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VIRTUAL RYOANJI PROJECT: Implementing a Computer-
assisted Collaborative Working Environment of a Virtual
Temple Garden

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Abstract: This paper introduces a simultaneous multi-user system that enables collaborative work over the computer network. In particular, we focus on the garden planning of a traditional Japanese temple. We reproduced the stone garden of Ryoanji Temple, Kyoto, in cyberspace using VRML and developed a multi-user network tool that allows participants in different locations to carry out a collaborative work of arranging stones within this cyber-garden. We added some new extensions on top of Community Place browser ⁽⁴⁾, Sony Co., so that the participants could interactively reflect their actions and communicate simultaneously. The cyber-garden model is written in VRML 2.0 ⁽⁹⁾ and Java. The result of each collaborative exercise is also uploaded on the Web in VRML format, and are accessible by the general users using ordinary VRML browsers; thus subject to public evaluation.

Keywords: 3D multi-user environment, avatar manipulation, collaborative work, cyber-garden, VRML 2.0.

1. Introduction

Rapid progress of the Internet has brought the possibility of computer-assisted urban planning and decision making over the network. The three-dimensional virtual environment, in particular, would give an intuitively comprehensive solution to both the output and the process of urban planning. It would also provide a better chance of citizen participation where users could share a virtual space to present their ideas, discuss with each other and develop a collaborative work.

For instance, suppose that two people in different locations “log in” to the same server machine from their local network computer. The server machine would provide a “cyberspace,” i.e. a space shared in common by various users who are logged in via computer network. By manipulating their own avatar, users can communicate with each other in the cyberspace. VRML (Virtual Reality Modeling Language) ^{(2), (8), (9)} is a technology that allows us to reproduce such cyberspace in the form of three-dimensional space similar to the real world. Changes in VRML and



Figure 1. Stone Garden of Ryoanji Temple, Kyoto, in the 16th century.

other Internet technologies are covered in the next section.

Our project focuses on the implementation of a simultaneous multi-user collaborative environment. As a first step to the implementation, we will, rather than trying to create a full-featured planning tool in a single bound, focus on the garden-planning model of a traditional Japanese temple. Ryoanji, Kyoto, is noted for the beauty of its stone

garden originally constructed in the 16th Century. Figure 1 shows the old record of the stones arranged in Ryoanji (Please refer to Appendix A for the images of today's Ryoanji). We reproduced the garden in cyberspace using VRML and developed a multi-user network tool that allows several participants in different locations to carry out a collaborative work of arranging stones within this cyber-garden. Each participant is represented with an avatar so that their movements will be clearly acknowledged by the others. By manipulating their own avatars, the participants can "lift," "move" and "fix" the stones to build an ideal cyber-garden of their own.

When fully developed, the Ryoanji model will be applicable to collaborative working system for urban planning where citizens in different locations can simultaneously experience the virtual town construction as if they are manipulating the real city. In the past, planners had to assemble in one place to draw maps and build models of each option; with the aid of a collaborative working tool, the entire planning procedure could be carried out within virtual space with relative ease. It would significantly promote citizen participation.

In the following sections, we will explain the details of our garden planning tool. We will start off with the technical and social backgrounds of our Ryoanji Garden Planning Tool. We will then go through the concept of the tool, the actual process of arranging the stones, methods of exhibition and evaluation, the interface, possibilities of future developments and conclusion, followed by an appendix of prototype source code.

2. Technical and Social Backgrounds

First, we will briefly review the technical background of the Internet service, especially that of VRML, and the application of World Wide Web in urban planning both of which form the basis of our Ryoanji Garden Planning Tool.

(1) Elements of Internet Service

Before the Internet was brought into the world, all computer terminals were linked to those only within the same local network. They couldn't share information with computers connected to other networks, and each network existed separately. However, once the Internet was built, all the local networks were linked together; making every network computer capable of communicating with all the other computers even those on the opposite side of the earth.

Initially, the kind of data exchanged was limited to ASCII code characters. Text files were transmitted by using network tools such as ftp and telnet. Various E-mail-related services including network news

and mailing list are the products of these days. As soon as the network was opened to general and commercial use and the Web service was introduced, the Internet became remarkably popular. The Web service enabled the exchange of multimedia contents; e.g. pictures, movies and sound. Thanks to the Internet, people could receive multimedia data from any of the servers connected to the network.

Nevertheless, the pictures were still in the form of two-dimensional image and, apart from using few independently developed network application tools, the former Vdream-WIRL ⁽⁶⁾, for instance, it was impossible to handle three-dimensional objects via the Internet. It was only after the VRML technology was established that three-dimensional objects could be obtained and visualised as Web contents. In fact, one Web site has a VRML model of the Ryoanji Garden ⁽⁷⁾.

VRML itself has been updated considerably. The initial VRML technology (VRML1.0) ⁽⁸⁾ merely displayed three-dimensional static scenes that are sometimes referred to as walk-through images. The next generation (VRML2.0/VRML97) ^{(9), (10)} acquired the ability to describe movements and play background sounds in three-dimensional space. Currently, the multi-user technology is being built into VRML (VRML 3.0) that lets multiple participants share the same three-dimensional space within the network ^{(1), (3), (4)}. In the future, it may develop to a real-time multi-user three-dimensional world under distributed system environment.

As the VRML technology develops, the difference between the space within computer networks and that in the real world would become negligible. Therefore, it is not difficult to assume that a new society, a cyber

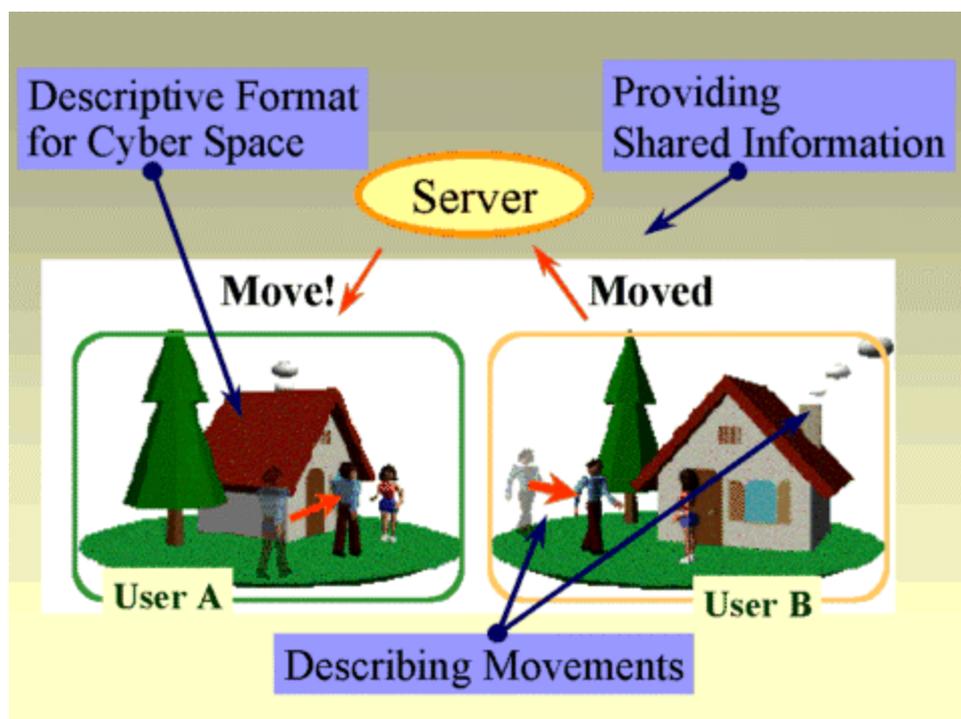


Figure 2. Sharing the information between the users logged in the same cyberspace.

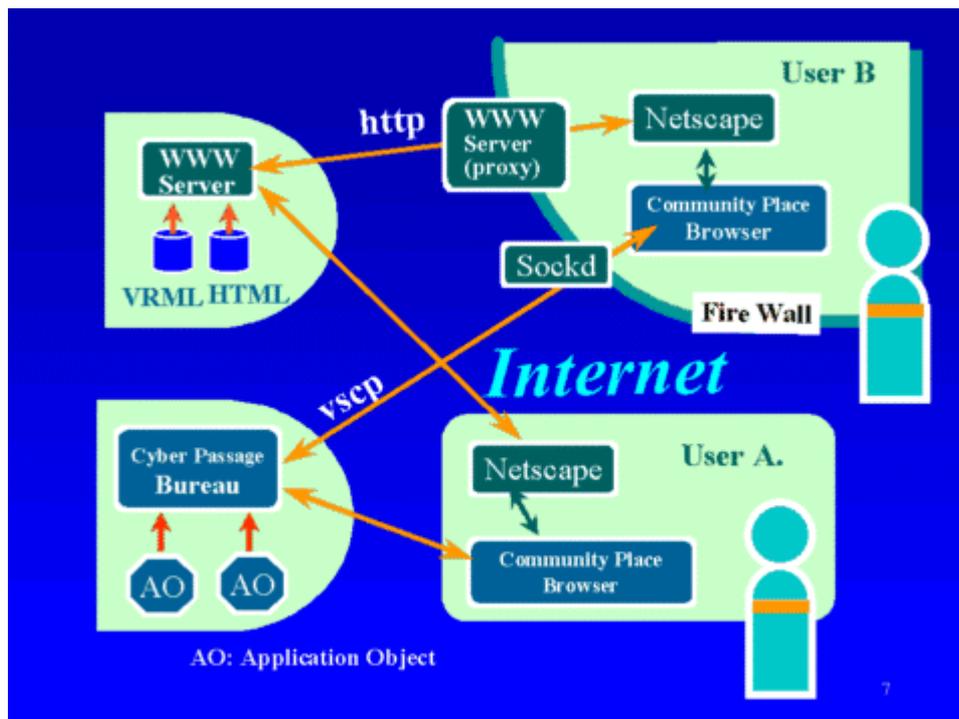


Figure 3. Mechanism of interpreting the shared information.

society, similar to our real society would evolve in the network. There are some other techniques that also support our Ryoanji Garden Planning Tool. In order to control three-dimensional scenes and the movements within the space, we need to both describe the geometric shapes and record the movements. These tasks can be carried out by using VRML, HTML (Hyper Text Markup Language) and Java language. We should also keep control of the shared data so that the users within the same cyberspace could share information in common. For instance, when one user makes a movement, it should be acknowledged clearly by the other users. The piece of information concerning a user's movement will be thus controlled and maintained by the server machine and received by every client system (Figure 2). In our Ryoanji project, we use network software called Cyber Passage Bureau for handling the shared information and a multi-user VRML browser, Community Place⁽⁴⁾, for interpreting the data at the client side (Figure 3).

(2) Utilising the Internet for Urban Planning

In conjunction with the recent developments, the Internet technology is gradually being adopted in the field of urban planning. The advantage of using it in urban planning process is that people located in different places could make two-way communications, even exchange information in real time. When the Web service first came up, the urban planners did not make the most out of this capacity of communicating in two-ways and

in real-time. The municipal government of Sapporo City, Hokkaido, for instance, provides various planning information including their outlines, locations and duration through its Web site ⁽⁵⁾. However, since it doesn't accept any feedback from citizens, it provides only one-sided service. Two-way communication has constantly popular in pre-Web services such as news or mailing list whereas the Web service seems to lack this aspect. Why, then, is the Web service so highly praised? As aforementioned, the Web service is distinguishable from other Internet services for its ability to transmit multimedia contents. Its popularity originates in the potential of multimedia data; in other words, it could be stated without exaggeration that only those who utilise multimedia contents would make good use of the Web service.

Therefore, whether or not urban planners use the Internet efficiently depends on how well they utilise all its features: two-way transmission, real-time communication and multimedia data manipulation through the Web service.

Recently, some governments and municipal authorities have launched a two-way urban planning communication scheme. In the case of Yamato City, Kanagawa, they summarised their urban planning problems on a map, uploaded the image onto their Web site ⁽¹¹⁾, and accepted comments from the citizens. They built their master plans based upon this feedback, thus, succeeded in utilising two-way multimedia communication. However, even in this case, real-time three-dimensional communication has not been adopted.

Our Ryoanji Garden Planning tool involves real-time, three-dimensional data transmission and, in this sense, is in accordance with the trend of utilising the Internet in urban planning context. In fact, when we think of the situation where multiple participants carry out a single task of constructing an urban model over the network, the ability to communicate in real time and to transmit three-dimensional contents are crucial. Once the urban planning support system is completed, we will be able to exchange three-dimensional model of town plans in real-time whereupon there will be no more need to assemble all the participants in one place at the same time.

3. Concept of the Ryoanji Garden Planning Tool

This section gives a brief introduction to the idea of our Ryoanji Garden Planning Tool. Further discussion follows in the next section. As mentioned, the ultimate objective of our project is to provide a full-featured urban planning support system. One of the essential points amongst all the factors in urban planning would be to gather a number of people who may have all different concepts, views and standpoints and induce them to cooperate in creating a single space.

Focused on this point, we designed our garden planning tool to correspond to multiple participants (we will call them players) carrying out a collaborate task. We reflected the exchange of opinions and different actions taken by planners with different roles in a usual collaborative work onto the arrangement of stones in a virtual garden. In order to make the player's role distinctive, we assigned different roles to each of them. Each player has a unique set of stones; the same number of stones, but in different sizes and shapes. A stone can be moved only by the player to whom it is assigned. By restricting "lifting" or "placing" other player's stone, we can give different role to each player. In other words, they can only complete the task by complementing and helping each other.

The process of collaborative work consists of four steps: discussion, temporary placement, resolution and settlement. The stones will be placed one at a time, and these steps are repeated for all stones. Should, at the stage of resolution, the temporary arrangement be voted down, they should start over from the discussion. These four steps reflect the general process of urban planning. As we enhance these steps to a more detailed, sophisticated scheme, this tool would be upgraded to an urban planning support system.

When all the stones are arranged and the stone garden is completed, the output will be exhibited in public and appraised as thus. This is equivalent to the public hearing of a proposal in urban planning. Based on the results from public evaluation, players can give another try on the arrangement. This step would equal to the process of feedback in urban planning.

In the following, we will explain the details of our Ryoanji Garden Planning Tool. We will start off with the process of stone arrangement, then the methods of exhibition and evaluation, the interface, and conclude with future developments.

4. Process of Arranging the Stones

The process of arranging each stone comprises of the following four steps:

- (1) Discussion on preferable location
- (2) Temporary placement
- (3) Adoption of resolution
- (4) Final settlement

Players should follow these steps repeatedly for each stone. In the following, we will explain each process in detail.

(1) Discussion

Players will first discuss which stone to choose and then its preferable location. The means of communication throughout this discussion will be gestures made with their avatars as well as “chatting.” Chat is one of the common methods of communicating over the Internet. Players “talk” with each other by typing their words from their console and displaying them on a chat window. By manipulating their own avatars, they may also move around the garden, change their viewpoints and communicate by gesture. Community Place of Sony Co., the browsing tool we adopted in this project, is equipped with a chat window.

(2) Temporary placement

As the talks come to a certain settlement, the players can try placing the stone temporarily in the garden and see the result. To avoid futility, we will restrict the maximal number of trials possible for each stone. In other words, players can go through the process of arranging and discussing repeatedly, up to a certain times. This trial and error would help the player to develop a common plan with the others.

A stone temporarily arranged would be expressed in different colour so that it could be distinguished from those that have been already fixed (Figures 4, 5).

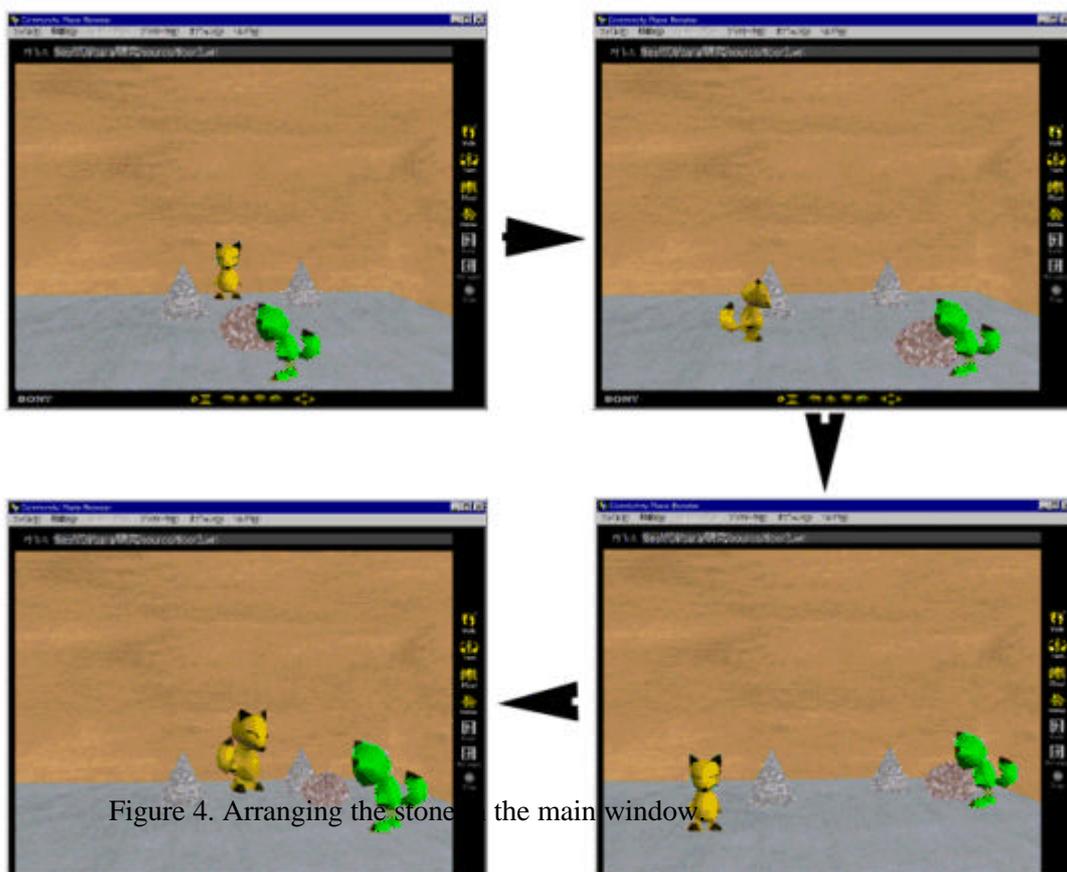


Figure 4. Arranging the stone in the main window

(3) Adoption of resolution

After placing the stone on a temporary basis, the players should proceed to the resolution and decide whether the temporary placement is adequate or not. It would take the form of an open vote by all the players. If the player agrees with the temporary location, he/she

should click "OK" button and, if not, "NO" button shown in the window (Figure 6). The polling score between pros and cons will be displayed in a small sub-window. We adopted this voting system to avoid an arbitrary decision made by a single player. The default setting requires approval by the majority of the players for passing it. If the temporary placement is voted down, the players should start again.

(4) Final settlement

Once the resolution is passed, the stone is no longer moveable and will be actually fixed to that location. Players cannot proceed to the arrangement of the next stone until this settlement is completed.



Figure 5. Communicating in real-time.

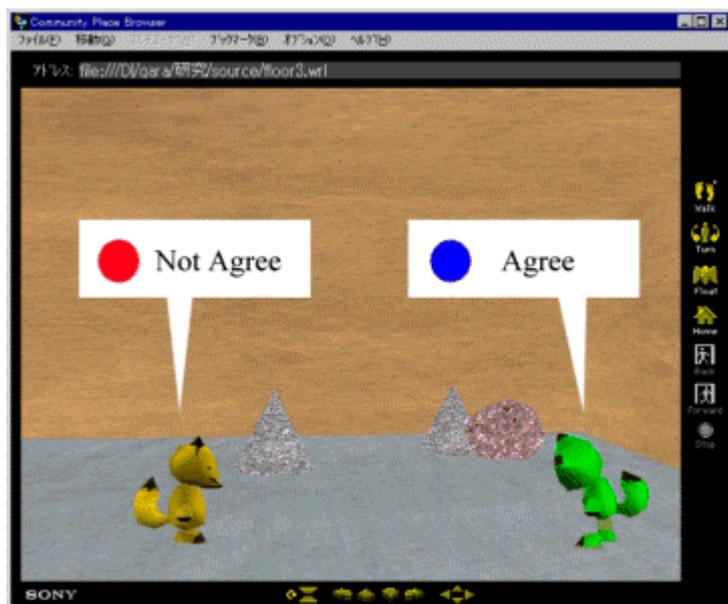


Figure 6. Communicating in real-time.

As for the next stone, these four steps have to be followed in the same manner, starting off with the discussion. After going through this process for all the stones, the garden will be completed and exhibited. The works will be uploaded on our Web site and will be subject to public appraisal. In the next section, we will describe the method of exhibition and evaluation.

5. Exhibiting and Evaluating the Work

All the works, including those that are still under construction, will be exhibited on our Web site. Using a VRML browser, visitors can, without actually taking part in the work, browse them over the Internet. In fact, the visitors can see the work from the corridor as if they are watching the original Stone Garden of Ryoanji. As they proceed along the corridor, they will find different works displayed one after another. As they keep walking down the corridor further on, they would come across the exhibition gallery full of completed works. All the results will be shown with the creator's name and their comments. Visitors can appreciate the completed stone gardens as if looking at pictures in an art museum.

After looking at the gardens, visitors can reflect their evaluation by casting their vote for the best. There is no definite standard as to the evaluating process and it is solely dependent on the visitors' judgment. This is similar to the fact that there is no standard basis of judgement in urban planning, and that citizens should rely on their own judgement when evaluating the plans. The polling scores will be displayed in the Web site in real-time. We expect this public ranking will motivate the players, help us grasp the trend of evaluation, and increase the visitors' interests in participating. In the following, we will introduce the actual interface.

6. The Interface

The interface of Ryoanji Garden Planning Tool consists of four window-typed frames. Their purposes and functions are as follows:

(1) Main Window

VRML file is downloaded into this window and displayed as a three-dimensional space. Players will be represented in the form of avatars and create the stone garden. Visitors, who are not involved in the work, can also enjoy the same scene from the corridor.

(2) Selection Window

This window displays a list of stones available. By clicking its image, players can select which stone to be used next. Once selected, the stone will appear in the main window.

(3) Action Window

This window is prepared for the players to make various complex movements including “grabbing,” “releasing,” “lifting up,” “putting down,” “pushing” or “pulling” the stone. By selecting the type of action from the list, the player can manipulate her/his own avatar accordingly. Other simpler movements such as moving to any four directions, looking up and down, or rotating the body of the avatar are controlled from the console; i.e. keyboard and mouse.

(4) Chat Window

This window shows the conversation made between the players. Visitors can also read the lines, but they cannot take part in the players’ conversation. The visitors can chat with each other and reflect their opinion to the works by evaluating the completed works.

7. Future Developments and Possibilities

As mentioned above, Ryoanji Garden Planning Tool is our first step towards the development of an urban planning support system. When fully developed, this tool should acquire the main factors and stages in the actual urban planning process. It will not only assist the actual urban planning steps, but also contribute to the understanding of the users’ behaviour and mentality within this wired space of computer network. There are quite a few studies on human behaviour and the psychological aspects of the real space, but whether or not these results could be applied to cyberspace remains an open question. Ryoanji Garden Planning Tool may help us understand the unique features of the emerging virtual society.

Currently, we are thinking of carrying out a comparative study of esthetic sense towards gardens in Britain and Japan through the garden planning process. Ever since early times, Japanese tone has valued “Wabi-Sabi,” the nicety of beauty that exists in simplicity and subtlety. We find certain similarity in cultural background of Britain and Japan; in fact, naïve factors such as elegant simplicity, subtlety or cosiness are highly regarded in British culture. This sensitivity that the British and the Japanese share in common may count towards their interests in constructing the simple stone garden within the virtual

space. Of course, these two cultures differ in many other aspects that may result in forming different cyber-cultures. Planning out the virtual Ryoanji garden may help us measure such cultural similarity and difference.

8. Conclusion

In this paper, we proposed interactive software for planning a stone garden site. It was an enhanced VRML multi-user tool with which participants in different locations could simultaneously "log in" to the same virtual space and carry out a collaborative work. The concept of working together in a virtual environment may not be new. As yet there are only few planning tools that does not require any special equipment and expenses ^{(1), (3)}; and, in this sense, we believe our system has lived up to the expectations.

Our aim is to construct a multi-user interface that support the planners carry out the urban planning process over the computer network. We believe that Ryoanji Garden Planning Tool reflects the main scheme of Japanese urban planning process and, therefore, qualifies as a prototype model of a full-featured urban planning support system. Moreover, it would help us investigate the unique features of virtual society and its culture. Study of cyberspace culture, particularly in terms of the difference it holds against that in the real space, is an important issue that should be investigated thoroughly to which, again, Ryoanji Garden Planning Tool could make a contribution.

9. References (All Web URLs effective as of 6 January 1998.)

- (1) Active Worlds: <http://www.activeworlds.com/>
- (2) Ames, A. L., Nadeau D. R. and J. L. Moreland (1995) "The VRML Sourcebook", John Wiley & Sons, New York.
- (3) Blaxxun Interactive: <http://www.blaxxun.com>
- (4) Community Place (Sony): <http://vs.sony.co.jp/>
- (5) Development Plans in City of Sapporo (in Japanese): <http://www.city.sapporo.jp/CityPlanning/City/DEVELOP/develop.html>
- (6) Platinum WIRL: <http://www.vream.com/3d11.html>
- (7) Virtual Kyoto – Ryoanji Garden: <http://www.planet9.com/earth/kyoto/index.htm>
- (8) VRML 1.0 Specification: <http://www.webcity.co.jp/info/andoh/vrml/vrml110.htm>
- (9) VRML 2.0 (VAG): <http://vag.vrml.org/>
- (10) VRML 97 Specification: <http://www.vrml.org/Specifications/VRML97>
- (11) Yamato City Urban Master Plan:

<http://www.city.yamato.kanagawa.jp/TOSI/TMP/e/index.html>

Appendix A – Pictures of Ryoanji Garden



Appendix B – VRML Source Code Sample

```
#VRML V2.0 utf8
```

```
PROTO Sony_WorldInfo [  
  field      MFString archive          []  
  field      SFInt32  armLength        -1  
  field      SFBool   avatarRoom       FALSE  
  field      SFInt32  backgroundImageType  0  
  field      SFString cpBureau         ""  
  field      SFString cpBureauWLS     ""  
  field      SFBool   collisionSound    TRUE  
  field      SFBool   collisionDisplay  TRUE  
  exposedField SFBool  turnButtonAvailable  TRUE  
  exposedField SFBool  floatButtonAvailable  TRUE  
  exposedField SFBool  homeButtonAvailable  TRUE  
  field      SFInt32  soundDeviceRate    22050  
  field      SFInt32  soundDeviceBits    8  
  exposedField SFBool  textureMagFilter    TRUE  
  exposedField SFBool  textureMinFilter    FALSE  
  exposedField SFBool  textureBlending    FALSE  
  exposedField SFFloat stereoViewRefDistance  2  
  exposedField SFFloat stereoViewEyeDistance  0.075  
  field      SFBool   cpb20MaterialColor  FALSE  
] {}
```

```
PROTO Sony_BindSharedNode [  
  field SFNode  transformNode NULL  
  field SFNode  scriptNode   NULL  
  field  MFString  action  
  Hello,sonybrowser:Hello,,,  
  Smile,sonybrowser:Smile,,,  
  Wao!,sonybrowser:Wao,,Wao,  
  Umm... ,sonybrowser:Umm,,Umm,  
  Wooo!! ,sonybrowser:Wooo,,Wooo,  
  Bye,sonybrowser:Bye,,,"  
] {}
```

"SonyActionPanel :

```
Sony_WorldInfo {  
  cpBureau "127.0.0.1:5126"  
  avatarRoom TRUE  
  armLength 25  
  soundDeviceRate 22050
```

```
soundDeviceBits 8
}
```

```
WorldInfo {
  title "ryoanji"
}
```

```
NavigationInfo {
  type "WALK"
  headlight FALSE
}
```

```
Background {
  skyColor 0.1 0.1 0.7
}
```

```
Viewpoint {
  position 0 4.1 10
}
```

```
PointLight {
  location 0 10 -10
}
```

```
PointLight {
  location 0 10 10
}
```

```
DEF YUKA Transform {
  children [
    Shape {
      geometry Box {
        size 50 0.1 50
      }
      appearance Appearance {
        texture ImageTexture {
          url "../paper01.gif"
        }
        textureTransform TextureTransform {
          scale 1.0 1.0
        }
      }
    }
  ]
}
```

```
}
```

```
DEF TATEMONO Transform {  
  translation 0 1 0  
  children [  
    DEF TS TouchSensor {}  
    Shape {  
      geometry Cylinder {}  
      appearance Appearance {  
        material Material {  
          diffuseColor 0.5 0.5 0  
        }  
      }  
    }  
  ]  
}
```

```
DEF ROCK Transform {  
  children [  
    Transform {  
      translation 0 0.125 -2  
      children [  
        DEF Rock1 Shape {  
          geometry Sphere { radius 0.25 }  
          appearance Appearance {  
            texture ImageTexture {  
              url "../stone.gif"  
            }  
          }  
        }  
      ]  
    }  
  ]  
}
```

```
Transform {  
  translation 2 0.5 3  
  children [  
    DEF Rock2 Shape {  
      appearance Appearance {  
        texture ImageTexture {  
          url "../stone.gif"  
        }  
      }  
    }  
  ]  
}
```

```
geometry Cone {
height 1
bottomRadius 0.5
}
}
]
```

```
Transform {
translation -2 0.5 -2
children [
USE Rock2
]
```

```
Transform {
translation -10 0.125 -10
children [
USE Rock1
]
```

```
DEF PSENSOR ProximitySensor {
size 100 100 100
}
```

```
DEF RockScript Script {
directOutput TRUE
url "scripts/RockScript.class"
eventIn SFVec3f avatar_position
field SFNode rockNode USE ROCK
eventOut SFVec3f rock_position_out
eventIn SFString rock_position_in
eventIn SFRotation avatar_orientation
eventIn SFString rock_orientation_in
eventOut SFRotation rock_orientation_out
}
```

```
Sony_BindSharedNode {
scriptNode USE RockScript
transformNode USE ROCK
}
```

```

action          "SonyActionPanel:          Hello,sonybrowser:Hello,, ,;
Smile,sonybrowser:Smile,, ,;          Wao!,sonybrowser:Wao,, ,Wao,;
Umm... ,sonybrowser:Umm,, ,Umm,;          Wooo!! ,sonybrowser:Wooo,, ,Wooo,;
Bye,sonybrowser:Bye,, ,;"
}

```

```

ROUTE PSENSOR.position_changed TO RockScript.avatar_position
ROUTE RockScript.rock_position_out TO ROCK.translation
ROUTE PSENSOR.orientation_changed TO RockScript.avatar_orientation
ROUTE RockScript.rock_orientation_out TO ROCK.rotation

```

Notes

- (1) The node named Sony_WorldInfo, Sony_BindSharedNode was individually developed by Sony Co. for its multi-user VRML browser, Community Place. Users will gain access to the server machine by specifying the name of the server in the cpBureau field of the Sony_WorldInfo node.
- (2) The garden scene is set up by various fields including Background, PointLight and Viewpoint; these fields are used for determining the background colour, location of the light source, and viewpoints of the avatars, respectively. Textures are mapped onto the floors and stones to make the scene realistic.
- (3) The ProximitySensor gives the degree of nearness towards the avatar. As the user manipulates the avatar, this field would generate its new coordinates (position_changed event out) and its new orientation (orientation_changed event out). And, whenever the avatar moves a stone, the following Route command lines refer to this value and give it to the script lines that calculate the new coordinates of the stone.

```

ROUTE PSENSOR.position_changed TO RockScript.avatar_position
ROUTE PSENSOR.orientation_changed TO RockScript.avatar_orientation

```

- (4) In the Script nodes, position of the script is specified in the URL field, the variable to be given in the eventIn field, and the variable to be fed back in the eventOut field, respectively. (The word script refers to an external Java programme source). The scripts would feed back the coordinates and the orientation of the stone. These

values are passed onto the following Route command lines whereupon the stone is redrawn in the scene:

```
ROUTE RockScript.rock_position_out TO ROCK.translation  
ROUTE RockScript.rock_orientation_out TO ROCK.rotation
```