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Extended Virtual Reality Space for Remote Lecture Supporting System

Yukiharu Kohsaka†, Koji Hashimoto†, Michiaki Katsumoto‡ and Yoshitaka Shibata†

†Faculty of Software and Information Science, Iwate Prefectural University
‡Communication Research Laboratory, Ministry of Posts and Telecommunication

Flexible Multimedia Lecturing Support System(FMLS) which is more user-oriented flexible education support system is introduced to provide more realistic common educational space where the students and teachers can share and interrupt together using Extended Virtual Reality Space technology(EVRS) and take into consideration of 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. Prototyped FMLS by which the lecture and practice of humans' organ system for nursing students is implemented and examined. Through the evaluation of the prototyped system, the usefulness of our suggested FMLS could be verified.

遠隔講義支援システムのための拡張仮想現実空間

高坂 幸春†, 橋本 浩二†, 勝本 道哲‡, 柴田 義孝†

†岩手県立大学 ソフトウェア情報学部
‡郵政省通信総合研究所

本稿では遠隔地に居ながら教師や学生が臨場感や存在感を持ちながら、授業や実習を受けることができるための拡張仮想現実空間に基づいた遠隔講義支援システムを提案する。本システムでは、Virtual Reality 技術とエージェント技術により利用者の感性や心理的な影響を考慮できる。本稿では、そのシステムアーキテクチャと実装、そして簡単なプロトタイプシステムについて述べる。

1 Introduction

Distance learning system is very effective and useful to realize joint lecture environment in which students located remotely can joint to 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 bidirectional 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/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 lack of ability of students' awareness for sharing lecture space and coexisting each other, reality of lecture 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 organized.

So far, we have investigated Flexible Multimedia System which can provide stable multimedia information to users by taking into consideration of dynamic changes of users' demands, computing and

network loads based on the concept of "Flexible System" [3]. This system can also realize dynamic connection configurations [4] among users' stations according to the purpose and contents of lectures and determine QoS (Quality of Service) of used media data at the lecture by taking account of the differences among usrs' demands.

On the other hand, we have also developed Perceptional Design Image Retrieval System[5] which reflects users' perception for the retrievals of design images. Using this system, user can retrieve required design images based on user's perception by issuing the words which describes 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 the lecture easily, and share the common educational space to all of participants and construct his own educational space freely according to individual perception and demands using Virtual Reality and Agent technologies.

In section 2, the concept of Flexible Multimedia Lecturing Support System(FMLS) is defined. The system configuration and architecture of FMLS are precisely described in section 3. The Extended Virtual Reality Space(EVRS) using Virtual Reality technology is introduced in section 4. Implementation and prototyping of FMLS is described in section 5.

2 The concept of Flexible Multimedia Lecturing Support System

FMLS that we have proposed 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

In order to realize more realistic and more effective educational environment in addition to FMLS we introduce Extended Virtual Reality Space(EVRS) based on Virtual Reality(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 by 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 to sharing lecture space using 3 Dimensional Computer Graphics technology. For an example, a lecture space with its interior, desks 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

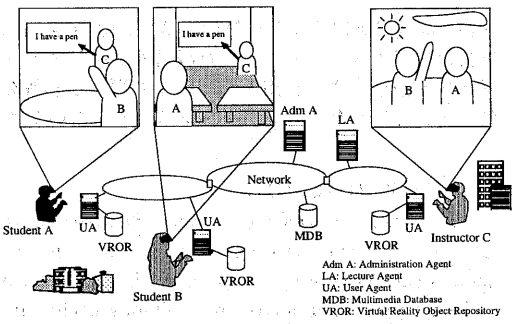

Figure 1: System Configuration

FMLS which we have proposed is shown in Figure 1. Instructors and students are able to join into multiple lectures from the distance locations. In order to share virtual lecture space among participants, users can take the lecture using Head Mounted Display(HMD) and Data Globe. The virtual lecture space is constructed on Computer Graphics System. The participants can share the lecture space 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

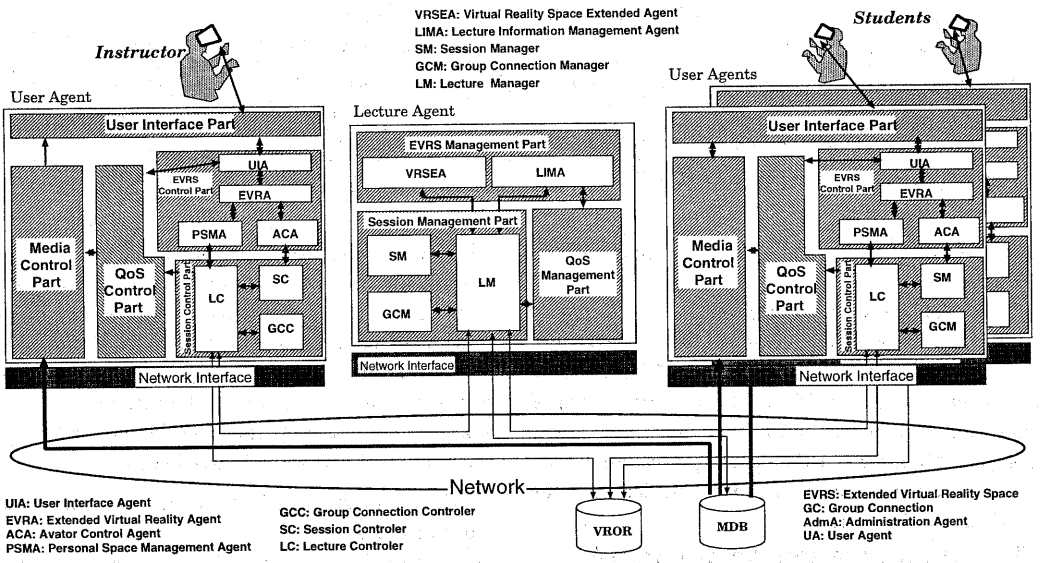

Figure 2: System Architecture of FMLS

input/output devices that interact with systems and other participants by using multimedia information such as a video, audio, image and text, and groupware such as shared window and white board.

Furthermore, this system provides Quality of Services(QoS) negotiation function 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.

The system is mainly consisted of User Agents(UA), Lecture Agent(LA), Administrative Agent(AdmA), Virtual Reality Object Repository(VROR) and Multimedia Database(MDB). UA provides graphical user interface functions and also transmits multimedia information as materials by taking account of computer power and network resources. 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 lecture guidance and registration functions. 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 shown system architecture of our FMLS are shown in Figure 2.

3.1 User Agent(UA)

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. UA mainly consists of five components as shown in Figure 2, 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 cooperating with 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 with media synchronization, media transform and flow control function.

3.2 Lecture Agent(LA)

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, LA manages session connections among UAs, and also manages par-

Table 1: classification of the objects

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

ticipants' information such as participating address and their name.

LA mainly consists of three components as shown in Figure 2. EVRS Management Part manages lecture information such as the names of lecture and participants. Session Management Part 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.

3.3 Administration Agent(AdmA)

AdmA plays a role of the administrator in a university. AdmA manages administrative information such as a curriculum, time scheduling, list of instructor names and students for each class. Furthermore, in order the students to smoothly join to the lecture, AdmA also keep profile database for each user, and downloads the related profile with participants when they join to the lecture.

3.4 Virtual Reality Object Repository

Virtual Reality Object Repository(VROR) maintains spatial objects such as white board, desks, chairs, avatars as students, teachers or staffs by which the participants can organized their own lecture room. These objects are selected by participants based on their perception.

3.5 Multimedia Database

Multimedia Database(MDB) contains multimedia data as educational materials which are consisted of a video, audio, image and text. These materials are retrieved from the database and multicasted to the all of the participants.

4 Extended Virtual Reality Space

In order to provide rich and realistic lecture space, Extended Virtual Reality Space(EVRS) with the following characteristics is provided:

1) Reconstruction of a space
Students and teachers can organize their own educational space to effectively learn and instruct the lectures depending on user's preference. For an example, one student can build a quiet and small lecture space like his home, while other student can organize a widespread lecture space where he can actively communicate with other participants.

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

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

4) offering/acquiring the multimedia information in the shared virtual space
EVRS enables users to offer and acquire multimedia information from the virtual space. Furthermore, users can regard these multimedia information as objects in the EVRS.

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

In our EVRS, a participant can recognize the existence of other participants as avatars, and easily communicate each other by touching the objects and avatars.

The various objects used in FMLS are classified into Table 1.

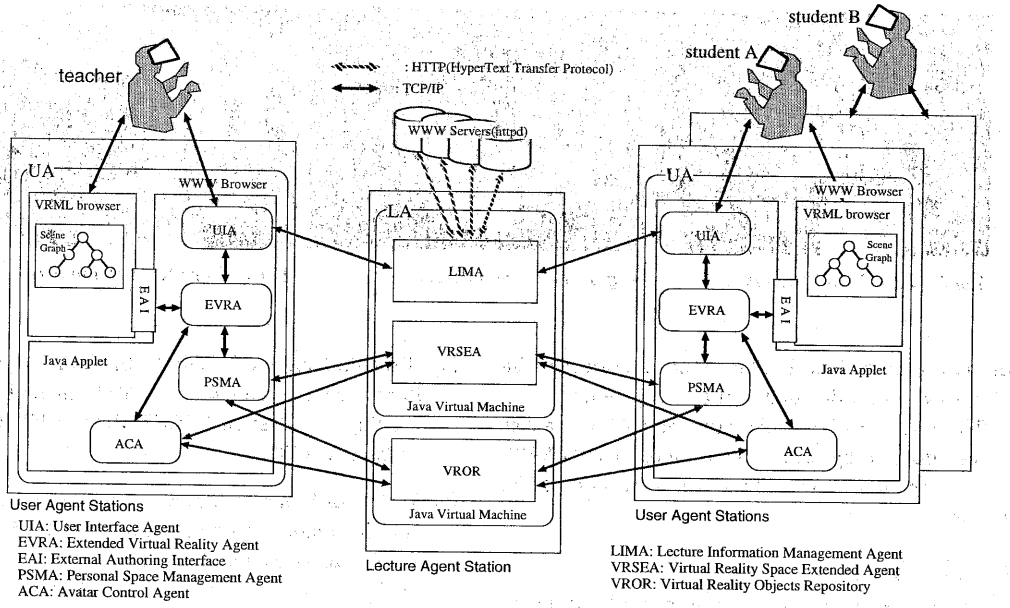

Figure 4: Process Configuration

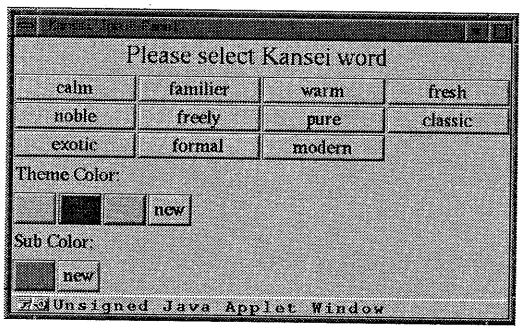

Figure 3: Color Coordination Window

4.1 Reflection of Human Perception

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, common object, avatar. For an example, by specifying the perception words "stable" from color coordination window in the UIA as shown in Figure 3. The PSMA in the UA responds to this word "stable" and determines the best color coordination equivalent to the word, "stable" by consulting to the knowledge base in PSMA. As a results, the color in his lecture room is determined and textured.

5 Implementation and Prototype

In order to verify the functions of our EVRS as indicated in Figure 4, a prototyped system was implemented on multiple SGI graphics workstations connected by 100 [Mbps] FastEthernet. The EVRS was realized by using VRML2.0, its control functions are controlled by Java1.0 and External Authoring Interface(EAI)[6].

All of the agents in each UA are implemented by Java and inheritted threads and 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.

Fig.5-7 show an example of the lecture with "Human Organ System" 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.

Fig.5 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 the view. Fig.7 shows another view of the same lecture space from the student B which is different from

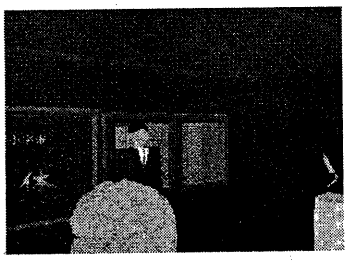

Fig.5 : View from Student A

Fig.6 : View from teacher

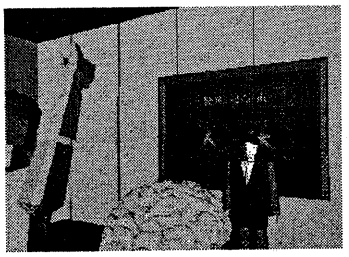

Fig.7 : View from Student B

the view from student A. These students can take the lecture by both video material and the model.

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 share the common educational space to all of the participants and construct their own lecture rooms freely depending on their perceptions. A prototype system was implemented using VRML2.0 and Java and evaluated the suggested model through the simple lecture. Currently we are developing the practical version of FMLS for nursing and social work.

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