Literature Review
for
Non-Euclidean Game Engine

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Table of Contents

Abstract

Nowadays, most game engines and for this reason most of the games use Euclidean geometry as a base for their development. Euclidean games as we describe them do not bend space and time. As these games continue to get developed, non-Euclidean games also started to get popular because things you can do with non-Euclidean spaces are more mind blowing and confusing for us to perceive, therefore this creates a great field to discover both for developers and players. Our objective is to create a non-Euclidean game engine that will contain non-Euclidean features to help game developers create their own games using these features as they see fit. In this report we will detail the geometry and methods we will use.

Keywords: Non-Euclidean geometry, Game engine, Euclidean geometry

1. Introduction

Game engines are created and used to develop new games or remake existing ones; they are IDEs for games. They make complex game development processes simpler by providing tools to make normally big tasks done easily, while the game engine does all the work in the back. To put it another way, game engines are frameworks designed specifically to be used in development and creation of video games.[1] Unity, Unreal Engine, Source and many more examples can be given for game engines that are used today.

Since the creation, or even idea, of the first video game, developers have mainly used Euclidean geometry to represent their games. Because, Euclidean geometry is what we use in tasks we perform in our daily lives. From our way of perceiving the world to the way we represent the fiction world we use in our games. [2] Euclidean geometry that most games use is geometric representation of axioms and theorems on the plane and solid figures employed by the Greek mathematician Euclid.[3]

Video games always try to introduce new concepts to draw people into their game's "alternative reality".[2] As game developers were looking for these new concepts to introduce, some of them were interested in the idea of non-Euclidean geometry, which is literally any geometry that is not the same as Euclidean geometry. [4] Thus our objective is to give game developers some tools they can use to develop this type of games.

This report goes through related works that got developed before and lists software and libraries that can be used to both develop a game engine and implement non-Euclidean features.

2. Similar and Related Works

There are many works that make use of non-Euclidean geometry. Some of them is listed in the following sections.

2.1. Hyperbolica

Hyperbolica is a game with a non-Euclidean curved space where you journey through bizarre landscapes, solve puzzles, navigate labyrinths and do much more while also being challenged to perceive the non-Euclidean space.[5] At least this is how the game developer of this game explains his work. It is a game in development but the developer of the game shares development logs in video format in his Youtube channel. [6]

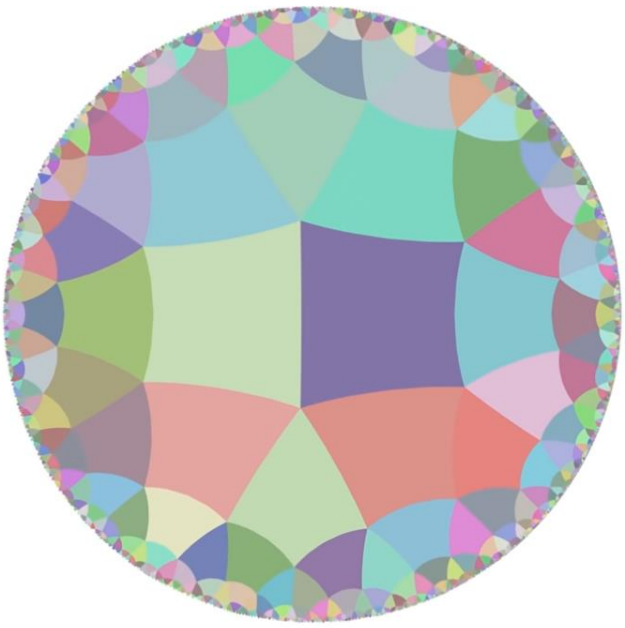

Figure 1 - Hyperbolica's Tilemap

The game uses Unity Game Engine and creates a hyperbolic geometry by making square per vertex number five instead of four (shown in Figure 1) and by making use of visual tricks and changes on perspective locations of game objects. It is a complex method and is detailed in a development log developer recorded and published on YouTube. [7] He also has other development log videos where he goes into detail of Non-Euclidean geometry and a video where they show a demo of their non-Euclidean game engine. [8] [9]

2.2. Antichamber

Game devs describe this work as being a mind-bending psychological exploration game in a Escher-like world where hallways wrap around upon each other, spaces reconfigure themselves and accomplishing what you think is impossible, maybe is the only way forward.[10] This game uses Unreal Engine 3 as their game engine. Antichamber uses many camera tricks and uses perspective manipulation to make some mind-blowing puzzles to solve. The game makes use of something called a stencil buffer which is an extra data buffer found on modern graphics hardware.[11] There are videos that go into detail about how Antichamber makes use of it. [12]

2.3. Superliminal

Superliminal is a puzzle game based on the perspective and optical illusions. What you do with an object in the game may cause unexpected results. Players need to change their perspective and think outside the box to solve puzzles and progress through the game. Game scales objects you interact with according to angular diameter and lets you solve puzzles by scaling objects to different sizes.

3. Software and Libraries

Many different software and libraries can be used to make a non-Euclidean game engine possible. We listed the primary options in the following sections.

3.1. Unity

Unity is the world's leading application for creating and developing real-time 3D content, which may be a game or an animation. It also provides a wide range of tools to make these content and lets users publish them to a wide range of devices. [14] Thus unity is one of the best game engines to make a game project in and Unity uses C# as its scripting language which is a common and easy to use programming language. It does not provide tools for making a game in non-Euclidean geometry and our task will be enhancing it with prefabs, scripts and even add-ons if needed to make a game engine for non-Euclidean projects using tricks on perception.

3.2. OpenGL

OpenGL is one of the first frameworks that come into mind for developing graphic applications. Since its first release in 1992, it has become the industry's most widely used and supported 2D and 3D graphics application programming interface. [15] OpenGL let us write a game engine from scratch giving us the ability to make non-Euclidean rendering the default option however it lacks the uncountable number of tools (i.e. objects, materials, collisions which will be needed to implemented from scratch) Unity provides us with, in exchange for more customization.

4. Conclusion

Using non-Euclidean geometry is a new concept that game developers make use of to expand concepts of game development. In our report we analyzed games done in non-Euclidean geometry and features they used to provide us with ways we can implement in our engine. Report also goes through software and libraries one can use to code a non-Euclidean game engine.

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