A SYNCHRONOUS DISTRIBUTED VR MEETING WITH ANNOTATION AND DISCUSSION FUNCTIONS

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Abstract. Owing to cloud computing Virtual Reality (VR), a note PC or tablet with no necessity of high spec GPU can be used for sharing of a 3D virtual space in a synchronous distributed type design meeting. In this paper, in addition to sharing a 3D virtual space for a synchronous distributed type design meeting, we developed a prototype system that enables participants to sketch or make annotations and have discussions as well as add viewpoints to them. We applied these functions to evaluate an urban landscape examination. In conclusion, the proposed method was evaluated as being effective and feasible. Operation is limited with one person, and more optional shapes should be prepared in future work.

Keywords. Spatial design; distributed synchronization; cloud computing; annotation; discussion board.

1. Introduction

In the spatial design field such as architectural design, urban design, and industrial design, a consensus-building process among a variety of stakeholders such as project executors, designers, neighborhood residents, users, and general citizens is required. Since it is necessary to share three-dimensional images to study design, 3DCG (3-Dimensional Computer Graphics), VR (Virtual Reality) and BIM (Building Information Modeling) systems have been developed. Design meetings using these systems have been traditionally held in the same-room and at the same time. In recent years, the mobility of people’s activities, and cloud computing
technologies have become advanced in the modern age of information and globalization. Therefore, system developments and design trials of an asynchronous distributed type are used which means that stakeholders participate in the design process at different places and at different times (Maher and Simoff, 1999; Matsumoto et al., 2006). This allows expansion of communication opportunities, without a participant needing to worry about restrictions of space and time.

In a synchronous distributed type of environment, research on designs supporting a system for sharing three-dimensional virtual space exists. There is a system which allows designers to be physically immersed in their sketches and physical models, literally inside life-size, real-time representations of these, while sharing them remotely with another system of the same sort (Dorta et al., 2011). However, in this research, a framework for two or more stakeholders to participate in a design meeting of a synchronous distributed type using a standard spec PC is proposed. The data volume of the content of a design study is usually large. Therefore, when drawing 3D graphics with a client PC, a client PC with a high spec GPU (Graphics Processing Unit) is required (Gu et al., 2009; Shen and Kawakami, 2010). A standard spec PC cannot necessarily be used to participate in a design meeting. To solve this problem, Fukuda et al. (2012) presented the capability of a synchronous distributed type design meeting by using the cloud computing type VR (cloud-VR).

In cloud-VR, contents are transmitted by the video compression method of the H.264 standard. Commands about viewpoint change, plan changes, etc. of the three-dimensional virtual space on the client running on Microsoft Windows or Android OS or are calculated from the VR contents on a cloud computing type VR server. Then the calculated contents are displayed in real time on the client as a video, using the H.264 standard (Figure 1 and 2). One user can operate the virtual space of the cloud computing type VR, and the time for which it can be operated is less than 2 minutes. A user who wants to operate is allowed to operate it for less than 2 minutes. Therefore, this system has the following merits. 1) A highly efficient graphics environment is unnecessary in a client. Therefore, even at some sites or places where it is difficult to use a high-performance PC, it is still available on
mobile devices. 2) Plural participants can share a viewpoint, alternatives, or the VR setup in synchronization. 3) The VR application version or 3D contents are unified by the management on the server side.

Including the reported synchronous distributed 3D virtual space research (Fukuda et al., 2012), this study focuses on the annotation function – allowing freehand sketching in a 3D virtual space – and the discussion function – allowing stakeholders’ real-time text discussion about a place in a 3D virtual space to facilitate study of a spatial design. In a word, the system can be used with a note PC or Android OS tablet with no necessity for a high spec GPU. Moreover, it can use 3D virtual space, and meanwhile necessary sketches or memos can be added in a synchronous distributed type design meeting.

2. System Design

2.1. ANNOTATION FUNCTION

Apparently, when using 3D virtual space to explore a design, people expect to be able to draw a sketch, and add figures and memos to the 3D virtual space. For instance, people would like to draw arrows or sketches to indicate their notes and changes to a plan or VR content in a co-design work. Thus, annotation can be defined as freehand sketching in a 3D virtual space in this paper. To annotate, an intuitive and seamless interface is necessary so that a designer’s thoughts or a meeting may not be interrupted. Although a system based on pen interaction can already add annotations to VR contents and show them on a digital board (Fukuda et al., 2009), such a system is intended for a synchronous meeting where everyone is in the same place. Another system (Jung et al., 2001) has been executed by using Java3D and VRML (Virtual Reality Modelling Language), but this is available for the asynchronous distributed type meeting by using 3D virtual space. Above all,
we are aiming to develop a system that can be applied to a synchronous distributed meeting.

Annotation can be used not only to include 2D information but also to identify a certain position in 3D virtual space. In addition, a virtual camera must be set up to describe annotations. The requirements for annotation are below.

- Save an annotation in the form of XML. Each annotation has a category, a project id, and content information.
- An annotation can be open and closed in the 3D virtual space.
- In the Closed state, a new icon is put at the position where a new annotation is placed. Users can open it by clicking on the icon.
- In the Open state, install a virtual camera placed at the position of an annotation and show its content. When the VR virtual camera moves back from the position of the annotation, the content of the annotation gradually becomes transparent until it disappears completely.
- In the Edit state, place a camera at the position of an annotation, and show its content. While editing in a 3D virtual space, no other operations are allowed.
- To close the window, select whether to save or cancel changes generated by the editing process.
- An annotation can be copied and cancelled.
- When opening or editing an annotation, the background is supposed to be translucent for easy editing operation.

Also, a schema of an annotation requires the following conditions.

- Show the schema in 2D.
- Enable drawing of freehand sketches and/or basic shapes.
- Enable clicking on shapes (a polygon, circle, textbox, etc.) and select one.
- After selection of a shape, enable users to change its colour and transparency.
- After selection of a shape, enable users to change the colour, size and transparency of the border line.
- After selection of a shape, allow movement of the shape by dragging a mouse.
- Resize the shape if a form is resized or a vision field is changed.

2.2. DISCUSSION FUNCTION

In synchronous face-to-face meeting, sharing a 3D virtual space, oral discussion is carried out by using video conferencing systems. However, the conversation will be lost after it finishes.

On the other hand, although a common text-chat-system can store the contents of a conversation, it is difficult to specify the position and range of the virtual space. In order to solve these problems, Fukuda and Kaga (2005) presented a system linking the subject of a discussion to its position in the 3D virtual space.
However, it is an asynchronous distributed type, and only a limited point can be specified. So a certain range besides one point is also necessary as a discussion area.

The discussion function developed in this paper can display a discussion board upon a point or an area whose radius can be defined by a user. Furthermore, since it is difficult to discover a discussion board in the wide range of a 3D virtual space, adding viewpoint information with a discussion board to show the discussion board quickly is a useful feature. The following instructions describe the designed functions and concepts.

- Create a new discussion or its area: a user creates a new discussion board at any point in a 3D virtual space. The discussion board has a category, a project ID, longitude, latitude, a radius of the discussion area (0 in some case) and a password.
- View an existing discussion or its area: view the discussion or its area which has already been created.
- Edit an existing discussion or its area: edit the discussion or its area which has already been created. “Edit” here means to revise the discussion board information, including adding, editing, and deleting comments as well.

3. Verification

A prototype system was implemented based on the specifications described in section 2. Next, although the client needed to load annotations and/or discussion data from a server to display or update them for technical verification, the latency in this regard was small, and the system was suitable for use in a synchronous distributed meeting.

A case study of an urban landscape examination was given (Figure 3).

Figure 3. Screenshot of a synchronous distributed design meeting by using cloud-VR.
Supposedly, there was an imaginary VR project which was a renovation plan in Shimonoseki Buzenda shopping street (100m width, 350m extension), Shimonoseki City, Yamaguchi Prefecture, Japan. The content of cloud-VR was shown on a Windows laptop PC or Android OS tablet in the synchronous distributed meeting. Meanwhile, design work was being performed along with using a video conferencing system such as Skype. Combined results from the examination led to the following conclusions.

3.1. ANNOTATION FUNCTION

Figure 4 shows the annotation function’s flow, while Figure 5 shows the capture of a created annotation. The main menu for annotation edit provides functions as below.

- Button on the top right: cancel and save the edited operation
- Left button: tool buttons for drawing and editing a shape
- Bottom button: Select colour and set transparency or frame when drawing shapes.

In this imaginary project, typical work using the annotation function is described. Suppose a street has to be renewed and it must widen its sidewalk, a draft of where to place trees must be made, street lamps and benches have to be place, all taking account of many factors such as safety, function, security and infrastructure influence. Furthermore, according to the draft, tree species, lighting and bench forms would be selected and determined. The VR content can put a line around the areas which need to be revised, show what has to be moved using arrows, or note detailed information. An enclosed line enables users to highlight...
important things to be done. Also, participants are able to share the content intuitively. On the other hand, there are still many unclear problems, as described below.

- Editing of annotations is limited to only one person. That is, two or more participants cannot use the annotation function simultaneously right now. Nor can the same one be opened or re-edited before other users have closed it.
- Contents of annotations need to link with the displayed plan. In a design process, several plans are registered into VR, and usually discussed by comparing them. The developed annotation function was realized to connect viewpoint information. However, no link has yet been implemented between the annotation content and the displayed design alternative. Therefore, the annotation content sometimes does not match the displayed design alternative to which it should correspond.
- Since orthographic projection on VR is not yet available, it is difficult to sketch correctly in accordance with the scale.

3.2. DISCUSSION FUNCTION

The flow of the discussion function is shown in Figure 6, and Figure 7 is an icon showing the subject area being discussed.

The typical work using the discussion function was stated in this imaginary project. In order to offer rest areas, a small park is preferred to be located in a shopping street because it is easy for people to gather there. To explore a design for that, designers may set up a discussion board, and questions may arise such as from which direction people visit the shopping street or which intersection gathers the largest number of people. Then consultants who understand the amount of
pedestrian traffic give the right answers. Next, designers receive those answers and discuss the position of the small park. Because the discussion area function has been developed in this study, it is possible to specify the approximate area used for discussion. However, the challenges below remain.

Figure 6. The flow of the discussion function.

Figure 7. Icons of both the annotation and discussion functions.
Editing of discussions is limited to only one person. That is, two or more participants cannot edit discussion function simultaneously right now. Nor can the same discussion be opened or re-edited before other people have finished typing and then closed it. As result, it is necessary to inform participants of this procedure during a video conferencing system.

The best discussion board to use when spatial information is not necessary should be considered. In this study, the Skype chat system is used to discuss things without spatial information.

A discussion area cannot be defined except round a shape. On the other hand, it became clear that the discussion area is not limited to a circle shape during the design study. For instance, discussion areas defined by the vertical surface of a building façade, the line of a pedestrian way, or a polygonal shape created by free-hand drawing should be implemented.

4. Conclusion

This study has a designed annotation function and discussion function which are essential for a 3D virtual space in order to allow synchronous distributed meetings. A prototype system was developed and verified through a case study. The contributions of this research are as follows:

- The annotation function seamlessly enables users to draw sketches and shapes and add memos in a 3D virtual space by freehand. Because viewpoint information is also saved when writing an annotation, it has proved easy to reproduce. Problems remain, such as that annotation editing is limited to one person, so several people cannot edit the annotation function simultaneously. Also, the contents of annotations need to link with the displayed plan.
- The discussion function enables users to combine the information from a point or a certain area with textual discussions on a 3D virtual space. Future work on the discussion function should address the issues that discussion editing is also limited to only one person and two or more people cannot type discussions at the same time. Additionally, it is necessary to be able to specify a discussion area in various shapes.

It is necessary, as future work, through experiments involving meetings of three or more persons, real design project meetings, international meetings, etc. to investigate the possibilities for synchronously distributed VR meetings.

Acknowledgements

A portion of this research was done with the assistance of funded research by Ministry of Economy, Trade and Industry via FORUM8 Co., Ltd.
References


