SHARED VIRTUAL SPACE FOR ARCHITECTURAL EDUCATION

SUNGHO WOO
Department of Environmental Engineering, Osaka University
2-1 Yamadaoka, Suita, Osaka, Japan, 565

AND

TSUYOSHI SASADA

Abstract. Our research in recent years has included the subject of providing co-operative work space in the field of architectural design. We propose raising the quality of architectural design by extending the physical space of the architectural laboratory into the virtual space of the network (i.e. Internet). In this paper, this extension is called Multi-user work space. The aim of this paper is to provide Multi-user work space with the feature of synchronous/asynchronous, bidirection and peer-to-peer/client-server, and to popularize architectural design by providing Multi-user work space with a seamless environment in time and space.

1. Introduction

Design support tools, for architectural CAD systems, have been developed to assist designers solve a variety of project specific problems, document and communicate the progress of design solutions. With the computer providing the medium for communication, recent developments in the World Wide Web (WWW) and its associated WWW viewers now provide a basis for people to interactively share information and to hold meetings while the participants are spread worldwide.

The WWW, in conjunction with tools such as Netscape, is an extremely effective mechanism for individuals to share and distribute information. In effect, WWW constitutes a storage area for static text, images, audio and documents, etc. to form a virtual office which is very useful for collaborative work. However, the user's interaction is unidirectional, asynchronous, and limited to a client/server model in which only predefined (and sometimes
dynamically determined) data are provided. In effect, as a storage area of information, WWW is data-driven, where the resources are simply passive data supplied by remote servers acting as proxies for data producers. Given WWW’s convenience of centralized access, we propose to augment WWW to support service-driven, real-time user interactions. These interactions are bidirectional, synchronous collaboration among participants in collaborative work. This paper discusses our recent work in merging these capabilities into WWW’s framework for collaborative design. Specifically, we describe how asynchronous and synchronous paradigms are reconciled, how interactive service is provided and propose new collaborative CAD system based on its concepts and lastly, verify its practicality and usefulness through a case study.

2. A model of collaborative CAD - Multi-user work space

When it comes to the process of collaborative design projects related to architecture and urban design in a university setting, a few conditions are needed for smooth collaboration using computers and networks. Participants located elsewhere can review designs and exchange views immediately in a seamless environment on the network. Furthermore, if required, participants can review designs, immediately operate an authoring tool, and record the results of the design review and the contents of modification using agent tools. The record of examination is saved automatically.

The established design system used in our university laboratory is a single-user application (not shared) by nature. It was developed as a tool to assist designers in the design review and recording changes while solving various specialized problems. Therefore, there is a functional discordance between the design tools for review and the groupware for long distance communication.

We propose the Multi-user work space system which extends the established design system. The group-oriented Multi-user work space system is a model of a design environment where the collaboration progresses smoothly between the university and students, or between the university and the architectural organizations designing a project. The Multi-user work space system is comprised of virtual space shared by participants and various tools provided for supporting design work in it. If needed, the Multi-user work space system has synchronous and asynchronous functions. Furthermore, the Multi-user work space system has interactive functions.
3. Virtual Space

Virtual space is the main work space of the Multi-user work space system and has an interface with various tools. It consists of shared virtual space and private virtual space. Shared virtual space allows multi-users to interact on the Internet. On the other hand private virtual space is not shared for private work. The shared virtual space allows many kinds of tools in the Multi-user work space system to be shared, and changes in the Multi-user work space system such as motion, data modifications and sound are transmitted to the users immediately. In this case, the problem of having a seamless environment in time and space is solved. The private virtual space has a function in a separate space (not shared) in the Multi-user work space system. The design process needs to set limits to the public, and needs to progress in private space until the design is partially completed. Thereafter, the shared Multi-user work space system accommodates changes. In addition, the people concerned in the design process are free from the restraints of being present at the same time and same place. This can be compared to using a bulletin board for communication. The asynchronous function improves the quality of communication or design.

Virtual space is based on a peer-to-peer approach with no centralized server, where peers communicate by IP multicast. Conceptually, the shared state can be seen as a memory shared over a network where a set of processes interact by making concurrent accesses to the shared memory. The peer-to-peer approach without a centralized server means that as long as any peer is active within a world, the world along with its objects remains "alive". Since objects are fully replicated (not approximated) at other nodes, they are independent of any one process and can exist independently of the creator.

The data in virtual space consists of Virtual Reality Modeling Language (VRML) data and Object data (Dive’s format data) on the WWW. VRML data is linked with other VRML data on the WWW, and is connected by virtual space anywhere in the world. In addition, it is possible to use text, images, movies and sound data on the WWW browser. Consistency and concurrency control of data is achieved by active replication and reliable multicast protocols. That is, objects are replicated at several nodes where the replica is kept consistent by being continuously updated. Updated messages are sent by multicast so that all nodes perform the same sequence of updates. The dynamic behaviour of objects may be described by interpretative scripts in Dive/Tcl that can be evaluated on any node where the object is replicated. A script is typically triggered by events in the system, such as user interaction signals, timers, collisions, etc. Users navigate in virtual space, see, meet and collaborate with other users and applications in the environment. A participant in a virtual space is called an actor, and is either a human user or
an automated application process. An actor is represented by a "body-icon" (or avatar), to facilitate the recognition and awareness of ongoing activities. The body-icon may be used as a template on which the actor's input devices are graphically modeled in virtual space.

4. Tools in shared virtual space

There are various tools for effective progress when users author and browse objects and communicate between participants in a virtual space. It augments WWW to support service-driven, real-time user interactions. And the form of these interactions is bidirectional collaboration between the participants in a collaborative work.

4.1. WEB ROBOTS DATABASE

Web Robots Databases are used to manage and effectively search the distributed data on the internet. The List of Active Robots has been changed to a new format. This format allows more information to be stored, allows, faster updates, and information to be more clearly presented. The Web Robots Database is composed of robot, intelligent agent and a search engine. A robot is a program that automatically traverses the Web's hypertext structure by retrieving a document, and recursively retrieving all documents that are referenced. Intelligent agents are programs that help users with things, such as choosing a product, or guiding a user to fill forms, or even helping users find things. A search engine is a program that searches through databases of HTML documents gathered by a robot. When needed, the Web Robots Database represents the data as an icon using a keyword search. The icon palette is called the parts box. In the parts box, macro, which defines the movement of objects in virtual space as well as object data, can be arranged. It is made of Dive/Tcl, and has its own interface window.

4.2. INTERACTIVE BULLETIN BOARD

The Interactive Bulletin board is a asynchronous or synchronous tool which enables effective communication between participants for smooth collaboration in virtual space. The project participants state his or her opinion on the WWW and exchange it using the bulletin board, which records a still image and text. To interact with an interactive bulletin board service, the user must be able to post new messages. For more efficiency, messages are also indexed. The home page of the interactive bulletin board is an HTML document that
displays a link to a fill-out form for posting new messages, and linkages to indices of existing bulletin board messages. The messages in the database are indexed by year/month and subject category.

To post a new message, a form on the home page of bulletin board is used to direct the user to choose a subject category and to activate the POST message button. Upon activation, a post message fill-out form is generated and displayed with keytext presented based on the chosen subject category. The user is prompted to select existing keytext, add new keytext, enter a message title, message text and images (if needed). There are no restrictions on the length of messages. The POST message button on the home page of bulletin board is activated to display this form. When the message is submitted, the Hyper Text Transfer Protocol (HTTP) server generates a HTML document for the new message and updates all corresponding keytext and index files, including the home page of the bulletin board.

The interactive bulletin board has an information server that supports user authorization and implements the CGI program interface. CGI is an interface for running external programs under the HTTP server on the WWW. CGI is a gateway which handles information requested from the client, and converts the result to the HTML document, and sends the HTML results to the client. CGI is linked with various resources in the world, and can use machine power and applications from a distance. It connects between applications and is operated componently to exchange applications if required.

4.3. DESIGN STUDIO

This tool produces the still-images of designs being created in virtual space considering environmental conditions. On the WWW browser, if some data, such as the position of the sun, its color and texture is inputted, radiance which calculates a shadow of the object displays the input result. Radiance is connected with the WWW using the Common Gateway Interface (CGI). Design studio allows the distributed user to use the machine power and renderer of server interactively. Likewise, it makes the design review possible with improved quality of the rendering in virtual space.

4.4. AUTHORING TOOL

The authoring tool is equipped with programs which manipulate various objects, produce executable macro, and then modify the objects. The authoring tool which is used for making Object data or VRML object-oriented data utilizes free software on the Internet. In order to decide on the design of virtual space, attribute data such as color, texture and shape, data is edited visually consulting the database.
4.5. BROWSING TOOL

The browsing tool is equipped with programs which edit and produce the results of the design review, and give the results as a format of a variety of hypermedia in virtual space. New types of design review use the concept of a time axis in virtual space. It is possible to reconsider the design contents after recording and reviewing the contents. The renovated presentation which contains a wide variety of data such as still images, animation and walkthroughs becomes prominent. To produce an animation which has been made using traditional recordings, one needs to integrate the previewer (tool to make the motion script), walkthrough and recorder. It analyzes the data of virtual space on various conditions and suggests an application which saves the results of the analysis.

5. Conclusion

The distinction between synchronous and asynchronous collaboration is somewhat arbitrary since there is no absolute dividing line between the two extremes. In some cases, participants receive very quick feedback from others. In other cases, the feedback time is more delayed (hours or days). Most systems are for asynchronous collaboration, meaning participants do not get immediate feedback. The reason is that the WWW clients talk with servers, and servers are passive, so clients cannot use servers to communicate automatically with other clients.

In this paper, we describe how to transfer our research from asynchronous, unidirectional and client-server to synchronous+asynchronous, bidirectional and peer-to-peer+client-server in collaborative CAD. Furthermore, we proposed a new collaborative CAD system allowing participants to interactively control with consistency, concurrence on the concepts.

Furthermore, in the architectural project, participants enter into a shared virtual space which they made, and review the design interactively. This system is an available environment for participants to access data made by collaboration on the WWW at anytime. Each participant can see what he or she wants using the interactive function, such as walkthroughs and examiners (review tool of rotating the object) and non-interactive functions, such as still images and animation, while he or she communicates with another participant.

Each participant can review the design in the Multi-user work space made by themselves. It is easy to use an authoring tool for making data, gathering opinions of participants on the bulletin board, VRML viewing and application analysis of the shadows from a distributed area. All of them is
composed componently. This design environment makes the design review possible at any stage of design in the Multi-user work space on the WWW. In this paper, interactive, synchronous Multi-user work space system makes it clear that there is the possibility of open architecture design with progressive communication between participants distributed geometrically.

References


Dean Taylor and Kevin O’connor:1997, Experiences with remote collaboration for concurrent engineering, in Mary L. M., John S. G.and Fay S.(eds), Formal Aspects of Collaborative CAD, IFIP97, Australia, p.29-48

http://206.79.196.34/avatar/Avtdefn.html
http://sap.mit.edu/dsof/research/creative_design.html
http://www.worlds.net:80/alphaworld/aw-about.html


Mao-Lin Chiu: 1997, Representations and Communication channels in collaborative architectural design, in Mary L. M., John S. G.and Fay S.(eds), Formal Aspects of Collaborative CAD, IFIP97, Australia, p.77-96

Milad Saad and Mary Lou Maher:1995, Exploring the Possibilities for Computer Support for Collaborative Designing, in Milton T. and Robert T. (eds), The Global Design Studio, CAADFutures 95, Singapore,


