Flexible Multimedia Lecture Supporting System based on Extended Virtual Reality Space

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Abstract

Distance learning system is very effective and useful to realize joint lecture environment in which teacher and students located remotely can join to the same lecture and exchange their ideas and opinions to each other. However, the current systems do not necessarily provide sufficient educational effects because: 1) only simple lectures using bi-directional TV conference are provided, 2) students' awareness for sharing lecture space and coexisting together is weak, 3)psychological influence of individual background or perceptions for educational environment is not considered. In order to resolve these problems, Flexible Multimedia Lecturing Support System(FMLS) which is more user-oriented flexible education support system is introduced. Our system provides more realistic common educational space where the students and teachers can share and interrupt together using Extended Virtual Reality Space technology(EVRS). Our system can also consider the individual perception or preference to organize the education space suitable for each student using perceptional information processing and agent technology. The system architecture and its implementation are precisely described. We prototyped our FMLS by which the lecture and practice of humans' organ system for nursing students are examined. Through the evaluation of the prototyped system, the usefulness of our suggested FMLS could be verified.

1. Introduction

Distance learning system is very effective and useful to realize joint lecture environment in which teacher and students located remotely can join the same lecture and exchange their ideas and opinions each other. There are many distance learning systems which are used in actual educational environment. However, the existing systems are not necessarily sufficient from the education points of view.

First of all, since the existing distance learning systems usually use the conventional bi-directional TV conference system via satellite or wired networks, more sophisticated and flexible user interruptions or operations are not supported. Generally, various lecture types including broadcasting lecture, man-to-man lecture, panel discussion type and self learning types must be provided and dynamic switching from one lecture type to another must be realized depending on the progress of the lecture. At the same time, multiple lectures in different locations have to merge or split depending on the teacher's demands. Secondary, since current distance learning systems on different campus may not use the same computing resources such as computing power and network bandwidth, and the materials used in the lectures are variety including audio, video, images, graphics and text, their quality of services(QoS) must be guaranteed even though the resource environment on different campus are different. Thirdly, since the current distance learning systems[1][2] are weak in ability of students' awareness for sharing lecture space and coexisting each other, reality of lecture environment should be improved. Furthermore, since the educational effects are psychologically influenced by each student perception in educational environment such as lecture rooms and neighborhoods, teaching staffs or education tools, more careful lecturing space for each student must be designed.

So far, we have investigated Flexible Multimedia System which can provide stable multimedia information to users considering dynamic changes of users' demands, computing and network loads based on the concept of “Flexible System”[3]. This system can realize dynamic connection configurations functions[4] among users' stations according to the purpose and contents of lectures, and determines QoS (Quality of Service) for media data used in the lecture by taking account of the different users' demands. On the other hand, we have also developed Perceptional Design Image Retrieval System[5] which reflects users' perception for the retrieval of design images. Using this system, user can retrieve required design images based on user's perception by issuing the words which describes the features and an impression of the design images.

In this paper, we propose on Flexible Multimedia Lecturing Support System(FMLS) based on Extended Virtual Reality Space(EVRS) interface which enables users to study lecture, and share the common educational space to all of participants easily and construct his/her own educational space freely according to individual perception and demands using Virtual Reality(VR) and Agent technologies.

In section 2, the concept of FMLS is defined. The system configuration and architecture of FMLS are precisely described in section 3. The EVRS using VR technology is introduced in section 4. Implementation and prototyping of FMLS are described in section 5.

2. The concept of FMLS

The proposed FMLS has the following functions:

1. Providing multimedia information according to users' demands and computers and networks resources.
2. Providing education and multimedia information by considering the background of each user such as educational level, special field, native language and the proportion of grasp.
3. Providing functions to realize various lecture types.
    - Knowledge Sharing type(1:N), Cooperative Working type(M:N)
    - Dynamic group/lecture configuration such as merging and dividing
4. Providing reality of educational environment over the network.
    - Sharing lecture space among participants
    - Awareness of the existence of participants

So far, we developed a flexible multimedia support system[4] which provides the above functions (1) and (2). In order to realize more realistic and more user oriented educational environment beyond the previous system[4], we introduce EVRS based on VR and Agent technology. VR technology enables us to construct more realistic lecturing space. Agent technology enables us to realize easily intelligent educational user interface using knowledge as a proxy of user. Furthermore, the influence of human visual perception to educational space is also considered. The educational environment is realized on the computer system and user can construct his own lecture space, and can participate by sharing lecture space using 3 Dimensional Computer Graphics technology. For example, a lecture space with its interior, desk and chair layout, colors and patterns on the chosen objects is constructed by each user by reflecting his visual perception.

3. System Configuration and Architecture

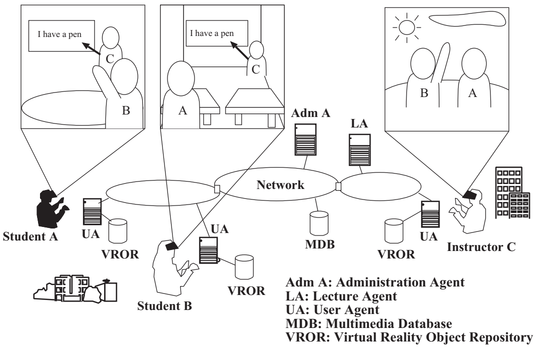

Figure 1: System Configuration

The proposed FMLS is shown in Figure 1. Instructors and students are able to join into multiple lectures from the distant locations. In order to share virtual lecture space among participants, users can take the lecture using Head Mounted Display(HMD) and Data Globe where the virtual lecture space is constructed on Computer Graphics System. The participants can share through each user's HMD. Each user's educational environment can be individually constructed depending on his best perception. These HMD and Data Globe are input/output devices that interact with systems and other participants by using multimedia information such as a video, audio, image and text, and group-ware such as shared window and white board.

Furthermore, this system provides QoS negotiation function[4] for multimedia information as materials in the lecture considering users' QoS demands and resources of computers and networks depending on the purpose and contents of each lecture. For example, media streams from a instructor to students may require higher priority on the generic lecture type, while media streams among students may require the moderate quality.

System Architecture: FMLS is mainly consisted of User Agents(UA), Lecture Agent(LA), Administrative Agent(AdmA), Virtual Reality Object Repository(VROR)

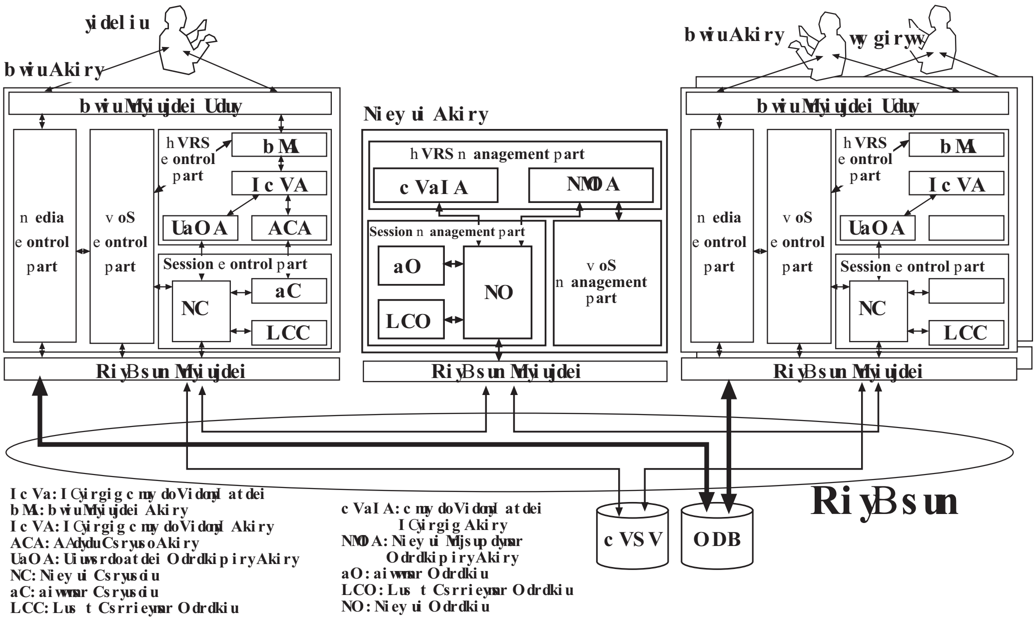

Figure 2: System Architecture

and Multimedia Database(MDB) as shown in Figure 1. UA provides graphical user interface functions and also receives multimedia information as materials by taking account of computer power and network resources. Furthermore, UA provides user interface function using EVRS which takes account of user's perception, multimedia transmission function to offer the various materials organized by multimedia information. LA manages connections and configurations of lecture, and provide QoS negotiation and dynamic reconstruction functions. AdmA manages domains such as the campus, faculty and department in the university. Furthermore, AdmA provides the administrative information such as time scheduling, siravus, registration information, lecture guidance. VRORs preserve spatial objects such as the elements of desks and chairs to construct sharing learning space. MDB maintains multimedia data as educational materials used on the lectures. The details of the system architecture of our FMLS shown in Figure 2 are explained in the following.

UA mainly consists of five parts as shown in Figure 2, including User Interface Part, Media Control Part, QoS Control Part, EVRS Control Part and Session Control Part. The User Interface Part controls hardware devices such as HMD and Data Globe. EVRS Control Part interacts with the user, and provides functions which takes account of user's perception and demands and constructs a sharing lecture space by retrieve the suitable objects from VRORs and MDBs. Session Control Part controls session connections to other entities according to messages from LA. QoS Control Part manages the amount of computing and network resources to guarantee the QoS of the materials used in the lecture. Media Control Part transmits/receives multimedia data from LA with media synchronization, media transform and flow control function. Furthermore, EVRS Control part consists of User Interface Agent(UIA), Extended Virtual Reality Agent(EVRA), Personal Space Management Agent(PSMA), and Avatar Control Agent(ACA). UIA provides EVRS and material list used in the lecture to user and receives requests from the user. EVRA integrates objects which consists EVRS mentioned in section 0, and create view of the EVRS for user. PSMA creates and controls the objects taking account of user’s perception. ACA creates and controls avatar object according to situation of other users such as join, leave.

In order to realize dynamic reconstruction function which enables users to change lecture types such as the generic lecture, cooperative working types and panel discussion type dynamically, **Lecture Agent(LA)** manages session connections among UAs, and also manages participants' information such as lecture type, participating address and their name. LA mainly consists of three parts as shown in Figure 2. EVRS Management Part manages lecture information such as the names of lecture and participants. Session Management Part

Table 1:Classification of the Objects

objects class	examples	attributes	User Operation	stored location
Space Objects	lecture room seminar rooms	shared	selectable	Repository
Presentation Object	desks, chairs bookshelves	movable	selectable	Repository
Avatar Object	students, teachers secretaries	active	selectable	Repository
Media Object	multimedia materials	dynamic	retrievable	DB Server

manages connections, system configurations and status among UAs. QoS Management Part manages the amount of computing and network resources for the lecture, and negotiates QoS among UAs.

4. Extended Virtual Reality Space

In order to provide rich and realistic lecture space based on the system architecture described in the previous section, EVRS with the following characteristics is provided:

1) Offering/acquiring objects in the shared virtual space
EVRS enables user to offer/acquire various objects from the repository in virtual space or database. Those objects can be classified into the following four classes:
- space objects such as lecture room, laboratory or office,
- presentation objects such as desks, chair, whiteboard or TV,
- avatar objects such as students, teacher, secretary,
- media objects such as electronic materials for lecture on practice,

The characteristics of those objects are summarized into the Table 1.

2) Awareness of existence and status among participants:
It is required to be aware of the existence and status of other participants to communicate to each other. In order to realize the awareness, we use avatars. For example, if a participant requires a floor to insist his opinion, then his avatar raises the hand instead of himself.

3) Metaphors as system functions and conditions:
We use metaphors to understand easily the functions used in EVRS. For example, an instructor can view multimedia teaching materials by touching bookshelf objects. Student can also talk to other students by touching avatars.

4) Construction of personal lecture space reflecting his/her perception:
Students and teachers can reconstruct their personal lecture space to learn effectively the lectures depending on user's preference. For example, one student can build a "quiet" and "small" lecture space like his home, while another student can organize a wide lecture space where he can actively communicate with other participants.

5) Sharing a space among participants:
In order to easily recognize the existence of other users, the lecture space of all participants is sharing each other although the views from each participant are individually different.

4.1. Reflection of Human Perception

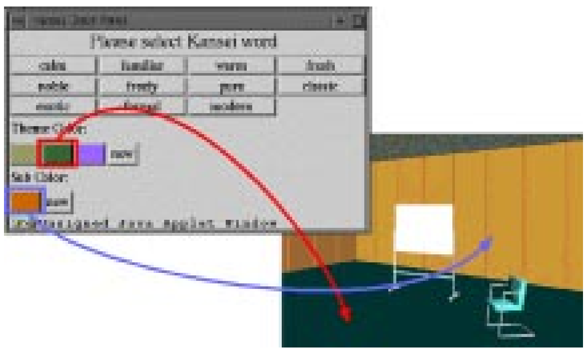

Figure 3: Color Coordination Window and Reflection to the space

By taking account of the relation between the color coordination of 3D objects organizing a EVRS and the participants' perceptions, each participant can reflect his perception to his own lecture space. For example, by

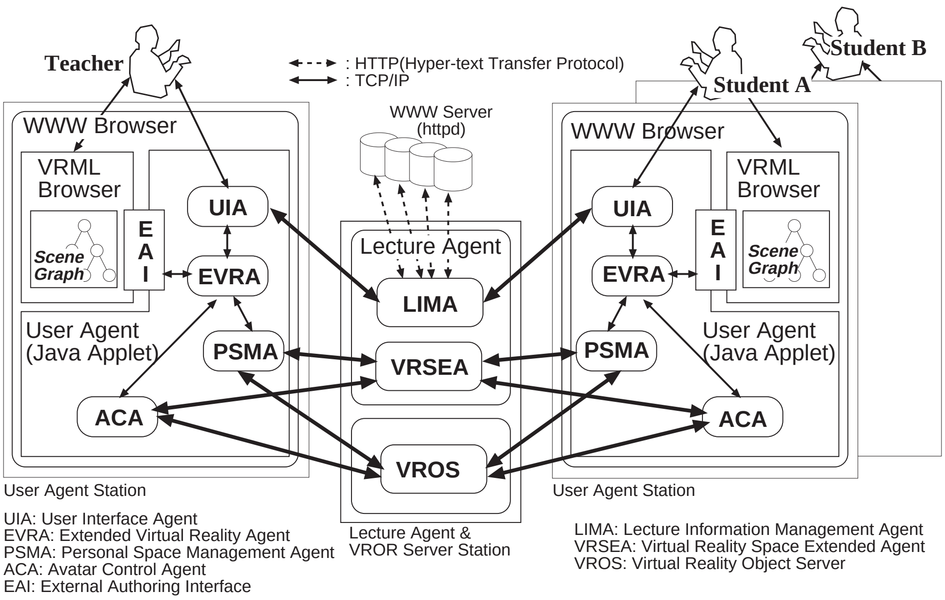

Figure 4: Process Configuration

specifying the perception words "calm" of color coordination window in the UIA as shown in Figure 3, several primary colors which are related to "calm" are displayed. Then, user can select one of primary colors to fix the basic color of the most dominated areas such as floor. After that, the user selects one of color combination for other space component among the nominated secondary colors which can be well coordinated a primary color for floor. The PSMA in the UA responds to this word "calm" and determines the best color coordination equivalent to the word, "calm" by consulting to the knowledge base in PSMA. As a results, the color in his lecture room is determined and painted.

5. Implementation and Prototype

In order to verify the functionality of our EVRS, a prototyped system was implemented on multiple SGI graphics workstations connected by 100[Mbps] Fast-Ethernet as indicated in Figure 4. In order to represent various EVRS objects such as desks, bookshelves, avatars for teacher and students and to modify their translation, orientation and behavior of the avatar, EVRS objects are implemented by using VRML2.0. These EVRS objects are stored at VRORs in advance.

In order to realize the EVRS, the VRSEA in LA manages the locations, the directions and the URL of the shared objects shown in Table 1. This information with those objects are transmitted between VRSEA and PSMA in UAs by message passing. PSMA in UA activates local objects such as space objects and environment objects. The user's perception to his personal space is also reflected at the PSMA when these local objects are activated. On the other hand, the ACA in UA also manages the information of the locations, directions and the URL and the avatar objects movement such as "raise hand" or "go in/out from/to lecture room". This information with avatar are transmitted between the ACAs in UA through VRSEA. External Authoring Interface(EAI)[6] performs interface functions to visualize various objects to users through the browser.

All of the agents in each UA are implemented by Java and their instances are concurrently operated on multiple threads. These agents act on the WWW browser at UA as one Java applet. The message passing between these agents can be realized by calling "methods" and using TCP/IP protocol.

Figure 5, 6, 7 shows an example of the lecture with "Human Organ System" in nursing school by two students and one teacher. The teacher instructs the lecture using the video material concerned with "Human Organ System" on the white board and "the brain model" by 3D CG objects on the desk.

Figure 5: View from student A

Figure 6: View from teacher

Figure 7: View from student B

Figure 6 shows a view of the lecture space from the student A where the lecture space is color-coordinated by his perception and the other student B and the teacher are metaphored by the avatars in his view. Figure 7 shows another view of the same lecture space from the student B which is different from the view from the student A. These students can take the lecture using both video materials and the CG models.

The questions from the student to the teacher can be informed by "raising their hands" in the EVRS. Thus, more interactive and realistic lectures could be attained.

6. Summary

In this paper, we proposed Flexible Multimedia Lecturing Support System based on Extended Virtual Reality Space which can shared the common educational space by all participants and constructed as their own lecture rooms freely depending on their perceptions. A prototype system was implemented using VRML2.0 and Java and evaluated the suggested system through the simple lecture. Currently we are developing the practical version of FMLS and will evaluate the usefulness of the suggested system through the actual lecture for nursing and social works in Iwate Prefectural University.

7. References

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