An investigation into the practical uses of spherical non-Euclidean geometry in games

Is spherical non-Euclidean geometry in the Unity game engine practical?

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# Introduction

## Justification

The problem that is being investigated is that of ‘Can non-Euclidean geometry be practical in the creation of a 3D game?’. Euclidean geometry is defined by a collection of rules as set out in “The Elements” (Euclid, 300 bce) and has formed the basis of geometry in all modern society, see *figure 1 ‘zero curvature’*. As a result of Euclidean geometry being a key aspect of society, it has an influence on video games as well, “Since the conception of the first video game, its visual representation has always been done mainly in the fashion of the Euclidean geometry.” (Guimaraes, Mello & Velho, 2015).

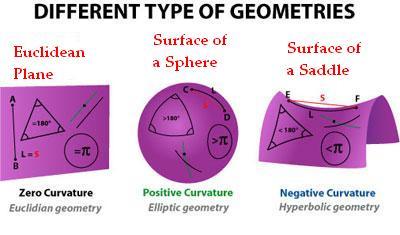


Figure 1: The Difference Between Euclidean and Non-Euclidean Geometry (Kurniadi, 2011).

Wolf (2018) states that “video games can easily allow for non-Euclidean configurations”. However, Taylor (2003) also says “In keeping with these cultural prejudices, descriptions of the optical space of video games presume an uncomplicated optical scheme, founded on traditions of linear perspective.” This suggests that, despite non-Euclidean geometry being, theoretically, easy to implement, a complicated form of non-Euclidean geometry needs to be done to a high quality to be successful. Currently, to make games intuitive and familiar to players the industry heavily relies on the conventions set out in film and television (Wolf, 2004) this means that games designers have neglected the possibilities that abstract design methods provide. This has the potential to be one of the key aspects of why there is a lack of games that utilise non-Euclidean geometry.

The output design will involve, but not be limited to, an environment containing a procedurally generated maze that is created in a spherically non-Euclidean world. In this a basic character controller will be present, allowing for the movement within the maze. However, there is no intent to have any gameplay elements present, such as UI or a formal gameplay loop. However, this is anticipated to change as development progresses.

## Aims

This paper aims to investigate the uses, and potential uses, of spherical non-Euclidean geometry, research why non-Euclidean geometry is typically not used in video games, and try to establish a viable method for the implementation of a spherically non-Euclid geometry in the Unity game engine (Unity Technologies, 2020).

## Objectives

* Conduct a review of academic literature regarding non-Euclidean geometry.
* Research and evaluate the uses, and potential uses, of spherical non-Euclidean geometry in the industry.
* Determine a system for simulating spherical non-Euclidean geometry.
* Create a program in the Unity game engine (Unity Technologies) using said system.

# Literature Review

## Overview

## Euclidean Geometry

## Non-Euclidean Geometry

### Examples of Non-Euclidean Games

### Hyperbolic Non-Euclidean Geometry

### Spherical Non-Euclidean Geometry

## What can Spherical Non-Euclidean Geometry bring to the Games Industry

## Summary

# Output Design

## Overview

## Spherical Non-Euclidean Geometry

## Maze Generation

## Possible Issues

## Testing

# References

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