58468-9_17.*