Walking Through a Large Virtual Environment in a Small Physical Space

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Introduction

This Summer in the Future Computing Lab I worked on developing a new technique to improve the immersivenss of a virtual environment. This technique will allow real walking throught environments that are much larger than the tracking area of a head mounted display. This technique will then be used along with 3D data from real world photographs, provided by Brian Nacey, and coordanates of the objects in the photographs, provided by Barbara Morales, to create a complete walk-through of a portion of Woodward Hall.

Background

Various other techniques have been implemented to provide the user with explorable virtual environment past the limitations of a head mounted display's tracking area. Some of these techniques include applying a translational scale to the forward direction of travel, or stopping the user to reorient them at the boundaries of the tracking area. These techniques can introduce noticble perceptual conflict, or break the users presence in the environment.

Geometry Modification Technique

Our technique dynamically modifies the geometry of a virtual environment to redirect the user within the tracking area. This technique takes advantage of change blindness, which is when a person viewing a visual scene apparently fails to detect large changes in the scene. We use this phenomenon to scale the wall and reorient the door of a room while that section is out of the users field of view. This makes our technique ideal for interior environments such as an office building.
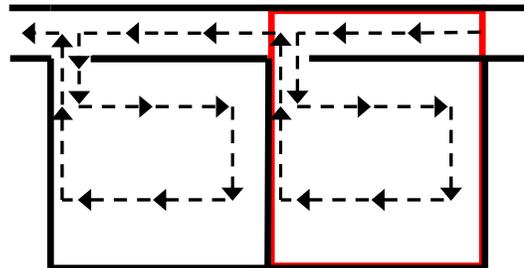

Figure 1: In black is a representation of the user's perceived environment. In red is the boundary of the tracking area.

Example Environment

With prior knowledge of dimensions for a room and hallway that would work optimally for our tracking area, I created an example environment. I used Google Sketchup to create the 3d models for each part of the environment (walls, floor, doors…). I then created the environment using the OSG Virtual Environment framework developed by Evan Suma.
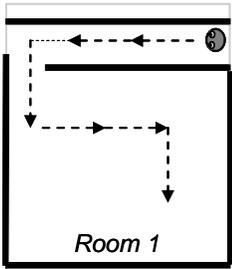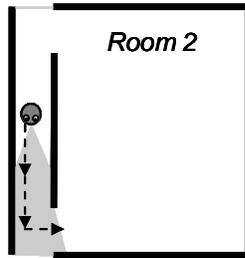
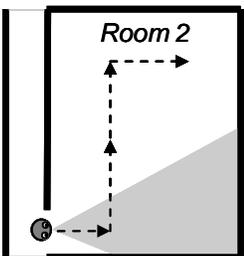State 1: Corridor and first room are within the tracking area
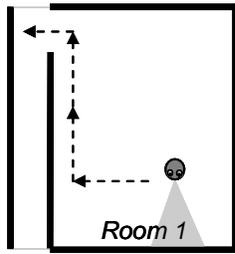
State 2: The exit is changed and the corridor is realigned along the perimeter
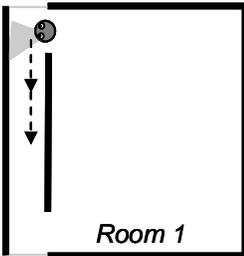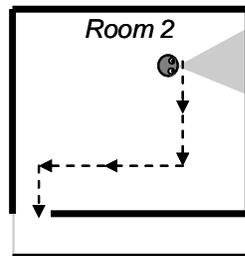
State 3: As the user moves down the corridor the next door is added

State 4: As the user approaches the door, the first room is replaced with the second room.

State 5: As the user enters the second room, the first door is removed

State 6: The exit is changed and the corridor is realigned along the perimeter

Limitations

The way that this technique is handled requires all geometry modifications to be designed be hand. This creates a lot of work for the end user, as they would have to manually place all models in the correct orientation through each stage.

Automation

Creating an algorithm that will automatically apply the geometry modification technique will allow the end user to input an arbitrary model and get back a virtual environment that fits within the tracking area. The first step of automation would be to create the models based the vertices of the room. Then, if needed, a scale is applied to the room to fit it within the tracking area. Next, the location of the door, for after the switch, is determined by comparing the original location of the door from each adjacent wall. Then, the trigger location of the switch is determined, and when the user activates the trigger the switch is made.
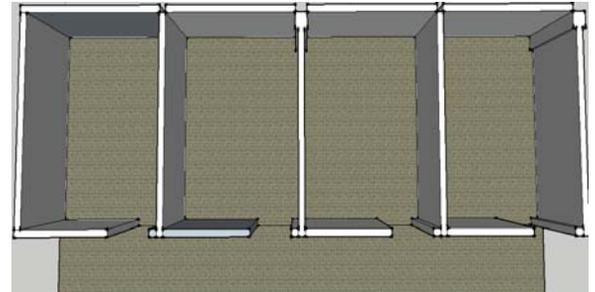
Issues

If the distance between rooms is too large for the tracking area then we can apply a scaled transition gain. Another possible issue would be that the room dimensions are too large or irregular to fit within the tracking area. If this happens then a possible solution would be to reorient the user. Failure cases can be avoided by augmenting the environment with existing, but more noticeable techniques.

Future Work

There are parts of the automation process that we left off due to time constraints. Things such as texturing and location the trigger points are work for the future. Other future work would include running studies on the geometry modification technique to prove, or disprove that it is a less noticeable than other tested methods.