

# Math 198 Project Proposal

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## Introduction

My project will be a first person shooter (FPS). This FPS will be unique (and less of a video game) in that it will incorporate elements of hyperbolic geometry, such as hyperbolic trajectories, movement in hyperbolic space, and even objects exhibiting hyperbolic geometry. Since FPS games often need collisions, the project will also require a great deal of work in creating realistic (and thus believable) collisions. The project will run in Syzygy/Aszgard, and will incorporate a nonstandard input device such as the Nintendo Wii remote and/or Microsoft Kinect.

## Definition of a Shooter

In video games, the "shooter" genre can take a variety of forms: first person, third person, and everything in between. This specific project will take the form of a **first-person shooter**, albeit a very primitive one. The main reason for this choice is the environment of the CUBE. The CUBE is an immersive environment for a single person through the use of the wand and head tracking. This is the ideal environment for a first-person shooter; the single person with head tracking becomes the single player.

The player will be grounded, and able to move as in most first-person shooters. Movement in the x and z directions (across a floor) will be handled by the wand's joystick, and aiming by the position of the wand. The wand's shape will be in the form of a weapon model, and target models will be placed for the player to fire at. These models will most likely be made of some basic primitives; good looking models is not the priority for this project.

## Features of the Application

The following is a list of proposed features, listed by priority. Features at the top of list will be implemented first.

1. Movement of projectiles with a hyperbolic trajectory. (This has been completed as my Miniproject)
2. The ability to switch between hyperbolic space and Euclidean space, using a button on the wand.
3. Drawing of trajectory curves for objects. This can be activated with user input through the wand, and allows the user to inspect hyperbolic curves that result from a given firing position.
4. The ability to aim and fire with the wand.
5. The ability to move in an environment using the wand's joystick.
6. Advanced collision testing. This simulates momentum of objects in both parabolic and hyperbolic space. As with most forms of interactive entertainment, this is estimated to take the longest amount of time and the largest amount of work.
7. Multiple weapons, each with different firing velocities. This allows the player a convenient way to inspect the effects of speed on the trajectory of an object in hyperbolic space.
8. Primitive hyperbolic objects for the player to inspect and fire at, such as a sphere, cube, etc.
9. (If time permits) Integrate the Wii remote and nunchuk as an input device for the application. This will be done if and only if the wand is deemed unsuitable and/or unintuitive for FPS controls.

I estimate that in the time I have, I will at least complete item 8. However, item 6 (collision detection) could be a potential pitfall. With all games (and many 3D simulations), collision detection is a complex affair, both theoretically and in terms of implementation. This is also very much a computer science topic. If collisions turn out to take far too much time, I will implement something simple and move on to other parts of the project.

## Mathematics behind the project

There are three mathematical challenges behind the project:

1. Hyperbolic geometry
2. Hyperbolic kinematics (which consists of translation)
3. Collision Detection

Of the three, collision detection will most likely be the most difficult, with hyperbolic geometry being a close second.

## User Interface

While I suggested Microsoft Kinect earlier in the semester, I feel it is not suitable for this project. In the gaming industry, the Kinect has been a poor choice for so-called "hardcore" games such as first-person shooters. As there is no good model for implementing good controls for this type of game with the Kinect, using the Kinect effectively with this project will be difficult, and is an unnecessary exercise.

The Nintendo Wii remote, on the other hand, has been used successfully as a suitable user interface with many first-person shooter games, and is considered a much better input device than the traditional game controller. Since it has been proven to be intuitive for players, and since it is similar to the wand, I believe implementation of the remote will be easier than the Kinect and much more beneficial for the project.

## Purpose of the Project

The end goal of this project is to give the player an intuitive sense of hyperbolic geometry. This includes the paths objects take in hyperbolic space as well as the shape of familiar Euclidean objects. The player is able to shoot at targets and learn how to aim in hyperbolic space, which helps develop a sense of paths in hyperbolic space.