Building a VR Synthesizer in Unreal Engine 4

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INTRODUCTION

Digital synthesis can sometimes come across as lacking in interactive capabilities and impersonal, resulting in a less enjoyable experience compared to real analogue synthesizers; these tend to be much more enjoyable and personal to use as the user is physically turning knobs, sliders and even hooking up cables. This project aimed to bridge the gap between user and digital synthesizer by implementing more physical user interaction, through the use of Virtual Reality. The project also aims to encourage the exploration of synthesis in the newer generations of sound designers and music producers, as many digital synthesizers come with ready to go pre-sets out of the box and being that digital synthesis is dominant today, the process of synthesising is often forgotten about.

The concept behind this project was to create a synthesizer that could be controlled and played by the user via manipulating shapes and objects inside of a VR space. The synthesizer was constructed within Unreal Engine 4 and laid out like a small musical playground for the user to play with.

The project explores the technology behind the extended reality market, as well as game engine possibilities, different methods of synthesis and audio driven gaming.

METHOD

Development took place in Unreal Engine 4 using a free installable Modular Synthesizer plugin, created by Epic Games developer Dan Reynolds and is readily available to install inside of the Unreal Engine. This plugin hosts the appropriate features to make a full-fledged working modular synth if explored entirely.

Unreal Engine 4 makes use of a "blueprint" coding feature which is relatively easy to use and offers a lot of creative freedom. Making use of this feature allows for endless possibilities as well as the incorporation of Virtual Reality.

This project currently consists of 3 main features;

The C Major scale can be produced by the Modular Synth using the number keys on a PC or by interacting with the game space using either mouse & keyboard or full virtual reality character movement.

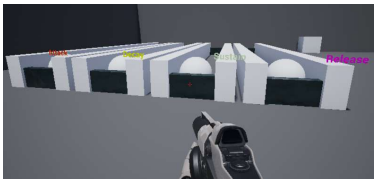
Level interaction is done by either the users' pawn colliding with the labeled metal cylinders shown in the corresponding image, or, by striking said cylinders using the VR system hand controllers.

2 oscillators, both with 5 interchangeable waveforms: Sine, Saw, Triangle, Square and Noise.

This feature can also be controlled by using key binds as well as mouse & keyboard or virtual reality character movement.

Level interaction is achieved by the users' pawn stepping on the labeled waveform podiums. This process switches the oscillated waveform appropriately.

Lastly, a working ADSR envelope (Attack, Decay, Sustain & Release) for fundamental sound manipulation.



This feature can be controlled by the user physically pushing the labelled spheres down their respective alleys. The user can pass through the black barriers, but the sphere cannot. The distance from its starting point at which the sphere is pushed corresponds to the ADSR range.

These features set a strong foundation for a game / production tool

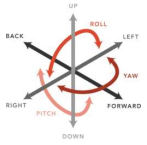
BACKGROUND

The research into this project covers a range of relevant topics, including;

- Virtual Reality Systems and how they work
- Full body Motion Tracking
- Available Systems on the Market
- Audio driven Games
- Methods of Synthesis
- Available Game Engines

An example of research included in the project report:

VR systems make use of smartphone technology, such as motion sensors and gyroscopes, vital for motion tracking the head, hands and body.



The VR headsets relies on a system known as the 'six degrees of freedom' (6DoF), allowing for head motion tracking. 6DoF consists of forward/back, up/down, left/right, yaw, pitch and roll. Each of these factors together allows for the freedom of movement in a 3D space. (Hull, 2007)

To achieve the six degrees of freedom, VR systems make use of:

An **accelerometer**; a small device that measures proper acceleration (the acceleration of a body in its own instantaneous rest frame) to detect three-dimensional movement. *(Allan, 2011)*
A **MEMS** (microelectromechanical system**) gyroscope** measures angular velocity in order to maintain rotational motion and gives us yaw, pitch and roll. Essentially, a gyroscope determines orientation for angular movement and comes in the form of a tiny sensor, between 1 to 100 micrometres. *(Allan, 2011)*
A **magnetometer** is a device that measures the strength and direction of the Earth's magnetic field around a fixed point along three perpendicular axes (X, Y and Z). *(Allan, 2011)*
Aspects are explained more in-depth in the project report.

REFERENCES

- Parisi, T (2015) *Learning Virtual Reality*. O'Reilly Media
- Shibata, T (2002) *Displays* in Elsevier, Volume 23, Issues 1-2, April.
- Hull, D (2007) Fundamentals of Airplane Flight Mechanics, Springer, Berlin, Heidelberg.
- Allan, A (2011) Basic Sensors in iOS, O'Reilly Media
- Walter, P (2007) The history of the accelerometer. 2006. Sound & Vibration, 41. 84-92.
- Melim, A (2019) Tracking Technology Explained, Oculus developer blog.
- Passaro, V (2017) Gyroscope Technology and Applications: A review in the Industrial Perspective. MDPI.
- Malventano, A (2016) SteamVR HTC Vive In-depth – Lighthouse Tracking System Dissected and Explored, PcPerspective.com
- Carmigniani, J (2010) Augmented reality technologies, systems and applications. Multimed Tools Appl 51, 341-377 (2011).
- Paradiso, J. Landay, J (2009) Guest editors' introduction: Cross-reality environments. IEEE Pervasive Computing 8, 3.
- Roads, C (1996) The Computer Music Tutorial. The MIT Press.
- Pinch, T. Trocco, F (2004) Analog Days: The Invention and Impact of the Moog Synthesizer. Harvard University Press; New Ed edition
- Collins, K (2008) Game Sound: An Introduction to the History, Theory and Practice of Video Game Music and Sound Design. MIT Press.
- Dodge, C. Jerse, T (1997) Computer Music: Synthesis, Composition, and Performance. Schirmer; 2 edition.
- Bristow-Johnson, R (1996) Wavetable Synthesis 101, A Fundamental Perspective.
- Reynolds, D (2016) *4.17 New Audio Engine: Early AccessQuick-Start Guide*. forums.unrealengine.com
- Huber, D (1991) *The MIDI Manual*. Focal Press; 1 edition.

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