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Management of Multimedia Data on a Distributed e-Learning System

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***Abstract*—We have proposed and implemented a distributed e-Learning system based on P2P architecture. In this system, contents are held by agents which are distributed among all nodes. These agents migrate to requesting user's node and serve contents. These contents can include multimedia data, such as audio and video. If one agent holds entire multimedia data, they cannot be played until completing a migration of the agent. As a solution for this issue, we divide multimedia data into multiple fragments by time series and individual agent holds each fragment. Therefore, not only the start of playing multimedia data is earlier, but also the entire download time is shorter because users can download these fragments from many nodes at the same time. We have confirmed the effectivity of this method by experiments.**

***Keywords*—P2P, Mobile Agent, e-Learning, Multimedia.**

I. Introduction

Nowadays, e-Learning systems are very popular in everywhere. Especially, Web-based training (hereafter we abbreviate as WBT) is commonly used. We are concerned with asynchronous WBT that allows learners to use the WBT on their own time and schedule, without live interaction with instructors.

Although a large number of studies have been made on asynchronous WBT, all of them are based on the client/server model. But client/server systems generally lack scalability and robustness. In recent years, P2P systems are very popular because they have potential for offering a decentralized, self-sustained, scalable, fault tolerant and symmetric network of computers providing an effective balancing of storage and bandwidth resources.

We have proposed and implemented a distributed e-Learning system based on P2P architecture[1], [2] using Maglog[3] that is a Prolog-based framework for building mobile multi-agent systems. The proposed e-Learning system has two distinguishing features. Firstly, it is based on P2P architecture and every user's computer plays the role of a client and a server. Namely, while a user uses the proposed e-Learning system, his/her computer (hereafter we refer to such a computer as a node) is a part of the system. It has some number of contents and has responsibility to serve these to requesting nodes. Secondly, each contents in the system is not only data but also an agent so that it has functions, such as scoring user's answers, telling the correct answers, and showing some related information without human instruction.

In the proposed system, contents can include multimedia data, such as audio and video. The size of multimedia data is expected to be large compared with text data. Therefore, if an agent holds multimedia data like text data, the size of the agent become huge and slow to migrate. Eventually, the start of user's learning is delayed. Thus in this study, we propose the agent which manage multimedia data. In addition to this, we propose and implement the method which manages large size multimedia data.

II. Proposed e-Learning System

While a user uses the proposed e-Learning system, his/her computer is a part of the system. Namely, it receives some number of contents from another node when it joins the system and has responsibility to send appropriate contents to requesting nodes. The important point to note is that the contents a node has are independent of the contents in which the user is interested as shown in Fig. 1.

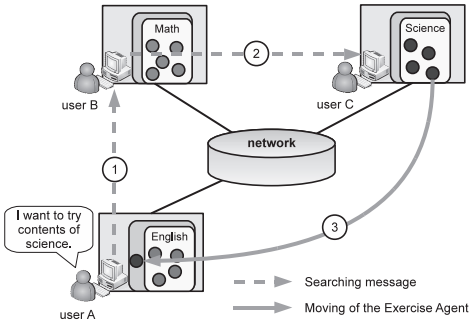


Fig. 1. Searching contents in proposed e-Learning system.

Generally, in addition to service to show contents, a WBT server provides services to score user's answers, to tell the correct answers, and to show some related information about the contents. Therefore, for the proposed system, it is not enough that only contents are distributed among all nodes. Functions to provide the above services also must be distributed among all nodes. We adopt mobile agent technology to achieve this goal.

III. Multimedia Data In The Proposed System

In the proposed system, contents is held by an exercise agent (hereafter we refer to an exercise agent as an EA). When a user requests contents, an EA which holds the requested

contents migrates to the user's node and serves it. If an EA holds contents including multimedia data, the size of the EA becomes huge and the time for migration increase. Namely, the time from requesting contents to completing a acquisition of it increase. For this reason, multimedia data are separated from EA in the proposed system as shown in Fig. 2. The separated data is held by a media agent (hereafter we refer to a media agent as a MA) which specialize in management of multimedia data. Therefore, even if the size of multimedia data becomes large, EA can serve contents in a constant time and MAs serve multimedia data afterward. MA is independent of EA in the proposed system. An EA refer MAs to use multimedia data which the contents contain.

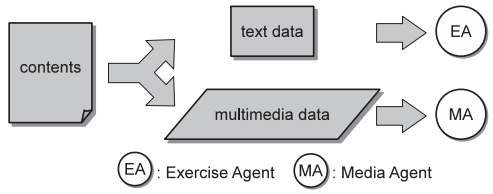


Fig. 2. Separating contents into text data and multimedia data that are held by each agent.

IV. Dividing Multimedia Data

A MA which is requested by a user serves multimedia data after completing a migration to the user's node. Therefore, if one MA holds entire multimedia data, they cannot be played until completing download. In this study, as a solution for this issue, we divide multimedia data into multiple fragments by time series and individual MA holds each fragment. When multimedia data is requested, these MAs migrate to the requesting user's node and serve a fragment of the multimedia data. Then the user plays the fragments which gathered on the user's node. In this method, users can start to play multimedia data without waiting the download of the entire data. Therefore, the time from requesting multimedia data to starting to play it shorten. In addition, these MAs are distributed to many nodes, so users can download these fragments from many nodes at the same time. Consequently, the entire download time also shorten. Fig. 3 shows dividing multimedia data into multiple fragments.

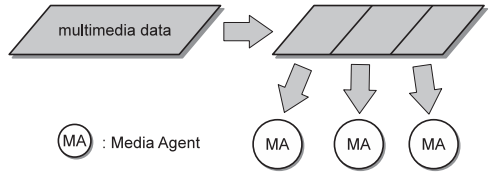
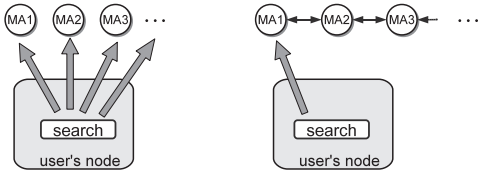


Fig. 3. Dividing multimedia data into fragments that are held by each MA.

It takes some time to search agents in the proposed system. Therefore, there is a possibility that the playing speed of the multimedia data is faster than the acquiring speed of it if the user's node searches all MAs having the fragment of the requested multimedia data as shown in Fig. 4 (a). Then, the user cannot play the multimedia data smoothly. To solve this issue, when each MA is created, it searches a MA holding the following fragment previously and records its location (hereafter we refer to this record as a link). Namely, each MA is linked in the order of time series of the multimedia data it holds. Consequently, the user can obtain the entire multimedia data by only one searching firstly.

In the proposed system, agents on each node might migrate as a node joining or leaving. Then, if a MA migrates, the link which the MA has needs to be updated. Consequently, each MA has not a unidirectional link but a bidirectional one. When one of divided MAs migrates, it tells the previous MA the information of own migration. Fig. 4 (b) shows MAs which have bidirectional links.



(a) search without link (b) search with link

Fig. 4. Searching MAs in the proposed system.

V. Experiments

We investigate how the start time of playing multimedia data changes by the division size of it. The division sizes of multimedia data are 5MB, 10MB, 20MB, and non divide.

Fig. 5 shows the result of the experiment. As a result, the average time of response are suppressed in a constant time when dividing multimedia data, while the average time of response increases as the size of multimedia data increases when not dividing multimedia data.

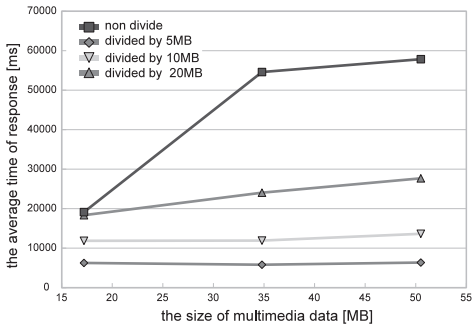


Fig. 5. Comparison of the average time of response by the division size.

VI. Conclusion

In this study, we have proposed and implemented the method that manages multimedia data in our e-learning system. We divide multimedia data into multiple fragments by time series, and an agent holds each fragment and is distributed to each node. Consequently, the start of playing multimedia data is earlier and the entire download time also is shorter than when an agent holds entire multimedia data.

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