Citizen Participatory Design Method using VR and A Blog as a Media in the Process

Tomohiro Fukuda, Atsuko Kaga, Hideaki Izumi and Takanori Terashima
This research concerned the establishment of a citizen participatory design method using VR (Virtual Reality) and CGM (Consumer Generated Media) as design media or a communication media in the design process. For this, problems in the citizen participatory design are addressed, and the continuous study method using VR and a blog is shown. Then, evaluation is conducted by considering an actual design project as a case study. Furthermore, VR functions needed through the case study are developed. Using this method, a small patio on which parasols were permanently and lawfully set up on a road lot was completed.
I. Introduction

In order to reproduce a downtown area which has problems of people and businesses leaving the city centre, and aging of society, an approach was developed in which local residents and storekeepers participate in the renovation process positively themselves, sending a continuous message that the community area is energetic and sustainable. For this, there has been an increasing need for effective use of open street space. For example, social experiments in which cafes extend into the street space temporarily have been increasing rapidly since 2003. To improve the charm of public spaces, there are two reasons that citizens’ participation in municipal affairs is indispensable [1]. One reason is that local residents have many ideas which can assist with a design. Another reason is that local residents continue to have an interest in the state of their town when they participate positively in community development of an area. Such participation produces the attractive idea leading to the design described previously.

When taking forward space study with a citizens’ participatory design method, the validity of VR has already been shown to be an effective communication tool among stakeholders [2-7]. The VR system is intuitive and easy to understand interactively [8]. The authors describe a VR system developed until now. At first, the interior design system [9], the bridge environmental design system [10], and the landscape design system [11], etc. were developed by using VRML (Virtual Reality Modeling Language) and Java as a toolkit. These systems work on a note PC with a Windows OS. However, there were also restrictions of hardware or software, and the frame rate had to be set to 1-2fps (frames per second) in order to maintain the quality of representation required for evaluation of an environmental design. Therefore, this was not sufficient for real-time rendering for which 10 or more fps is needed. However, evaluation of the environmental design by CG still picture, animation, photo montage, and a physical model was most useful, and this system was innovative. In recent years, Virtools Dev and UC-win/Road which are commercial VR software has been developed as a toolkit. This allows the systems development period and the contents creation period to be shortened, and also permits a reduction of data load time through optimization of the data structure. Based on this toolkit, the following were developed: a road environmental design system [12], picture overlay systems such as a hand-drawn sketch and a concept visualization system using particles [13], a dome type screen system which can display a life-size scale [14], an environmental design support system which can treat space and activity in integration [15], a landscape evaluation system using a cellular phone with a GPS camera [16], a soil calculation system [17], and a traffic simulation system for LRT [18]. Furthermore, in order to evaluate these VR systems, they were applied to an actual environmental design project and were evaluated (Figure 1).
However, no reports have yet been made on using VR continuously after specifying a design process. Moreover, it is necessary to consider how media other than 3-dimensional media (records of meetings, existing examples, master plan, etc. in text or picture form) are unified with three dimensions.

This research is advanced in the following three ways. First, problems in the citizen participatory design method are addressed and a continuous study method using VR and a blog (web-log) is shown. Next, evaluation is conducted by applying the study method to consideration of an actual open space design as a case study project. Finally, further VR functions that are needed are developed as a result of evaluation.

2. Citizen participatory design and continuous design study using VR and a blog

2.1. Consideration of citizen participatory design process

Generally the stakeholders connected with a design process can be classified into the four following categories.

- **Project executor:** A project executor runs an enterprise. An individual, a council, a company, etc. can be set as project executor in a civilian enterprise. In a public enterprise the project executor is a government.
- **Design team:** A design team answers to the project executor and creates design alternatives. Moreover, in addition to architects, consultants, etc. who create design alternatives, academic experts who make suggestions on the design alternatives from a technical standpoint are contained in a design team.
- **Citizen:** A local resident has an interest and is influenced directly by the undertaking of a project. A general citizen is most susceptible to the influence of construction and completion as a user.
- **Administrator:** An administrator manages the facilities which are the object of a design. An individual, a council, a company, etc. can be set as an administrator in a civilian enterprise. In a public enterprise the administrator is a government.

A design process proceeds through the following three stages, in which these four stakeholders are involved.
1. The design team creates design alternatives.
2. The stakeholders have a meeting and the design alternatives are studied.
3. The design alternatives are re-created to find the optimal solution as a result of the study.

In the citizen participatory design of this research, the degree to which local residents participate in a design is determined by the “Citizen Power” scale which is from No.6 to 8 in Table 1[19].

<table>
<thead>
<tr>
<th>Rank</th>
<th>Citizen Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Citizen Control</td>
</tr>
<tr>
<td>7</td>
<td>Delegated Power</td>
</tr>
<tr>
<td>6</td>
<td>Partnership</td>
</tr>
<tr>
<td>5</td>
<td>Placation</td>
</tr>
<tr>
<td>4</td>
<td>Consultation</td>
</tr>
<tr>
<td>3</td>
<td>Informing</td>
</tr>
<tr>
<td>2</td>
<td>Therapy</td>
</tr>
<tr>
<td>1</td>
<td>Manipulation</td>
</tr>
</tbody>
</table>

Figure 2 shows the general stakeholders in a citizen participatory design process. The features and considerations are the following:

- Promotion of the continuous design study among a number of stakeholders: A method of continuously supporting the design process is needed. As data required for study, in addition to 3D models such as VR, texts and pictures such as records of meetings, an advanced example, and master plan data are included.
- Design creation and study by collaboration between local residents and a design team: A designer must work with residents, seeing the situation from their viewpoint.
- Restrictions on the time and the place for a face-to-face type meeting: It is necessary for absentees and new participants at a meeting to rapidly understand the process of study.
- Growth of the community through a participatory process: Through this process, consciousness of the importance of community development is raised and the independent maintenance and operation is expected after spatial completion is completed.
2.2. Continuous design study using VR and A blog VR

VR has already developed some functions with high accuracy, such as comparison of a current condition and design alternatives, sunlight shadow simulation, described in Chapter 1. It is proposed that VR is used not to present the completed design contents in the final stage as the presentation model, but also to show VR content of a design study at every meeting, like a physical study model. Although producing VR content in parallel with design study many problems, it was produced according to the content of each design study. In this study, 3ds MAX is used as 3D modeling software, and Virtools is used as VR software. Figure 3 shows the system flow to create VR contents, a 3ds MAX screen shot, a Virtools screen shot, and a baked texture material with lighting simulation. Table 2 shows the specification of the notebook PC that VR contents execute. Table 3 shows developed VR functions. Some functions in italic type in Table 3 were used in the case study of Chapter 3.

Computer

<table>
<thead>
<tr>
<th>Computer</th>
<th>Sony VAIO PCG-6E1N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Intel Pentium M 2.13 GHz</td>
</tr>
<tr>
<td>RAM</td>
<td>1.00 GB</td>
</tr>
<tr>
<td>VRAM</td>
<td>128MB (NVIDIA GeForce Go6200)</td>
</tr>
<tr>
<td>OS</td>
<td>Microsoft Windows XP</td>
</tr>
<tr>
<td>Resolution (pixels)</td>
<td>1024 by 768</td>
</tr>
</tbody>
</table>

A Blog as middleware of the design tool

Design studies are often advanced by holding face-to-face meetings. However, since not all members can attend every meeting, a system for sharing the design contents and arguments is needed. Therefore, the authors focus on CGM. This can improve communication because each stakeholder offers and shares information. The reasons authors adopt the blog system instead of the bulletin board system for CGM is as follows. The blog system can store multimedia, such as text, drawings, CG still pictures, CG
animations, and VR along a time-line. Formal and informal asynchronous communication can be performed. Information can be updated easily. Information can be categorised. Information is easily controllable person by person. VR contents are hyperlinked from a blog page (Figure 4). The blog server in this study is shown in Table 4.

**Table 3. Developed VR functions [12-18].**

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewpoint setting</td>
</tr>
<tr>
<td><strong>Fly-through</strong></td>
</tr>
<tr>
<td><strong>Walk-through</strong></td>
</tr>
</tbody>
</table>

**Navigation**

- Plural camera viewing
- Camera height / speed / angle setting
- 2D map
- Plan / Section view
- Visible length setting

**Comparison of design alternatives**

**Object Allocation study (translation / rotation)**

**Nightscape simulation**

**Design study**

- Overlay mapping
- Object scale change
- Soil calculation
- Traffic simulation

**Human activity study**

**Design presentation**

- Amination
- Flow visualization
- 3D sound

**Table 4. Specification of the blog server.**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS</td>
<td>Linux (Fedora 4)</td>
</tr>
<tr>
<td>Web server</td>
<td>Apache ver. 1.3</td>
</tr>
<tr>
<td>Database</td>
<td>MySQL ver. 1.41</td>
</tr>
<tr>
<td>Scripting language</td>
<td>php ver. 4.42</td>
</tr>
<tr>
<td>Blog software</td>
<td>blogn+</td>
</tr>
</tbody>
</table>

Figure 4. Connection between VR and blog.
Anticipated subjects in using VR and a blog continuously

The anticipated subjects in using VR and a blog continuously for a design study are described below (Table 5).

- Regarding VR work, the design process does not yet address how VR contents should be produced efficiently.
- Regarding VR use, in the citizen participatory design, it has not yet been established what functions are required to allow effective inquiries using VR continuously.
- Regarding blog, a gradual method of information disclosure has not been established.
- Regarding blog work, it has not yet been established how far time and work effort can be reduced compared with a bulletin board system etc.
- Regarding blog use, it has not yet been established how understanding of a study process can be deepened by using a blog.

<table>
<thead>
<tr>
<th>WORK</th>
<th>USE</th>
</tr>
</thead>
</table>
| **VR** | Design process doesn’t address how VR contents should be produced efficiently.  
It has not been established what functions are required to allow effective inquiries using VR continuously. |
| **BLOG** | It has not been established how far time and work effort can be reduced compared with a BBS.  
It has not been established how understanding of a study process can be deepened by using a blog. |

A gradual method of information disclosure has not been established.

### 3. Application and evaluation of the design study method in a case study project

#### 3.1. Citizen participatory patio design project

The citizen participatory real design project is a small patio, which is a road lot, and surrounded by buildings in downtown Takamatsu city, Japan. Originally, there were benches, signs, electric poles, garbage cans, etc. all over the open space in disorder. Moreover, multiple-purpose and constant use of the area was not possible. Therefore, the design concept removed the existing unnecessary elements (Figure 5). In this project, three shopping malls and a residents’ association established the patio council, and this council furthered the plan as the project executor. Moreover, the patio council members took a lead role in furthering the plan, took responsibility for maintenance, and planned events. Figure 6 shows the design process and stakeholders. There were four main steps in the design process of the patio. First, a designer and design team created design alternatives. Then, the patio council studied the alternatives. The alternatives were re-created based on the patio council’s study. Then, administrators, such as the government and the police, studied the alternatives. Design publicity was carried out from
the stage where the consensus-building of the alternatives was carried out to the last stage. The process continued with feedback. Table 6 shows the design process and VR application. All “Step 1” meetings are abbreviated in Table 6 because some “Step 1” meetings are always held before “Step 2” meetings. Figure 7 shows the representative photos in the design process.

Figure 5. Patio design project: (1: Aerial photo, 2 & 3: Plan and photo of original condition, 4: Final plan).

Figure 6. Design process and stakeholders of the patio project.

<table>
<thead>
<tr>
<th>Date</th>
<th>Step in Figure 6</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Contents of study</th>
</tr>
</thead>
</table>
| 4/6/2005   | Council meeting 1|               |                                                                      | - Activity report of the previous year  
- Policy of year 2005                                                          |
| 5/25/2005  | Council meeting 2|               |                                                                      | - Introduction of patio examples  
- Discussion about operational management of patio  
- Introduction of VR                                                      |
| 6/10/2005  | Council meeting 3|               |                                                                      | - Analysis of current patio                                           |
| 6/17/2005  | Council meeting 4|               |                                                                      | - Introduction of operational management of patio examples  
- 1st design alternatives of patio                                         |
| 7/1/2005   | Meeting with city government |   |                                                                      | - Confirmation of division of roles of patio project                        |
| 7/11/2005  | Council meeting 5|               |                                                                      | - Establishment of a policy of the patio council                           |
| 7/15/2005  | Council meeting 6|               |                                                                      | - 1st nightscape design alternatives of patio                              |
| 8/11/2005  | Council meeting 7|               |                                                                      | - Study on approximate estimate sheet of construction  
- Establishment of nightscape policy                                           |
| 8/12/2005  | Meeting with fire station |   |                                                                      | - Discussion about fire protection equipment on patio                       |
| 8/12/2005  | Meeting with city government |   |                                                                      | - Presentation of the patio council’s design alternatives  
- Discussion about division of roles of construction and operational management |
| 9/22/2005  | Council meeting 8|               |                                                                      | - Report on the result of discussions with city government  
- Confirmation of plan                                                        |
| 10/24/2005 | Meeting with all administrators |   |                                                                      | - Presentation of the patio council’s design alternatives  
- Sharing of problems                                                         |
| 11/11/2005 | Meeting with police department |   |                                                                      | - Presentation of the patio council’s design alternatives  
- Discussion about permission for occupancy of roads                         |
| 2/1/2006   | Council meeting 9|               |                                                                      | - Report on rejected subsidy  
- Policy of year 2006  
- Study on public events                                                      |
| 3/18-19/2006| Public event     |               |                                                                      | - Presentation of future patio (VR, MR)  
- Lighting experiment                                                         |
| 9/21/2006  | Council meeting 10|              |                                                                      | - Report on modified design policy                                           |
| 10/3/2006  | Council meeting 11|              |                                                                      | - Study of detailed design (parasol, pavement, etc)                       |
| 10/18/2006 | Council meeting 12|              |                                                                      | - Study of detailed design (parasols, pavement, etc)  
- Study on patio naming                                                       |

* Table 6. Design process and VR application (Bold & Italic: VR application).*
3.2. Application result of VR

A total of 22 study meetings were held from April, 2005 to October, 2006. In these, VR was utilized a total of 13 times. The main contents of the study are shown in Figure 8. Next, the work associated with VR contents is considered. As a result of producing content required for the design study preferentially for a short period of time, working efficiency improved. The detailed buildings around the patio, 3-dimensional trees, and the night view, which required much work, were made later on. Moreover, when design alternatives needed to be studied the day after a design meeting, data optimization work was done after the meeting ended. In addition, it became clear that the amount of data needed a management method (Figure 9).

The use of VR is considered. In this regard, reaching an exact understanding of space according to the content of the space study, and lively discussion on the design are mentioned. The latter is described in Figure 8. Application process of VR.

Figure 8. Application process of VR.

Figure 9. Number of polygons and texture size along the design process.

Figure 9. Number of polygons and texture size along the design process.
more detail. From the initial stage of a design process, VR of rough accuracy was shown, like a study model. In the initial stages, there were few opinions from the patio council members because it was the first time for council members who were non-professional to see VR. However, after three months of VR use, more opinions were expressed because council members were familiar to VR. Problems included raising the quality of representation of people, and a study function with greater dialogism. Chapter 4 is described to solve some of the problems.

3.3. Application result of blog

Figure 10 shows the blog interface and category of the patio project. The blog articles were exhibited separately from the articles only for stakeholders and the articles for public presentation. Article inspection rights were established for the former. The number of stakeholders was 40 in total, such as the patio council members and professionals. Moreover, the paper was devised so that it might be easy to access the information which a visitor wanted to acquire by classifying this information into two class categories. Next, the work associated with blog contents is considered. Work time and effort reduced sharply in regard to the input of reports, the layout design, user management, etc. as compared with the bulletin board system. Moreover, regarding rulemaking of information disclosure in the specialist team, this was fully established in advance and made available to the public. Therefore, the stakeholders involved in various positions were able to peruse it. Problems include the stability of system employment, and consideration of the information shortfall.

Next, blog use is considered. The blog was found to be very effective in allowing a virtual meeting between absentees and stakeholders involved in participation in the study process. Moreover, information exchange was
facilitated by public presentation of the study process. For example, a student from another university applied to hold a social experiment in the patio. It can be said that the blog offered a meeting place for people. However, a problem was that there were the only three comments uploaded from the patio council members. The blog was used to see project information like the bulletin board. Therefore, it was few to make the best use of an interactive feature of the blog such as comments and trackbacks. There were two reasons considered. The first reason is member’s age group was highly unfamiliar with PC operation compared to younger people. The second one is the member had met face-to-face frequently.

4. Development of VR functions needed as a result of evaluation

Two functions shown in italic type in Table 7 were developed. These were among the functions which the case study found should be extended by VR.

<table>
<thead>
<tr>
<th>Representation of contents</th>
<th>Human</th>
<th>Motion and direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>Seasonal change and secular change</td>
<td></td>
</tr>
<tr>
<td>Weather</td>
<td>Change of weather, such as fine weather and rainy weather</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>Solar dazzle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement in accuracy of lighting simulation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interface</th>
<th>Space design study support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Still picture automatic creation function corresponding to the combination of all alternatives</td>
</tr>
<tr>
<td></td>
<td>Edit, saving, and loading of a alternatives</td>
</tr>
<tr>
<td>Design process support</td>
<td>Display of the design process in network type VR</td>
</tr>
<tr>
<td>Extension of an experience</td>
<td>Sound environment</td>
</tr>
<tr>
<td>Function</td>
<td>Smell of the environment</td>
</tr>
<tr>
<td></td>
<td>Textures of an objective surface</td>
</tr>
<tr>
<td></td>
<td>Smell of the space</td>
</tr>
<tr>
<td></td>
<td>Space temperature</td>
</tr>
</tbody>
</table>

4.1. Representation of a human’s motion or direction

In this research, in order to provide high quality representation in a close-range view, photographic 2D data was used for representation of human beings. A 3Dsprites function was added to this data so that a 2D data source always has its surface facing into the camera. However, this method can be correctly expressed neither for the activity with a motion, nor directive activity. Development of the representation method of a motion and the representation method corresponding to all viewpoints was called for through the case study. Pictures and a script are needed both for showing the person’s motions and for showing a 360-degree view from this person’s viewpoint. The picture generation process is described. First, a video of a person is recorded. A video showing the person’s motions and a video showing a 360-degree view from this person’s viewpoint are recorded at
this time. Next, a loop section is extracted by movie editing software. Furthermore, each frame is changed into a still picture. Finally, color adjustment and alpha channel generation of each still picture are performed by batch processing. Next, the processing flows of a script are shown; No. 1 of Figure 11 for showing the person’s motions, and No. 3 of Figure 11 for showing a 360-degree view from this person’s viewpoint. The sum total number of sheets of still pictures to be used is “a” (constant). The number of still pictures displayed with each frame at the time of VR reproduction is “t” (variable). The result shows the No. 2 and No. 4 of Figure 11.

4.2. VR Still pictures automatic creation function corresponding to the combination of all alternatives

In the case study, carrying out a screen capture of the VR image and creating a still picture was done by combining alternatives to the viewpoint place manually from the menu screen. However, when alternatives and the viewpoint place which should be studied in a study item are varied and there are a large number of combinations, the time and effort of creation itself is huge. For example, in a case study, a total of 420 sheets of still pictures were needed for the pavement plan of ten alternatives, the parasol plan of seven alternatives, the tree protector of two alternatives, and three points of viewpoint places. Figure 12 shows system flow and VR still pictures generated automatically.

5. Conclusion

In this research, the continuous study method using VR and a blog as design media or a communication media in the design process is shown for the establishment of a citizen participatory design method. Regarding VR work, as a result of producing content required for the design study preferentially for a short period of time, working efficiency improved. Regarding VR use, VR of rough accuracy was shown from the initial stage of a design process. More opinions were expressed three months after starting of the project.
Regarding blog work, work time and effort reduced sharply in regard to the input as compared with a bulletin board system. Regarding blog use, blog was found to be very effective in allowing a virtual meeting between absentees and stakeholders in the process. A questionnaire result which has obtained a very high evaluation because respondents who were not professionals could understand plans intuitively was obtained. The system also helps to build trust among stakeholders.

Through the citizen participatory design process, the patio was completed in August 2007. In Japan, it is still very rare to set up parasols permanently and lawfully on a road lot. Over a period of one year since completion of construction, the patio council members have organized more than 10 events (Figure 13). A presentation of the satisfactory solution for each position, continuous tenacious deliberations, and an intelligible communication tool were required in order to realize this. This new example is realizable with the continuous design study and tenacious deliberations using VR.

In future work, adding to the solution of VR extension functions shown in Table 7, it will be necessary to consider the problem of who makes 3D data. In this research, the designer team created all the 3D data of the
current condition and the design alternatives. At present, the designer team which uses 3D data in the design process is still restricted. If role assignment is organized in which the government, which is the primary contractor, offers the current data, and a designer team creates only the design alternatives, the time and effort of data work of the designer team can be reduced, which will enable more designer teams to create 3D data than is possible at present. For that, it is necessary to consider the role assignment of data work etc.

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