Researches on Model of Navigation in CVE*

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Abstract: The prospect of collaboration among geographically dispersed participants over a networked VR is quite attractive. As a promising technology, Collaborative Virtual Environment (CVE) has already had many experimental applications in the fields of geo-data visualization, collaborative design and scientific exploration. Since navigation performed by groups has its own characteristics that go beyond individual navigation, this paper mainly discusses the characteristics of navigation in CVE, and proposed a process model for collaborative navigation on the basis of individual navigation model.

Key words: CVE; collaborative navigation; model

1. INTRODUCTION

The prospect of collaboration among geographically dispersed participants over a networked virtual reality is quite attractive. CVE involve the use of distributed VR technology to support group work. A necessary, but not sufficient, condition for a CVE is the provision of simultaneous multi-user access to a virtual reality system. However, there may be a world of difference between a multi-user system and one that actually supports cooperative work, and so a second condition is that the system must explicitly consider and support the needs of users who wish to work together. The essence of CVE is that users are explicitly represented to each other within a shared space[1]. Furthermore, they should be free to move around within this space, encountering each other and also objects and information of common interest. The interactive nature of true virtual reality systems means that they should also be able to interact with each other and with the objects and information. The development of effective CVEs has greatly increased the scope of CSCW, and it is now foreseeable that in the near future there will be experts separated by great distances, who will be working on problems together within a Virtual Environment (VE). CVE supports independent viewpoints for its users. Users themselves are represented to others through some types of embodiments, such as a screen name, a cartoon figure or a picture. In CVEs that are rendered in 3D graphics, users have graphical embodiments that are usually called avatars. In a typical CVE, there will be many avatars that populate the virtual environment. Each avatar represents and is controlled by one of the users.

As a promising technology, Collaborative Virtual Environment (CVE) has already had many experimental applications in the fields of geo-data visualization, collaborative design and scientific exploration which are currently the domain of single user virtual reality applications may also offer possibilities for collaboration. Many of these applications have the element of collaborative navigation, in which several users explore the environment independently and then try to work together on some interesting points in the environment.

2. INDIVIDUAL NAVIGATION IN CVE

* This research was supported by a National Science Foundation (40371090).

It is not a trivial task for users to coordinate among themselves and to achieve their navigational goal in an virtual environment. Spence[2], Wickens[3] and Bakker[4]proposed some general frameworks for navigation processes. Spences' model spans a whole range of navigation tasks including those in physical, virtual and information spaces. In fact, his definition of navigation is "the creation and interpretation of an internal mental model"(Figure 1).

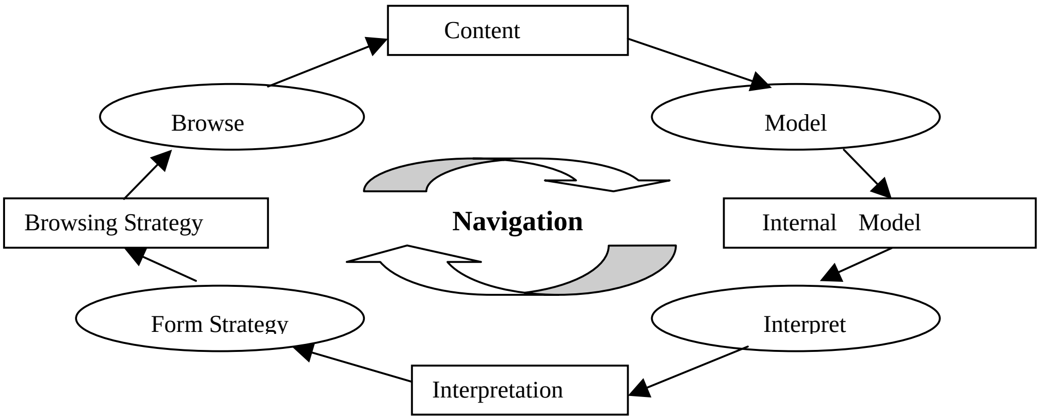

Figure 1. A general framework for navigation

The framework consists of four stages: *Browse stage*. The navigator perceptually registers the environmental content around him. The environmental content is the information that can be elicited from the navigation space. *Modeling stage*. The registered environmental content is used to build an internal mental model of the environment on both the local scale and a more global scale, providing understanding of what is perceptually available as well as how it fits into the larger picture. *Interpretation stage*. The internal mental model is used to decide whether the goal has been reached or whether the browsing strategy should be revised. *Formulate browsing strategy stage*. The browsing strategy is revised and a new direction for movement is chosen.

Though Spences' model is simple,it involes the components of Model(cognitive map), strategy, search (browse) and consist of recursive loops which are necessary for collaborative navigation.

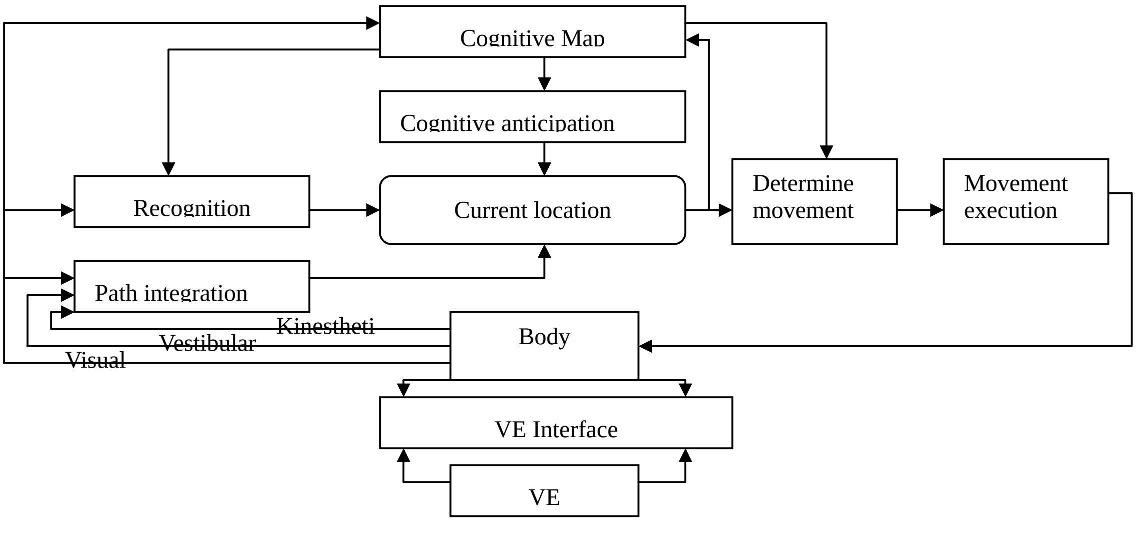

Figure 2. Bakkers' navigation model.

Figure2 shows Bakkers'navigation framework. The framework describes the mental processes and the information flows. The operator needs to have some internal representation of his own *current* *location*, both the position and the orientation, in order to determine a route or a direction of movement. *Recognition*, *path integration* and *cognitive anticipation* operate to determine the internal representation of the current location in the world. The model is applicable to immersive VE. Our collaborative navigation model is from many reference to the individual models.

3. COLLABORATIVE NAVIGATION

3.1 Features of Collaborative Navigation

The previous work deals mostly with the problem of individual navigation. Since navigation performed by groups has its own characteristics that go beyond individual navigation, we focus on the collaborative aspects of navigation in CVE. In the task of a scientific collaboratory, each of the scientists moves about the space and thus controls her viewpoint independently, and tries to find scientifically interesting points in the data space.They need to know their spatial surroundings, and coordinate themselves to accomplish their goal, which is often achieved through navigation in the space. This type of cooperative spatial navigation activity is named collaborative navigation[5]. I would like to list some characteristics.

a. Each participant has an independently controlled view of the environment. Different users can scan the virtual world from different angles and positions

b. Participants occasionally converge to a common location in order to discuss something interesting together.

c. Participant need to understand partners' perspectives. As Yang's experiment has shown[5], the overall collaborative navigation performance would be compromised if they do not know what their partner is looking at, and do not understand how the other's viewpoint is related to their own. As a result,

d. Participants have to know the environment to some extent.

The above characteristics specify some features that a successful collaborative navigation tool should support. At one time, there may be a clear definition of roles and responsibilities among participants, such leader. At another time, everyone may try to work on her/his own. Finally, people can work together yet without clear roles assignment. No matter what form of organization the navigators take, a collaborative navigation process is likely to require a system that supports the above listed characteristics.

3.2 Navigation model

Since the above features show that individual navigation can not apply in collaborative virtual environment, navigation model need to be developped. we are interested in the behavior of referring in conversation, since many of the difficulties in collaborative navigation are related to the problem of understanding what others are referring to[6].In this area, Clark's[7] model of referring communication is representative. In his model, referring is a recursive process of seeking mutual acceptance between conversation partners. In CVE, however, a pure verbal conversational model is not sufficient; since participants could use graphically represented action instead of utterances to communicate. These actions often serve as an indication or verification of the referent. A user may manipulate her avatar to face towards the referred object, or highlight the object using a light ray.

Based on previous research, we develop collaborative navigation model (Figure 3).The gray area is a spatial goal stack, which holds the user's task goal and the sub-goals. The dashed-line loop within the big rectangle is an evaluation process for handling incoming inputs from the visual or verbal channel, and for deciding which operation will be taken on the goal stack.. Verbal and visual scan input could trigger the evaluation process. Some new goals may be pushed in, or some

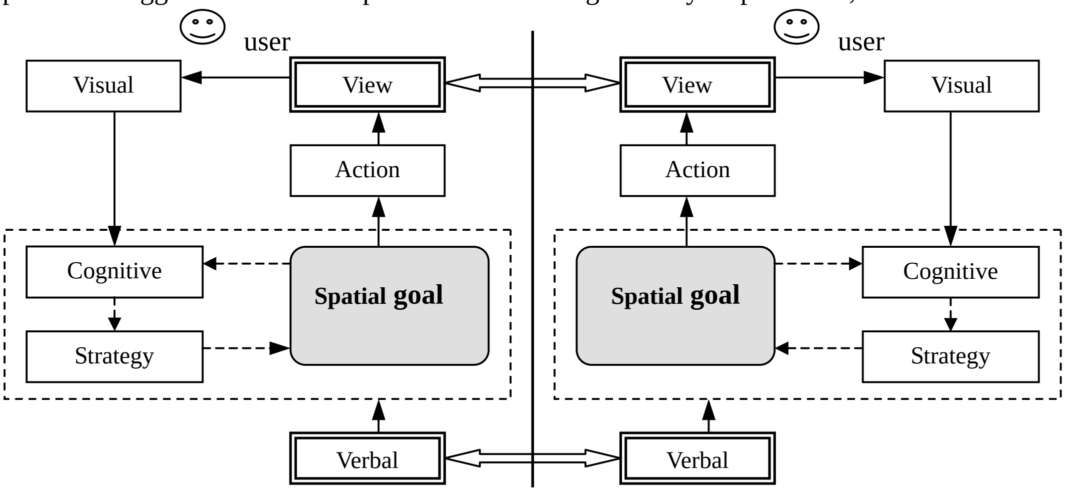

Figure3. Collaborative navigation model.

goals be popped out because of its evaluation being complete, or too difficult to accomplish. The solid arrow lines starting from spatial goal and back to cognitive map constitute the visual searching and tracking loop(Figure 4).

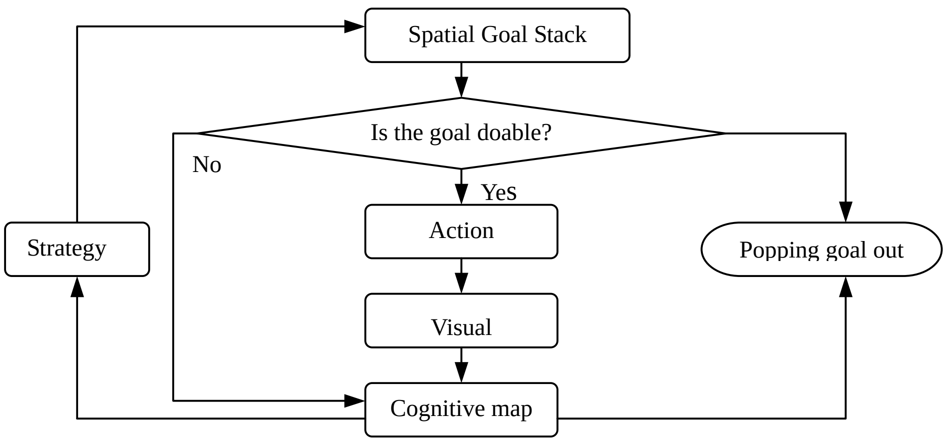

Figure4. Individual navigation process.

The collaborative part comes in when two individual navigation processes interact. The current state of technology supports two types of interaction between geographically distributed individuals: verbal communication and correlated views. When it is a serial process and time-consuming, people naturally turn to the visual channel, and try to make views across different sites correlated so that information can be transferred. We believe what is needed for a successful collaboration is not the shared view, but the shared mental model of what being worked on. Because of the currently limited channels (visual, verbal) available to convey information across distance, we have to better design the information presentation in these channels, so that the collaborative partners can correctly infer a shared model of the work environment. To do so, we need to examine the bigger loop across the site boundary(Figure 5):

The goal is to make the individual cognitive map gained during these big loops compatible with each other. Here, we are interested in finding the proper correlated views that ease the inference of a shared cognitive map. Views in different sites can be correlated in many ways, such as perspectives, LODs, scales and so on. Given a task, we want to study what are the good ways to correlate views in different sites, such that more useful information for constructing shared mental models is transferred.

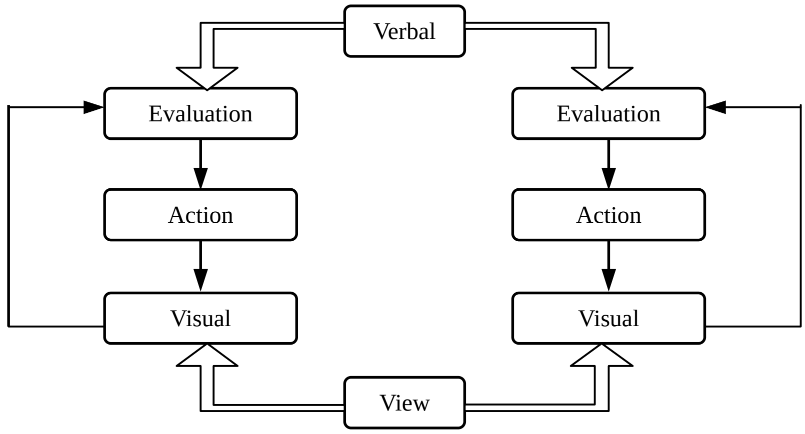

Figure5. Interaction loop process.

4.Conclusion

We have developed a simple collaborative virtual environment system. Based on our process model of collaborative navigation, we make some hypotheses regarding the effects of varying perspectives on collaborative navigation performance for the system. By our experiment, the hypotheses have been proved to be right. Although it is a work in progress, we have shown that our process model could make some predictions about the collaborative navigation performance under different display conditions. The research problem of how different perspectives affect collaborative navigation, many interesting issues still remain for further investigation. Then we can study concerning collaboration and spatial awareness on the basis of the model farther, which takes inportant role in theory.

5.References

[1]Gong Jianhua. Researches on distributed Geography Virtual Environment. (2004) http://www.jlgis.cuhk.edu.hk

[2] Spence, R. (1999). A Framework for Navigation. International Journal of Human-Computer Studies, 51(5), 919-945.

[3] Wickens, C. D. (1999). Frames of reference for navigation. In D. Gopher & A. Koriat (Eds.), Attention and Performance Xvii (Vol. 17, pp. 113-144). Cambridge, MA: MIT Press.

[4] N.H. Bakker. (2001). Spatial Orientation in Virtual Environments. Published and distributed by DUP Science.Netherlands.

[5] Yang, H., & Olson, G. M. (2002). Exploring Collaborative Navigation: the Effect of Perspectives on Group Performance. Proceedings of ACM CVE'2002 Conference on Collaborative Virtual Environment, 135-142.

[6] Churchill, E. F., Snowdon, D. N., & Munro, A. J. (2001). Collaborative virtual environments : digital places and spaces for interaction. London ; New York: Springer.

[7] Clark H,Wilkes-Gibbs D.(2001) Referring as a collaborative process. Cognition, 22, 1-39.