

A Web-based Presentation and Virtual Collaborative System in Medical Training

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Abstract

The rapid development of wired/wireless Internet technologies and computing devices, such as desktop, laptop and tablet PC, make it possible for education or collaborative work to move the real world to virtual spaces. Therefore e-learning with virtual collaboration through the Internet is expected to go as a powerful educational tool and enables users to study or work together anytime and anywhere. The proposed system consists of two parts – multimedia presentation tool and web-based virtual collaboration. The former supports synchronized multimedia presentation using Synchronous Multimedia Integration Language (SMIL). It allows synchronization of the contents of a PowerPoint presentation file and a video file so that the presentation shows slides and video on the same topic at any given time. The last is the web-based collaborative system in medicine. All participants can see the same screen at the same time and discuss their opinions in a web. Participants can use text along with associated symbols during the discussion over the shared windows. The symbols such as arrows or polygons have x-y coordinates to represent associated participants' questions and answers. Those can be set or removed dynamically using so called layered architecture that separates slide layer from annotation layer. Those annotations can be easily hidden for training purposes. XML files are used to record participants' questions and answers along with the associated annotations over some particular images.

Keywords: E-Learning, Multimedia Authoring, SMIL, Virtual Collaboration

1. Introduction

In modern society, Internet-based communication has become an important commodity in daily life, anywhere from instant messenger to hi-speed video conferencing. Internet-based collaboration or virtual collaboration may be carried out in various ways, e.g., simple text exchange through web pages, text chat, voice-over-IP and IP video conferencing [1, 2]. Sung stressed and analyzed collaboration in mobile learning environment and assessed some of their collaboration projects [3]. Pooshfam *et al.* proposed a system for annotating images and videos in a collaborative way [4]. The demand for the virtual collaboration has been overwhelming in the sectors including research community, academia, medical and some industry for various purposes, e.g., researchers getting better results by doing collaboration with their peers, schools offer distance education to serve broader community, medical doctors collaborate for better treatment of patients – by getting experts' opinions, industry use

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collaboration for more efficient sales and marketing meetings, *etc.* Volkmer *et al.* proposed a system for annotating images and videos in a collaborative way [5].

SMIL (Synchronized Multimedia Integration Language) is a XML based markup language by W3C recommendation to create multimedia presentations [6]. SMIL integrates multimedia elements such as text, images, video and audio by synchronizing them. SMIL provides an easy way for authors to compose multimedia presentations. Bouyakoub *et al.* have proposed a temporal authoring tool for SMIL document with incremental authoring based on H-SMIL-Net model [7]. Téllez has presented an IMS formats authoring tool for Docbook to produce SMIL compositions and e-learning contents [8]. Internet-based collaboration or virtual collaboration may be carried out in various ways, *e.g.*, simple text exchange through web pages, text chat, voice-over-IP and IP video conferencing.

In this paper, we are proposing a multimedia authoring and virtual collaboration system that produces multimedia presentations for e-learning contents and enables multiple users to do collaborative work. The proposed system consists of two separate tools: one is a multimedia presentation authoring tool and the other is a virtual collaboration tool.

The proposed authoring tool offers easy-to-use and efficient multimedia presentation authoring that utilizes Synchronous Multimedia Integration Language (SMIL). It helps the teacher presents the lecture by providing the capability of synchronizing video and power point file. The uniqueness about this e-learning system is the connection between synchronized multimedia presentation authoring and real-time slide annotation. In virtual collaboration, annotations use layered architecture that separate slides from annotation. In the annotation layer, various symbols such as arrows and/or polygons those are associated with x-y coordinates that represent the location on the slide. Those symbols are associated with valuable information such as teacher or students' opinions on the area of interest in some slides. All the discussion may be recorded in real-time using XML web-based database for permanent storage. With the proposed virtual collaboration, users can place a symbol on the location of interest in a slide and associate it with their opinions and multicast those to all the participants in the lecture so that they may be able to exchange their opinions. When the discussion is over, all the opinions from the discussion that are saved in an XML file may be saved into web-based database for future context based intelligent search. Location (coordinate) information can be used to retrieve opinions on some particular area of the images when selecting the region by polygon, which is typically a convex polygon, and use it as queries to the database for the location and associated opinions.

2. Multimedia Presentation Using SMIL

2.1. The Necessity of Synchronization and SMIL

By far the most effective way of communication is face-to-face meeting. In virtual collaboration community, resembling it as closely as possible would be the eventual goal. In order to achieve this goal, video and other multimedia elements become inevitable choices for the communication.

In this section, we would like to consider multimedia presentation and associated challenges. We termed a multimedia presentation when video and other multimedia elements are used as a main means of delivering the contents. The video and PowerPoint file are used to create multimedia presentation. When used with PowerPoint file, video must be synchronized with each slide so that the audience knows what the video is referred to. The following things must be considered when synchronizing multimedia elements:

- Duration of each slide (how long should it be displayed)

- Position of each multimedia element such as video, slide, and/or digital image on the screen
- Order of each element (which one shows up first)
- Types of supporting multimedia file and its player

Multimedia presentation is especially useful when there are digital images or textual descriptions that need visual explanation. Adding video and digital images to PowerPoint slides in our approach would include the aforementioned considerations. For such purpose, there is W3C recommendation that describes Synchronous Multimedia Integration Language (SMIL). It is a collection of XML elements and attributes that can be used to describe the temporal and spatial coordination of one or more media objects. With SMIL, different media objects can be combined into a single coherent multimedia presentation. SMIL can be used to manipulate location, size, type of media objects, bit-rate, *etc.*

SMIL document uses <smil> tag for opening and </smil> tag for closing as a root tag and is composed of <head> and <body> tags like HTML. <head> tag includes <layout>, <region> and <switch> tags with meta information. <layout> is divided into <region>s. <region> tag specifies the position and size of media object elements. In <body> tag, <text>, <audio>, <video> and <animation> tags are used for media objects, and <par> and <seq> tags are used for synchronization in parallel and sequential. The sample code of SMIL document for multimedia content is as follows.

```
<smil>
  <head>
    <layout>
      <root-layout width="500" height="380"/>
      <region id="A" width="500" height="280" top="0" />
      <region id="B" width="350" height="100" top="280" left="55" />
    </layout>
  </head>
  <body>
    <par>
      <audio src="audio1.wav" begin="0s" dur="150s" />
      <video src="video.mpg" region="A" begin="0s" dur="150s"/>
    <seq>
      
      
      
      <par>
        
        <text src="text1.txt" region="B" begin="90s" dur="40s" />
        <text src="text2.txt" region="B" begin="130s" dur="20s" />
      </par>
    </seq>
  </par>
</body>
</smil>
```

The comparison between <par> tag and <seq> tag is shown in Figure 1. In Figure 1, the time durations of the image, video, and text objects are 20, 30 and 20seconds each. The synchronized media object elements are played at the same time by <par>tag and the total time duration is 30seconds ($\max\{20,30,20\}$). The synchronized media object elements are played sequentially by <seq>tag and the total time duration is 70seconds ($\text{sum}\{20,30,20\}$).

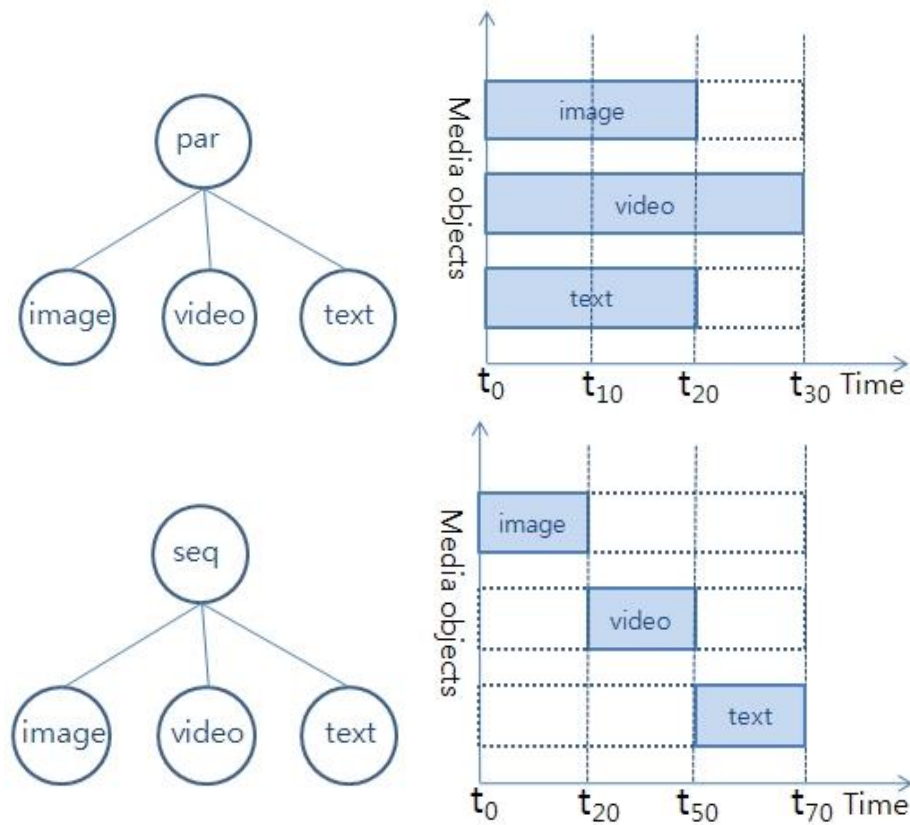


Figure 1. SMIL tree and synchronization in parallel and sequential tag

2.2. Multimedia Presentation Authoring

There have been many approaches in adding multimedia to presentations, but many of them are fairly complicated and require expensive equipment. In our approach, we are proposing an easy and inexpensive and yet efficient way of adding multimedia to presentations using Synchronous Multimedia Integration Language (SMIL.)

This concept was implemented using Java technologies such as JMF and JDOM and for the synchronization of multimedia components we used SMIL. As in Figure 2, it captures video and audio from a web cam and creates multimedia presentation by merging PowerPoint presentation slides and a captured or a prerecorded movie. One of the hard parts in creating such material is to specify synchronization relationships among media elements.

In our model, we synchronize the video and audio with the PowerPoint slides by creating a SMIL file that specifies the relationships among the elements in the presentation. A SMIL file can specify the duration of each slide, location and size of video and slide and so on. Once the presentation file is created, we can edit existing relationships such as duration of each slide.

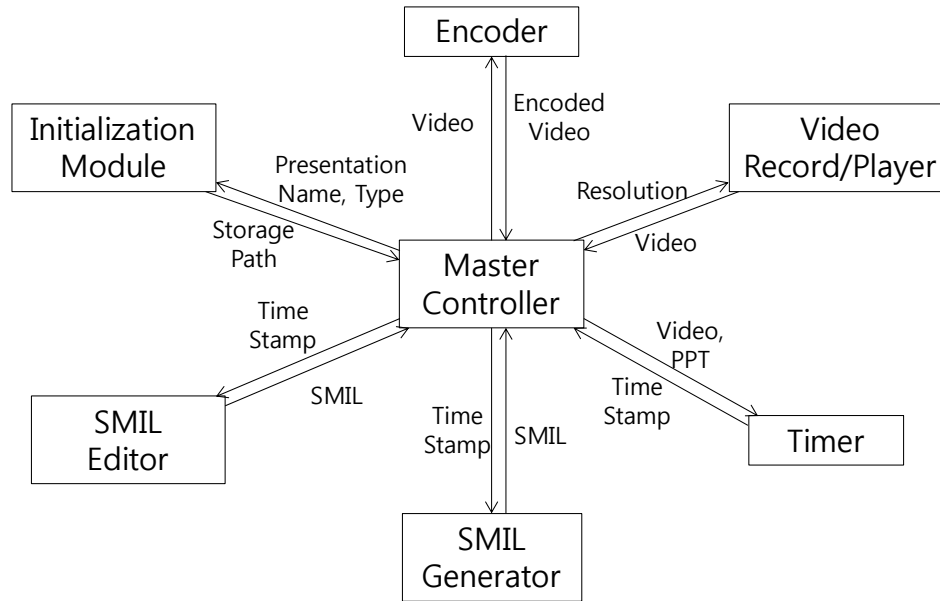


Figure 2. Block Diagram of Multimedia Presentation Tool

Main modules are described as in the following:

- The Initialization Module initializes a user session. It creates or opens an existing presentation based on user selection and initializes other modules in the tool.
- The JMF video capture module records video and renders it to the screen for monitoring. Its video playback module can play an existing video selected by user.
- Timer is triggered by user command. When the timer is started, it starts video capturing module and marks the beginning of the presentation displaying the 1st slide. As user moves on to next slide, it invokes the slide loader and keeps track of the time duration for each slide for synchronization with associated video. When the timer is stopped, it stops the video capturing and marks the end of the presentation.
- Encoder transforms AVI video into stream format and compress the size of video
- The SMIL Generator compiles the information about slides and time stamp for each slide, captured or pre-recorded video and synchronizes those into one SMIL file that enables synchronized multimedia presentation.
- The SMIL Editor is used for fine-tuning the synchronized presentation. The editor module reads the time stamps from the generated SMIL file. It waits for user command whether to write the edited timestamps back to the SMIL file. It also ensures that the accumulated duration of the entire slides is the same as the video running time.

The resulting presentation is in SMIL format, which means the following:

- Media is in stream format – encoded video synchronized with slides and other media elements, if any
- A SMIL file defines relationships among the media elements used in the presentation

- The SMIL file is playable by Real Player™ in our approach

SMIL may define location and size of visual elements (video, PowerPoint slides), duration of each slide and references to the video and slide files. Since SMIL is based on XML, an element and its attribute are identified and wrapped by tags. The elements and attributes in the generated SMIL file are consisted of the following:

- Region for video and PowerPoint slides: Regions are assigned to video and PowerPoint slides in each SMIL file using the element `<region>`. Each region is assigned a unique SMIL-ID.
- SMIL-ID: An ID is assigned to each child element of a SMIL element *e.g.* video or img in the example code.
- Parallel execution of child elements: Synchronized video and PowerPoint that are executed in parallel are child elements of `<par>` tag.
- Duration time: The `dur` attribute defines the duration time for each PowerPoint slide.

The example in Figure 3 is a SMIL file in action and corresponding source code. The markups for each region and media declarations are clearly shown. SMIL files contain only the references to media objects, not the actual media objects itself. Some SMIL players are currently available. The SMIL player we chose was RealPlayer™ due to its popularity.

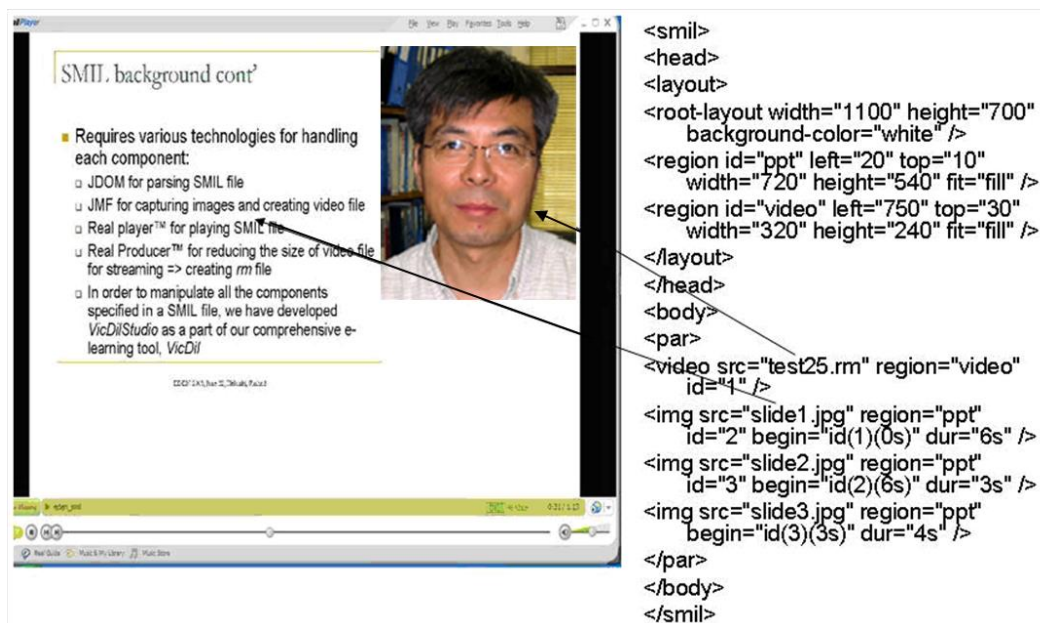


Figure 3. Multimedia presentation and its corresponding SMIL source file

3. Virtual Collaboration System

3.1. Multiple Lectures

The proposed system can offer multiple lectures and each lecture can have multiple topics. A lecture must be created by the system administrator upon the teacher's request. After the requested lecture is created, the requestor becomes the lecture administrator. The lecture administrator can have all the right to operate the lecture.

Any teacher can create a new topic after granted as an administrator of a lecture. In Figure 4, students can join several topics in different lectures simultaneously according to their access rights. It is the teacher's responsibility to upload and related files and/or multimedia presentation.

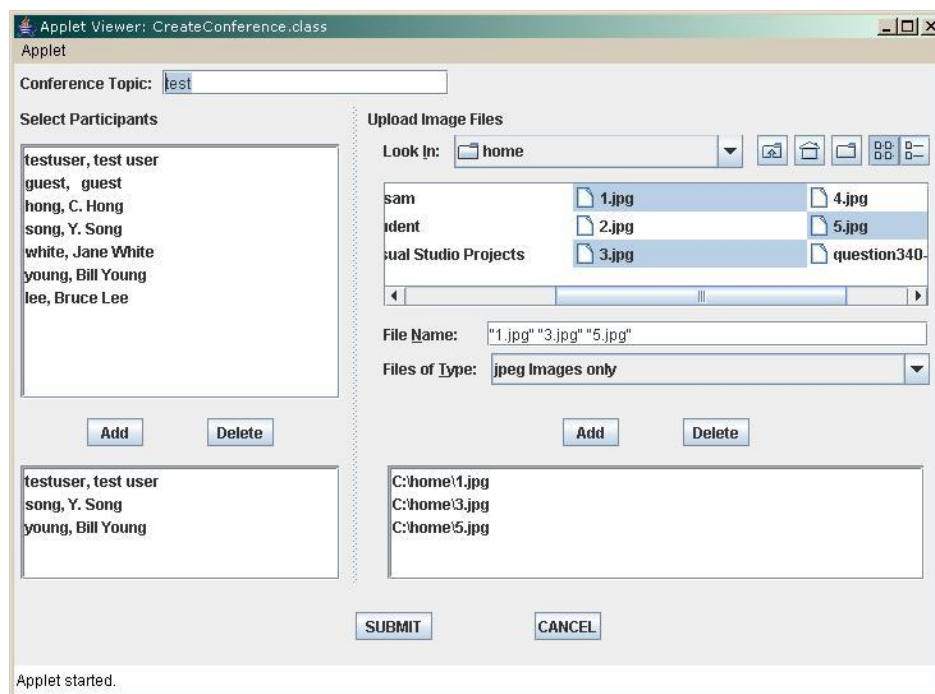


Figure 4. The screenshot of creating new topic

One of the important requirements of virtual collaboration is private person-to-person communication between participants. This collaboration system recreates face-to-face experience of traditional meeting by providing the independent (or not tied with the main window) private window. The participants create a private session with other participants. They can choose the name in the list of participants and request private session. If the recipient accepts the offer, the private session can be created. The discussion and any shared data in a private session are hidden from the other members.

In a shared window, the viewpoints of all participants are synchronized. If any participant expresses opinion using a symbol and comment, the content of every participating client

object is updated simultaneously. The user can move freely between the private and shared working space.

In this collaboration, shared working space can be synchronous or asynchronous. In a synchronous mode, the state changes are multicast and updated to other participants' views synchronously so that all participants can see the same view. The synchronous collaboration is typical in shared working spaces such as chatting, instant messenger or whiteboard. However, since the proposed collaboration can record all the synchronous discussions and related materials to the XML database, asynchronous collaboration is also possible by allowing legitimate users to log on the lecture at their convenient time and leave new marks and questions which are recorded in a XML database too. Then, the teacher can log on the lecture and answer those questions at any time.

The collaboration system offers access control mechanism that restricts users' access right to the available resources to protect the system and data from malicious operation. There are four types of access rights: Administrator, Member, Observer, Restricted.

3.2. Communication Architecture

Figure 5 shows the communication architecture between a server and clients. A user becomes a client when the user enters the topic room. First, a session manager in a client side tries to establish a socket communication with a connection manager in a server side. After socket connection, each working applet in a client side communicates with a topic manager independently using multi-thread operations. The connection and topic managers are implemented as Java applications and run on a server. The session manager is implemented as a Java applet running on a client's side.

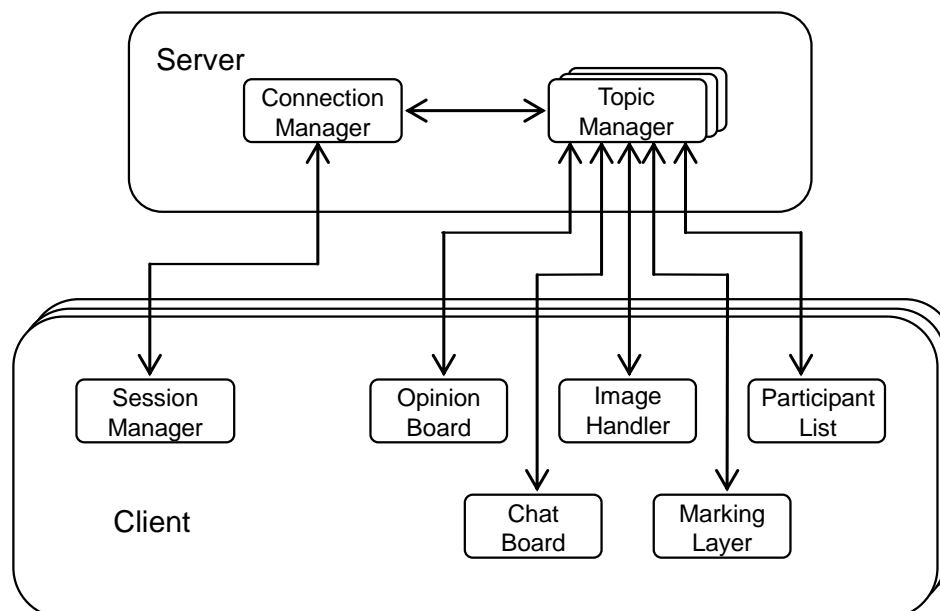


Figure 5. The communication architecture between server and clients

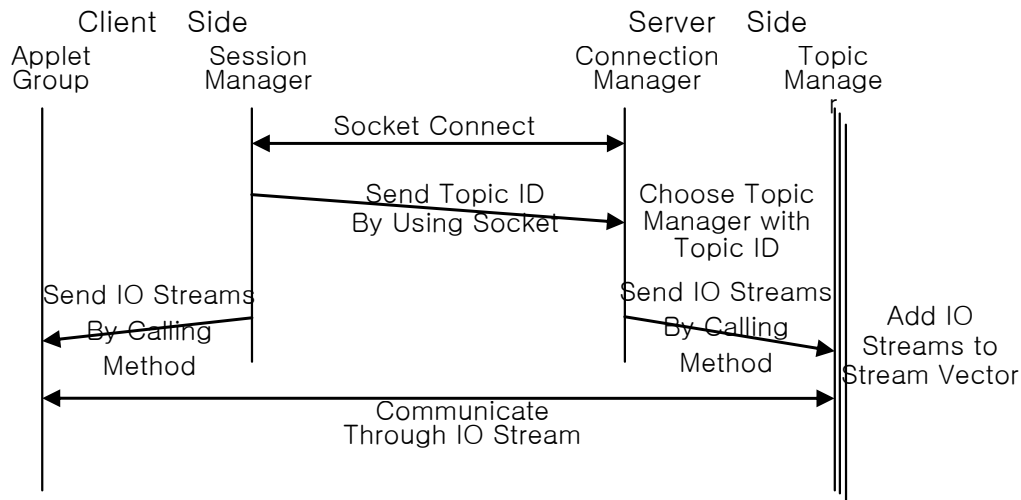


Figure 6. The sequence of message communication for entering a topic

Figure 6 illustrates the sequences of message communication between a server and a client when a user enters an existing topic. When a user requests to enter a topic, the session manager tries to connect a server by a socket which establishes Input/output object streams. Then, it sends a requested topic ID (identification number) to the connection manager in a server side. The topic ID is unique over the collaboration system, so the connection manager assigns requested IO object streams to the available topic manager. The topic manager adds new IO streams to the existing stream vector for clients.

4. Medical Applications

Virtual collaboration among the medical doctors can be performed by the following manner:

1. A doctor comes up with a case that needs discussion with other doctors who have the specialty in that field.
2. The doctor prepares a presentation regarding the case. The presentation uses digitized medical images and other available resources such as patient information and/or lab results, if any. The images used in the presentation will be available for discussion. When finished, they will be uploaded to the designated topic room.
3. The doctor then specifies the time and date and asks potential participant(s) to log on to the designated web site where the multimedia presentation for the case will be available for them to look at before the discussion begins. Each participant is requested to watch the presentation before the specified time.
4. On the specified date and time, participant(s) log on to the web-site and the doctor who requested the meeting becomes a host of the meeting.
5. Participants express their opinions through their web browser along with the information on area of interest in some digital images presented. Some relevant digitized material such as medical images can be uploaded from their location, if necessary. Their opinions are saved into an XML database eventually.

6. Discussion session continues and opinions exchanged among the participants until they reach some conclusions about the case. Chat window is used for all other messages that are not directly related to the case. The messages used in the chat window will not be recorded.
7. When finished, the host can call the meeting off using chat window.

The proposed medical collaborative system can be used to get second opinion from specialists. In this case, the system will be used asynchronously. The steps are similar to the previous case but there is no need for all the participants to be online at the same time. The requester of the second opinion needs to prepare all the images and other supporting document regarding the case. Once they are prepared, they will be uploaded for the specialists to see. The specialists then examine all the uploaded information and post their opinions using symbols over the images and other supporting documents regarding the requested case in any time.

Similar to the second opinion case, it can be used in e-learning to training the medical doctors. Experts on the images can post all the symbols and their associated explanations and hide the symbols from the trainee. The trainees then post their own opinion for the images and compare with that of experts'.

A discussion through the virtual collaboration tool is shown in the Figure 7. The opinions from the participants will be associated with the symbol on the image.

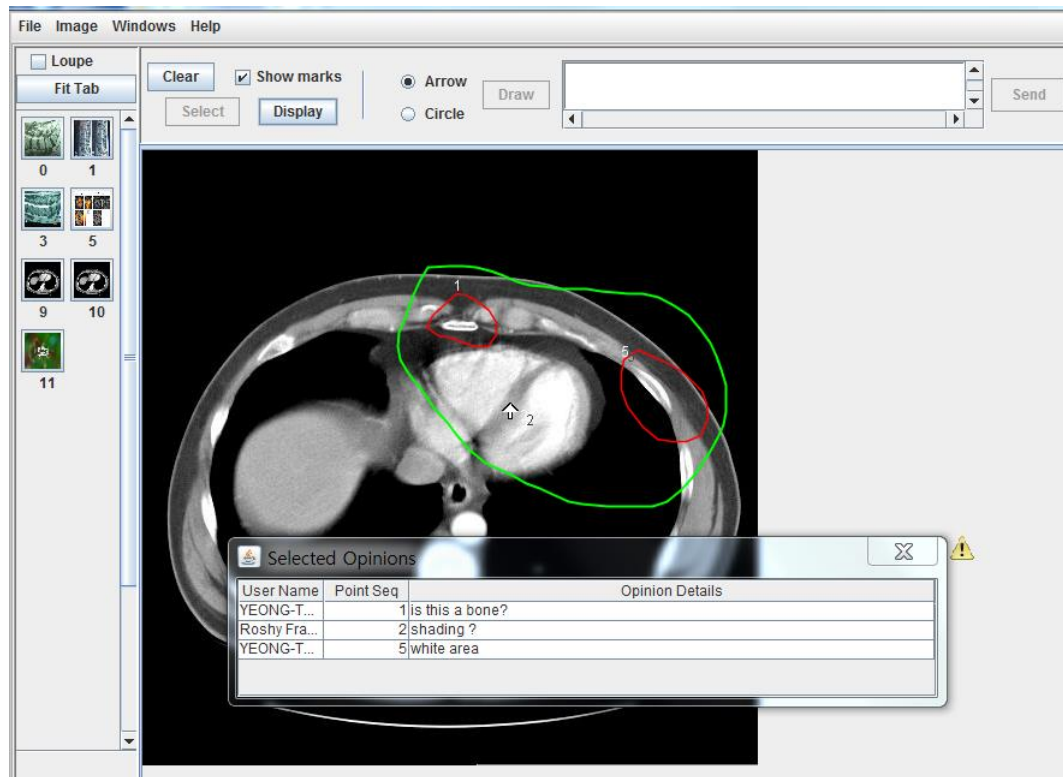


Figure 7. Virtual collaboration tool

5. Conclusions

We have proposed a multimedia authoring and virtual collaboration in e-learning system that helps authors to produce multimedia presentations from media objects and enables users to attend multiple topics in different lectures simultaneously.

The multimedia authoring system provides authors a tool to create multimedia e-learning contents easy to follow. The proposed system makes it possible to integrate diverse media types including text, images, audio and video, and synchronize media objects by generating SMIL documents automatically.

The virtual collaboration tool provides recordable discussions among users using spatial data associated with students' questions and the slides. Digital images and opinions are separated through the layered architecture. Users' questions or answers along with symbols are recorded to XML files and may be saved into web-based database for future context based intelligent search.

Our proposed system is expected to be a powerful educational tool through the multimedia authoring and virtual collaboration. It can be an efficient way for learning valuable knowledge and sharing information through the Internet anytime and anywhere.

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