Group Members:

Guilherme Diegoli Neto (diegoli@kth.se)
Bamarin (your name and email here)

Intended Grade:

A-C range

Project Working Title

Physical Interaction Model for Virtual Reality

Project Description:

For this Project, we want to implement a physical interaction model for a VR environment in the Unity game engine. Traditionally, most VR applications have limited or no physical presence of the player's hands in the world, instead opting to not allow for collisions with the hands and any object that the player might be holding. This design choice has been made in order to maintain a strict 1:1 representation of real to virtual hands, unconstrained by any boundaries that might be present in the virtual environment. While this has been the standard for a few years, developers are just now starting to realize that having physically present virtual hands greatly improves the feeling of immersion and allows for more interesting interactions with objects in the world. Recently released games, such as Boneworks, The Walking Dead: Saints and Sinners, and Half Life: Alyx all have physically present hands that can be used to interact with the environment in more ways than just the simple grabbing of objects.

Implementing such a system does present new challenges, however. While it would be technically possible to have physical hands that stick to 1:1 representation, such a system would not be the most immersive, since players expect different objects in the virtual world to have different aspects of weight, friction and such. Thus, in order to implement a truly immersive physical VR model, some compromises have to be made with the virtual representation of the player's hands.

In the paper "The Haptic Display of Complex Graphical Environments" by Diego C. Ruspini, Krasimir Kolarov and Oussama Khatib, the authors describe the concepts of a "physical position" and a "proxy position" in the context of haptic displays. While the physical position is unconstrained, the proxy position should obey by the constraints of the virtual world. We intend to base our implementation off this work and build it up from there.

Potential Feature List:

- "Proxy hands" model that displays virtual hands that follow the physical position of the controllers while still abiding by collisions and other restrictions of the virtual environment (essential for the project).
- Indirect manipulation of non-static objects in the scene via movement of the proxy hand, for example, pushing a cup off a table without grabbing it.

- Realistic representation of weight and friction when manipulating objects. Light objects can be easily pushed around, but heavier objects require more force to be moved.
- Virtual head and body collisions, meaning the player will collide with objects within the world as they move around, potentially knocking them around or having their virtual movement restricted.
- Intuitive grabbing and manipulation of objects in the environment. The simplest way to implement grabbing is to simply place the object within the hierarchy of the hand object while it is being grasped, however this method does not represent well how objects are grabbed in reality. The next items on this list describe several potential features regarding grabbing of objects.
- Grab points: Implement grab points for certain objects. For example, objects with handles such as cups and hammers are likely to be held from such handles in specific positions. Thin objects will be held by their thin edges. Objects with long handles such as brooms might be held in many positions among the handle.
- Two-handed grabbing: Allow for the holding and manipulation of objects held with both hands.
- Physics of held objects: Light objects should be easy to move around, intermediate objects should feel heavier when swinging around, and heavy objects should be difficult or impossible to lift and move around easily.