Using VCR to Support Different Styles and Types of Group Collaborations in Virtual Universities

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Abstract

To support many different group activities such as computer and network based meeting, seminar, conference, tele-lecturing, group project, team work, student instruction and club in a virtual university, a general framework based on a room metaphor or model is used to develop a desktop groupware system, called virtual collaboration room (VCR) that enables teachers and students to flexibly and naturally conduct their collaborative teaching/learning/working over the Internet without constraints on collaboration type, working style, group scale and system platform. As important component in our integrated educational system, University21, the VCR is discussed how to be employed and managed in a virtual university. With the use of Java applets for system implementations, users can enter the VCR from any standard Java enabled Web browser. VCR consists of user panel, object cabinet, object panel, a variety of objects in workspace, workspace panel. An object in VCR has a life cycle from birth, alive to death, and attributes such as owner, state, access mode, handler, and persistence. To further improve the quality of collaborations, natural object control and rich awareness function are fully supported.

Key words: collaboration, groupware, virtual university, VCR, object, space, awareness

1. Introduction

In a virtual university there are, generally, many different types of collaborative activities among teachers and students. These collaborations are currently carried out by using either asynchronous collaboration tools, such as email, newsgroup (bulletin) and joint document editor[2], or synchronous collaboration systems, such as chat, shared whiteboard [11] shared document viewer [7], shared workspace [12], collaborative simulation [1], NetMeeting from Microsoft and conferencing [5]. In spite of being very useful, they have the following inherent drawbacks when applied to group or team activities in a virtual university: (1) They support either asynchronous or synchronous group collaborative styles but not both. (2) They support only a subset of the group collaborative activities in a virtual university but not all that include meeting, seminar, conference, tele-lecturing, group project, team work, instruction of the research of undergraduate, Master and PhD students, club, etc. (3) They are not so effective and natural in supporting the group activities since their developments are focused on covering a wide range of applications rather than considering special features and requirements in collaborative teaching/learning.

To overcome the drawbacks of current collaboration tools/systems, it is necessary to find a new general framework of group collaborations by referring to fundamental characteristics of collaborative activities in a real university. It is common and natural that a group of people gather in a kind of physical room/office and carry out their joint work and collaborations. It is, therefore, rationale to design a virtual collaborative environment for virtual universities by referring to a physical room. This has motivated us to develop an Internet based desktop groupware system,

called a virtual collaboration room (VCR), by using a *room metaphor* or *model* as a framework, i.e., emulating a real room so as to enable more flexible and natural collaborations among teachers and students. Another good reason for using the room metaphor is that the VCR is a component of our *integrated educational system*, University21 [9], where rooms are generally regarded as units to construct the virtual university that consists of not only a number of VCRs but also other types of rooms such as virtual courserooms, virtual private offices, virtual administration offices, and virtual laboratories. As many VCRs may open simultaneously in a virtual university, it is necessary to easily administer those rooms by a teacher, a group chair or other corresponding person. Such room administration, supported by CGI and PERL5 based tools, can be carried out through a Web browser.

Although the word of room has also been used in other groupware systems, most of them just exploit the room concept as some kind of abstraction for their system functions [6,7,12]and have not made systematic developments based on the room model, i.e., by emulating a real room. Few representative groupware systems which are truly based on the room model are the TeamWave [3], the CBE (Collaboratory Builder's Environment, Lee, 1996) and the worlds [10] One common characteristic in the three systems is that they provide many rooms such as private rooms for all individuals and shared rooms for group meetings. People can switch work between individual work and shared work by moving among the different rooms. However, in a large organization like a virtual university where there exists simultaneously many teachers' and students' groups and each person may belong to different groups, the server load becomes too heavy to support so many rooms by such implementation. It is also unnatural to frequently move objects between private rooms and shared rooms during a meeting. To develop a more practical and natural virtual room, we believe that it needs to add some extra features and the associated control mechanisms to objects with reference of real objects. Thus, we first clearly define that any objects in VCR has its life cycle, owner, handler and sharing state which are controllable by users. The introduction of the new object features allows a VCR to flexibly and naturally support different types and styles of collaborations in a group. The types of objects in the most current collaboration systems are limited to a chat board, white board

and image. This limitation narrows the range of their collaboration types. Our VCR has a variety of objects, such as, chat board, white board, plain text file, voting, applet for interactive simulations, **HTML** file, image, audio, video, animation, group case, private drawer, recorded object, and so on.

No matter whether in a real or virtual room, collaborations in the room are involved with three basic elements: user, object, and space. The main differences of collaboration in a virtual room from that in a real room are that the space is a virtual projection to a screen, the objects are synthesized by software, and users are geographically distributed at different remote sites. Such differences result in barriers for a user to be effectively aware of the three elements and their mutual relations, and conflicts in joint actions when using a desktop groupware system by a group of people. It has been recognized that awareness is an important factor for a successful groupware system [4]Our system provides rich and effective support for awareness of the user, object, space, and their mutual relations. In addition, the VCR is developed by using a Java application for the server program and Java applets for the client program, a user can enter and use it from any computer with a standard Java enabled Web browser.

The rest of this article is organized as follows. The next section shows how VCRs are used in University21. An overview of VCR is given in Section 3 for helping a whole and concrete understanding of our system. Section 4 and 5 discuss two important issues, i.e., object control and awareness support in VCR, respectively. Conclusions and future work are addressed in the last section.

2. The Virtual Collaboration Rooms in University21

An integrated educational system (IES), that can support all teaching, learning and administrating activities in a virtual university, is an important and challenging direction in computer and network based global teaching and learning. University21 is the first IES that can be used by different scales of educational organizations ranging from an individual teacher or professional to a large virtual university. A general architecture of a virtual university is shown in Figure 1. It consists of two areas, the open area that is accessible by anybody and the

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restricted area that can be accessed by registered members only. The restricted area consists of many virtual rooms including virtual private room, virtual administration room, virtual courseroom, virtual laboratory and virtual collaboration room, which are associated with different activities in the virtual university. With considerations of the scalability criterion, each type of the rooms are implemented as relatively independent units which can be easily assembled or configured for building different scales and types of virtual universities.
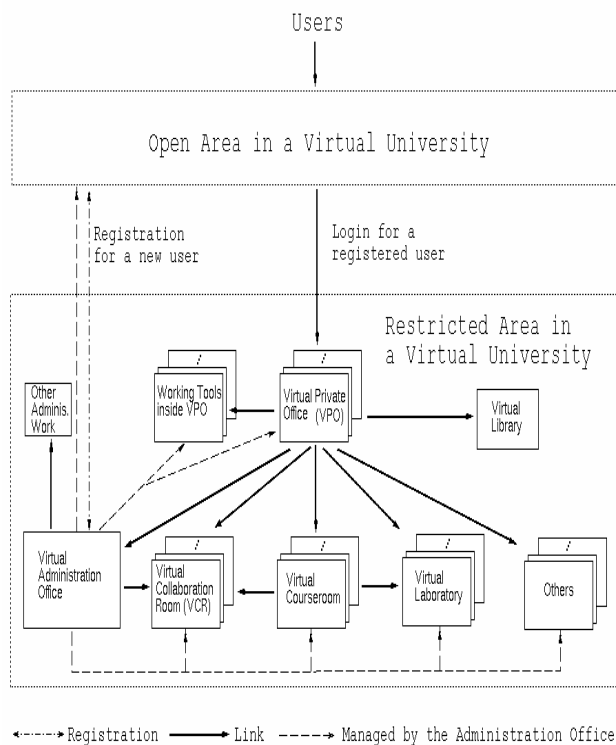

Figure 1. The general architecture of University21

The private office is an individual work surface which is owned by the individual for managing personal activities and private data. In addition, a user can enter other rooms from the private office to carry out other desired activities. The virtual administration office is designed and incorporated with many online administrative tools, such as those to manage users, curriculum, facilities, resources, plans, etc., which are used by authorized users upon their roles and responsibilities in a virtual university. The virtual courseroom is a hyper-environment consisted of exploration environment, supplement environment, evaluation environment and collaboration environment to systematically support for a teacher to author online materials, organize teaching activities and instruct students, and for a student to access the online course and to efficiently interact with a teacher and other students. The virtual laboratory

enables students to conduct course related online experiments and simulations to understand abstract concepts or formulae through interactive visualizations.

VCR, as stated before, is a desktop groupware system that enables a group of remote individuals to flexibly and naturally conduct their collaborative teaching/learning/working over the Internet. The flexibility refers to ability for people to use the VCR for a variety of collaborative activities without constraints on collaboration types, working styles and system platforms. The naturalness refers to people feeling that their collaborations in the VCR are as natural as in a real room. Designed as a general purposed collaboration room, VCR can support a variety of group or team oriented activities, and be used as more concrete rooms, such as

- *meeting room* for a group of people to hold a meeting, seminar and conference,
- *tele-lecturing room* for a teacher to give a lively lecture to remote students,
- *project room* for students to participate in a course oriented group project,
- *team room* for teachers and students to participate in a research oriented joint project,
- *instruction room* for the supervision of undergraduate, master or PhD research, and
- *cafe room* for informal discussions or general chat by any member.

A collaboration room can be *group owned* or *common*. A group owned room is owned and managed by a specified group for its lifetime while a common room is used by different groups during different periods of time. A collaboration room can also be *restricted* or *open*. A restricted room allows only assigned users to enter while an open room is open to anyone until the predefined user limit is reached. For example, the meeting room and tele-lecturing room are common rooms, the project room, team room and instruction room are group owned rooms, the cafe room is an open room, and the team room and instruction room are restricted rooms.

A user may enter different VCRs from a courseroom to conduct an online course related tele-lecturing and group project, from a virtual private office to carry out student instruction and team work, or from a virtual administration office to have a meeting. A virtual university, therefore, has many rooms open simultaneously. For handling these rooms, a room administration related to each type of room is required. Two examples are given in Figure 2 to show how a meeting room administration and a group project

administration function. A meeting room administration can create many meeting rooms that are used by different groups of users for specified topics and schedule all events held in a meeting room. Similarly, a group project administration can create many group project rooms that are used by different groups to conduct the specified project.
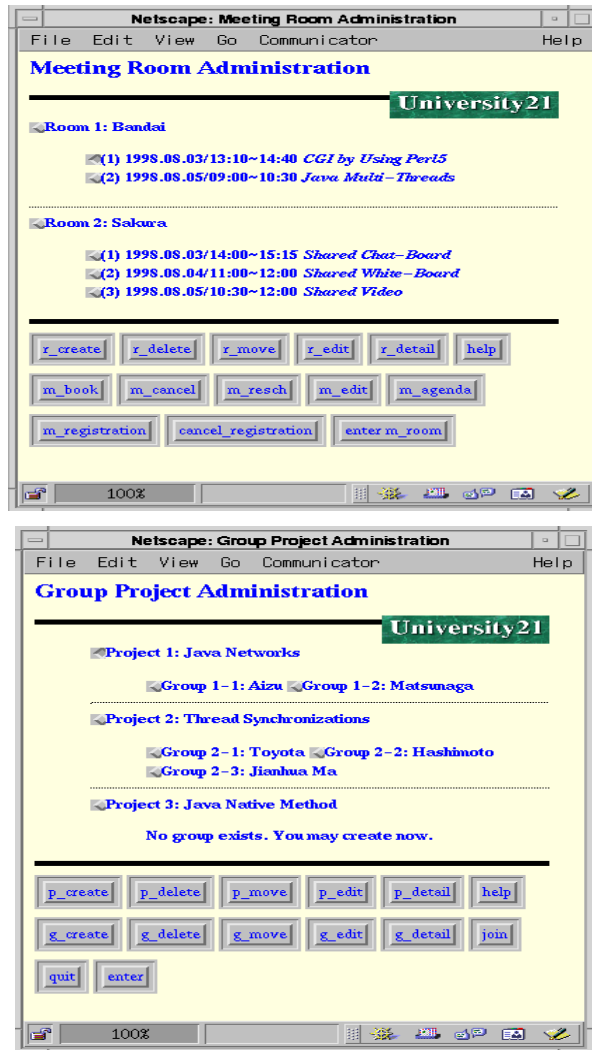

Figure 2. Meeting room administration (up) and group project administration (down)

Since there are many rooms working simultaneously in University21, servers are constructed in a tree structure as shown in Figure 3. There are a number of room servers under the central server and a room server is responsible for activities associated with a collaboration room. The central server is run on University21 main server, and it holds data about all rooms, including a list of rooms, a list of members in each group, a list of room servers available on the campus network, data used by each of rooms, and so on. The central server receives the discussion records

from the room server, and stores the data in the resource database of University21. Occasionally, the center server sends a previous discussion record to a client who makes a request. During a group collaboration, data received from a client is broadcast by the room server to other clients thus updating the shared group data.
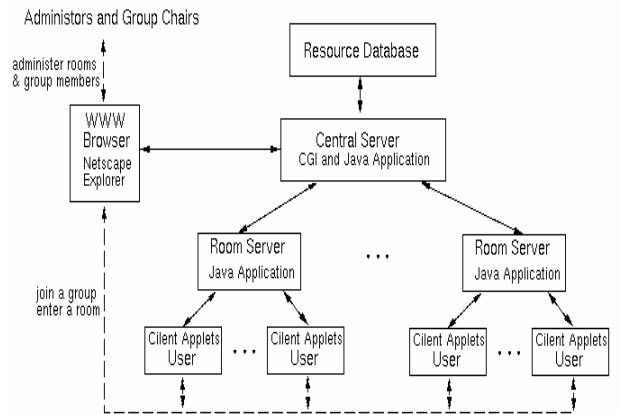

Figure 3. The server configuration for collaboration Rooms

3. An Overview of the VCR

A user can enter the VCR from any JAVA enabled Web browser. Figure 4 shows an example of a VCR layout. A VCR is divided into several regions and each of them has different functions as follows.
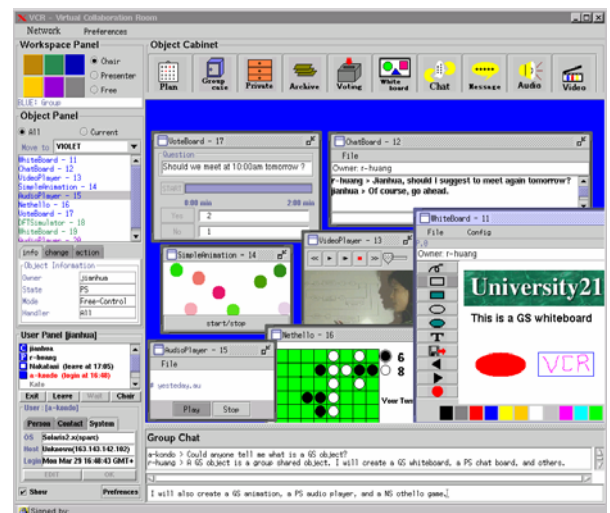

Figure 4. An example of room layout of the VCR

A *workspace* is a virtual space or a container where active objects are placed and users conduct work and interact with others via interactions with the objects. Due to a limited size of the display window, the display window is regarded as a visible subspace of the workspace. The workspace

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in VCR is divided into six working *subspaces* and only one of them is visible at a time. However, it can be flexibly switched from one working subspace to another and an object can be freely moved in the workspace.

A *workspace panel* is for controlling a visible working subspace.

An *object cabinet* is for storing and creating available objects. An object may be taken from the cabinet and put it on a workspace space.

An *object panel* is for controlling the objects in the workspace.

A *user panel* is for the management of user's presence (enter, exit, temporarily leave and return to a room), and status (a chair, a presenter and regular members).

A *group chat* is a text-based chat shared by all group members. When someone would like to chat with only a subset of people, he/she can create a partially shared chat board.

To support many different collaborative activities, VCR facilitates a variety of objects including chat-board, whiteboard, planning, voting, applet for interactive simulations, plain text file, **HTML** file or web page, image, graphics, audio, video, animation and recorded object. Each object has a life cycle from birth, alive to death. The birth of an object means that the object is created and put on a group workspace. Conversely, the death of an object means that it is destroyed and removed from a group workspace. To distinguish different objects in the workspace, a unique ID number should be assigned to each object when it is created. Further, an object has the following attributes: (1) a sharing state, i.e., group shared (GS), partially shared (PS) or non-shared (NS), (2) owner who possesses the privilege of controlling the object, e.g., manipulating and destroying it, changing its sharing state, and passing its ownership to others, (3) access control mode including the free mode by which everyone can operate the shared object, and the rotation mode by which only one people, called a handler, is allowed to operate the shared object at a time, and (4) persistence which means that the object will be persisted in the room even all members leave the room (Such object persistence is very useful in supporting asynchronous collaborations).

A VCR is implemented by a room server and clients connected by TCP/IP as shown in Figure 5. The server program (a Java application) first creates a thread, called a *coordinator* that waits for connections from clients. After a user successfully enters the room, the client program (a Java applet) will be automatically downloaded to the user's local machine and then make a request to connect to the room server. If the request is accepted, the coordinator creates anew thread, called an *assistant*, to manage communications of the client with the server and other clients. When receiving a message from a client, the corresponding assistant will decode it and decide what response to make. If a message is from a non-shared object of a client, the assistant sends a response only back to the client. A response to a shared object is sent the clients who share the object via the coordinator and other assistants. The *recorder* in the room server keeps a record of messages from clients. It creates a log for each alive object and records a whole process of manipulations on the object. The *database* in a room server stores useful room data such as a list of group members, recorded objects, objects in a group case and a private drawer, and others. Each client consists of a *dispatcher*, a set of *objects* on a workspace and a *room manager*. The dispatcher is responsible for sending and receiving messages between the assistant in the room server and the objects or the room manager in the client's side. The room manager will manage the workspace and objects, capture and present necessary awareness information, and take correspondent actions after receiving input from a user. When a user exits the room, the client program exits from the user machine and the related assistant is accordingly removed from the room server.
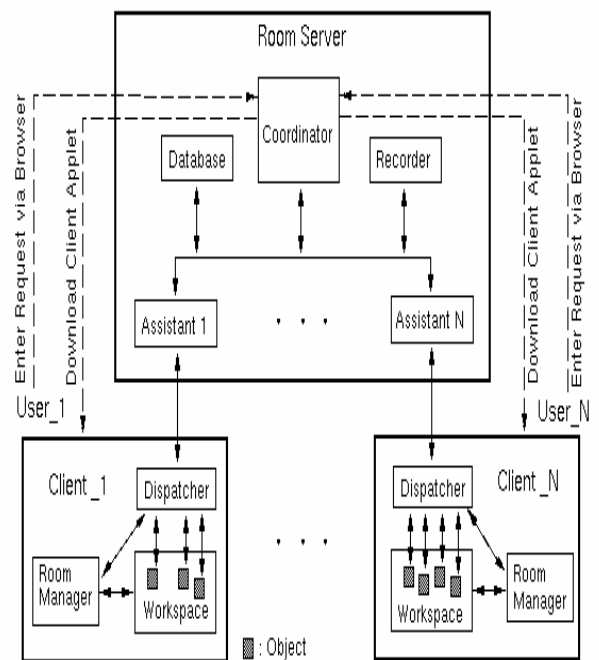

Figure 5. The server configuration for collaboration Rooms

4. Object Control

As there are many different types of objects and many objects can simultaneously exist in the workspace, moreover, each object has the life cycle and the several changeable attributes (owner, state, access mode, handler, and persistence), it is necessary to provide a set of functions for users to easily and naturally control objects. The object control mainly includes object creation, object manipulation, and object destruction.

4.1 Object Creation

All available objects in a VCR are originally stored in *Object Cabinet* which consists of VideoPlayer, AudioPlayer, MessageBoard, ChatBoard, WhiteBoard, VoteBoard, Archive, PrivateDraw, GroupCase, and PlanFolder. Upon a need for objects in collaborations, the objects are taken from the object cabinet and initially put in the current visible subspace of the workspace. The objects are created. There can be many objects of a same type in the workspace if need be. For example, there are a group shared whiteboard (ID is 11) and a partially shared whiteboard ID is 19) created as shown in the object list of Figure 4. Figure 6 shows the process of creating an object, partially shared audio player. After clicking AudioPlayer icon in *Object Cabinet*, a user has to assign a sharing state to the object and select users from the user list if the object is partially shared. Thus, the object, AudioPlayer, is created and the related users can see the created object in the workspace. When creating an object, the server automatically assigns a unique ID to the object.

4.2 Object Manipulation

After an object is created, any related user has a certain right to manipulate the object upon his/her status. Each user can be an owner or regular member, and/or handler. The status of a user can be dynamically changed during collaborative activities. As an owner, a user has a right for all kinds of the object manipulation. As a handler, a user has an access right to use or operate the object. As a regular member, a user can make a request as a handler. Object manipulation, as shown in Figure 7, mainly includes (1) moving an object in and between the subspaces, (2) changing object state, owner, handler, and access mode, (3) recording an object and keeping an object persistent in the

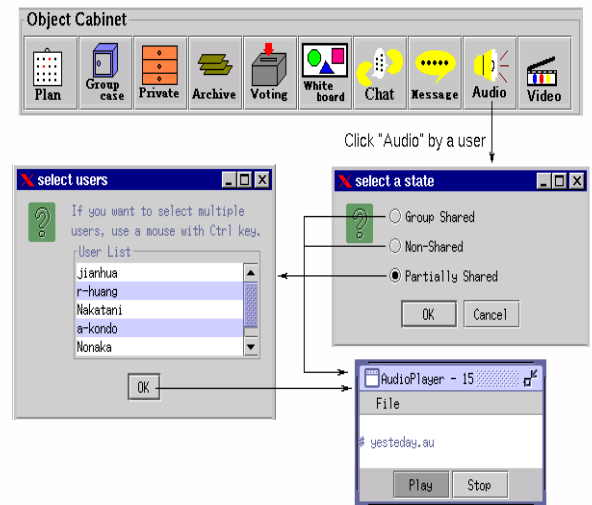workspace, and (5) using or operating an object.

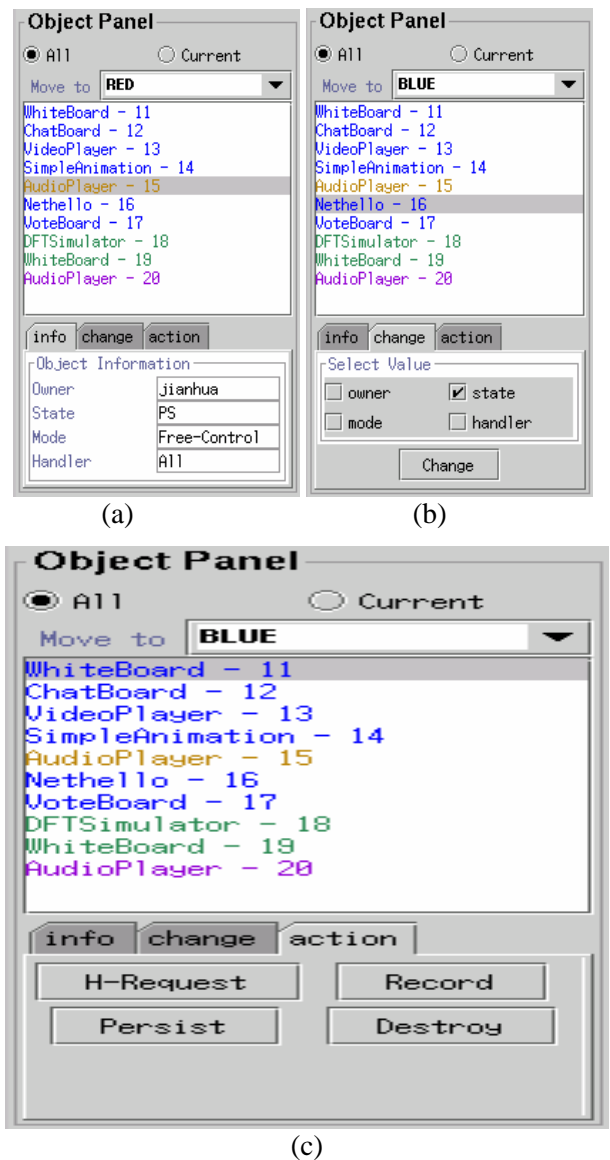Figure 6. The process of the object creation

(a)   (b)

(c)

Figure 7. The object panel

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4.3 Object Destruction

Only the owner of an object has a right to destroy the object from the workspace by clicking *Destroy* in Figure 7(c). Or the object is automatically destroyed in the case of its owner exits the room without either passing the ownership to others or making the object persistent.

5. Awareness Support

Being geographically distributed at different remote sides, people in the VCR must perceive certain types of awareness information, know how to interpret its meaning, and realize how to apply that information to make their decisions or actions in collaborations. Awareness is an important issue in developing the VCR aimed at supporting natural and good collaborations. Two fundamental issues are (1) what types of awareness information to be supported and (2) how to capture, transmit and present the awareness information. Presentations of awareness information can be implemented by using a variety of media types, such as, text, color, icon, blinking text, tele-cursor, image, sound, audio, and video. It has been stated that user, object, and space are three important elements of collaborations in the VCR. Naturally, user awareness, object awareness, and space awareness are three essential types of awareness information that should be provided to users in the VCR.

5.1 User Awareness

It is important for a user to perceive sufficient information about others, such as, others' existence, roles, activities, or reactions. In the VCR, user awareness information supported includes
users' presence and status

Users' presence information is automatically captured by the VCR system when they login the room and represented by a square icon in the user list as shown in Figure 4. If a user temporarily leaves the room, the user's name is marked with an unfilled square icon. A character **C** or **P** on the top of the square indicates a user's status as a chair or/and presenter. Otherwise, a user is a regular member.
users' general information

Each user's general information, such as, name, location, contact address, phone, fax, email, URL, local computer system, and login/leave time, are available from The **User Panel** in Figure 4 by clicking a user's name and selecting the **Person**, **Contact**, or **System** tag.

users' intentions or actions

Some user intentions or actions, such as exit and temporary leave, are monitored and supported in the **User Panel** according to defined policies.

5.2 Object Awareness

Just as a real room, many objects may be placed in a VCR and be active simultaneously. Each object has various states and attributes. A plethora of objects (with associated features) in the workspace can easily confuse users making decisions or actions. Sufficient awareness information about each object is a basis to support responsive and effective interactions among users in their collaborations so as to improve the quality of collaborations. In the VCR, object awareness information supported includes
object existing state

When an object is created, it is placed in the subspace (visible space) of its creator. In order to draw all users' attention, birth of the object is presented by a peep sound and blinking the object name in the object list. When an object is destroyed, the object name is immediately deleted from the object list with a peep sound.
object spatial information

In the **Object Panel** of Figure 7, there is a list of object names with their ID numbers. If a user clicks **Current**, the user can see a list of the objects in the current visible subspace. If a user clicks **All**, the user can see a list of all objects including the objects in other invisible subspaces.
object attribute information

An object has several attributes (owner, sharing state, access mode, and handler). These attributes are accessible for users from the **Object Panel** by selecting an object name in the list and clicking **info**.

5.3 Space Awareness

Space awareness relates to how users perceive the location of objects and the focus of other users awareness in the workspace.
Users' attentions in the workspace

The workspace is divided into six working subspaces each represented by a color (red, green, blue, orange, violet, and gray). The user entry in the name list also has an adjacent colored square indicating the users current working subspace.

Objects' locations in the workspace

Just as users current working subspace is indicated by color, an object subspace is indicated by the color of the object name in the object list. When an object is moved from one subspace to another, the object list entry changes color and users hear a peep sound.

6. Conclusion

VCR is a general purpose desktop groupware system which can be used to flexibly and naturally support a variety of group activities in a virtual university. In contrast to the other room model based systems, the VCR system was focused on natural object features and control in a room. The new object features and their associated control mechanisms play an important role in developing a VCR which can support different types and styles of group collaborations more naturally. Another significant contribution of our system is the systematic awareness support of people, space, object and their mutual relations. The VCR is an ongoing project from which a series of research issues are to be identified and investigated in the future. It was not good idea to incorporate real-time voice and video communication tools into the VCR due to low bandwidth and lack of QoS control in the current Internet. Fortunately, a new infrastructure of the gigabit network is under construction in Japan and a high-speed link has been connected to the University of Aizu. We are about to develop and incorporate such communication tools into the VCR. Although client program implemented in Java applets make entrance and use of the VCR simple and convenient, Java applets have some limitations (for security reasons), such as the difficulty in manipulating local files. As the ability of manipulating local files is important and useful in collaborations, the Java security API for digitally signed applets is being exploited to solve this problem. Although the current VCR is able to open a Web page to all clients, a client linked scroll bar has not yet been implemented. A mechanism for joint and synchronous control of playing continuous media objects (audio, video, animation and recorded sessions) is also under development.

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