ABSTRACT
This article proposes a framework for community support in infant education. The framework adopts the concept of "Discussion-Embedded Video (DEV)," which is video data within which some comments and discussions are virtually "embedded." By watching the video and embedded comments, participants, including parents of children, school teachers, medical staff, psycho-specialists and other specialists, can more effectively conduct discussions about children. Moving images of the children are recorded by multiple cameras, and by editing the multiple video streaming data, personalized motion pictures of one child are created. Participants can then watch this edited video and discuss it. This article describes the system’s basic concept, schematic illustration of implementation, and an example of its use.

KEY WORDS
Early childhood education, Internet, Video streaming, Electronic bulletin board

1. Introduction
The advancement of information technology has enabled us to apply various types of software and hardware to the education sector. Until recently, the main targets of "information technology in education" have been institutions of higher education such as universities. Many tools have been developed for this sector, including off-line CAI tools and on-line integrated learning environments. However, there has been little information technology developed specifically for elementary and infant education. This is partly because end users operate IT tools by themselves, whereas children in elementary and infant schools cannot use IT tools properly. Therefore, the major part of the research efforts in this field focuses on the improvement and support of teachers’ education.

2. Concept of Discussion-Embedded Video (DEV)
DEV is a computer-mediated education system that uses a “discussion-embedded” digital lecture video to effectively manage discussions. In this system, comments that are contributed by the participants are conceptually embedded in the corresponding parts of the video automatically, and the reply comments by other participants are represented in the same way as in a traditional BBS. In DEV, the participants can read the comments on the related topics while watching the lecture video, and can also watch the corresponding part of the lecture video while reading the discussion.

This article proposes a system for supporting infant care using a combination of digital video and an electronic bulletin board. The original system was developed for e-learning in higher-education sectors. In order to apply the original system to infant care support, we have adopted a multi-camera system. The multi-camera system uses multiple cameras to capture the actions of pupils in the classroom, whereas the original system assumed the usage of a single camera. A single camera, however, is not suitable for infant education because pupils in the classroom move around a great deal, thus a single camera often misses the pupils’ movement. To solve this problem, we have decided to employ multiple cameras to capture pupils’ motions.

In this article, Section 2 provides a summary of our original system, called DEV (Discussion-Embedded Video System). We then in Section 3 explain the basic framework of the extension based on the usage of multiple cameras. Tools are also described in the same section. Then, in Section 4, we show the implementation direction. Section 5 provides a summary.
Through the use of a DEV, discussion can be managed whereby the participants can clearly comprehend the relation between the discussion and the lecture. Using this method, participants also can more deeply understand the content and background of the discussion. Therefore, the participants can easily contribute comments to the discussion, and consequently, the DEV system archives a more effective distance-learning education environment in which further discussion is promoted. Figure 1 illustrates the conceptual structure of the DEV system.

Figure 2 is a practical sample interface of the DEV system. As shown in that figure, DEV’s user interface is constructed in two parts. The first part is a video display component, which shows streaming video. The second part is a BBS component. Basically, the structure of the BBS component is identical to that of traditional BBS, where all comments are managed in a hierarchical manner. However, there is one important difference: in traditional BBS, all messages are arranged based on the submitted time of each message. In DEV, however, comments are arranged based on the time of the corresponding video scene. Therefore, it is easy to recognize which part of the video data is related to the message.

In Fig. 1, “Comment 1” was submitted first, followed by Comments 2, 3, and 4. Traditional BBS displays all comments according to the time submitted, but DEV shows another order. For example, the corresponding video components of Comment 3 comes before that of Comment 1; therefore, Comment 3 is shown before Comment 1. The other comments will be displayed in the
same manner. Furthermore, there are direct links between comments and corresponding video components. When users click the comment icon, the corresponding video part will be played. On the other hand, when users watch the video, the corresponding comment will be shown on the display. By employing such a display method, users can easily understand background knowledge about the video’s contents.

3. Use of multiple cameras for infant education

3.1 Extension of the DEV system to the mDEV system

The original DEV system was developed for higher education. In DEV, a lecture video is provided in the video area (area ‘A’ of Fig. 2). A lecture video is usually recorded by one video camera only. When we apply the DEV system to infant education, however, a single-camera system is not sufficient. Partly this is because pupils in infant education move around a lot, and one camera cannot record such motion satisfactorily. Therefore, we extended the existing DEV system into mDEV, the multi-camera form of DEV, which in our implementation uses four cameras. One camera is positioned at each of the top four corners of the room, with each camera recording a particular part of it. As a result, we can cover the entire room from various viewpoints. This is in contrast to the original DEV, in which there is only one video area in the user interface.

There are essentially two methods of using multi-cameras in DEV. The first is to modify the user interface into one that can deal with multiple video images. The other is to edit four video images into one video stream. The edited video stream is subsequently displayed on the video area of the original interface. Because the original DEV system was developed as an WEB application, all information is displayed on the browser, but this area is insufficient for displaying four video images. Furthermore, although we have adopted four cameras for our mDEV, other applications may require many more. Therefore, we opted for the latter method, i.e. edition of multiple video streams.

3.2 Digital endless tape

Recording an entire nursery session requires an enormous amount of disk space and often include meaningless scenes. Furthermore, implementing editing functions is complex. Therefore, we need to select much simpler method. We decided to link fragments of video scenes of certain predefined length.

When a teacher wants to record a video, he/she will send a recording command to the video recorder, after which recording will start. Teachers often send recording commands when they notice something such as a quarrel, happening. This is a very natural and simple method of recording, though there is one drawback to this method: any action that occurs before the command to record is sent will not be recorded. Teachers, however, often want to watch the previous scene before something happened. For example, when a teacher notices children fighting, he/she will want to know who started the fight. In such a case, the video scene occurring before recording command is sent would be very helpful. Consequently, we should implement this function to apply the DEV system to elementary education.
In order to realize the above mentioned function, we use "digital endless tape." The term "digital endless tape" means a digitally realized endless tape. First, a video image is recorded for a predefined interval. The image recorded for each interval, which is called the video image segment (VIS), is then stored in a linked list. The length of the linked list is fixed. All elements of the linked list contain VIS, and the newly recorded VIS is stored in the oldest element of the linked list.

When teachers send a recording command to the video recorder, the current VIS is selected, then the selected VIS is linked to the recording list. Each VIS has its own interval, for example, 5 minutes.

3.3 Editing video streams
In the mDEV system, a video stream displayed on the video interface is represented by the sequences of VISs. Once a record command is issued, all cameras start recording, and the four VISs are created and stored. These four VISs represent an image captured at the same time but from different viewpoints.

After the end of each day's schooling, teachers start editing the sequence of VISs. The editing operation is really quite simple: the only action required is to connect the appropriate VISs. Thumbnail images of each VIS are shown in the editing pane. Teachers select the appropriate VIS by clicking on it.

4. Current status
Currently, the mDEV system is still under development. The basic structure of the mDEV system is identical to that of the original DEV system, with the difference being that the contents of video data are displayed on the video area of the user interface. Our development efforts are being concentrated on improving the editing tool described in Section 3.3, and this task will be finished by February 2005. We will then be able to describe the system in more concrete terms at the conference. This system will be implemented as a WEB-based application on the Windows operating system. After completing the prototype system, we plan to evaluate it in a real environment.

5. Summary
In this article, we proposed an application of discussion-embedded lecture video with multiple cameras, called mDEV, for elementary education. In mDEV, participants, including school teachers, medical doctors, psychology specialists, and other professionals will be able to conduct discussions over the Internet. The mDEV system is based on the DEV system, which was developed for distance-learning support for the higher-education sector. In order to apply the DEV system to the field of elementary education, multiple cameras are used to record students’ activity more accurately.

After recording each day’s education activities, teachers will edit the video scenes. All video scenes are divided into predefined intervals, called video interval segments (VIS). By editing these VISs, teachers easily re-create a specific video scene through the simple procedure of connecting two appropriate video scenes.

The mDEV system is currently under development, and will be implemented on the Windows operating system. Upon completion, the prototype system will undergo test evaluation in a real elementary education environment.

References: