THE ACTIVEWORLD TOOLKIT: ANALYZING AND VISUALIZING SOCIAL DIFFUSION PATTERNS IN 3D VIRTUAL WORLDS

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Abstract. The ActiveWorld toolkit is an open source toolkit developed at Indiana University. It allows researchers to explore social diffusion patterns in three-dimensional (3D) virtual worlds, specifically those built using ActiveWorlds technology. Written in pure Java, the toolkit provides the ability to not only visualize the structure of virtual worlds (spatial position of 3D objects, their size and orientation, age of objects in the world) on a true-to-scale map but also the activity of users' avatars inside the virtual worlds such as their idle positions, movement trails, actions performed (such as clicking or teleporting) or chatting behavior.

1. Introduction

Three-dimensional virtual worlds are increasingly being used in education[1] and research. There exists a large body of research dealing with design, construction and way-finding in virtual worlds. Recent work (Börner and Penumarthy, 2003) has done analysis and visualization of social diffusion patterns in 3D virtual worlds. Such identification of social patterns is very valuable in gaining insight into the behavior of users in a virtual world and can help answer questions such as "How effective is the leader in keeping his/her group of Avatars together?", "Are the navigation clues in the virtual world sufficient or do they result in confusion?" or "Which regions or objects in the virtual world attract the most attention?" etc. Visualization of users' behavior in virtual worlds enables researchers and designers of virtual worlds to get a good overview of the structure and usage patterns and can help understand the implications of a certain design.

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[1] A list of institutions involved in using virtual worlds for education in Active Worlds can be found at http://www.activeworlds.com/edu/awedu_participants.asp

In this paper we begin with a description of spatial, temporal and user activity data used in the ActiveWorld[2] toolkit and the procedure of using this data to map virtual worlds. Then we discuss the use of this toolkit in analyzing virtual worlds and provide examples of how questions such as those mentioned above can be answered using the toolkit. The paper concludes with a discussion and future work.

2. Spatial, Temporal and User Activity Data

The ActiveWorld toolkit can be used to map virtual worlds based on information about the set of 3D objects that make up this world or to visualize the activities of their virtual inhabitants. The latter requires access to user logs. Subsequently, we describe the respective data input for the application of the toolkit to ActiveWorlds[3].

2.1. 3D OBJECT DATA

The design of a world is described by two files: (1) a propdump file, which holds information about the placement of objects and their orientation in the world and (2) a registry file, which holds information about all possible objects that can be placed in the world, along with their dimensions. In order to map the world onto a 2D plane, a polygon is first constructed at the origin for each object as per the dimensions in the registry. The objects are then scaled according to a scaling factor that depends on the dimensions of the original world and the screen size of the visualization. Subsequently each object is translated and rotated as per the positional information provided in the propdump file. The result of these operations is a true-to-scale map of the virtual world.

2.2. USER LOGS

The Avatar's usage information is held in log files, gathered by bots in the virtual world. Bots look like Avatars in the virtual world, but are really just software components that serve to collect information about the activities performed by an Avatar in the world. We have set up bots in several worlds in the Quest Atlantis (Barab et al., In press) universe and LinkWorld (Börner et al., In press). Bots in ActiveWorlds have a limited "hearing range", i.e. they can capture information about events in the world only within a 400 meter radius, thus necessitating the placement of bots at several locations in the world. LinkWorld, for example, is large enough to require bots in 9

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[2] Henceforth referred to simply as 'the toolkit'. This toolkit can be downloaded from http://iv.slis.indiana.edu/sw/
[3] http://www.activeworlds.com

different areas. These bots continuously monitor their surroundings and log all activity to log files. The information logged includes timestamp, location in 3D coordinates, orientation and other data such as ID of the object that was clicked, or text of the chat for each action performed by an Avatar such as moving, talking or clicking.

3. Analyzing and Visualizing Virtual Worlds

The ActiveWorld toolkit provides designers, users and researchers of virtual worlds tools to evaluate the efficiency and suitability of a virtual world for a particular task. For example, consider an educational treasure hunt in a virtual world where the idea is to let kids follow clues to find treasure, picking up bits of information about issues such as environmental pollution, conservation of natural resources, etc. This requires designing the clues for the hunt in a way that is appropriate to the level of the users' cognitive abilities. Critical to the success of such an event is ability to successfully navigate through the world. Some questions about the treasure hunt that can be asked are "Were most of the users able to follow the clues and find their way through the world?", "Which group of users was most focused?", "Which users were lost and at what point?", "Which parts of the treasure hunt was most or least challenging?" etc.

The map in figure 1 shows the treasure hunt "Comidas!" that took place in LinkWorld[4], mapped using the toolkit. The lines indicate trails of the Avatars with color indicating the time. The age of the buildings is also encoded using color with older buildings shown as dark and progressively younger ones shown in brighter teal. A well-designed treasure hunt would show up on the map as organized trails. Extremely difficult to read clues would lead to confusion and the resultant random movement of the Avatars would be immediately seen on the map.

The toolkit also lets us concentrate on a single user or groups of users at a time. This allows us to find out, for example, whether a particular group of people converged over time or diffused over time.

In this map, we see that most of the users followed similar paths while navigating through the treasure hunt. This observation can be combined with the chat text analyses to confirm that the clues in the hunt were at a level appropriate for the users. Most users stick to the center, north and south-east of the world while a couple of users seem to make jumps to other directions, viz north-west, west and east. In addition, there is a user that has taken a very long trail from south-east to north, indicating that this user probably did not have any idea of his/her location.

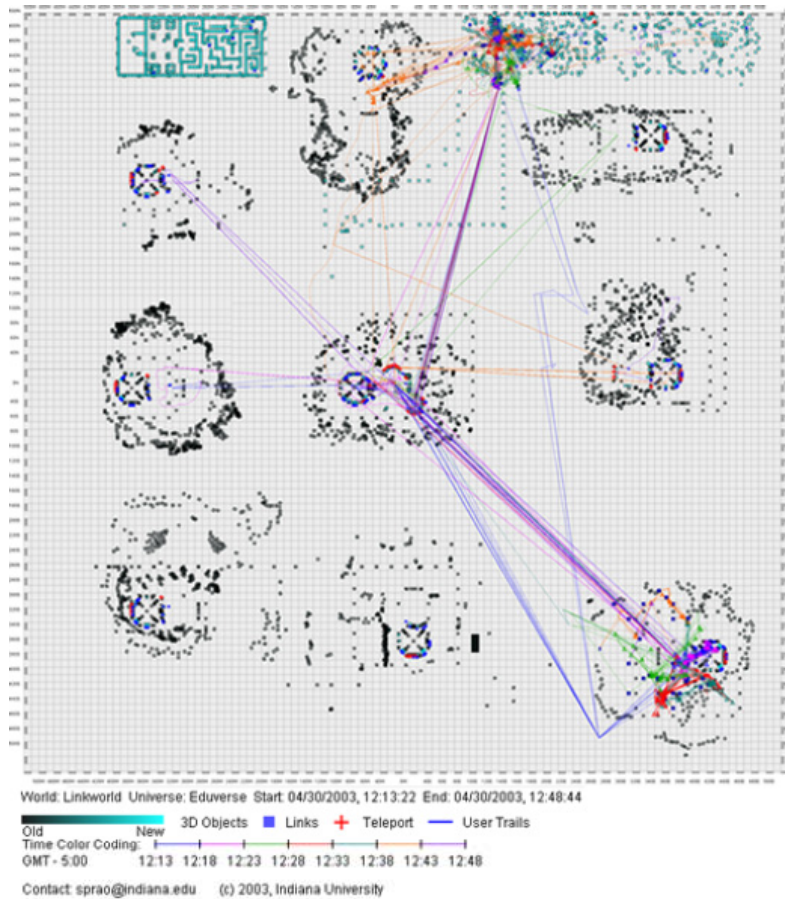[4] LinkWorld is one of the worlds built using ActiveWorlds technology for extensive use in the BorderLink project (http://www.borderlink.org/).

World: Linkworld Universe: Eduverse Start: 04/30/2003, 12:13:22 End: 04/30/2003, 12:48:44

Old   New   3D Objects ■ Links ✚ Teleport — User Trails
Time Color Coding:
GMT - 5:00   12:13 12:18 12:23 12:28 12:33 12:38 12:43 12:48

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Figure 1. Mapping *'Comidas*!*'* in LinkWorld

The toolkit can also visualize where users talked to each other. The chat text itself is also available through the log files and analysis of the chat can be done, for example, to identify the topics that were found to be most exciting by a group of people in the world. More detailed examples of analyses that have been done using this toolkit can be found in (Börner and Penumarthy, 2003).

4. Discussion and Future Work

The ActiveWorld toolkit is a novel tool for automatic mapping of virtual worlds and the analysis and visualization of spatially explicit, time coded

user data. Its application to the facilitation, optimization or study of online user data combined with pre and post-experiment questionnaires yields a rich collection of data that can be mined to discover patterns of behavior.

In the future, we hope to provide real-time mapping in the toolkit. This will allow for visualizing the activity of a virtual-world (modifications of 3D objects and user activity) as it happens. It is assumed that real-time visualizations will change user behavior and we plan to run experiments to see what changes of user behavior occur.

The presented toolkit can be seen as a proof of concept of a general toolkit that allows mapping of arbitrary spatially explicit events over time. The envisioned general toolkit will be applicable to map such diverse data as the trails of GPS users, the position and movement of RIF tagged products, the migration of paper authors or the diffusion of information over geographic and semantic space.

Acknowledgements

References

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