A Software Framework for Universal Multimedia Access

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Abstract: Recently, immense multimedia information has come to be exchanged on the Internet, where 3DCG, video, image, sound, and text are involved in various circumstances with terminal devices, networks and users different in their competences and performances. This fact may easily lead to 'digital divide' so called unless any special support is given to the weaker. We have already proposed a new concept of 'universal multimedia access' intended to narrow the digital divide by providing appropriate multimedia expressions according to users' (mental and physical) abilities, computer facilities, and network environments. In this paper, we discuss a software framework for our new concept and its implementation.

Keywords: Multimedia system, Switching functions, Monitoring functions, Multimedia transmission protocol.

I. INTRODUCTION

Recently, immense amount of multimedia information has come to be exchanged on the Internet, where 3DCG, video, image, sound, and text are involved in various circumstances with terminal devices and networks, and users different in their competences and performances. This fact may easily lead to the so-called 'digital divide' unless any special support is given to the weaker users.

A universal design concept is proposed to support handicapped people in their social activities [1]. In the computer science field, the universal web [2] has been proposed to develop this concept. However, this does not support changes in the contents, the media and the quality of service (QoS) function to use the devices and network environments to their full capacity. On the other hand, many studies on the QoS function have proposed optimizing the video quality for priorities areas at users' requests [3]. These studies focused on the performances of devices and network environments, but not on the users' abilities or equipments. Of course, there were also several studies on 'universal multimedia access (UMA)' but they could not narrow the digital divide because they concerned 'content switching' only [4].

In consideration of this fact, we have already proposed a new concept of UMA [5, 6] intended to narrow the digital divide by providing appropriate multimedia expressions according to users' (mental and physical) abilities, computer facilities and network environments. In this paper, we discuss a software framework for our new concept and its implementation.

II. UNIVERSAL MULTIMEDIA ACCESS

The digital divide is caused by the differences in users' personal competences, computer facilities, and network environments. Therefore, multimedia information is necessarily accompanied by the need to switch the user interface, the media and the QoS parameters, thus reflecting these differences. Here, we present a new approach to UMA for handicapped people to help them to use their devices and network environments to their full capacity. Our purpose is exclusively to develop a new mechanism for appropriately switching user interfaces, media and QoS parameters based on a concept such as that shown in Fig.1.

III. SWITCHING FUNCTIONS

UMA means to selectively provide three kinds of switching function (SF), namely, user interface switching (UIS), media switching (MS), and QoS switching (QS). Fig.2 shows these switching functions working as follows:

(SF1) UIS: switch to the user interfaces (UI) appropriate for users' competences and display devices,

(SF2) MS: switch to the media which is appropriate for users' competences, performances of terminal devices and networks,

(SF3) QS: control the media qualities so that they are appropriate for users' competences and terminal devices.

These functions are applied in ascending order (from SF1 to SF3) when starting to use multimedia information or in descending order when it is being used.

1. User Interface Switching

UIS sets up the following items.

(U1) A writing style which is appropriate for the users' language ability,

(U2) The UI type and annotation option which are appropriate for users' computer skill,

(U3) The media size, font size, number of media, and number of characters which are appropriate for the size of the display device.

In addition, the I/O function is reflected by the users' disability.

2. Media Switching

MS switches to the appropriate media according to predetermined priorities after determining usable media types and the QoS parameters. The numbers and types of media are selected by UIS. The media and their quality are limited by the performances both of terminal devices and networks. When MS could not continue to play a medium because of an overload of CPU or network, MS is switched to UIS to reduce this load.

3. QoS Switching

QS controls the media size and media rate with QoS parameters to measure the performances of both terminal devices and networks. The QoS parameter 'Size' means:

(S1) Video – Give priority to frame sizes

(S2) Audio – Give priority to sampling resolution and stereo sound

(S3) Image - Give priority to size of image

(S4) Text – Enlarge characters

The QoS parameter 'Rate' means:

(R1) Video – Give priority to frame rates

(R2) Audio – Give priority to sampling rates

(R3) Image - Give priority to display timing

(R4) Text – Take priority over any other medium

IV. Monitoring Functions

The SF is selectively provided by the management system and receives several types of message from 4 monitoring modules and the network interface (NI) as shown in Fig.3. These modules monitor the following items to send/receive event messages as shown in Tab.1.

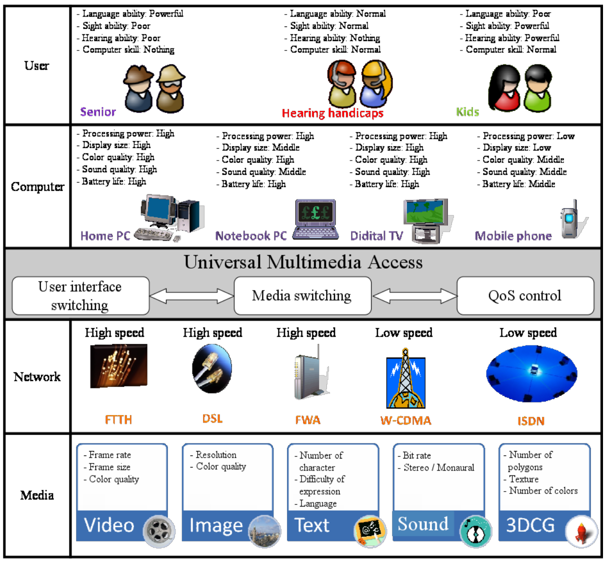

Fig.1. Universal multimedia access

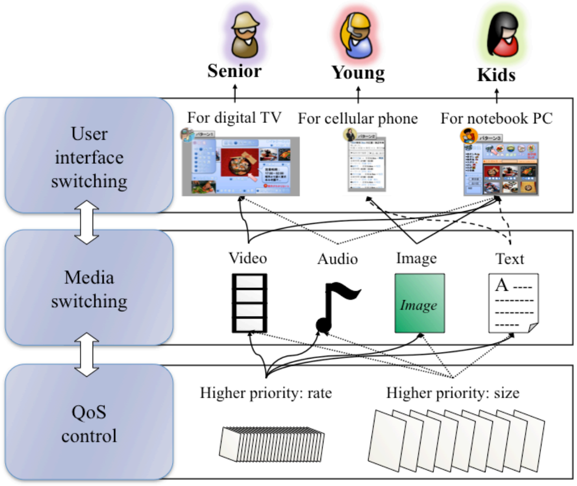

Fig. 2. Switching functions

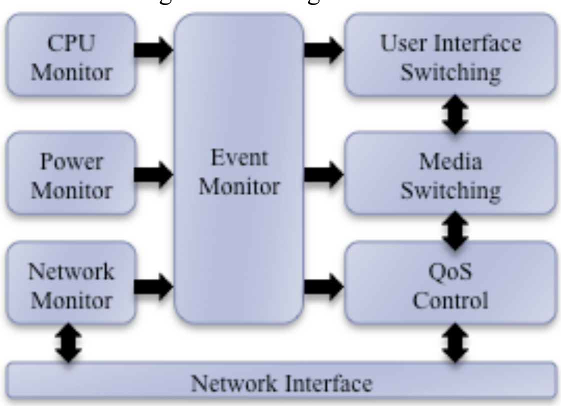

Fig. 3. Configuration of Management System

(M1) CPU Monitor: give the CPU load average to the Event Monitor for checking the CPU load factor.

(M2) Power Monitor: give the power consumption to the Event Monitor for reviewing the power resources.

(M3) Network Monitor: give a throughput to collect packet loss rates and the round trip time (RTT) using the real time transmission control protocol (RTCP).

(M4) Event Monitor: request to each SF according to the events from other monitoring modules and user's operations.

In addition, the QS receives the message and the media data from the NI.

V. Transmission Protocols

The management system keeps synchronizing a master media with some slave media as shown in Fig.4. These synchronizations are caused both within and among multimedia contents by the network time protocol (NTP) according to the common time line. A transmission protocol has 4 layers constructed on real time transmission protocol (RTP) and RTCP to use multimedia contents for supporting three types of SF and to keep these synchronizations. Figure 5 shows this transmission protocol and their layers to be achieved as follows:

(L1) Multimedia Transmission Protocol: media combination, inter-media synchronization,

(L2) Media Transmission Protocol: media exchange, intra-media synchronization,

(L3) Frame Transmission Protocol: frame rate control,

(L4) Packet Transmission Protocol: packet rate control, congestion control.

A multimedia contents is provided with a starting phase and a switching phase as shown in Fig.4 and Fig.5, respectively.

In the starting phase, the UIS is applied to UI according to the command 'Request(Action)' from the event monitor after receiving users' information and computer specification as shown in Fig.6. Also, the MS and the QS are performed to provide appropriate media and media qualities synchronized by the 'Request(…)' from the event monitor, respectively.

In the switching phase, each SF is performed according to user's request for parameter change 'Request(Change_**)' and media quality change 'Notice(Change)', a notification of overflow and underflow 'Notice(Over) from monitoring functions as shown in Fig.7. Also, each SF returns 'Accept(…)' or 'Refuse(…)' to apply these request.

Table. 1. Types of Event Message

Type of message	Type of information	Meaming
Report	User	User information
	Computer	Terminal information
	Network	Network information
Request	Content	Send the content data
	Action	Execute the request
	Change_**	Change to another request
	Kill	Stop the process
Accept	Accept to request 'Chage'	
Refuse	Refuse to request 'Change'	
Notice	Change_**	User's request for another threshold
	Over_**	Over flow or under flow to threshold
Display	Content	Display content
	Reply	Replay for notice 'Change_**'
Info	Information of any other event	

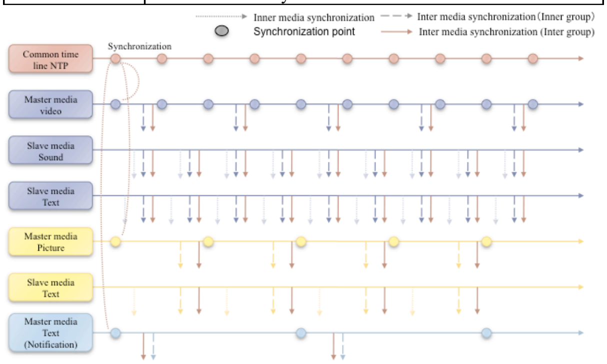

Fig. 4. Mechanism for multimedia synchronization

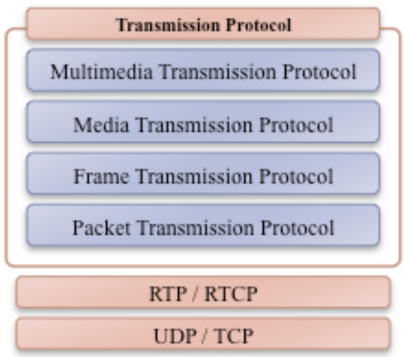

Fig. 5. Transmission protocol

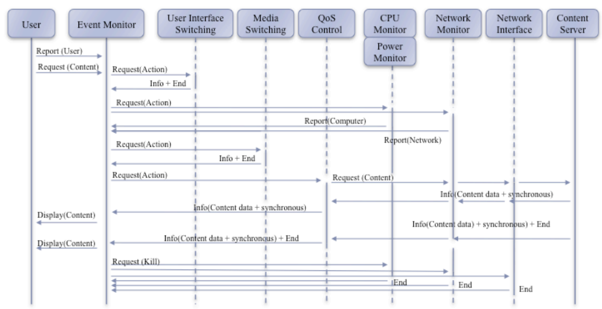

Fig. 6. Event sequence at starting phase

VI. Implementation

A prototype system has been developed as a client-server system in C++, Win32API and WinSock2, which supports a multi-thread to enable playing several remote media simultaneously. But, the current system hasn't supported the SF yet. The client software and the server software are configured such modules as shown in Fig.8 and Fig.9, respectively. A snapshot is the client software recommended for kids using notebook PCs as shown in Fig.10.

VII. CONCLUSION

In this paper, we discussed a software framework for our new concept and its implementation. Currently, we are implementing switching functions for providing appropriate multimedia expressions according to users' (mental and physical) abilities, computer facilities and network environments. In the future, we will evaluate our software framework, define rules for each switching function and develop a multimedia markup language for UMA.

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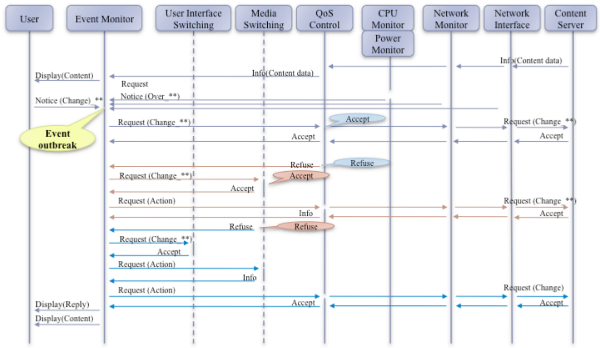

Fig. 7. Event sequence at switching phase

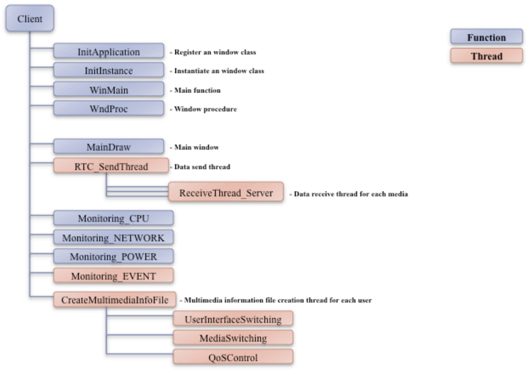

Fig. 8. Module configuration for client software

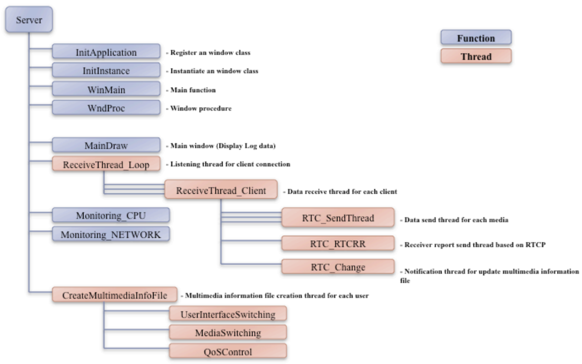

Fig. 9. Module configuration for server software

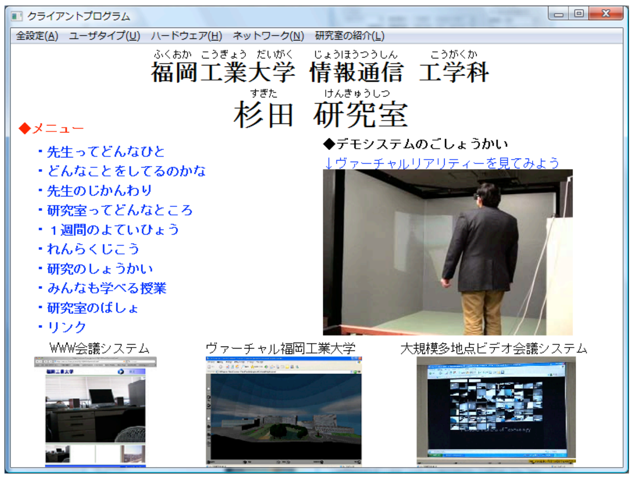

Fig. 10. Prototype system for kids using a notebook PC