Guided Navigation of Virtual Environments

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ABSTRACT

This paper presents a new method for navigating virtual environments called "The River Analogy." This analogy provides a new way of thinking about the user's relationship to the virtual environment; guiding the user's continuous and direct input within both space and time allowing a more narrative presentation. The paper then presents the details of how this analogy was applied to a VR experience that is now part of the permanent collection at the Chicago Museum of Science and Industry.

1. INTRODUCTION

Today's Virtual Reality (VR) technology provides us with an opportunity to have experiences that would otherwise be impossible. We can smoothly and continuously interact while immersed in environments that would be inaccessible or impossible to experience. In these environments, we are free to roam and explore. architectural walk throughs for example, scientific visualization, and even games like DOOM place us in alternative worlds while giving us methods for navigating these virtual spaces. These methods allow smooth and continuous interaction that can immediately influence the constantly changing presentation, but they rely on the user's actions and thoughts to bring structure to the experience. If any narrative structure (or story) emerges it is a product of our interactions and goals as we navigate the experience. I call this emergent narrative. In some applications this complete freedom to explore is appropriate. However, there is an alternative. This is the process of empowering the author to bring structure to the experience, which makes this medium more appropriate for applications such as teaching, storytelling, advertising and information presentation. To do this, we will need to balance the interaction (exploration) with an ability to guide the user, while at the same time maintaining a sense of pacing or flow through the experience. This type of guidance is the process of a providing narrative structure. Like a narrative presentation any solution must guide the user both temporally and spatially.

2. PREVIOUS WORK

Virtual environment navigation has mainly consisted of building new methods and technologies that allow the users to control the position and orientation of the virtual camera, through which they see the virtual world. Early work in camera control (even before the advent of VR technology) focused on specifying camera movements over a path. [1, 4] In an effort to address the needs of animation production and does not address the issue of interactive camera control.

A number of different researchers have addressed the issues behind camera control for manipulation and/or exploration applications. [2, 5] All of these methods focus on providing better ways for the user to roam free, exploring within the virtual world. It is this ability for the user to directly control his/her place in the virtual world that is so often synonymous with the words "virtual reality." While these methods couple smooth, continuous interaction with the smooth and continuous presentation available in real-time computer graphics environments, they do nothing to guide the user. There is no room for an author's intentions to influence the experience. Therefore there is no narrative structure.

Researchers in interactive narrative working with linear material like digital video have worked to unfold it in order to provide a non-linear environment for the user [3]. Shots are interactively laced together into sequences and these sequences tell a story. Because shots are the smallest building blocks available, the interaction intermittently guides how these shots are laced together.

The traditional analogy of how these types of interactive experiences are structured is often referred to as the branching analogy. Each branch represents a linear segment traversing part of the narrative space. A linear segment is played until the next node is reached. It is at these nodes where options are provided. The advantage of branching is that the experience does have a narrative structure, the interaction is guided. The disadvantage is that one can interact only at the nodes thereby chopping up both the interaction and the presentation.

The goal set forth is to find a way to marry the advantages of immersive VR experience with the advantages of narrative structure. How do we allow the smooth, continuous interaction and presentation, to coexist-exist with the structural and temporal qualities of narrative (plot and pacing)? In other words, how do we balance the notion of interaction with guidance (telling).

3. THE RIVER ANALOGY

Here I propose an alternative analogy for navigating virtual spaces. Instead of linking a sequence of branches and nodes, or giving the user free rein, I suggest that the navigation paths be more like a river flowing through a landscape. The user is a boat floating down this river with some latitude and control while also being pushed and pulled by the pre-defined current of the water. Like the branching structure this approach constrains the audience's movement through the space to interesting and compelling paths. But there are some unique advantages to this approach: the flow of the experience, the continuous input of the rudder, and multiple levels of structure.

The river analogy assures an uninterrupted flow. When in a boat you float down the river even when you are not steering. The pre-

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sentation is continuous regardless of whether or not there is input. The amount of control you have over the boat varies with the properties of the river. If the rapids increase, you move faster with less room for swinging from side to side. Alternatively, the pace can slow and the river can widen giving room to steer from one bank to the other.

In the river analogy the boat's rudder can be likened to audience input. A rudder takes input continuously. The amount of influence may vary depending on the water conditions but you can always provide the input. It is also the case that the rudder may have both an immediate and a long term impact on the navigation. How the rudders are used can determine both your local position within the river, but also a more global position, such as which fork in the river your boat might take.

The river provides two levels of guiding structure. First is the local structure of the river including the water flow, rocks in the river, the width between the banks, etc. Second, is the global structure, including both the path the river flows and the forks that separate and/or rejoin. The audience input has influence on how both levels of this representation are navigated. The rudder or input can steer between the banks while the position of the boat when a fork is reached will dictate which part of the fork the audience will travel.

Like a river, a guiding navigation method should guide without interruption of the presentation. This creates a sense of interaction by constantly accepting user input and guiding it with a higher level, longer term structure.

4. APPLICATION OF THE RIVER ANALOGY

A highlight of the Chicago Museum of Science and Industry's new exhibit, *Imaging the Tools of Science*, is the virtual reality experience. The primary goal of this exhibit was to expose and educate the visitor to what VR technology is and can do. Any experience that was going to be successful, was going to be highly constrained by the issues inherent in bringing an immersive experience to a public place like the museum. In a museum setting it is necessary to limit the amount of time a person spends, provide an interface that keeps people from getting lost and frustrated, while at the same time making them aware that they have some direct and immediate control over how they move through the environment. To meet these demands it was decided that the experience would be between 2 and 3 minutes long with a clear beginning, middle, and end. This allowed the user to feel they had a complete experience while allowing the museum to predict how quickly they could move people through the exhibit. These constraints required the user's navigation to be guided through the virtual world, and the river analogy helped us address these issues.

In this application, the analogy of the river was taken quite literally. We defined a path through the virtual space as the river. The user was then guided through the space much like a water-skier behind an invisible boat. The boat or anchor moves along the path at a rate that varies as specified by the creator of the experience (the author). The user is then tethered to the anchor by a spring that constantly pulls them along. Meanwhile the user is free to look in any direction he or she chooses. Figure 1 shows the model we used. This model gives the user direct control over where they are looking while at the same time giving them indirect control over their local position. Looking in a given direction will impart some force in that direction and allow the user to swing over in that direction moving closer to the object they are watching. At the same time the boat continues to pull them along the journey, maintaining a sense of pacing and flow.

There are a series of parameters that can change the nature of this interface: the current and desired speed of the anchor, the amount of thrust the user is imparting, and the spring and damping constants. In this implementation, all of these values are free to change throughout the experience. The changes are encoded at

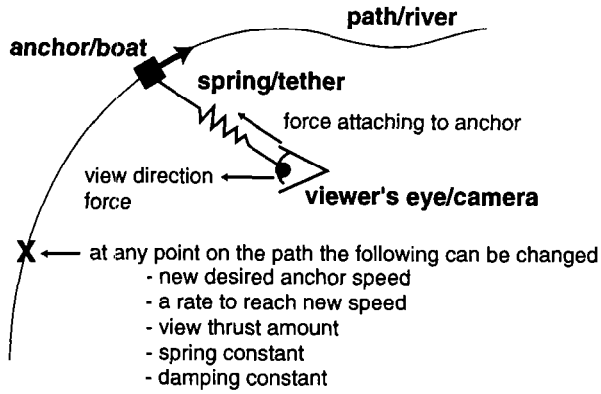

Figure 1: An application of the River Analogy, consisting of a number of different parts: the anchor moving along the path, a spring attaching the user position to the anchor, a thrust imparted by the user dictated by the direction the user is looking, and a general viscous damping to prevent the user from oscillating about the anchor position.

locations along the path, allowing the author to specify over which areas of the journey the user is more or less free to roam. For example, as the user approaches a larger open space the author many choose to slow down the anchor, decrease the spring and damping constants, and increase the viewer thrust allowing the user more latitude and time to explore. Alternatively, the author might focus the experience by increasing the spring constant, speeding up the anchor, and reducing the thrust.

5. CONCLUSION

It is clear that there are VR application for which the current methods of navigation are not sufficient. Some of these applications suggest the need for a method to guide the user as s/he navigates the virtual landscape. The River Analogy provides a way of thinking about how the author's intentions can steer the interaction given by the user to create a guided navigation. This paper has presented this analogy and one particular application of this analogy to an existing public VR exhibit. This work only begins to touch on the potential of guided interaction for virtual environments.

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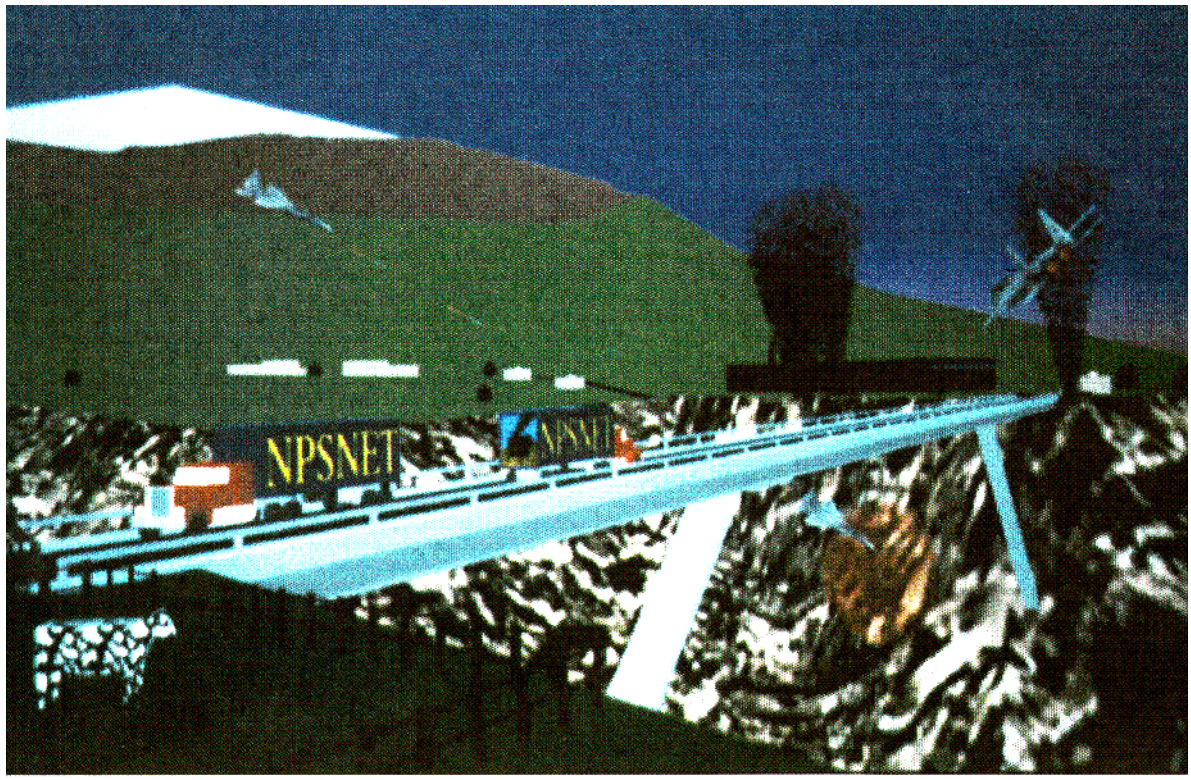

Macedonia, Brutzman, Zyda, Pratt, Barham, Falby, and Locke,
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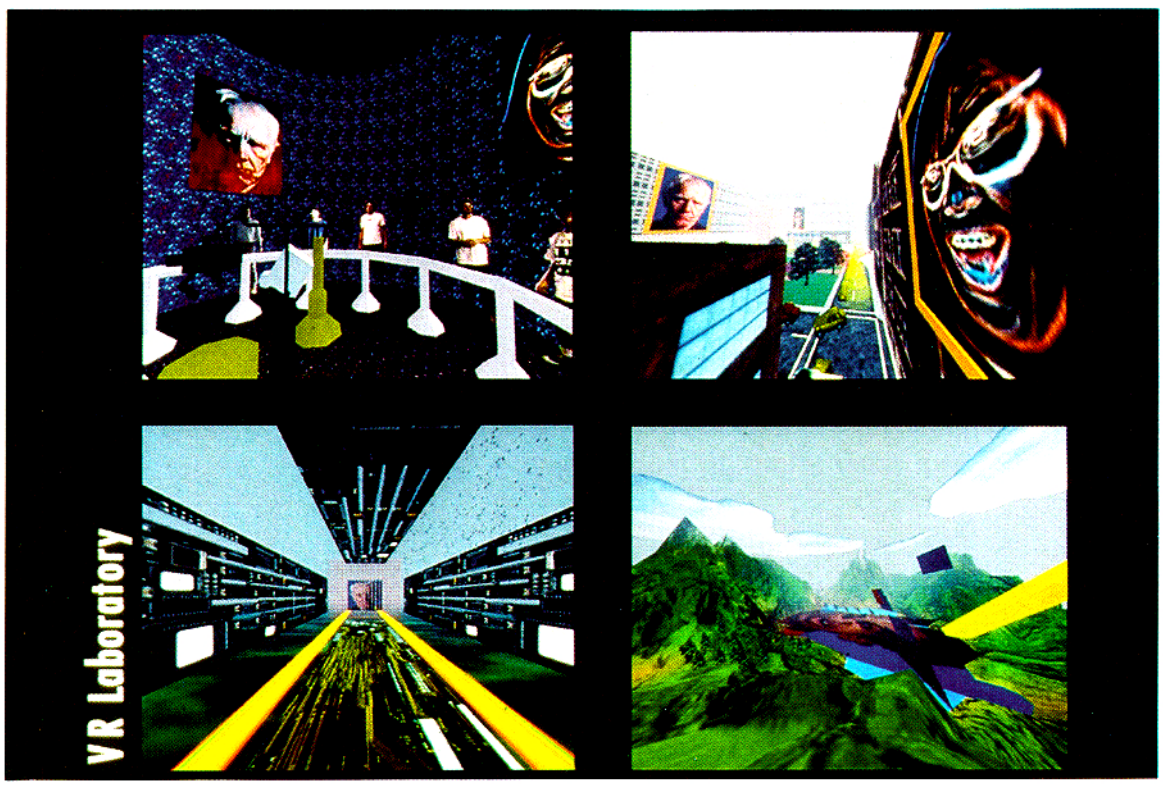

Four images of the virtual environment that visitors to the Chicago Museum of Science and Industry are guided through.

Galyean, "Guided Navigation of Virtual Environments"