An Advanced Automated Authoring Based on Cloud Cooperative Event- Driven Technology for Web-Based E-learning System in Higher Education

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Doctor of Philosophy

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SOKENDAI (The Graduate University for Advanced Studies)

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Summary

Information technology and the Internet are major drivers of research, innovation, growth and social change. The growth in Internet has brought changes in all walks of life including the education. In higher education, the education methodologies are changing from the classroom based methodology to the use of information and communication technologies (ICT). It is a new trend to facilitate the interaction and communication between teacher and student, and also to meet the social demands for a flexible educational system. Therefore, increasingly the organizations are adopting e-Content as the main delivery method to educate students and train employees. At the same time, educational institutions are moving toward the use of the Internet for delivery, both on campus and at a distance mode. For the instructor, tutoring can be done at anytime and from anywhere. Online materials can be updated, and learners are able to see the changes at once. When learners are able to access materials on the Internet, it is easier for instructors to direct them to the appropriate information based on their needs. However, the content development is still the most challenging task in implementing E-learning, it is a time consuming and a costly process. Furthermore, the course data should be maintained and updated, especially if in the field of computer science, change frequently, then the cost for the updates will add up. Thus, the successful implementation of e-content have been hampered which led to a dearth of high quality E-learning content in many institutes and universities over the world especially in developing countries. This dissertation provides a main contribution to solve the limitations of existing authoring tools in the content development process to create effective and rich e-contents and to support the developing countries in adopting online education for an internationalized educational program.

This dissertation consists of eight chapters briefly describes as follows:

Chapter 1 presents the background of the study and the objective scope of the research. The information technology and the Internet are major drivers of research, innovation, growth and social change. The growth in Internet has brought changes in all walks of life including the education. Based on the characteristics of higher education, online learning contents are strongly required to support distance education and boost up the learning curve of learners in the points of view of E-learning. However, the content development to produce the e-contents is still the most challenging task in implementing E-learning, there are many key factors that hamper the successful implementation of e-content which led to a dearth of high quality E-learning content in many institutes and universities over the world especially in developing countries. Furthermore, The cloud cooperative event-driven approach between client and server allows much more efficient computing by centralizing data storage, processing and bandwidth what leaded us to employ the cloud computing in this research. Cloud computing also allows consumers and businesses to use applications without installation and access their personal files at any computer.

Chapter 2 presents the review of related studies and technologies. As there exist several approaches consider the problem of on-demand learning content development, therefore we studied and surveys the existing work for content authoring and existing tools for meeting and lectures recording. As there are several techniques to create learning content, we detached the review on four subsections aspects: manual crafting authoring, semi-automatic authoring, the lecture recording tools and the meeting capturing tools. The author summarized the important solutions addressing the content development issues in the point of view of its technology and stressed the missing and lacking of technology to provide a more suitable world wide content development solution in higher education.

Chapter 3 describes the overview of the WebELS platform. In order to prove and implement the hypothesis of this research, an E-learning platform dedicated to higher education was needed. Thus, the WebELS platform was used in this research which is an Internet-based E-learning system that originally designed to support flexibility and globalization of higher education in engineering and science especially in Ph.D. education. The system has been distributed based on open source software (OSS) policy. The WebELS system is focusing on learning authoring, archive of learning materials and the distribution of the learning contents on the web for on-demand learning and online meeting supporting by that

both learning modes i.e., synchronous ans asynchronous. WebELS is functioning in a low-speed Internet environment keeping high quality slides along with video clips and audio. A variety of client computers such as Windows, Mac OS and Linux can be used on the same feature, function and system environment. Every user can use the system over the Internet access via any web browser application.

Chapter 4 introduces the design concept of the novel automated authoring system proposed in this thesis. The system was implemented within an online lecture platform. The background processing of the system, the export/import functions to integrate the two WebELS system modules i.e., Meeting and Learning, the post-editing and playback procedures are all explained. The author proposes a new method of authoring to facilitate and provide an automatic content development process for professors. The authoring system works as a background processing on a lecture platform and can capture the whole presentation event once the lecturer activates it on the client side. The learning content generated on the meeting module includes the meta-data, presentations files, lecturer video stream, and the synchronization data of slide changing and cursor annotation. Thus, the created content can be exported and imported to the learning module using the export/import functions. At the learning module a post-editing phase is possible to further improve the content. The content will be saved on the learning module server where it will be playback by students anytime and anywhere through the Internet.

Chapter 5 shows the implementation details of the proposed automated authoring system. The system architecture, system cloud computing, data files, the course generation algorithm and the data structure are described. The automated authoring system is based on client-server architecture. The client side is a web-based E-meeting application that can be accessed by any web browser by both lecturers and students. Client (lecturer) is connected to the meeting server that share streaming and data among the connected users online. The server is a web application-based server using Red5 for streaming and Apache Tomcat for content managements. The author proposes the event-driven technology to maintain the real-time authoring between the client and the server developed into the course generation algorithm. The Cooperative event-driven consists of event generator and event processing engine harmoniously collaborating in real-time. Event generator senses a fact and represents the fact into an event and knows only that the event has occurred on the client side. The event-processing engine is where the

event is identified, and the appropriate reaction is selected and executed on the server side. The course generation algorithm is activated once the client decide the start recording the presentation and it will manage slide changing, cursor annotation and the streaming quality adjustment and the data structure of the content automatically. The algorithm technique in authoring is different form others, since it does not exactly cut the video file but instead it use the time position marks. Thus, the system authoring becomes faster and reduce the work load on the server. Moreover, the output based on the marked time positions is easier to edit and manipulate. Once the presentation is finished and the automated authoring system is deactivated, on the server side the algorithm will automatically generate the learning content package.

Chapter 6 focuses on the online video meeting improvement contributions. The author designed two functions to support and enhance the online meeting presentations in the E-meeting module of the WebELS platform, such as automatic streaming adaptation and video embedded synchronization. Automatic streaming adaptation is for goal to adjust the audio/video stream quality of users during the online meeting to support and keep stability of connection for users under low speed Internet environment. Video embedded improved the variety of contents that can be used during an online presentation. Rarely E-meeting systems support the video content to be shared online among the connected users. Therefore, we designed a new function on the E-meeting module to enable using a video content type for an online presentation and the video playback control is synchronized in real-time among all the connected clients.

Chapter 7 presents the experimental results of the proposed system. The author has evaluated the performance of the automated authoring system in term of CPU and bandwidth usage when it is used in different scenarios. Moreover, we designed a comparative study of our proposed system with other related existing software for automatic content generation based on several indicators. The overall experience demonstrated that the Automated Authoring System is indeed a feasible way to combine apparently different tasks: teaching in class, online presentation, and multimedia authoring in a one single activity as shown in its main benefits for both students and professors in higher education. The resulting AAS documents they are as good as courseware produced by current authoring systems with much less time, efforts and cost. Moreover, the AAS contents are integrated

into a Web-based teaching and learning environments, which is an important step on the long way to making teaching and learning more time and space independent.

Chapter 8 concludes the dissertation. This dissertation describes the implementation of a novel automated authoring system that is for goal solving some of the major issues in content development in term of time, efforts, complexity and cost, also to support the higher education activities. All professors in both developed and developing countries can create their learning contents online using the proposed system. The system can support both learning modes in higher education at the same time i.e., synchronous and asynchronous. It is considered to reduce the time, efforts and the high cost required by the existing tools for the e-content development. Moreover, the author proposes the suitable automatic streaming adaptation for the WebELS Meeting module. The function ensure the stability of the online communication under the low speed Internet by enabling the server to automatically adjust the users streaming quality based on their network speed. Moreover, the author also implements the video embedded synchronization to enable professors in the engineering field and other field to use the video type format for an online presentation synchronizing its real-time playback among the connected users and the possibility to insert annotation on the video for a deeper explanation of the contents. The research contribution is strongly targeting the developing countries where the E-learning methodology is still hard to present due to several issues such as cost, bandwidth, technology access and complicated software solutions.

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Chapter 1

Introduction

1.1 Background of the Study

The rapid advancement of technology and the informatization of society are very important factors that prepared the way for the changing methodologies of higher education from the traditional classroom-based methodology to the use of information and communication technologies (ICT). It is a new trend to facilitate the interaction and communication between teacher and student, and also to meet the social demands for a flexible educational system. In higher education, students utilize ICT materials to support their learning and research activities. Based on the characteristics of higher education, Internet-based E-learning and online meeting systems are strongly required to support distance education and boost up the learning curve of learners in the points of view of E-learning [1][2].

Online lecture is an important factor to support higher education activities by teaching a group of students whether at same location or over the globe through the Internet especially in Ph.D. education. However, the traditional online lectures as for the traditional classroom-based presentations deliver contents in a one-size-fits-all manner to students [3]. It wastes time of more advanced learners by presenting introductory concepts and often is too fast for slow learners who do not possess the required prerequisite knowledge. Therefore, capturing and archiving presentations is becoming an increasingly important part of the E-learning contents generation in several academic institutions [4]. It is proved to be the fast and efficient way of creating contents for E-learning. Al Nashah, et.al [5] and Greenberg [6], showed in their research that the students consider the captured

lectures an effective tool to help them succeed in their learning process and that it falls into the need-to-have category in universities and institutions, since it is a significant new pedagogical tool that increase the flexibility of students and boost up the learning curve. Kolwich, [7] proved in a study of capturing a presentation in higher education, students have reported that"having lectures available online would help them retrain lesson materiel, and 76% said they believed it would help them improve their education". Thus, reviewing a recorded presentation might give a real feeling that can be experiences by all senses, where students review the presentation materiel, see and hear the presenter talk as if one is actually attending a physical lecture. Furthermore, students can access to these learning contents whenever and wherever they wants. In order to acquire every relevant aspect of the live presentation, three basic streams have to be captured. First and foremost, the teachers verbal narration which accompanies the slides presentation. These two sources are considered being essential streams, whereas the live video should be considered in its importance for distance learning. Furthermore, several users technological requirements are requested, e.g., (1) Convenient and quick to create and edit contents, (2) able to edit in the last saved editing stage, (3) able to use the system without software installation, and (4) support structure based navigation to enable some features such as next, previous slide, play and pause video [8].

Currently, there is a dearth of high quality E-learning content in many institutes and universities over the world due to the content development issues [9] [10] [11] [12].Content development is by far the most challenging task in E-learning. It is a time consuming and costly process [13] [14]. Furthermore, the course data should be maintained and updated, especially if in the field of computer science, change frequently, then the cost for the updates will add up. One of the options that many institutes adopted is to videotape their regular lectures in order to produce online lectures using a simple video format. A group of these online lectures will form a complete online course. Thus, several efforts are needed to achieve that such as man power to record, extra software for mixing and editing that require IT level to maintain rather than the high price to maintain and install it. Therefore,recent challenging research is focusing on improving the courseware production to enable instructors create rich E-learning contents to solve the content development issues. Hence, the new trends and future directions of E-learning is focusing in developing newest solutions for improving development and high quality of learning contents [15].

1.1.1 Higher Education Characteristics

Content development for online learning has to be addressed differently than for classroom teaching. The content needs to be interactive acting like a virtual teacher and not merely a fancy electronic page-turner. The students should be able to understand the problems interactively during the lecture, and if necessary guided intelligently. Online education deals with both undergraduate and postgraduate education. It is also desired to provide continuing education to professional people to upgrade their knowledge. The content for online education for undergraduate and postgraduate students needs to be designed keeping in view their requirements. The undergraduate studies generally follow the lecture-tutorial-laboratory paradigm. Tutorial work is an essential component in the consolidation of students understanding of the lecture materials. The online courseware shall, therefore, be developed to supplement the classroom teaching. The system has to be user friendly and should act like virtual tutor to provide guidance to students outside the classroom. The mode of teaching at postgraduate level and continuing education is usually through lectures and at times with laboratory. The online course content, therefore, has to be quite comprehensive and more effective than a book or lecture notes [16], [17], [18]. Some characteristics for higher education are show as follows:

- Graduate students are responsible persons who can learn by themselves and can also utilize many materials to support their learning and research activities.
- Regular activities in graduate programs are self-learning, group meeting, teacher-student discussion and academic presentations.
- Major activities are joining research meetings and presentation of academic research articles at international conferences.
- Using online content is becoming a trend for obtaining knowledge due to the vast availability of information and content from the Internet. It is considered to support the classroom-based learning due to the increasing of social demand in international communication scale.

However the traditional style of face-to-face education is not able to meet the demand of the society because of limitations in location, time and cost. Moreover,

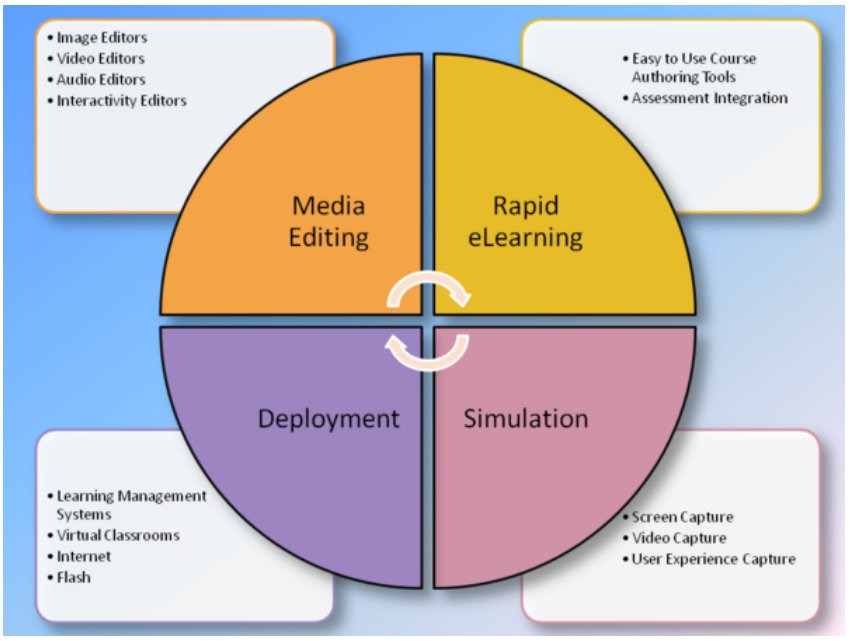


FIGURE 1.1: Innovation and knowledge for E-learning in higher education

Synchronous, multimedia communication and collaboration tools currently lack of support and solutions [17]. Ruchi, et al [19] proposed a comprehensive conceptual model that can be applied in differing pedagogical environments relating to IT education for adult learners. It provides a framework to guide education managers, instructional designers and developers who are creating accessible IT E-learning environments. Figure 1.1 [1] shows the circle of innovation using ICT tools that allows learning and information sharing dynamically and immediately for higher education students.

Therefore, we proposed to develop a platform that supports both synchronous and asynchronous learning approaches and especially for developing countries which will be a big step for changing the education characteristics using An Internet-based E-learning systems to support the online education activities according to the social demands and requirements.

1.1.2 Online Education

With the introduction of the computer and Internet in the late 20th century, E-learning tools and delivery methods expanded. The first MAC in the 1980s enabled

[1] Original source owned by Ref.[20]

individuals to have computers in their homes, making it easier for them to learn about particular subjects and develop certain skill sets. Then, in the following decade, virtual learning environments began to truly thrive, with people gaining access to a wealth of online information and E-learning opportunities [21].

By the early 90s several schools had been set up that delivered courses online only, making the most of the Internet and bringing education to people who wouldn't previously have been able to attend a college due to geographical or time constraints. Technological advancements also helped educational establishments reduce the costs of distance learning, a saving that would also be passed on to the students - helping bring education to a wider audience.

In the 2000s, businesses began using E-learning to train their employees. New and experienced workers alike now had the opportunity to improve upon their industry knowledge base and expand their skill sets. At home individuals were granted access to programs that offered them the ability to earn online degrees and enrich their lives through expanded knowledge.

The term "online education" is intended as generic, referring not to specific applications but to the field of educational computer networking, regardless of educational level, pedagogy, or design [22]. The concept of online education is an extension from E-learning, which occurs when there is a physical separation of instructor and student. In the near future, it will become apparent that computers and other forms of technology are heavily used in classrooms and their objectives and results of those objectives will be heavily monitored and scrutinized. [23]. Online education makes use of live broadcast, interactive video and presentations. This electronic networking provides access to various resources, and online presentation enables student to communicate with their instructors, and even technical experts easily. This provides student with the opportunity to personally communicate with relevant parties and exchanging ideas [24].

Offering multimedia courses over the Internet has become the most recent option in computer assisted instruction. With combined emphasis on learner-centered and distance education, development of multimedia rich courses that can be accessed over the Internet has become not only an attractive and creative option for faculty, it is now a suggested or even required course of action. Such courses will have the potential to serve a dual purpose by enhancing the learning experience for resident students, while opening the educational experience up to

distance students [16], [22], [25]. This new trend of education through the Internet is rapidly growing for its benefits such as :

- Online education makes the "lifelong" easier, it can be an effective way to educate people [26]. With the latest E-learning solutions it is possible to acquire new knowledge and take part in lifelong learning.
- Online education can remove the geographical barriers. Through the online courses, student can get degree or certifications from other countries universities by following the courses over the Internet.
- With the use of online education, governments and institutions all over the world can avoid the cost duplication [27]. When instructors are spread around the country each of them serving their own geographical area, there will be an enormous duplication of studies throughout each country. This degree of duplication can be reduced by introducing online education.
- Professors and students time saving. Online education can make the learning more time efficient than traditional classroom education [14].
- The high cost of education affects students in higher education, to which distance education may be an alternative in order to provide some relief. Distance education has been a more cost-effective form of learning, and can sometimes save students a significant amount of money as opposed to traditional education [28], [29].
- Online education if it is created in the proper way, it can be accessible for all kind of people in both developed and developing countries, offering by that an opportunity for getting knowledge and degrees world widely.
- Online education offers societies to become more technology updated.

Figure 1.2 [2] shows the possible learning activities for taking a part of an online course. Online education can cover several areas of learning offering different possibilities based on the demands such as individual learning, asynchronous learning and synchronous learning modes [30].

Many platforms and systems addressed the online education in the synchronous and asynchronous mode. Recently the MOOC (Massive Open Online Course) is

[2] Original source owned by Ref.[30]

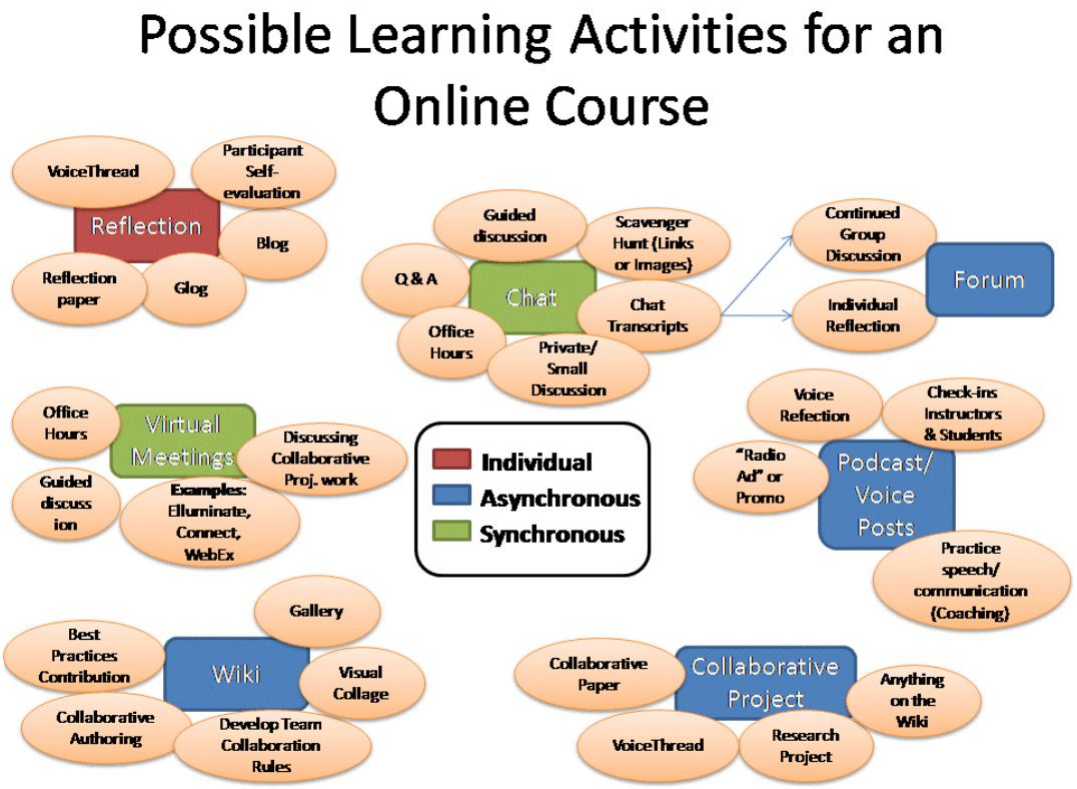


FIGURE 1.2: Possible learning activities for an online course

one of the latest examples of supporting online education [31] in an asynchronous mode which is spreading all over the world rapidly. Many MOOCs use video lectures, employing the old form of teaching using a new technology [32]. Another interesting platform that demonstrates its usefulness and effectiveness in supporting asynchronous online education for undergrad students in many universities and schools over the world is Moodle [33]. Academy of Mine [34], Coggno [35], Digital Chalk [36], Litmos [37] and WizIQ [38] are all platforms supporting online education and offer their platform on a SaaS (Software as a Service) basis. Some offers authoring tools to enable professors created their courses, some support online presentations and others reply on third party tools to create the courses and use the platform to promote and deliver the contents for end-users. These platforms are mostly high costly and not user friendly to be used by all kind of users, moreover none of these platforms address the low-speed Internet environment areas to support their online education. Therefore, making the online education more time and cost efficient than traditional classroom education is an ongoing job and the main focus of our research contribution.

1.1.3 Cloud Computing Technology

Cloud computing is a computing term or metaphor that evolved in the late 1900s, based on utility and consumption of computer resources. Cloud computing involves deploying groups of remote servers and software networks that allow different kinds of data sources be uploaded for real time processing to generate computing results without the need to store processed data on the cloud [39]. The idea of cloud computing is based on a very fundamental principal of "re-usability of IT capabilities'. The difference that cloud computing brings compared to traditional concepts of"grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organizational boundaries. Cloud computing is about moving services, computation and/or data for cost and business advantage off-site to an internal or external, location-transparent, centralized facility or contractor. By making data available in the cloud, it can be more easily and ubiquitously accessed, often at much lower cost, increasing its value by enabling opportunities for enhanced collaboration, integration, and analysis on a shared common platform [40] [41]. The Cloud computing can be delivered into three areas :

- **SaaS** (software-as-a-service): : In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. On the customers side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted & maintained. Such services : Google Apps [42], Salesforce [43], WebEx [44], WebELS [45].

- **PaaS** (platform-as-a-service): Here, a layer of software, or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider‘s infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySql and PHP), restricted J2EE, Ruby etc. Coghead [46], Google Application Engine [47], etc are some of the popular PaaS examples.

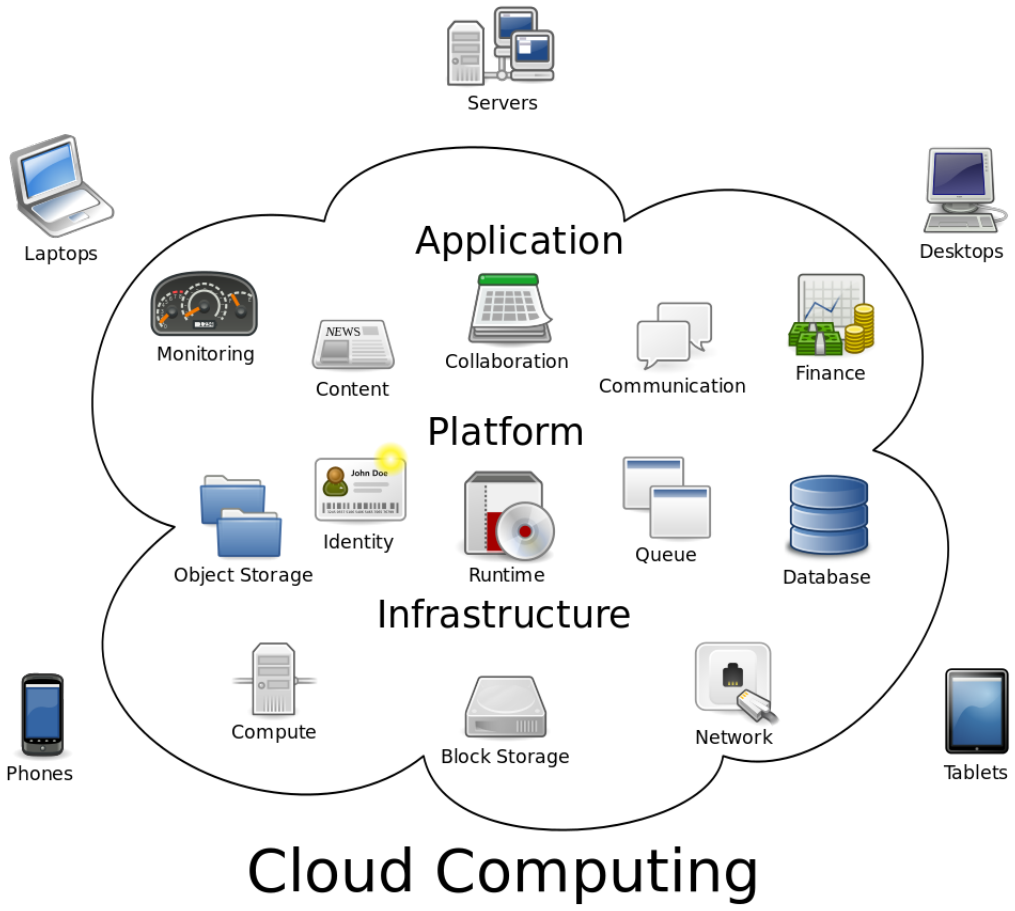


FIGURE 1.3: Cloud computing metaphor

- **IaaS** (infrastructure-as-a-service): IaaS provides basic storage and computing capabilities as standardized services over the network. Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. Some common examples are Amazon [48], Tera [49],etc.

Figure 1.3 [3] shows the cloud computing metaphor diagram. In the thesis, the cloud computing definition is a technology that uses the Internet and central remote servers to maintain data and applications. Moreover, it facilitate the employment of the event-driven approach for the authoring purpose for the client-server E-learning platforms. The cloud cooperative event-driven approach

[3]Original source owned by Ref.[39]

between client and server allows much more efficient computing by centralizing data storage, processing and bandwidth. Cloud computing also allows consumers and businesses to use applications without installation and access their personal files at any computer. Cloud computing technologies can be implemented in a wide variety of architectures, under different service and deployment models, and can coexist with other technologies and software design approaches. The cloud technology was introduced recently in many E-learning studies for its importance and benefits [50], [51] [52]. However, in this thesis we developed a new technology of authoring based on the event-driven approach through a cloud cooperative client-server communication. Normally, E-learning systems usually require much more hardware and software resources. There are numerous educational institutions that cannot afford such investments, and cloud computing is the best solution for them.

1.1.4 Content Development Issues

Information technology and the Internet are major drivers of research, innovation, growth and social change. The growth in Internet has brought changes in all walks of life including the education. e-content includes all kinds of content created and delivered through various electronic media from "old media" such as print and radio to the increasingly sophisticated electronic tools with combination of sounds, videos, images and text. e-content requires huge amounts of creativity both at 'information' level as well as the 'technology' level [53] [54]. The e-contents are "anything that can be produced/created, stored, processed, managed and transmitted using digital technologies and can be used for learning in different contexts: in formal education and training programmes, in non-formal general education and in continuing vocational training courses, as well as for self-learning." [55]. However, the content development is still the most challenging task in implementing E-Learning, there are many key factors that hamper the successful implementation of e-content which led to a dearth of high quality E-learning content in many institutes and universities over the world especially in developing countries. Some of these issues are as follows:

- Poor technical infrastructure : The technical infrastructure in developing countries is not yet highly developed, which means access to Internet is hard and usually slow. Thus, disable both instructors from using the available

tools to developed their learning contents materials and students from accessing to the learning materiel to review it [56] [14]. Therefore, a serious consideration of content development for low-speed Internet environment is highly required.

- Financial restrictions: The cost of e-content development can be a limiting factor with regards to reaching a broad target of audience and making sure that everyone can afford this service due to the high cost of equipments and tools to develop the e-content. The process outcome ranges from being very sophisticated and expensive [57]. Therefore, Many of the virtual campus projects highlighted the need to adopt open source technologies in providing suitable flexibility and functionality in a cost effective manner [58].

- Time & efforts: Several studies revealed that creating e-content takes a longer time, hence hindering the implementation of E-learning in many universities [59] [60]. Usually most professors are busy with routine teaching and research tasks and therefore do not have time to convert their courses from hard copy to e-content. This is due to the lack of easy technology in the available authoring tools that require time to understand, use and software installation, etc. Moreover, many e-content development tools require a man power to use, for example using the videotaping approach [61], require a camera man to handle the recording and special software for mixing the data to produce the electronic format of the course. Thus, time and efforts are still highly used and consumed for creating the e-content what refrains many professors from adopting the E-learning approach in their classes and universities.

Since a relevant and high quality e-content is vital to success of E-learning, we have proposed in this research a new method to improve and facilitate the e-content development taking in consideration the above issues. Generating rich learning contents automatically will motivate many professors to adopt this solution that can enable them to be in a remote access with abroad student and local student at same time, while creating their learning courses to be used as a reference later.

1.2 Objective and Scope of the Research

Based on the explanation in the above sections, authoring developments are urgent issues to support the sustainable development of global society.To create a proper course for E-learning, you need an authoring tool to facilitate this work. The definition of authoring tool is "a software or system package that can be used to create and package content deliverable to end users. Though authoring tools have a range of uses, they are commonly used to create E-learning contents" [62]. Thus, these tools provide many facilities helping the author to create a good e-content for courses. In fact, e-content has very important features that make the work easier than paper-content which are storing, modification, re-usability and sharing of information [63]. E-content is a digital information delivered over network-based electronic devices, i.e., symbols that can be utilized and interpreted by human actors during communication process, which allow them to share various and influence each others knowledge, attitudes or behaviour [64]. It may also be defined as "digital text and images for display on web pages" [65]. E-content means content in electronic form. It is a combination of text, audio, video, images with visual effects. Any digitized content that can facilitate the learning process and/or learning outcome can be termed as e-content [66].

Increasingly, organizations are adopting e-Content as the main delivery method to train employees. At the same time, educational institutions are moving toward the use of the Internet for delivery, both on campus and at a distance mode. For the instructor, tutoring can be done at anytime and from anywhere. Online materials can be updated, and learners are able to see the changes at once. When learners are able to access materials on the Internet, it is easier for instructors to direct them to appropriate information based on their needs [67]. In the process of E-learning, structured and validated e-content can serve as an effective virtual teacher. These solutions should be considered as a world-wide-solution, by means of an E-learning solution to support both developed and developing countries. Developing countries where a high quality Internet service is not available and the lack of educational resources are especially considering. It is well recognized that in the future, developing countries would play the key roles in sustainable development ever more than before, where opportunities on higher education are limited [68].

Based on the requirements and social demands for the globalization of education, the missions of the research conducted on this thesis are defined as follows:

- To solve some of the major current issues in content development such as time, cost, scalable and editable contents which will make E-learning more efficient in higher education.
- To provide a peer-to-peer interaction between learners and professors while automating the process to generate an e-content course accessible anytime and anywhere.
- To create multiple choices for students to learn in real-time by attending the online lectures or in on-demand by accessing later to the created e-contents from the lectures. Thus, we will be pushing education From a one-time instruction in one location to a scale content recordable and replicable instruction anytime, anywhere.
- To support higher education in developed countries where Internet infrastructure and access to technology is still not yet developed through an easy-to-use and powerful tool of E-learning that covers several activities from online to on-demand to hybrid approaches under low-speed Internet environment.

In this thesis, we proposed an novel automated authoring method embedded into an online lecturing platform for higher education. The proposed system is invented to support flexibility and globalization of higher education especially for Ph.D. education. The automated authoring system generates rich E-learning contents automatically as a background processing. The system is based on a cloud cooperative event-driven technology, this last stands for the online communication and collaboration between client and server during the authoring process. The event-driven is initialized by lecturer while giving the online presentation such as control presentation slides (next, previous, last, first, random slide selection), cursor movements on the slides and changing streaming quality of audio video to support different bandwidth environments. When the event engine listeners are initialized on the server side to execute and proceed the authoring procedures such as slide-video synchronization, capture cursor data, adjust streaming quality of the recorded video , etc. The proposed system allow online interaction among the connected users during the online presentation, e.g., professor and students,

while generating the E-learning content on the server side. The new automated authoring tool is implemented on a cloud computing environment to ensure reliability of the system. Cloud computing is a strategic technology that uses the Internet and central remote servers to maintain data and use applications without personal software installation. This strategic system allows more efficient computing by centralizing storage, memory, processing and bandwidth [52]. Thus, our research contribution aims in developing the automated authoring system based on cooperative event-driven is to solve some major E-learning issues such as content development and courseware production efficiently.

The proposed system was developed under the WebELS platform (Web-based E-learning system) that supports both asynchronous and synchronous E-learning activities, such as on-demand learning for self-learning, online meeting for multi-location group discussion and online lecture for real-time remote lecture distribution, separated into two different modules of the WebELS platform i.e., Meeting and Learning [69], [70]. Thus, the automated authoring system linked the two modules by generating learning content automatically under the WebELS meeting and to review the contents on the WebELS learning module to support globalization of higher education in science and technology.

In addition, lightweight application and cross-platform supported are important key factors. Therefore, web-based applications which can be accessed via the general web browsers is the proper solution to break down a defect of various client limitations. We implemented the WebELS system as a SaaS concept of a cloud computing to minimize IT investment costs of the education section and business companies. By cloud-based we mean that every software function as well as data is automatically downloaded from the WebELS server through an Internet browser to a user's client computer and functioning on it without any special software modules and devices. A usual computer with usual operating systems such as Windows, Linux and Mac operating systems is enough in use.

1.3 Organization of the Thesis

The general description and contents of this thesis are shown as follows:

- Chapter 2 presents the related studies and technologies review. Background information, recent progression, and approaches for authoring technologies are summarized.

- Chapter 3 gives an overview of the WebELS system. The platform concept, overall architecture design, system modules i.e., Meeting and learning are described.

- Chapter 4 introduces the design concept and overall procedures of the new automated authoring system. We proposed an automated authoring based on event-driven technology for real-time synchronization of slides and lecturer video stream. The system is embedded on the E-meeting module of the WebELS platform.

- Chapter 5 shows the implementation of the proposed system. We described in details the system overview, cloud service computing, the course generation algorithm base don the event-driven technology and the data structure of the learning contents generated by the proposed system is also presented.

- Chapter 6 focuses on the E-meeting module of the WebELS platform improvement and contributions. We presented a new function of automatic streaming adaptation. We also presented the improvement in the document types format that can be used for the online presentation such as the video embedded.

- Chapter 7 presents the experimental results of the system. The evaluation focus on the authoring performance of the proposed system, a comparative study based on several indicators and examples of the practical usage of the system in local and international seminars.

- Chapter 8 presents the contributions of this thesis, mentions some limitations of the system and the future research directions.

Chapter 2

Literature Review and Related Studies

2.1 The Growth of On-demand E-learning Content

The rapid growth of Internet and with the increasing use of networked computers and achievement of telecommunication technology, the Internet has been widely recognized as a medium for network-enabled transfer of skills, information, and knowledge in various areas [71]. It changed the way we learn, education was highly infected by the progress of technology and forced instructors to find a new ways to deliver knowledge to students since the traditional context of learning experienced a radical change and people were not anymore limited by time and location. Thus, E-learning is became a hot topic in higher education and has been growing as a popular topic since the inception of the first web-based courses in the mid-to late 1990s [72]. The E-learning has been crucial to meet this new challenge. There are a variety of definitions of this term, for the purpose of this study, E-learning is defined as learning that involves a web-based component, enabling collaboration and access to content that extends beyond the classroom. In addition to the term E-learning, the terms online and distance are used in this research to refer to more specific instances or courses involving E-learning. In general, online is used to refer to courses that have a majority online component, and distance is used to refer to courses in which the instructor and students are not in the same physical classroom space. Moreover, it is important to mention that in any E-learning environment,

technology can be used with either a content approach (providing content itself or access to available content) or communication approach (providing communication facilities or access there to). It is also important to note that technologies can either be networked or stand-alone. The mind map in Figure 2.1 [1] shows and illustrates the E-learning environment and approaches very well.

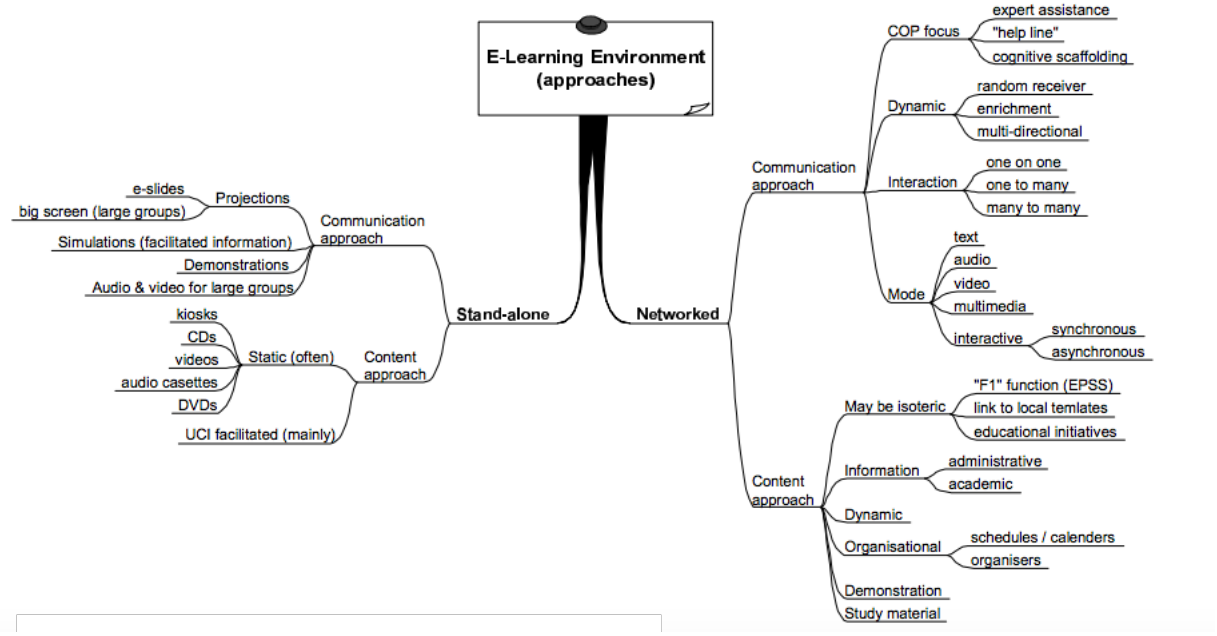


FIGURE 2.1: E-learning environment (Approaches)

In this thesis we focus on an hybrid approach that bring both the content approach and communication approach together to support a wide range of activities for higher education students. We tried to investigate solutions and the existing technologies that uses a communication approach through a network to support the content approach i.e., develop E-learning contents automatically. This will allow to increase the number of the E-learning courses for institutions and universities all over the world. These on-demand E-learning courses are highly in demand to support the higher education studies. At BCC (Brisolt Community College) which is one of the institutes started offering E-learning courses to their students since 1999, a report was released by the college showing that the number of students enrolled in the E-learning courses just from 2009 has been increasing dramatically. 36% of BCC students are enrolled in at least one E-Learning course and E-Learning courses themselves comprise 18% of total credit [74][75]. Figure 2.2 and Figure 2.3 [2] shows two charts that demonstrate the growth (just since

[1] Original source owned by Ref.[73]
[2] Original source owned by Ref.[74]

2009) in BCC's E-Learning course offerings and enrollments. This is one of the several cases existing where the access to the E-learning courses by students keeps increasing [76], [77], [78].

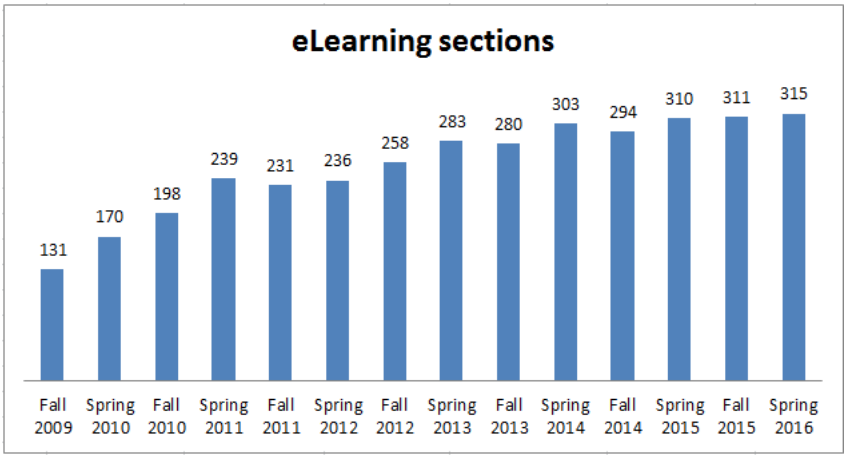


FIGURE 2.2: E-learning sections grow trough several years

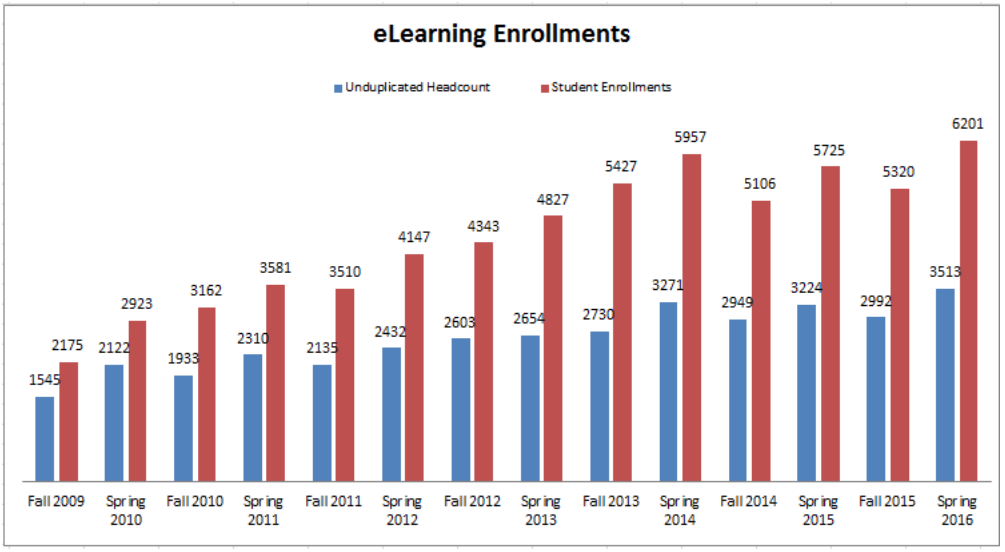


FIGURE 2.3: Number of students enrolled in E-learning courses since 2009 at BCC

2.2 e-Content Development Methodologies

Looking to the rapid increase of E-learning requests by learners all over the world motivates institute and private companies to develop several multimedia authoring tools to create e-contents. Even though several approaches are considering the development of on-demand learning content development, but still a lack of

technology is remaining. In this coming sections we will cover some of the existing work for e-content development. As there is several techniques to create learning content, we detached the review on three subsections aspects: manual crafting authoring, semi-automatic authoring and the lecture & meeting capturing tools.

2.2.1 Manual Crafting Authoring

Manual presentation authoring has a long history and it is supported by a number of commercial environments. The usual computer support for manually crafted authoring is manifested in form of production environments, such as image editing tools (Photoshop, Illustrator, GIMP, or Maya). Microsoft's PowerPoint [79] is a well known tool to builds linear slides shows. Instructors can import their images or videos to the presentation created by PowerPoint. Macromedias Director/Shockwave, Flash [80] and Oratrix GriNS [81] [82] enable animated and interactive presentations mainly on the web.

Macromedias Dreamweaver [80] and Microsofts FrontPage [83] are designed for supporting the authoring of web pages. Each of these applications tries to ease the authoring process by introducing authoring metaphors. Macromedia Director, for example, models the authoring process on a stage production where media items form the cast that can perform certain actions. It also provides a set of stylistic means for designing a final look and feel of the authoring process. It is left to the author, though, to figure out how these metaphors help in the creation of their presentation structure. In another aspects of manual authoring, there exist some tools based on the above environments to generate online learning content. For instance, iSpring [84] is a tool used to convert PowerPoint presentations into an E-learning courses as a flash video format. Figure 2.4 [3] shows the interface of the video E-learning course generated using the tool iSpring.

A Lecture of Demand (LoD) tool set is proposed for producing reusable web-based multimedia presentation. It uses PowerPoint presentation file and video file [85]. The LoD system requires external software to encode and consolidate all video files into a single real video file. They use SMIL to save output and playback by Real Player. Although these tools provide the user with much freedom during the development process, they are not equipped to support the complex process

[3] Original source owned by Ref.[84]

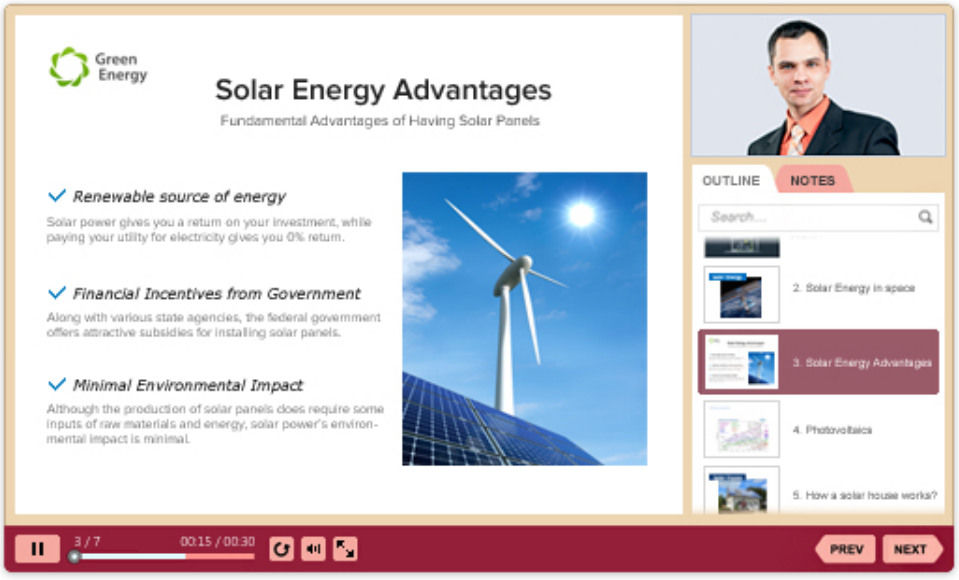


FIGURE 2.4: iSpring tool content interface

of content development, because they assume that the user has a sufficient level of expertise.

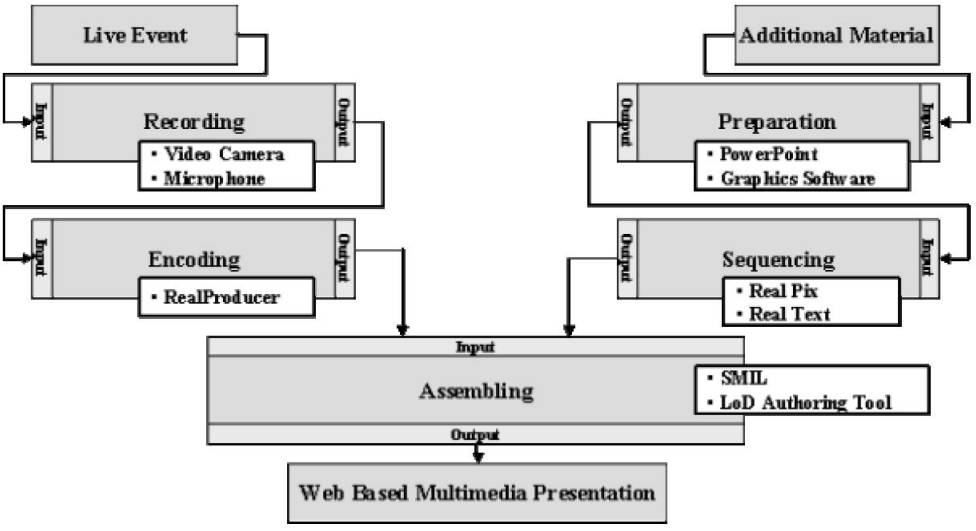


FIGURE 2.5: LOD system overview

Figure 2.5 [4] shows the system overview of the production process and the technology used for LoD by [85].The creation of content process require several manual interpretation and external software.

Reviewing this section of the available solutions and technology to create E-learning courses, we can say that none of these tools support the online knowledge

[4]Original source owned by Ref.[85]

sharing and need a third part software to employ the presentation material on the web.

2.2.2 Semi-Automatic Authoring

The semi-automatic authoring apply on the semi-interactive entrainment in creating the multimedia contents between client and server or between client and the application. Moreover, the interaction between client and server is mainly client authoring processing by means of the synchronization and the data management is done on the client side and by then save it on the server side. Theses generation systems has been a focus of multimedia research for over a decade. There is usually three different concepts in creating the learning contents i.e., slide-based learning content, video-based learning contents or slide-video learning contents.

Related to these approaches: the work presented by Barry, [86], suggested a set of tools to support documentary videography, such as a script network populated by video clips, where the network displays the position of a clip in a collection of events related to the subject of the documentary, a common sense annotation for each video clip, providing an expanded context for a clip, a suggestion prompt that delivers a direct suggestion for the next shot taken, a display of story structures related to the documentary subject that can be used for video organization into story threads.

Chunwijitra, et.al [8] proposed in their work to create a multimedia learning contents using a raw video files and slides presentations and designed an authoring interface that enable instructors to apply the synchronization between video and slides. Using their key marker concept they can generate a set of video clips synchronized with the slides presentation. The system is does not exactly cut the video file but instead it use the time position marks. Thus, each slide will have an individual video clip. We have tested the editing interface in their proposed work and could create a learning content using a raw video as shown in Figure 2.6. However, their system require to have a raw video at first stage, converting process of both video and slides documents, apply the semi-automatic synchronization for each slide which make it more time consuming for content development. Moreover, the system does not enable the slides duplication that was presented in two different sequences in the lecture.

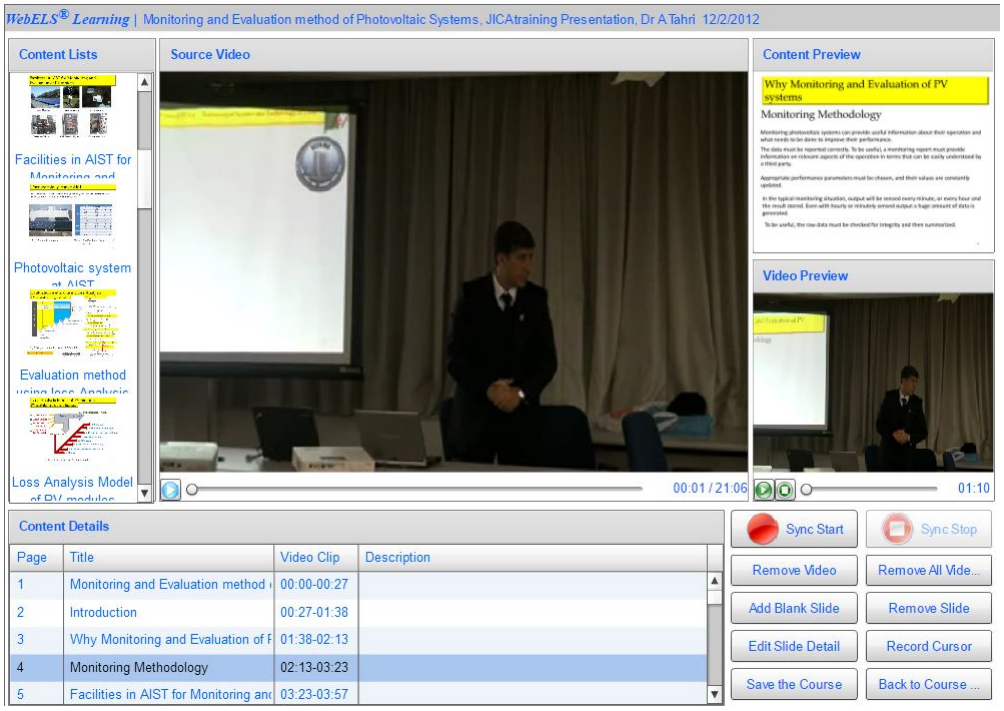


FIGURE 2.6: The Editing interface of the WebELS Learning module

We find a similar approach proposed by Jaroslav, et.al [87] who used the raw video records of lectures to prepare archive of audiovisual lectures including DVD movies, compressed video formats for web as well as interactive presentations. Their process to create usable educational contents include scene capturing, editing and rendering of teaching suitable parts, adding additional content and comments, conversion to the requested video/multimedia format and publication of final materials. These two proposed research workflow can be presented as shown in Figure 2.7 [5]

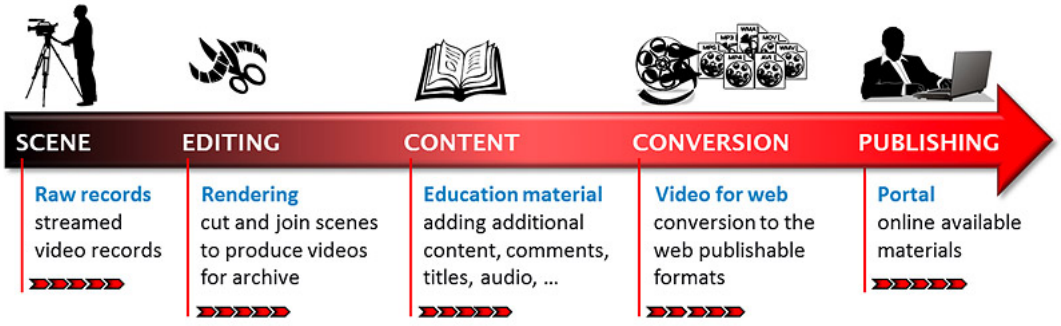


FIGURE 2.7: Semi automatic content development process

Hirzallah [9] proposed an on-the-fly creation of the video content from the classroom lecture. He developed the Slide Generation algorithm (SG) used to

[5] Original source owned by Ref.[87]

detect the change of slide by capturing the image from camera as shown in Figure 2.8 [6]. This system however requires high-end computer performance for saving and comparing algorithm and the slides are in low quality since they got captured through a camera.

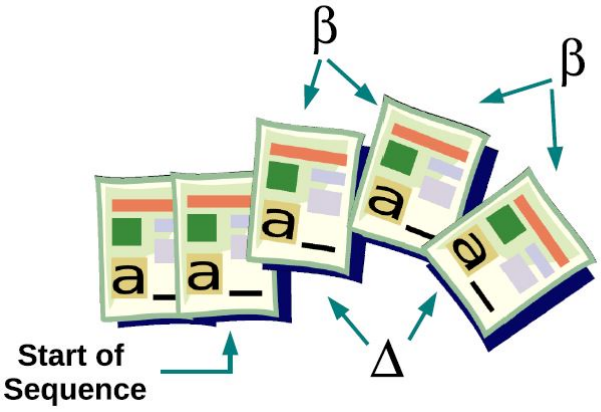


FIGURE 2.8: The Slide Generation (SG) algorithm

Moreover, software productiveness have been released. CamStudio is a popular product. It is a free software that allows to record all screen and audio activity on the computer and create video files, on-the-fly recording [88]. This product can create streaming videos using built-in streaming Flash video producer. It can also record video from webcam with annotation feature. However, as disadvantages is does only under the Microsoft Windows family and does not permit the content editing but instead it needs to re-record after the content was created. Mediasite [89] and Capture Station [90] are other authoring products. They allow real-time recording of screen including the presentation and audio activity on the computer to create video-based content. Mediasite and Capture Station allow editing the live presentation before publishing, however they requires some special system and hardware in order to work.

Most existing semi-automatic authoring systems focus on one aspect of the authoring process. None of these systems support the complete authoring process from the initial exploration of the domain to the final presentation production. Moreover, these tools can supports only the off-line mode content editing and no end users can be supported during developing the learning content.

[6] Original source owned by Ref.[9]

2.2.3 Lecture Capture Technology

Lecture capture is just what it sounds like–a way to capture or record (full or partial) lectures. With most lecture capture tools, lectures can be pre-recorded and distributed to students ahead of time, or they can be captured during a live class session and made available for review afterwards [91]. There is exist several commercials systems and tools in the market that offer a full lecture recording for faculties and universities. We can site projectorBox [92] system seamlessly records RGB information that is sent to a lecture halls projector and detects when one presentation end and when the next begins using a heuristic method. This system however ignore to capture the presenter stream audio/video which is very valuable for a consistent E-learning content.

EYA system provides features to record the presenter and audiences who are present in the hall in one-hour interval and store them on a web server for later delivery [93]. Although this system completely eliminates the manual intervention in creating the lecture, these systems do not store the details about the content except its title and does not support end users i.e., online users.

[94] they used an intelligent and aware environment to achieve the automatic video production based on lectures. Their system is interesting, however it require several technologies to be used such as special cameras, video mixers, image processing software, etc.

Panopto [95] is a software for lecture recording available on the market. It enables the integration with the learning management systems used by universities. Figure 2.9 [7] shows the recording interface of the Panopto software. The lecturer can select whether using power point or screen sharing to capture in their PCs while recording their stream. This software will generate two separated videos i.e., lecturer stream and the screenshare video for playback. This software however require high bandwidth speed and software installation to be used since it records two stream simultaneously. Moreover, it is costly to keep updating the contents using the software and it does not support online end-users interactions.

Echo360 [96] is another lecture recording solutions that records and publishes instructional contents for students to review anytime and anywhere. It specialises

[7] Original source owned by Ref.[95]

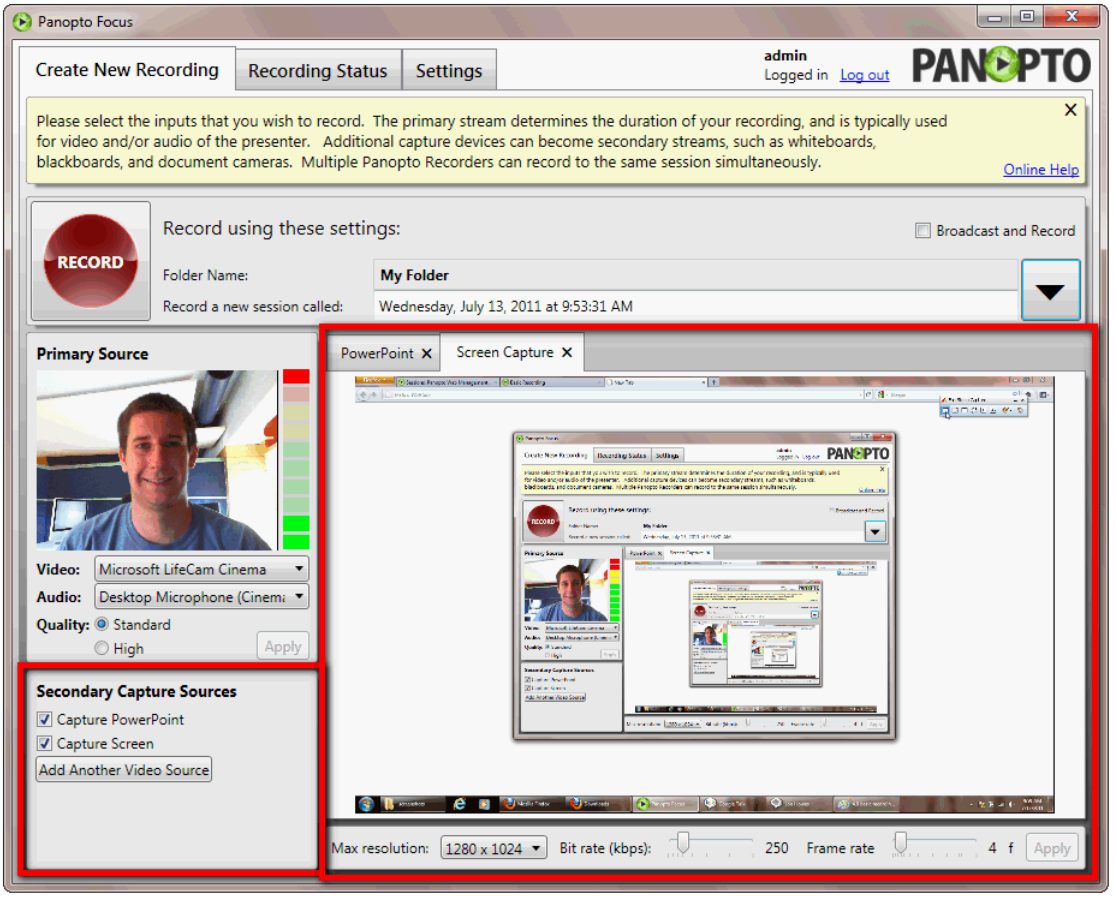


FIGURE 2.9: Panopto, lecture recorder

more in large scale recordings in classes that are equipped with video/audio hardware. The system does not offer any interaction options for instructors such as chat function of online users. This system require a central server for managing the capturing tool. Figure 2.10 [8] shows how the students can review the lectures playback.

Tegrity [97], are also an available commercial lecture capturing tools that have similarity to the previous ones. However, tmost of these tools and solutions hey are costly and some does not offer the online interaction between professor and students but rather using a special software to capture the presentation in the lecture hall and using some mixers will produce the content that need by next to be uploaded and shared on the web which is time consuming.

[8] Original source owned by Ref.[96]

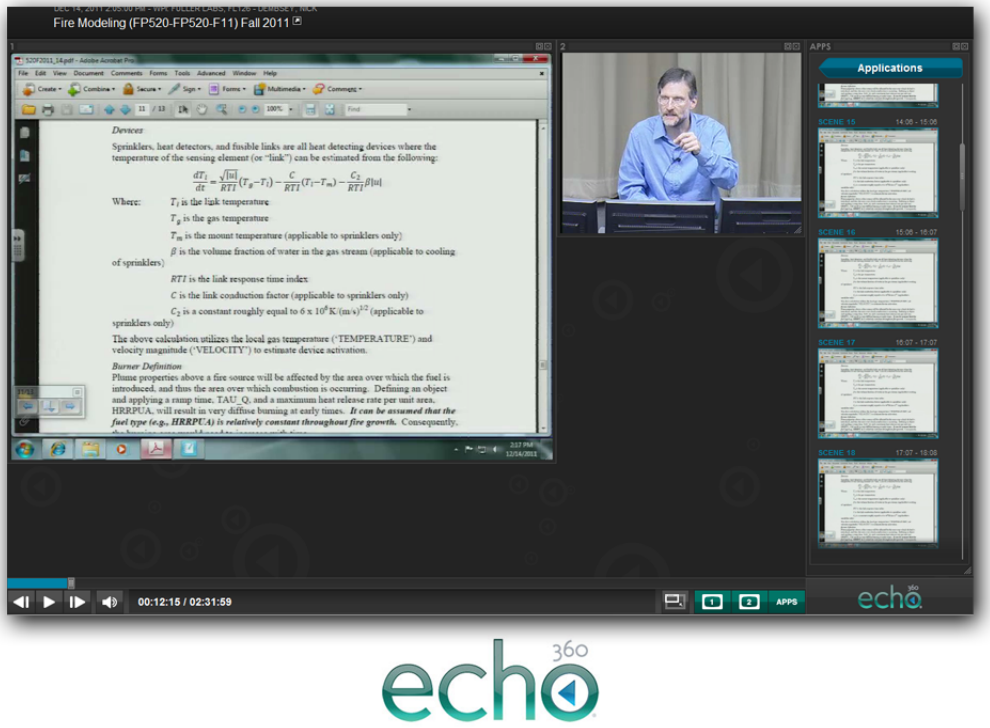


FIGURE 2.10: Echo360 EchoSystem player

2.2.4 Meeting Capturing Technology

Meeting and lecture recording tools comes very close to the target we are aiming at. The meaning of these tools is recording a classroom-based activities, prepare it in a digital format that students can then watch over the web. The main difference is in their method to capture and record the data and the complexity in generating the learning contents automatically. For meeting systems already several commercial products exist in the market and offer a recording of meeting feature such as Spreed [98] GoToMeeting [99] and Lunc 2010 [100].

Those systems offers the feature of recording but in a different concept since they capture all the audio/video stream during the meeting which might be confusing while reviewing the meeting content instead of focusing on the speaker or presenter. Moreover, those systems recording feature is based on a standard and common technology used for a long time which is screensharing technology [101] [102] [103]. Using screensharing method it is possible to capture all what is happening on the user pc. This might have some copyright issues since it will display all user data. Furthermore, sharing this data and recording it at same time will require a high speed Internet and high performance PCs rather than the high cost

to deploy it in ordinary universities and institutions over the world especially in developing countries.

WebEX [44] is a notable solutions for pre-conference planning, conferencing and post-conference. It can support several operating systems and they included also the recording meeting option for users to enable the presentation playback as shown in Figure 2.11 [9]. However, the recording is based on desktop screen capturing i.e., screensharing technology and the WebEX employs a proprietary format that requires using a media converter or special viewer application. Moreover, the use of this system require a high speed Internet environment and special software.

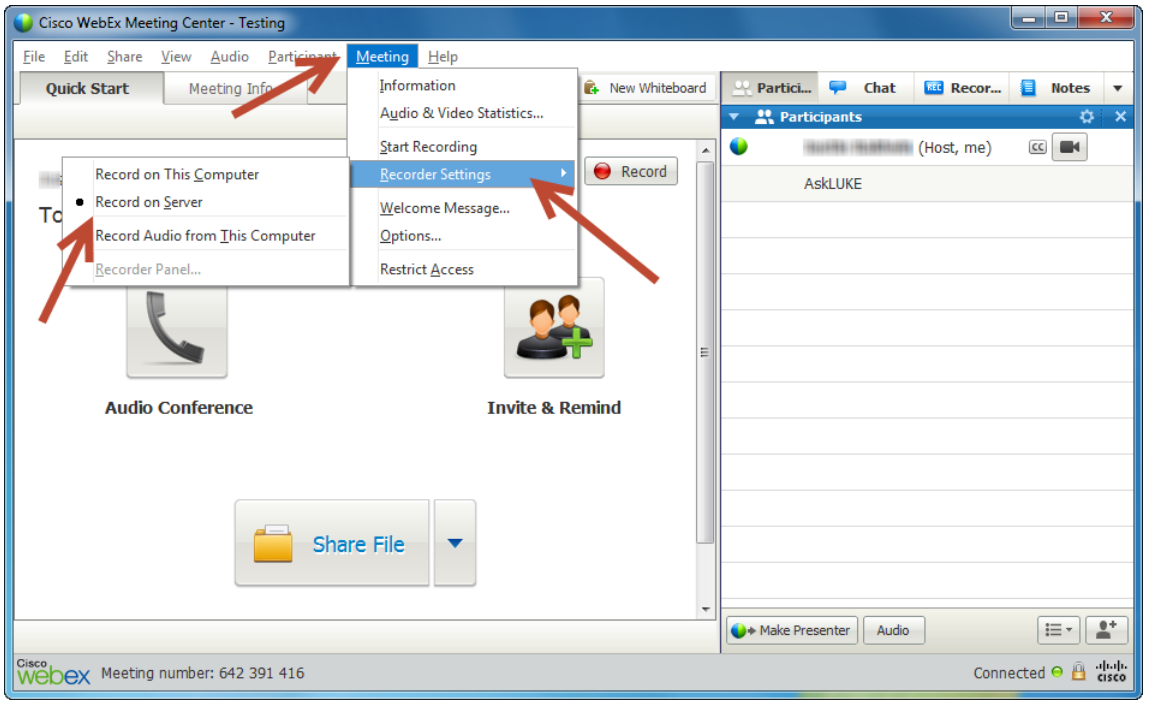


FIGURE 2.11: Cisco WebEx recording interface

Supplementary, some other video meeting systems are published using an open source licence such as BigBlueButton [104] and OpenMeetings [105]. BigBlueButton is an open source web conferencing system developed primarily for distance education. It supports multiple audio and video sharing, presentations with extended whiteboard capabilities, integrated VoIP using FreeSWITCH, and support for presentation of PDF documents and Microsoft Office documents. Moreover, users may enter the conference in one of two roles: viewer or moderator. As a viewer, a user may join the voice conference, share their webcam, raise their hand, and chat with others. As a moderator, a user may mute/unmute others, eject any

[9] Original source owned by Ref.[44]

user from the session, and make any user the current presenter. The presenter may upload slides and control the presentation. Figure 2.12 shows the main interface of the BigBlueButton [10]. The BBB platform supports the recording of the meeting by capturing the users stream and use the screensharing technology to record the presentation as a video format using a third part system Opencast Motterhorn [106] that need to be installed separately to enable the recoding feature.

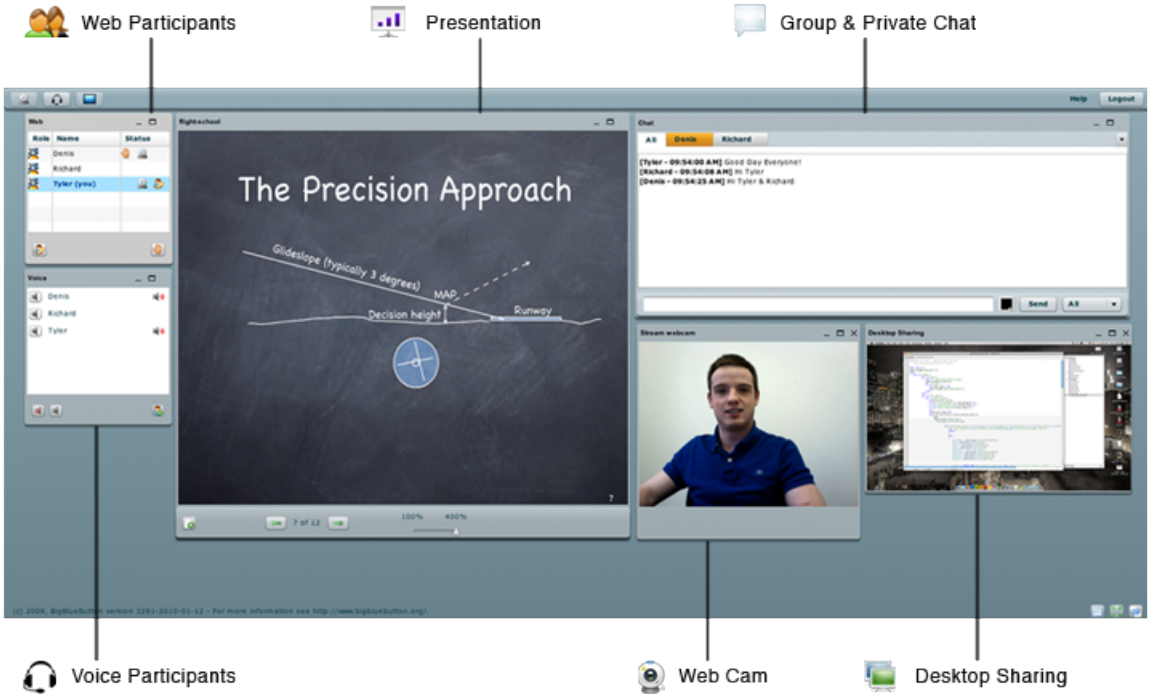


FIGURE 2.12: BigBlueButton main interface

OpenMeetings has the same features as the BigBlueButton patform being an online conferencing solution using video/audio communication and slides presentation. Moreover, it is possible to record the meetings using the OpenMeetings platform based on the same technology deployed in many of the current online conferencing systems i.e., screensharing. Those systems however, their technology is similar to the commercial ones based on screensharing methodology to record the screen interface of users by means of a desktop sharing that require a high-speed Internet environment and special software's for mixing streams and manipulating output content.

[10] Original source owned by Ref.[104]

2.3 Conclusion

Scanning the literature review, existing technologies and tools, we can say that some efforts are still needed to address the problems of content development and facilitate the creation of rich E-learning courses by instructors in the most efficient way. Our proposed research is very original and no other related systems so far presented the idea of integrating and combing two different modules of education i.e., meeting and learning using an embedded authoring system. Hence, supports the globalization of higher education and sustainability of its activities especially in developing countries where access to the technology is very limited. In the next sections we will present an overview of the WebELS platform (Meeting and Learning) and then presents the implementation details of this research objectives by means of the automated authoring systems based on the cooperative event-driven technology.

Chapter 3

WebELS Platform Overview

WebELS is an Internet-based E-learning system that originally designed to support flexibility and globalizing of higher education in engineering and science especially in Ph.D. education [69],[45],[107]. The system has been distributed based on open source software (OSS) policy. The WebELS system is focusing on learning authoring, archive of learning materials and distribute their learning contents on the web for on-demand learning and online meeting. The design of WebELS system is based-on characteristics of Ph.D education from point of view of E-learning that integrated to the concept of Content Management System (CMS). Some key characteristics of Ph.D education are in following: Typical style of Ph.D education is discussion or lecture in the classroom with the slide-based presentation. Also sometime on-line meeting, bulletin board and email are required for distant lecture.

- Ph.D students are individual scientist researchers. Sit-in classroom study is not a mainly activity of higher education but also join or contribute to the academic meetings, seminars and conferences with the presentations are important activities of this education.
- On-demand contents are important for self-learning. Slide-based playback with video-voice and synchronized cursor seems to be the reasonable for on-demand self-learning. High quality slides, voice-video and cursor synchronization are requested to be use in the narrow-band network.
- Various types of computer system are used by Ph.D students. E-Learning systems must be supported on multiple operating system include Windows, Mac OS, Linux and also mobile platforms.

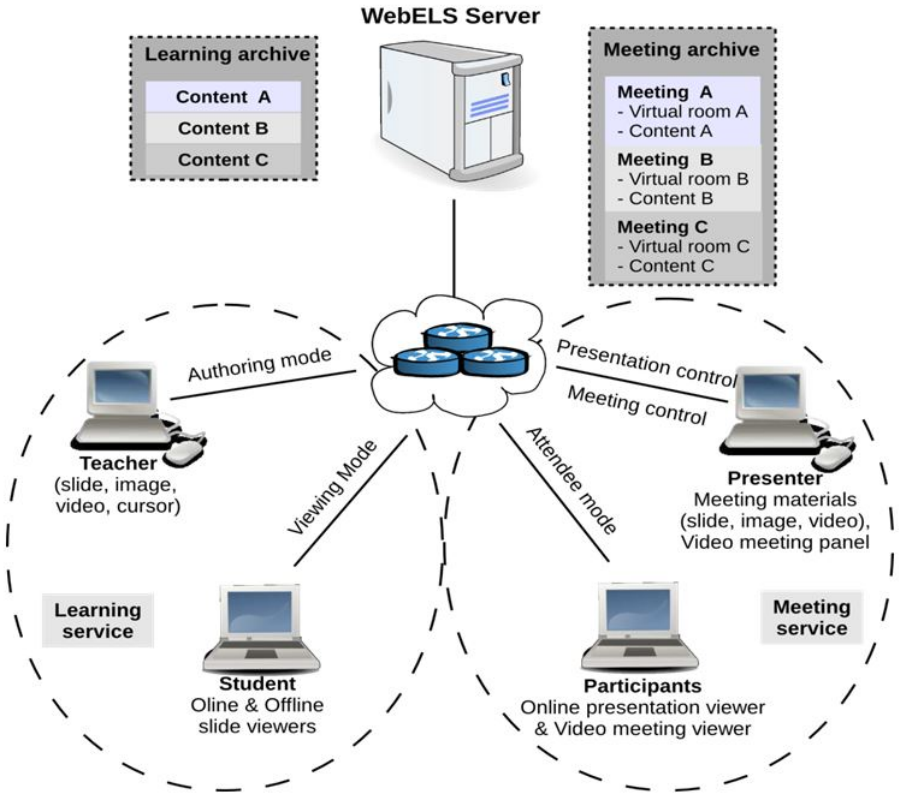


FIGURE 3.1: System Overview of WebELS System

Therefore, WebELS was developed as a server-based system functioning to support the above requirements of Ph.D. education. WebELS is functioning in a low-speed Internet environment keeping high quality slides, short video clip and audio. Flash programming language was suitable to use for archiving multiple OS support. A variety of client computers such as Windows, Mac OS and Linux can be used on the same feature, function and system environment. Every user can use the system over the Internet access via web browser application for example, Internet Explorer (IE), Mozilla Firefox, Google Chrome, and Safari and so on. Figure 3.1 shows the overview of the WebELS system.

3.1 WebELS Meeting Module

The WebELS Meeting module supports the synchronous E-Learning approach. To cover the online activities, several useful functions were integrated into the WebELS Meeting system such as content-authoring, online presentation, video

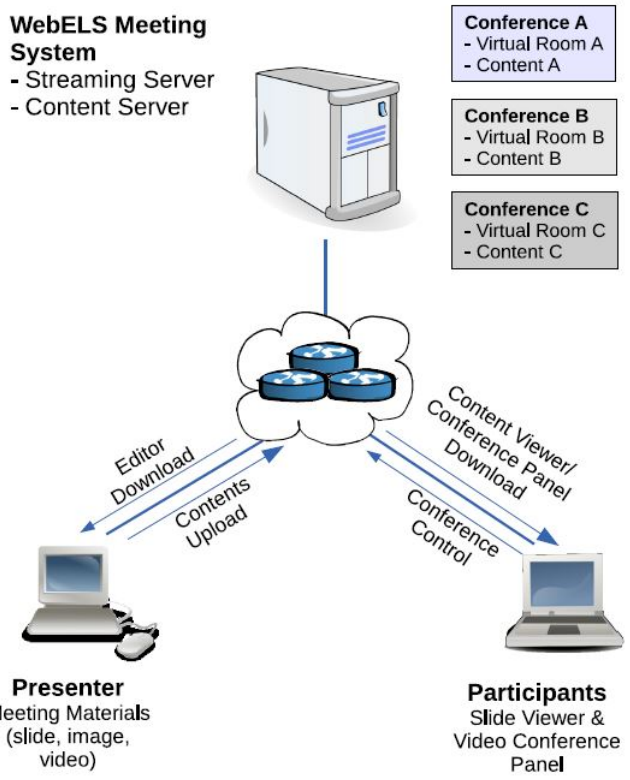


FIGURE 3.2: WebELS Meeting System Diagram.

conferencing and so on. This module is designed as an administrator free system for authoring tool, slide presentation tool and video meeting window. Every logged-in user has the same right. By clicking the presenter grant button, a user can obtain the presenter right who can change slides, point a cursor, annotate drawings, zoom and scroll slides and so on. It also has an easy-to-use interface for non-IT users. Users can edit their own meeting contents on their personal computer and share to the meeting participants. The advantage of the system is a combination of online video meeting and online presentation document. The participants can follow the presenters focus of discussion. They can also see and follow the synchronization of the active content with the same content and quality as same as the presenter view.

The basic design of WebELS Meeting was proposed for content-based meeting. Each content has its own virtual room that can be used for meeting management, the system diagram is presented in Figure 3.2. Any users who are accessing to the same content can share the online presentation and join the online video conference at the same time. Figure 3.3 shows the E-meeting panel design that supports the

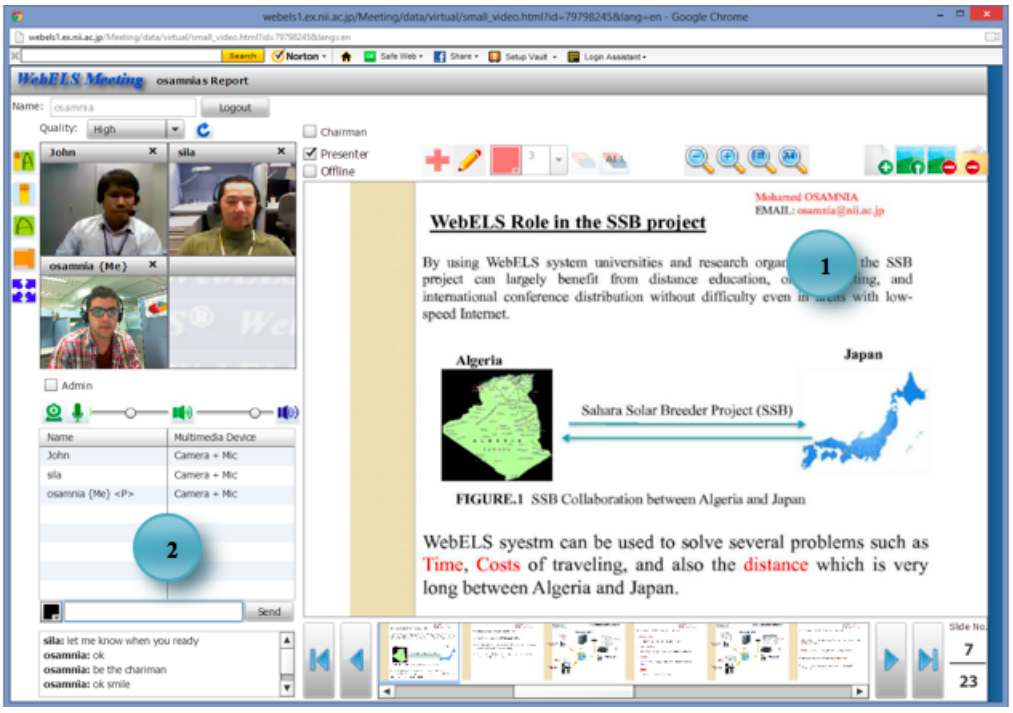


FIGURE 3.3: Example of using the WebELS Meeting system

(1) on-line presentation and (2) video conferencing simultaneously to be as "all in one" system using the Flash multimedia technology [108]

3.2 WebELS Learning Module

WebELS Learning system is designed to support flexibility and globalization of higher education in science and technology in asynchronous mode. Lecturers can use the system to create and maintain contents to be distributed online. Learners can browse the content list and start to learn using the content by themselves. The system provides all necessary tools during E-Learning process. Tools like content authoring, content management, user management, course management, on-demand viewer are included in the system as shown in Figure 3.4. The WebELS learning system supports authoring for video-based flash media content, each slide in the presentation document (.pdf, .ppt,.pptx, .doc, .docx, .odp) are converted series of slide images (.jpg) and by processing the authoring authoring, slide document and video recorded from the presentation are made to synchronize to create a video-based content. In many universities and institutes, undoubtedly, there are numerous slide presentations and recorded videos aiming to be reused but are

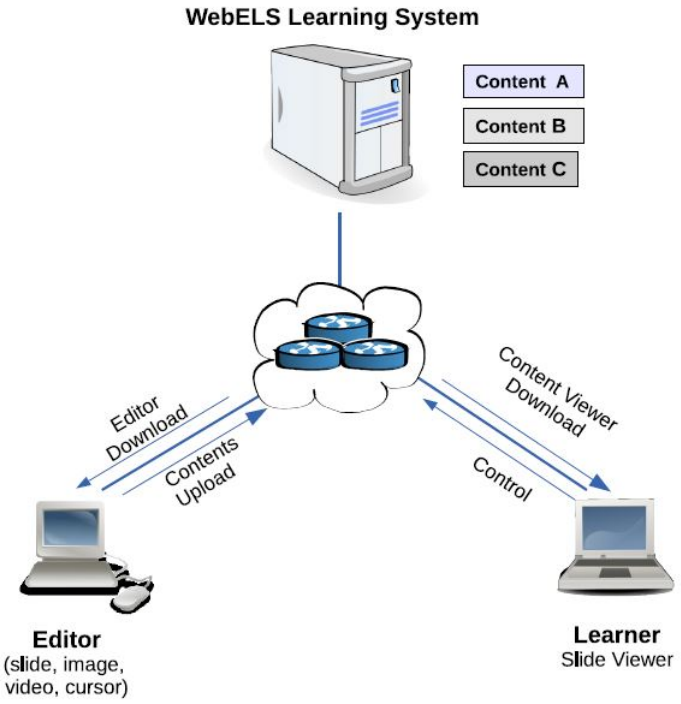


FIGURE 3.4: WebELS Learning System Diagram

just left unpublished because there is no system that easily manages its online distribution. The learning system technology provided by WebELS can help these valuables informations be distributed online [8].

Figure 3.5. shows the design of user interface for authoring functions and viewer interface respectively. For the authoring interface is it divided into six panels, namely (1) Slide Navigator Panel for showing all slide pages and for quick slide changing, (2) Raw Video Panel for displaying raw video stream, (3) Slide Preview Panel for previewing a selected slide, (4) Aggregated Video Preview Panel for displaying an aggregated video which is synchronized to a selected slide, (5) Content Information Panel for showing all details of synchronization slides, and (6) Editing Control Panel for managing learning content. Editing Control Panel contains synchronization tools, remove synchronized video, add blank slide, remove slide, pointer movement management and slide information editor. The authoring tool can help instructor to quickly create an online E-Learning content by simple processes. The viewing interface design is for students to view the learning contents created by the instructors. The interface consists of four panels, namely (1) Aggregated Video Panel for displaying the aggregated video of a current slide, (2) Slide Panel for displaying the current slide, (3) Content Information Panel for showing

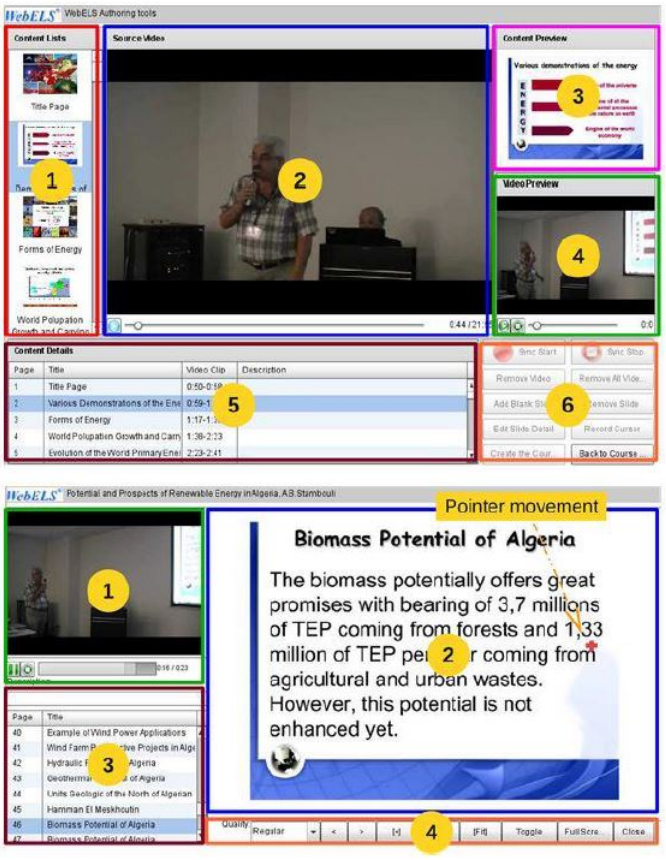


FIGURE 3.5: WebELS Learning System Diagram

slide information, and (4) Control Panel for controlling online learning content. Control panel contains quality control, zoom control, toggle view control and full screen mode. Student can toggle view between video and slide panels. They can also zoom both video or slide contents to examine more closely or in greater detail. Pointer movement is visualized in this panel in case the editor synchronized it with the aggregated video. The pointer mark automatically moves while the video is playing.

3.3 Room for Improvements

The WebELS platform supports both synchronous and asynchronous learning mode as discussed before. However, still some questions were asked such as what if some students could not attend the online presentation, what if instructors dont have recorded video of their presentation to use it on the learning authoring system

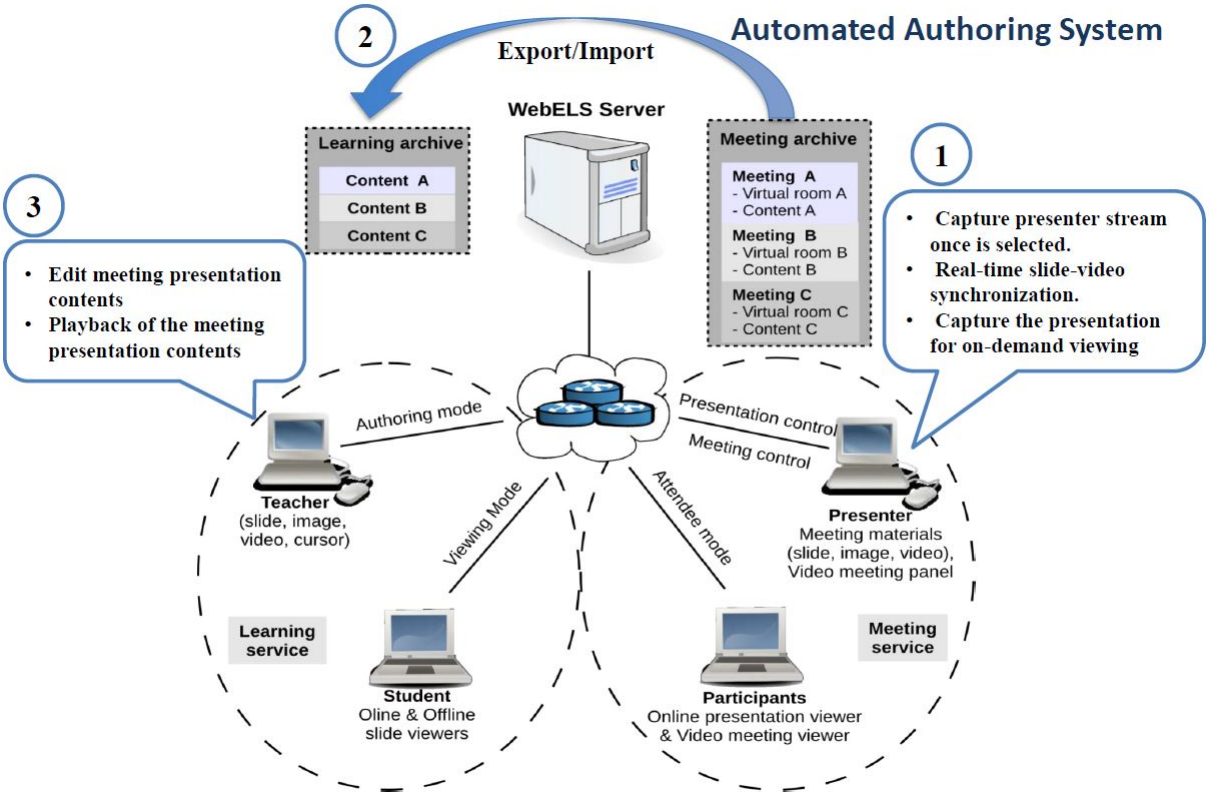


FIGURE 3.6: The Automated authoring system Workflow

and how to improve the courseware production in term of time, cost, location, materials, etc which are the main current issues in the content developments [57]. To answer those questions, we have designed and developed an automated authoring system which integrates both the Meeting and learning modules of the WebELS platform. The automated authoring system is a novel idea developed within the WebELS Meeting system as a background processing system to create learning contents automatically during the online presentation.

Figure 3.6 shows the workflow of the automated authoring system on the WebELS platform i.e., Meeting and Learning modules. If the professors wish at any moment to capture their presentation for later use as a reference of the lecture or for students who could not understand or missed the lecture, they can activated the automated authoring system and it will start automatically processing at the background of the WebELS Meeting system. The system will capture all lecture events in real-time based on the event-driven approach we used within the automated authoring system and generate a learning course by the end of the online

lecture. Thus, will enhance the WebELS platform and make it a robust environment to support the higher education activities and satisfy the social demands for internationalization education.

Moreover, we have designed two functions to support and enhance the online meeting presentations in the E-meeting module of the WebELS platform, such as automatic streaming adaptation and video embedded synchronization. Automatic streaming adaptation is for goal to adjust the audio/video stream quality of users during the online meeting to support and keep stability of connection for users under low speed Internet environment. Video embedded improved the variety of contents that can be used during an online presentation. Rarely E-meeting systems support the video content to be shared online among the connected users. Therefore, we designed a new function on the E-meeting module to enable using a video content type for an online presentation and the video playback control is synchronized in real-time among all the connected clients [109].

Chapter 4

Advanced Cloud Automated Authoring System Embedded in the Online Lecturing Platform

4.1 System Design Policy

The automated authoring system is designed to provide an advanced cloud authoring tool for supporting content development in E-learning. Aiming to assist instructors to achieve their learning materials on the web for on-demand learning, online meeting and online lecture for the globalization of graduate education in science and technology as well as the social demands, focusing on dissemination of multimedia contents. Based on the characteristics of Ph.D. education in the points of view of E-learning [1] [107], we designed the policy and concept of the proposed system as follow :

- PhD students are research partners as well as students whose activities as individual scientists are involved in higher education. Joining research meetings and giving research presentations at international conferences are typical examples. Slide-based presentation followed by discussions is a typical style.
- Slide-based lecture is a typical style of classroom lecture, and slide-based playback with voice-video of lecturer and synchronized cursors on a learner's computer seems to be reasonable for on-demand self learning.

- Supports synchronous and asynchronous E-learning, i.e., on-demand self-learning and multi-location Internet-based meeting,
- Powerful and easy-to-use content authoring that support variety of documents,
- Fully automated background authoring solution for instructors to create rich learning contents through the Internet,
- A free open source solution to solve content development and courseware production issues without the need for third part software installation,
- Possibility to be used for all level of education to improve the online learning, as well as for business sector fields,
- Instructors use the system to generate learning contents as group-based lecture mode with online students or as self-content mode creation with no connected students,
- The system developed to support also students presentations, international collaborations, class sessions, etc.
- Must be available "anywhere and anytime" and must work even in strict firewall and proxy settings,
- Supports multi-operating systems and multi-browsers,
- Should be available not only in advanced countries where broadband Internet is widely used but also in developing countries such as in Asia and Africa where narrowband Internet is normally used.

4.2 Online Lecture Platform

The automated authoring system proposed in this research is placed on a multi-functional E-meeting system based on cloud-computing, built on the Web-based E-learning System (WebELS) platform. The lecture platform designed to enhance the on line meetings and lectures through the Internet using Flash-based multi-media technology in developing it. Unlike the majority of E-meeting systems that require IT skills to use, the design of the proposed E-meeting system is addressed to non-IT users offering a simple and flexible interface. The lecture platform is

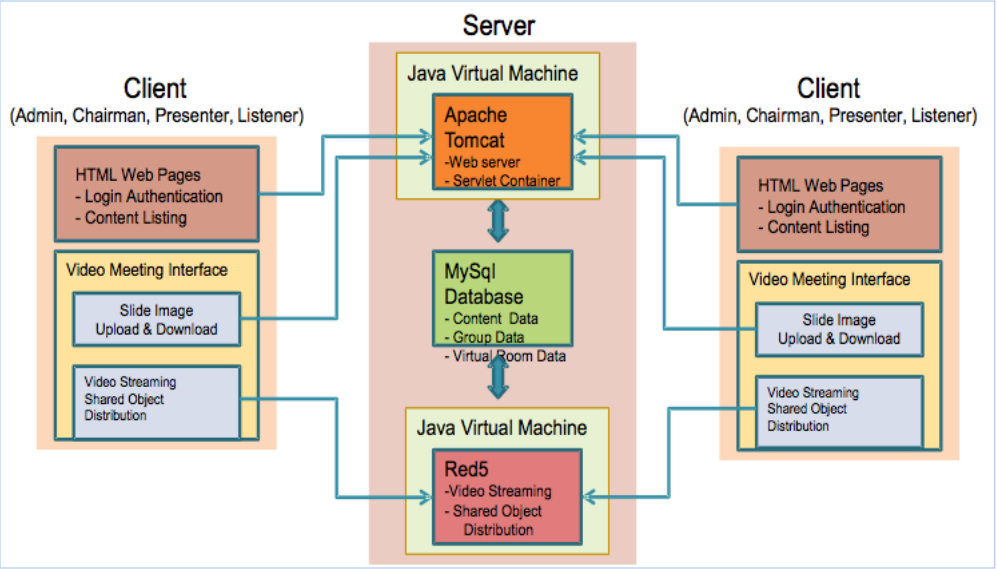


FIGURE 4.1: Online lecture platform diagram

made possible by combining the on-line slide presentation and video conferencing system to create a virtual classroom, where the meeting participants congregate via the Internet. Hence, the lecture system offer important features such as, on-line presentation, on-line annotation, video conferencing, and chat massaging system, and use of various document types, which are the required features for a virtual collaborative learning system.

Figure 4.1, shows the system diagram of the Flash-based lecture platform and demonstrates the different technologies we used on both client and server side such as: Apache tomcat, MySQL and RED5 for server side. The client needs to open the browser and access to the WebELS Meeting server through the Internet.Real Time Messaging Protocol(RTMP) [110], Real Time Messaging Protocol Tunnelled(RTMPT) [111] is used for both slide synchronization and audio-video communication. Since WebELS meeting is client server architecture, all the events in the meeting system that include the whiteboard for on-line presentations and on-line annotations, video conferencing, and chat messaging are in real-time streaming using flash technology on the client side, supported by using the Red5 as streaming sever. Therefore, those events were the input of the automated authoring system in processing the lecture in order to generate a learning contents automatically. Video conferencing, slide-presentation and cursor pointing are functions on the lecture platform that were used for the development of the automated authoring system.

FIGURE 4.2: Automated authoring client controls functions

4.3 Automated Authoring System as a Background Process

4.3.1 Authoring Controls

Since the authoring process is fully automated, we designed a simple command button for lecturer to activate the events that will be captured and executed by the server side in real-time authoring. Comparing to other related systems that offer capturing online meeting using the screensharing technology such as [104], [105] and offering only two commends Start recording, Stop recording in an unclear design that can be difficult for non-IT users to manage. In our system design we developed a simple and easy to understand design with more authoring controls button that each of it have a specific function to execute an event on the server side. Figure 4.2 shows the authoring controls created for the automated authoring system, first the lecturer need to push the button **Start** to activate the background process where the automatic authoring will process and wait for the lecturer events to execute. During the online presentation if the lecturer wish to take a break at any moment due to a long lecture for example, pushing the button **Pause** will send a signal to the server to deactivate the authoring procedures such as stream recording and the slide-video synchronization. During the system is paused even changing slide or sharing the stream with other users will be not considered or treated till the lecturer will push the button **Resume** to activate the system again and continue the authoring process. Once the presentation is over, the lecturer need to push **Stop** button to terminate the authoring process on the server side and based on that the system will automatically prepare the data and generate the learning package.

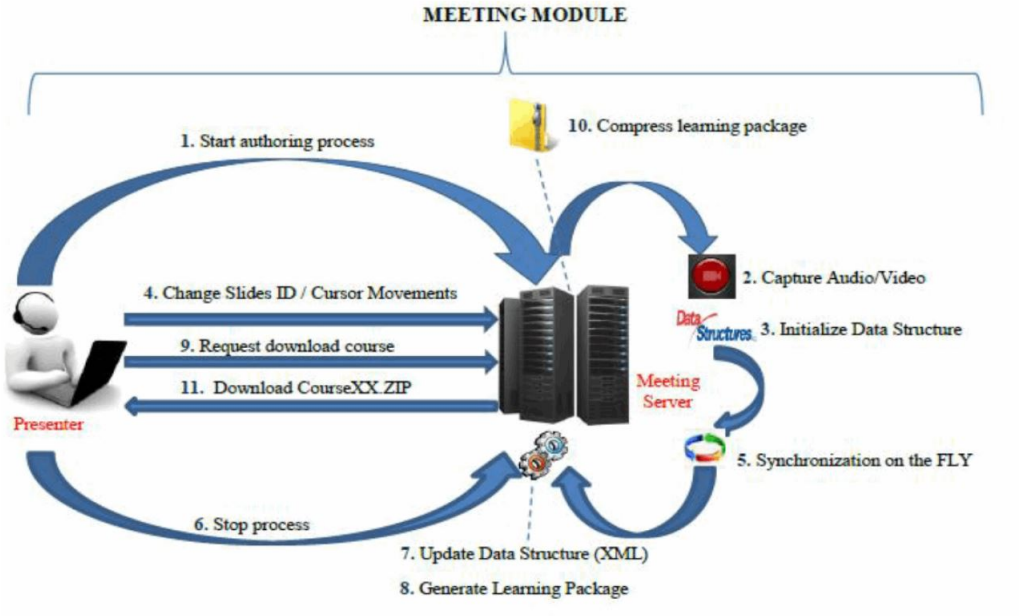


FIGURE 4.3: Automated authoring overall procedures

4.3.2 Operation Workflow of The Background Process

Figure 4.3. Shows the overall procedures of the automated authoring system when activated within the E-meeting system during an online presentation to create learning contents automatically. The procedures are based on a series of events actions by the presenter and executed by the server in real-time by means of co-operative event-driven technology. (1) is activating the authoring process, the system will automatically (2) detect the presenter stream audio/video among the online users and record it. (3) The system will initialize the data structure and generate XML files i.e., metadata (content_description and slides_description) that contains basic information of the learning course such as course title, slide title, description, image name, etc. (4) Change slide ID and insert cursor position is events made by presenter that the system will automatically detect it and apply our course generation algorithm (5), Once the presentation finished, the presenter need to stop the authoring process at the server side (6). Thus, the system will automatically execute two processes (7) update the data structure with the synchronization and cursor data, and (8) run an archive script to generate the learning package that contains the presentation materials such as video recorded, slide images, metadata, etc. The learning package will be created and saved at the server side once the process is deactivated. To ensure the copyright issue of the scientific contents presented by the speakers, we designed the system to allow

only the presenter or chairman to activate/deactivate the authoring process and by then download the courses on their personal computers. (9) The presenter sends a request to the server to download the learning package. (10) At the server side, the system will prepare the course.ZIP file to be exported on the presenter PC (11).

4.3.2.1 Video Stream Recording

The video in E-learning can be a powerful way for any organization to meet it's learning objectives effectively and rapidly. However, one of the biggest considerations for using video in E-learning courses is managing the recording and file size. In our approach we designed the system to capture the lecturer stream online whatever is the device he/she using to share the video-audio data which is mostly Webcamera. Recording a Webcam nowadays provides a significant role since video hosting is now being a trend. Instructional videos are one of the most shared videos in the net that are made using a webcam recorder online. There are several Webcam recording tools [112] [113] that support recording the stream. However, in our system we designed an independent recording method to capture the lecturer stream and to enable a variety of qualities during capturing. Moreover, an automatic streaming features was introduced to facilitate the lecturer work especially for those who are non-IT familiar, See 5.7.

4.3.2.2 Cursor Capturing

Figure 4.4 shows the workflow of online video recording and cursor pointer movement synchronization. We used the lecturer video recorded timing as a baseline timer for the synchronization process. The cursor movement positions are recorded as a series of mouse coordinates (X,Y) correspond to the baseline timer of the video under recording. This function only records the data when the mouse button is pressed by the lecturer. The recorded video and the pointer synchronization data are separately stored into an archive file where each slide has its own pointer movement data, See 5.7.

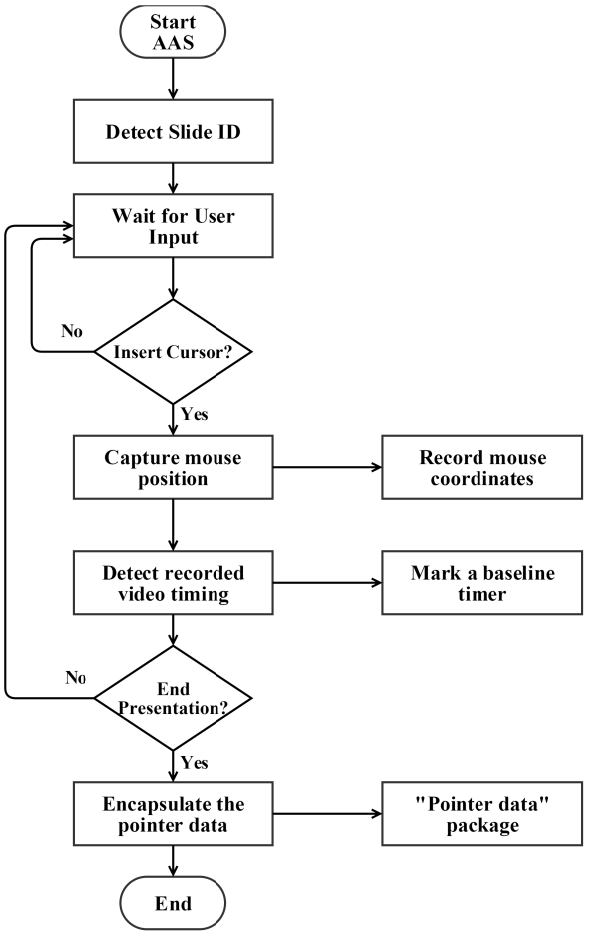


FIGURE 4.4: Cursor data capturing

4.3.2.3 Slide-video Synchronization

This process is the main feature of the system. Uniqueness of our proposed system is that the method of synchronization is on real-time communication between client and server using the cooperative event-driven approach. The CG algorithm will manage the synchronization process during the authoring. We designed a time sequence scenario for adding slides to the package or by deleting it and also the order of changing and manipulating slides is totally free by lecturer. Since each slide include a special ID, the system can automatically detect in which slide the lecturer is positioning and based on that process the event. Figure 4.5 shows an example of the synchronization methodology between slides and the lecturer video under recording on the server side. See 5.7 for more details on the course generation algorithm implementation.

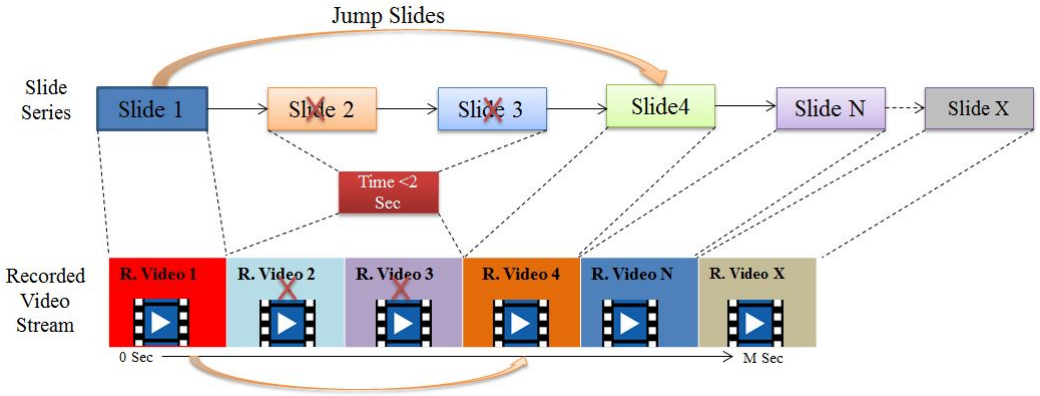


FIGURE 4.5: Slide-video synchronization of the automated authoring system

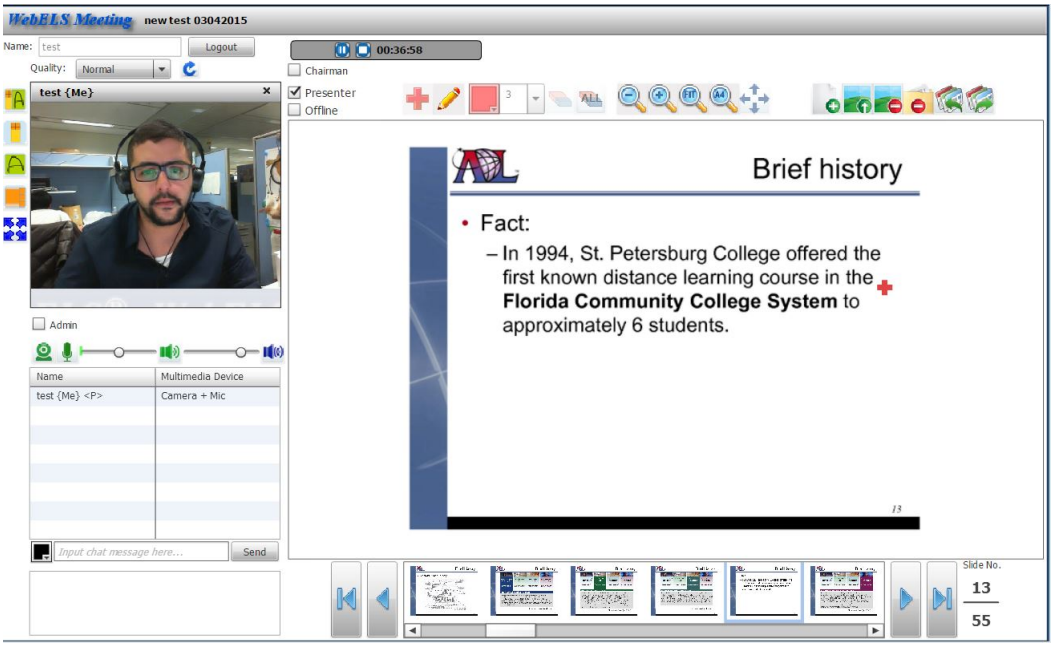


FIGURE 4.6: Example of using the automated authoring system embedded into the E-meeting module to create learning contents

Figure 4.6 shows an example of using the automated authoring system which is embedded into a lecture system. In this example, the system is used only by one user which can be the lecturer to create learning contents to be used as a reference for students later.

4.4 Integrating Online Presentation and Content Development

Another Key feature in our research and system development was designing a new functions of Export & Import. Those two functions merge and integrate the two modules of WebELS i.e., Meeting and Learning [114]. By means, once the learning contents is generated automatically based on the online presentation, the content can be exported and imported to the learning module. In developing the embedded automated authoring system under the WebELS meeting module we designed a similar learning package structure to the one on the learning module so it can be edited and played back on the learning module. Thus, the learning module needed to be kept so it will be combined with our system to offer a full authoring solutions for instructors. Moreover, some issues remained in the learning module data structure such as lack of video embedded content type to be used for the course since only slide image is supported, slide duplication is not allowed apart if instructor repeat the uploading process again which is time consuming and slides with a short video discussion are hard to synchronize since it's based on a semi-automatic synchronization process. Therefore, we have optimised and improved the data structure created by the automated authoring system to support the above issues and to enhance the learning courses quality and compose it close to real situation. The learning content created on the meeting server, can be downloaded from the main page by the lecturer anytime and anywhere. Thus, the learning package is saved on the lecturer PC and at anytime and anywhere the lecturer can import it to the learning module in a very simple process. The learning server will decompress the CourseXX.ZIP to prepare the course template and then insert it to the data base of the contents to be ready for playback by students anytime and anywhere as shows in Figure 4.7.

4.5 Post-Editing and Playback Contents

The course.ZIP downloaded on the presenter machine will be ready to get imported to the E-learning module of the WebELS platform anytime the presenter decides. The import function will insert the course.ZIP generated at the E-meeting into the database of E-learning module courses. Moreover, the courses imported to the

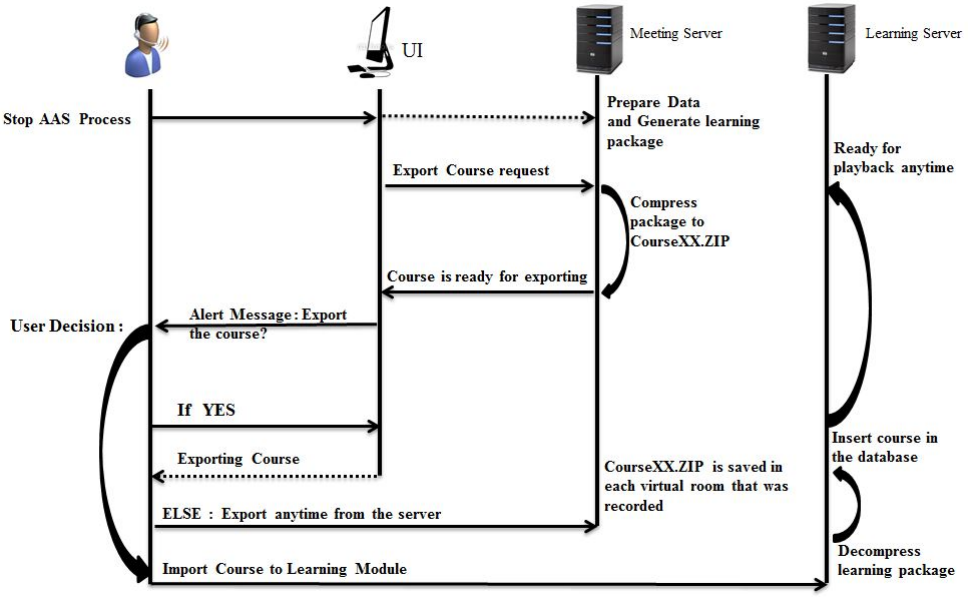


FIGURE 4.7: UML of the export/import process

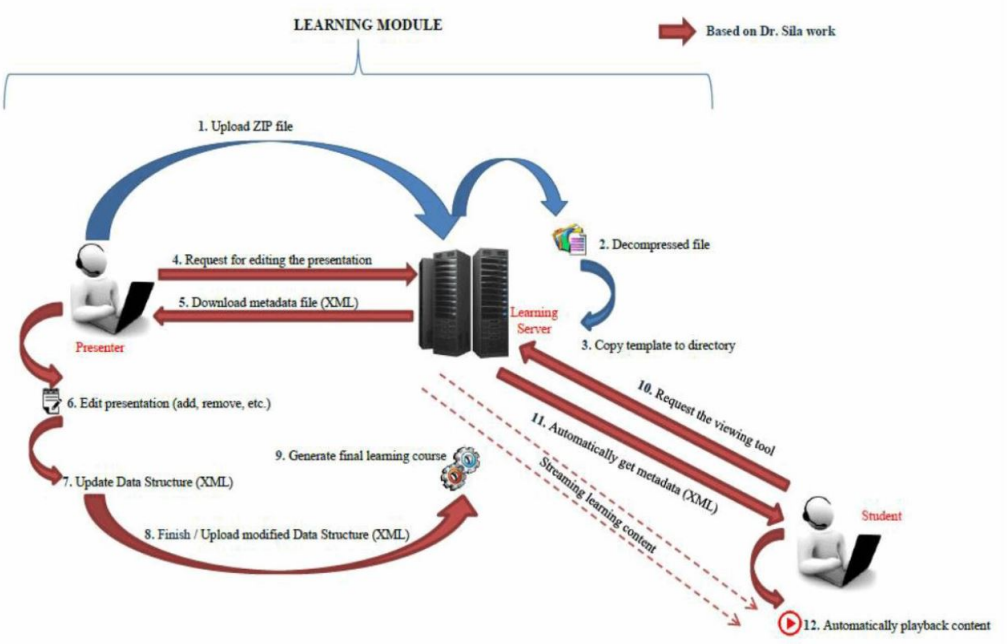
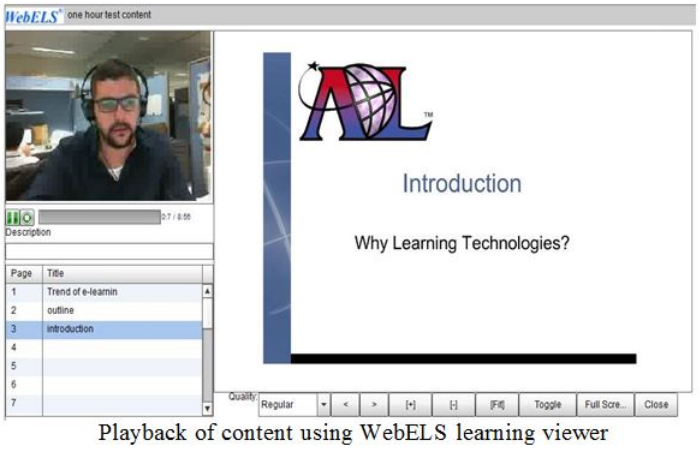


FIGURE 4.8: Edit and playback overall procedures

learning module can still be edited by the presenter using the E-learning editor mode [8]. The instructors can make further improvement to the courses by adding, removing slides or videos, etc. The overall procedures of the editing and playback functions are presented at Figure 4.8. From importing the course to the Learning module to edit it so then play it back by the students, the client-server processes are as follow. (1) Instructors upload the course.ZIP exported from the Meeting module to the Learning module. (2) The server decompress the ZIP file, (3) copy the template to courses directory and insert it to the database. (4) If the instructors wish to improve their courses so the client side process will send a request for editing the presentation, (5) server will download the metadata XML files, (6) instructors edit their presentations (add, remove, etc), (7) upload the updated metadata files once the editing is over, (8) at the client side finishing the editing process and upload the modified metadata files, (9) the server will generate the final learning course template. Once the course is created and saved at the learning module server, students can easily access to it and review it any time and anywhere in a simple process. (10) Student request the viewing tool, (11) the server will automatically download the playback viewer panel and the XML metadata files, and (12) the content will automatically playback at the student PC. While viewing the learning content, network connection is always needed for on-line flash streaming from the server.

Figure 4.9 shows an example of the content created using the automated authoring system within the E-meeting module in the post-editing phase. At this stage, the lecturer can add further modification on the content, and once the content is ready it can be saved at the server and reviewed by students by accessing to the learning module web page.

Editing interface for pots-editing using webELS learning module



Playback of content using WebELS learning viewer

FIGURE 4.9: Example of the content created using the automated authoring system at the post-editing phase and its playback

Chapter 5

The Novel Automated Authoring System Technology Implementation

5.1 Required Technologies

The automated authoring system is a client-server based. Therefore, to design both client and server side we needed to use and deploy some different technologies to manage the recording stream, create and store the metadata files that contain the synchronization data and capture the cursor pointer position to generate the learning package at the end of the process. Some of those technologies are presented below.

5.1.1 Adobe Flash Technology

Adobe Flash technology [80] was used on the client side which is an E-meeting system that supports video conferencing and slide-document presentations [108]. Flash is a very popular technology at the moment for its several benefits, such as lightweights applications, cross-platform supported and can be plug-in to any web browser. Moreover, Flash has their own technology to use the video stream format (FLV) that was the result of the captured video stream of the lecturer during the presentation in a good quality and light file size of FLV files. This

technology is used by several web services for instance, YouTube, BigBlueButton [104], OpenMeeting [105], WebELS Learning system [8].

5.1.2 Streaming Server

We have used the Red5 [115] for managing the and recording the video stream data since it is Java-based application, and compatible with Java technology that we sued in different modules. Red5 is an Open Source Media Server compatible with the Flash streaming content. Red5 delivers powerful video streaming and multi-user solutions to the Adobe Flash Player and other existing client technologies and it is the best solution for recording the audio/video stream online with high stability and quality. It supports the RTMP protocol [110] for communicating to Flash clients, which enable them to dynamically interact with the server to stream or capture the audio/video streams.

5.1.3 XML

XML (Extensible Markup Language) is a set of rules for encoding documents in machine-readable form [116]. The design of XML emphasize simplicity, generality , and usability over the Internet. We used the XML document for the metadata files to create and store the data of the learning content. This data will be readable by the learning playback interface to review the courses through the Internet.

5.1.4 System Requirements

- Hardware requirement

☐ Personal computer or,

☐ Notebook/Laptop

☐ WebCamera

- Software requirement

☐ Cross platform OS - Windows, Mac OSX, Linux are supported

☐ Web Browser - Firefox, Internet Explorer, Chrome, Safari, etc

- Adobe flash player plug-in

5.2 Architecture of the Proposed System

To support the system features, we designed the system architecture and structure as shown in figure 9. Since the system is based on a background processing, main workload is done on the server side where the client side is responsible on starting and stopping the system and sending the events during the online presentation. In the server side, the system combines Tomcat web service, Red5 streaming server, and MySQL database service for supporting the back-end process. The web service used to manage the raw files that are uploaded by the lecturer for the presentation such as document (PPT, PPTX, PDF, DOC) and video embedded (flv, avi,). Then convert to the required format, and prepare the content archive. While the streaming server is utilized for managing and sharing the audio/video stream data of the online users, capturing and recording the lecturer stream, share and record pointer movements data, record and share the slides synchronization data etc. The system handles the automatic authoring using the vent processing engine that listen and capture the events sent from the event listeners on the client side. This events engine will analyse the events sent from the lecturer and execute them by applying slide-video synchronization or capturing the cursor pointer position or managing the stream data quality during the online presentation. These functions are optimized and applied to support the cloud technology. Thus, the system can be installed in the cloud environment which allows centralize data storage, processing and bandwidth with other systems.

For the client side, flash technology is used for the E-meeting system where the proposed system was embedded. The automated authoring system use two main features of the WebELS meeting i.e., video conferencing stream and slide presentation whiteboard to process. The authoring control was designed on the meeting panel interface as a simple button control for non-IT users to manage. The client side include as well streaming controller, meeting management, and the import function that enable lecturer to download their content created at the server and import it to the learning module.The authoring controls are based on the event generator that will transform the presentation actions into events to be sent to the server and event engine on the server will decide the proper execution. The authoring is created for the lecturer to manage the presentation capturing

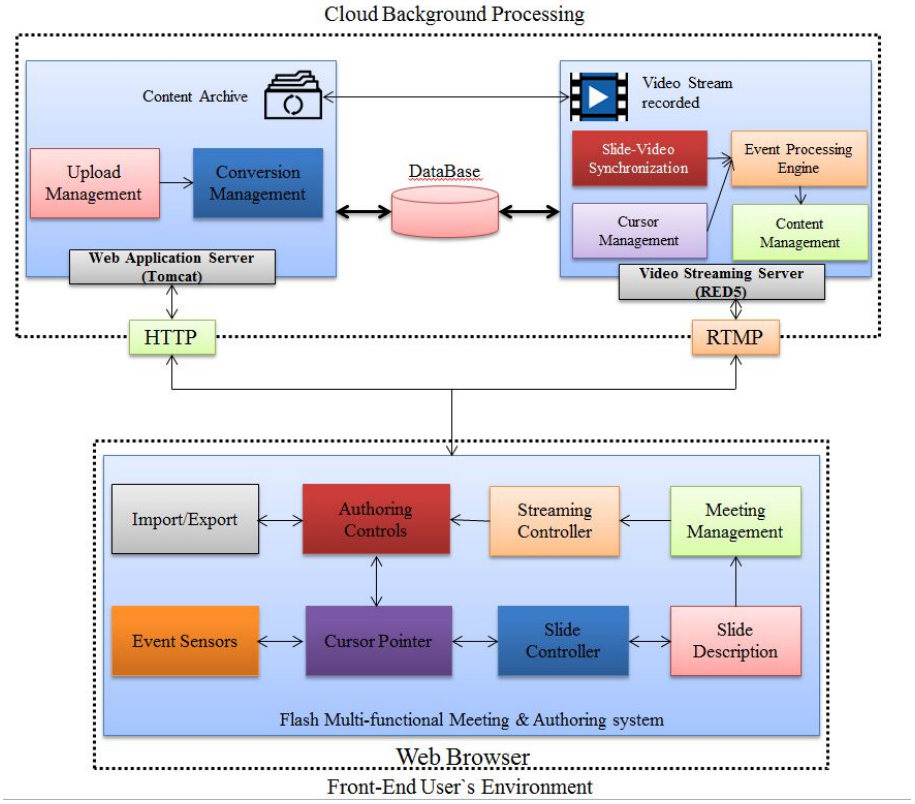


FIGURE 5.1: Automated authoring system architecture

during giving the lecture. The viewing interface is based on the WebELS learning module [8], designed for students to access to the learning contents saved on the server. The learning content is automatically started to display after downloading the matadata from the server.

5.3 Cloud Service of the System

The Internet and network technologies are now transforming to the next generation. The development of that technologies are fast delivering and rapidly evolving advanced utilization to support daily life usage. There are many modules, services and technologies which are depended on the functionalities and other factors use to sustain any Internet activities. Therefore, Cloud computing system is becoming a very popular technology at the present use to serve the server side services. Cloud computing is all the rage. The problem is that everyone seems to have a different definition [117] [118] [119]. In our system development concept, cloud computing is a technology that uses the Internet and central remote servers to maintain data and applications. This technology allows for much more efficient computing by

centralizing data storage, processing and bandwidth. Moreover, it allow users to access their data at any-time and with no need for software installation.

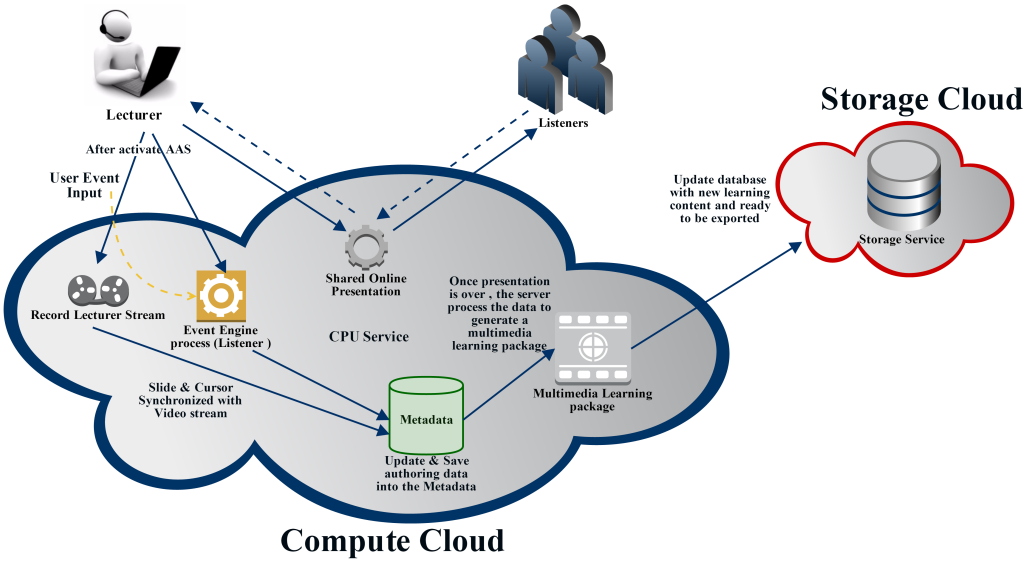


FIGURE 5.2: Proposed system architecture as a cloud service, the compute cloud manage the authoring process and the contents processed are saved on the storage cloud

Fig 5.2 shows the overview of the proposed system cloud concept. The Meeting server share the online presentation between the lecturer and the online listeners. The flow of the automated authoring applications starts If the lecturer activate the system during the lecture. Where the authoring computing will be fully automatic on the server located on the cloud environment and the multimedia learning content which is the output of the process will be saved in the server cloud storage.

5.4 System Overview

There are two main types of E-learning authoring tools: (1) the standalone system, (2) the client-server system. Fig 5.3 shows the overview of the automated authoring system which is based on a client-server architecture. The client side is a web-based E-meeting application which can be accessed by any web browser by both lecturers and students. Client (lecturer) is connected to the meeting server that share streaming and data among the connected users online. The server is a web application-based server using Red5 for streaming [115] and Apache Tomcat for content managements [120]. At any moments of the presentation if the lecturer

push start button of the recording it will by then activate the background authoring process. At the client side the system wait for the lecturer events (user event input) that can be occurred during the presentation such as slide control (changing and manipulating slides), input cursor on the slides (red cursor that indicate the exact position on the slide that lecturer is discussing) or managing the audio-video streaming quality. At the server side the **CG (Course Generation) algorithm** is activated to process the client event-driven through a serious of event engine. The algorithm observe every events occur during the presentation and execute it in real time. While the system is activated the algorithm is manipulating three sub-modules which are the components of the learning package such as : cursor data, slide-video synchronization and the streaming data of the lecturer video, see (Section 5.7).

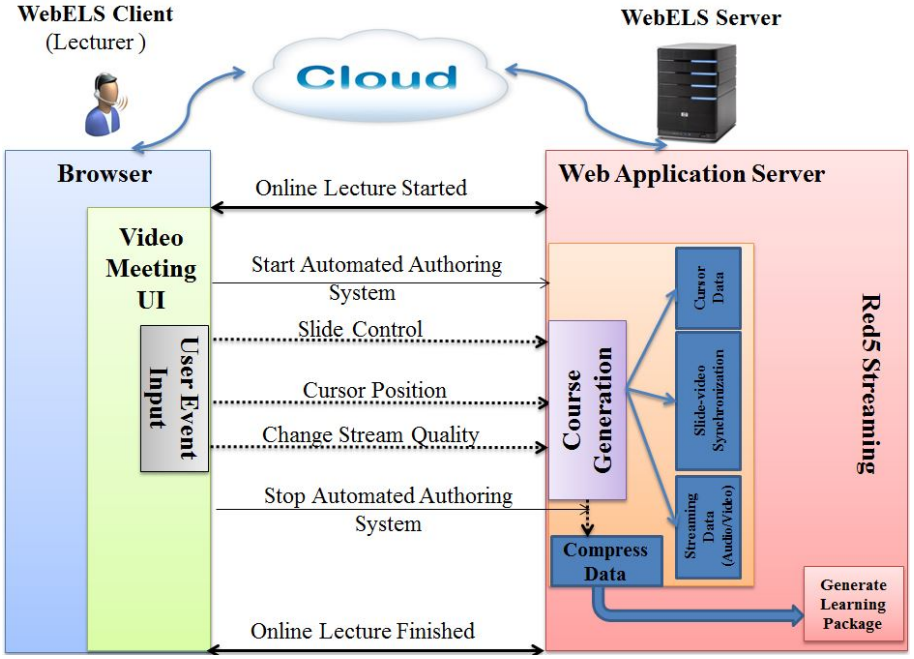


FIGURE 5.3: Automated authoring system overview as a client-server architecture

To support the infrastructure of the system in sharing the data between client and server, we defined metadata files to contain the CG algorithm processing data. First is the *content_description* file which contains the general details and informations of the learning content. Second, the *slide_description* file which save the slides details of the presentation and contain also the cursor and synchronization data processed by the CG algorithm during the online presentation. Stopping the recording by client at the end of the presentation will automatically stop the automated authoring system,the CG algorithm will update the last slide data and

generate a learning package. The learning package is the output of the system, it includes the metadata, presentations slides and recorded video stream. The package is a ZIP file generated by the server using an archive script, that can be exported from the meeting server and imported to the learning module for further editing or directly playback the multimedia learning course.

5.5 System Data Structure Initialization

Before discussing the authoring algorithm of the system, a discussion on the special data structure of the automated authoring system is necessary. There are many basic data structures that can be used to solve application problems. In our solution we designed the tree data structure type to manipulate the authoring. A tree is a collection of nodes connected by directed edges, it is a nonlinear data structure so it can be empty with no nodes. Fig 5.4 shows the initialization of the data structure of the proposed system, where the root of it is the learning content. In the second level of the tree, we have the metadata files i.e., content_description, slide_description and the data files. content_description is an internal node having several childes presenting the details information of the learning course such as: Title, abstract, author, reference, etc. Those childes are filed by data from the instructor while preparing the content which will be stored in an array. slide_description is also an internal node, It's childes contain the detail information of the slides presentation data filled by the instructor such as tile, description of each slide. Since it is the initial data structure, the array contain only the tile, description but not yet the cursor and video index timing data which is created by CG algorithm during the authoring. These data will be stored in an XML document in the server and a virtual link will be created to connect them. The third internal nodes is the data files related to the data structure root. As an initialization image files is filled by the slides presentations, video file contain the video embedded files that instructor might upload to be used for the presentation. However, remain files are empty, see next section for more details on data files.

5.6 System Data Files

According to the data structure described above, the presenter have to give the slides data and insert slides description and details (Optional in uploading , since

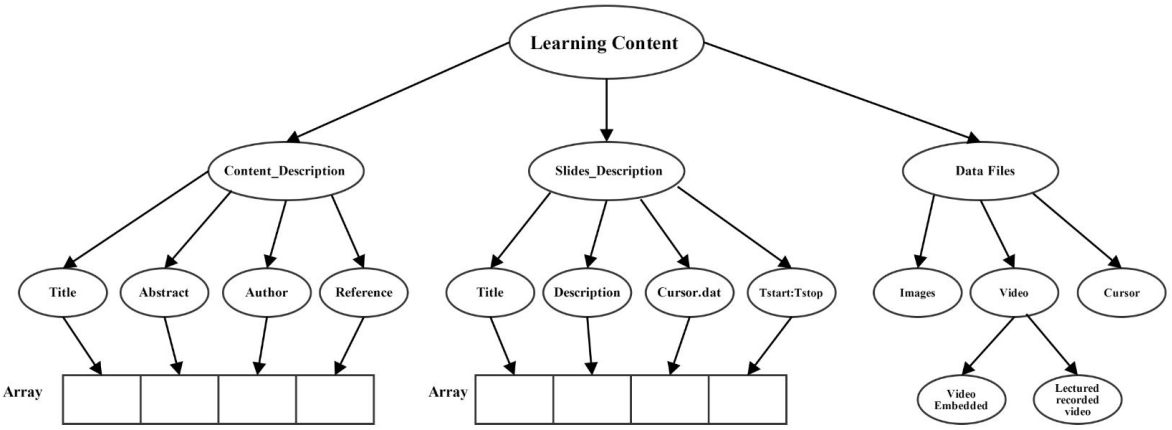


FIGURE 5.4: Data structure initialization of the proposed system

it can be added during post-editing) to allow the CG algorithm to proceed them. Fig 5.5 shows the data files structure of the system. Normally, the content development process include five parts. (1) content information putting, (2) image converting and attaching, (3) video embedded converting and attaching, (4) audio-video stream of the lecturer recording, (5) cursor actions recording, (5) slide-video synchronization.

1. **Content information putting:** Before starting the lecture, the instructor need to prepare their presentation materials, at the uploading interface of the WebELS Meeting [108], Content title, author name, content password can be inserted which are the childes_nodes of the content_description node. Furthermore, after importing the content to the learning module, instructor can add further details to the content such as category/subcategory, abstract, reference, etc [8]. Next, instructor can insert the slides details such as title, description (Though this step comes after the uploading step (2) or (3)). These data will be saved at the content details module on the server that is connected to the slide info module.

2. **Image converting and attaching:** The image used in the system can be converted from one (or combined) of the following primitive types : Formatted text with different typefaces, colors, languages; Still image in the following formats: JPG, PNG, TIF; PDF hardcopy; Microsoft Office documents: DOC, DOCX, PPT, PPTX, RTF; Open Office documents: ODP, ODT, ODS. After converting, images will be saved at the Image file and it's data will be connected to the module Slide info (Metadata).

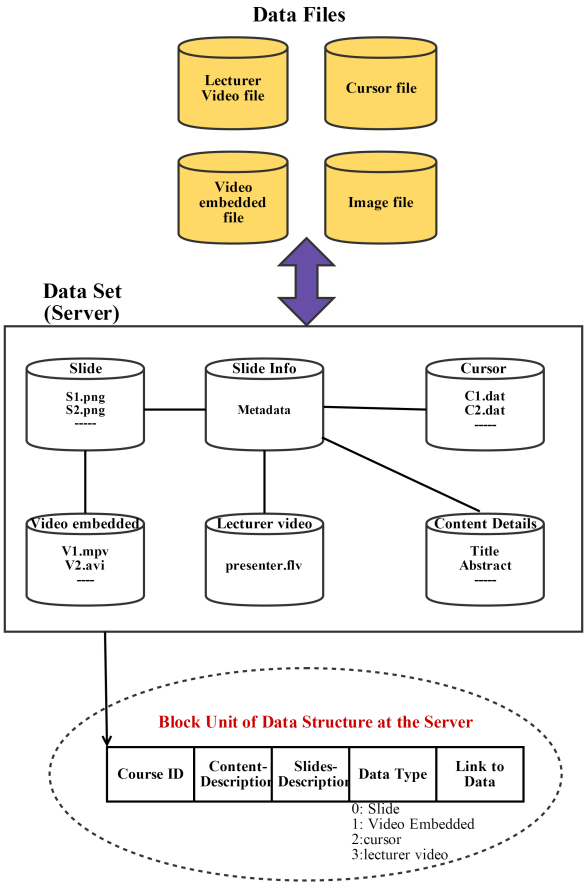


FIGURE 5.5: Data files of the background processing

3. **Video embedded converting and attaching:** In some traditional class, lectures do some demonstrations to give students intuitionistic impression. If some demonstration video clips are helpful for learners to understand the content easier, they can be inserted into the slides of the content. The layout of videos in slides can be managed by the E-meeting interface that can detect the content type (video or image) automatically and adjust the layout based on it. Currently, video formats such as AVI, MOV, MPG, FLV etc are supported to use in the system [109]. Videos will be converted to an FLV format on the server side and saved at the Video embedded file to separate it from the lecturer video recorded.

4. **Recording the lecturer audio-video stream:** The system detect the lecturer ID among the connected users and using the Red5 streaming server will start recording his/her stream data and save it at the lecturer video file on the server side to be a part of the learning package. This video is linked to the slide info to enable playback after synchronizing video and slides.

5. **Cursor actions recording:** The cursor actions in each slide are used to simulate lecturers actions in presentations or classes. lecturers can use mouse key to move or click on each slide to record cursor actions. Cursor actions will be shown as red-cross icon in slides when learners view the contents. Lecturers can use cursor actions to give tip on the topic where they are talking to, or show the points they want to stress out. Lecturers can record cursor actions according to the recorded video to be synchronized based on time it will occur. These cursor data will be saved in the Cursor file and linked to the slide info since each slides has is own cursor data presented as a Ci.dat

6. **Slide-video synchronization:** This process is the main feature of the system. Uniqueness of our proposed system is that the method of synchronization is on real-time communication between client and server using the cooperative event-driven approach. The CG algorithm will manage the synchronization process during the authoring.

Data files management is very important in organizing the learning content components. The server create a virtual room for each presentation where this data is stored in a root file called Lecture that include data files, synchronization data, content information data, etc. Thus, the unit block of data structure in each content look as shown in Fig 5.5. ContentID to identify the course, content_description, slide_description, data type (slide, video embedded, cursor, lecturer video) and a link to the data saved in each file to connect the learning content data components.

5.7 Course Generation Algorithm based on Cooperative Event-driven

In this section, we discuss the details of the Course Generation algorithm which takes in charge the slide-video synchronization, capturing cursor data, adjusting streaming quality, and managing the authoring controls of the lecturer. This algorithm is based on a cooperative event-driven approach by means of client-server collaboration based on a series of events entered by the client and processed by the server in real-time.

TABLE 5.1: Cooperative events list on both client and server which interact in real-time during the authoring process

Automated Authoring Events	**Client**	**Server**
Authoring Control	Start Authoring	Activate CG algorithm
	Pause Authoring	pause stream recording and synch process
	Resume Authoring	resume stream recording and synch process
	Stop Authoring	Finalize authoring process
Presentation Events	Change slides	Slide Si detecting and adding criteria
	Insert cursor	capture position and create cursor data
	Change streaming quality	Automatic BW detection and adjustment

5.7.1 Cooperative Event List

Cooperative event-driven consist of event generator and event processing engine harmoniously collaborating in real-time. Event generator senses a fact and represents the fact into an event and knows only that the event has occurred. Event processing engine is where the event is identified, and the appropriate reaction is selected and executed. [121] [122].

Table 5.1 shows the list of events embedded into our proposed system. We separated them into two sections based on roles: authoring control and presentation events. The client is where event generator is, while the server manage the event processing engine. We defined the authoring control as the actions done by the lecturer to manage the authoring operations. Once lecturer start the automated authoring, the CG algorithm will be automatically activated at the server side which includes the event processing engines that will execute the presentations events. The presentation events are what happened during the presentation scenario by lecturers such as changing slides, inputting cursor, or changing streaming quality. For each of these events, the CG algorithm will select the appropriate reaction. In case, the lecturer wish to take a short break or even to avoid capturing some slides for some copyright issues, he/she can pause the authoring system. Thus, the event engine as well as the CG algorithm will be deactivated. Once the authoring is resumed, the system will re-continue recording lecturer stream from the moment where it was paused and continue synchronizing data from the slide where the resume is occurred in case the lecturer changed the slide while pausing.

5.7.2 CG Algorithm

The CG algorithm starts once the automated authoring is activated on the client side. As shown in Fig 5.7 it is separated in two parts to show the exact process in both client and server. Once client push start button of the authoring, the CG algorithm is activated and will prepare the content template of the learning package that include the data files presented in the subsection 5.6. On the client side, we detect the lecturer ID among the connected users to start recording his/her audio/video stream at the server and initialise the time of starting the authoring as $T = 0$ using a timer. Thus, the algorithm at the server will wait and listen for the user events input that will be proceeded by the event processing engine. As shown in Table 5.1 presentations events are defined as three operations that will be transformed to an event using the event generator and proceeded by the event engine at the server during the presentation for authoring the content in real-time. These operations are: change slide, input cursor and change streaming quality. Each of these events will be manipulated by the algorithm as follows:

- **Change slide:**

If lecturer input change slide event, the client will send the information combined with the time value of slide changing which is basically the time sequence of the video recorded. Thus, we apply the adding slide criteria by comparing the time value T with the minimum time of slides predefined on the server T_{min}. T_{min} is the minimum value of time needed for the slide to be considered in the content package. In several actual presentation scenarios, the presenter need to skip some slides to don't pass the presentation time. Therefore, we adopted this concept in our authoring process and we defined $T_{min} = 2$ seconds. If the time sent from the client $T_{value} < 2$ seconds, then slide will be skipped and not created in the data structure of the course since it did not have enough time to be discussed. If $T_{value} > T_{min}$ then we call the program **Add Slide Si**. This program check the Slide ID S_i, if S_i is new, then create a new slide and video timing data synchronization, collect the cursor data of that slide if any and update the learning content data structure. If S_i is not new, for example in case presenter have to represent some specific slides for further explanation. Then, S_i will be duplicated including a new video timing data. Duplication means that the slide include same image file, title, description, etc but with a new video timing and cursor data since it was presented in two

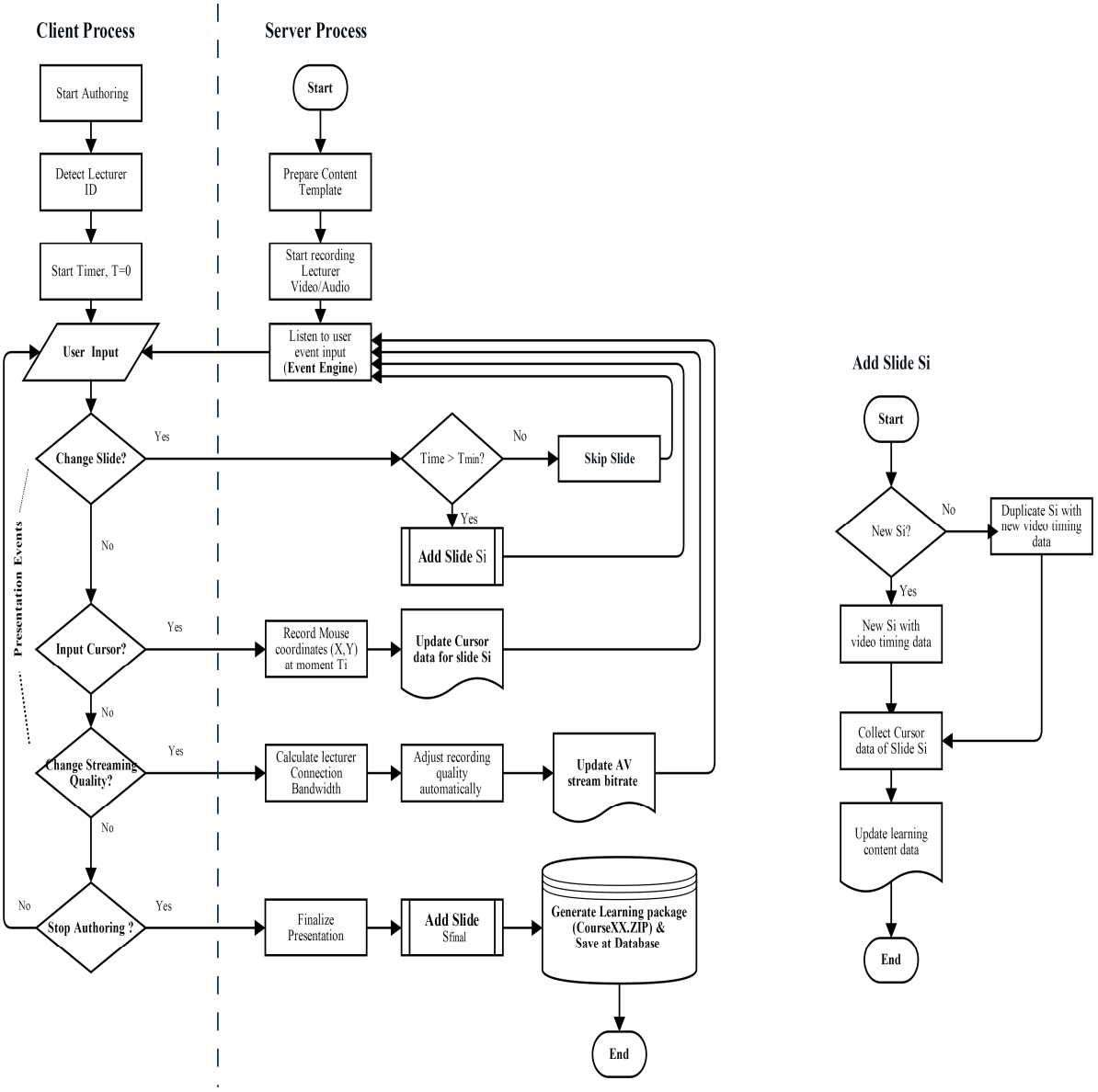


FIGURE 5.6: Course generation algorithm(CG) based on a cooperative event-driven between client and server

different moments and then update the data structure of the learning content. The slide changing data based on the video under recording is written as follows:

$$sv = [Si, Tstart : Tstop] \tag{5.1}$$

where

sv - is the slide-video synchronization data,

S_i - is the Slide ID,

$T_{start} : T_{stop}$ - is the time sequence (start, stop) used for the Slide S_i

Input: Change slide event
Output: Slide-video Synchronization.
Step.1: Detect event type on client side.
Step.2: Check slide ID.
Step.3: Detect time sequence for changing, T
Step.4: If time value, T>2sec, then program will proceed to *Step.5*, else it will move onto *Step.8*
Step.5: If slide ID is new, then program will proceed to *Step.6* else it will move onto *step.7*.
Step.6: Create a new slide-video synchronization data in the data structure.
Step.7: Duplicate the slide i with a new video timing data in the metadata.
Step.8: Ignore slide in the metadata
Step.9: If timer stopped, then program will proceed to *Step.10*, else it will go back to *Step.1*
Step.10: Save slide-video synchronization data and write it in the metadata file.

FIGURE 5.7: Step by step algorithm of changing slide process

The duplication concept can be explained more in Figure 5.8, where the slide imaged and description will remain the same but the video time sequence will be changed. This feature improved the data structure of the learning content compared to the one proposed by Chunwijitra, et.al [8] where it was hard to use the aggregated video for the same slide in two different time sequences. Figure 5.7 shows the algorithm of this process in step by step to be more simplified.

- **Input cursor:**

In case, the lecturer input cursor on the slides instead of changing slide or streaming quality then the event is detected. On the client side it will detect the mouse positions and record it as a series of coordination (x, y) and link it to the video stream recording timing on slide i T_i to be synchronized. Therefore, the video stream under recording at the server is used as a baseline timer for the synchronization. The program only records and capture the cursor data when the mouse button is pressed by the lecturer to minimize the size of the pointer action data. The values and structure which need to be recorded are shows as follows :

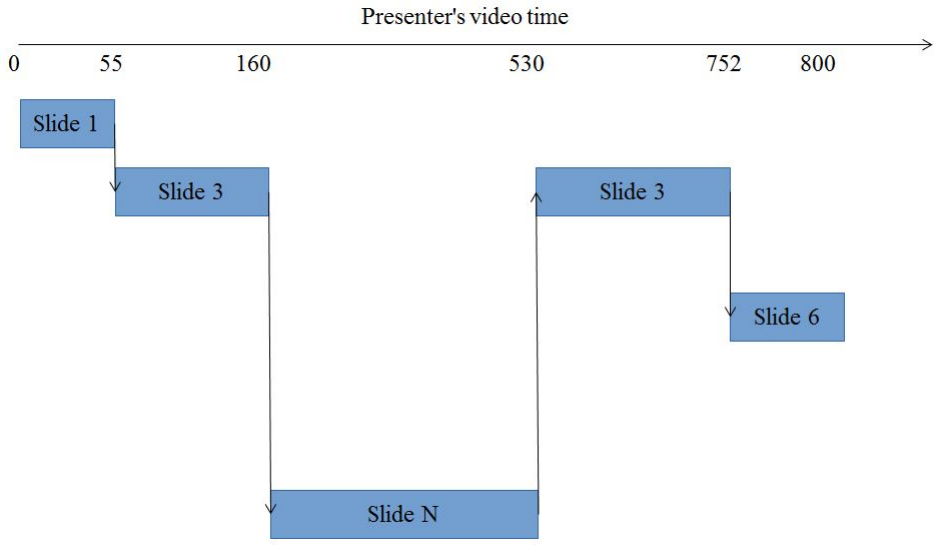


FIGURE 5.8: Slide duplication concept

$$pt = [timing]||[position] \tag{5.2}$$

where

pt - is the pointer index,

timing - is the recorded video clip timing in millisecond (ms),

position - is the mouse coordinate (X, Y) on Slide i at time T_i

At the server, it will update and save the cursor data for the slide i. The cursor data is saved in an independent file "Cursor file" and linked to the slides list metadata. Thus, the algorithm will go back to listen to the next user event input to process.This algorithm could be explained in step by step as shown in Figure 5.9.

- **Change streaming quality:**

The video in E-learning is a powerful way for any organization to meet it's learning objectives effectively and rapidly. In recording the lecturer stream, we considered both the size of the video recorded and the quality based on the lecturer

Input: Input Cursor event
Output: Cursor position, cr = [timing]|[position].
Step.1: Detect event type on client side.
Step.2: Check slide ID.
Step.3: Detect time when cursor is trigged ,[timing].
Step.4: Capture mouse coordinate *(x,y)*.
Step.5: If slide ID is new, then program will proceed to *Step.6* else it will move onto *step.7*.
Step.6: Create a new cursor position data for Slide I in the data structure cr = [timing]|[position].
Step.7: Duplicate the slide i with a new cursor position data in the metadata .
Step.8: If timer stopped, then program will proceed to *Step.9*, else it will go back to *Step.1*
Step.9: Save cursor position data for each slide and write it in the metadata file.

FIGURE 5.9: Step by step algorithm for inserting cursor process

bandwidth connection during the authoring process. To support both the presenter video streaming during the online presentation, and the streaming recording we developed the automatic streaming adaptation [**?**]. Thus, the system will calculate the presenter bandwidth every 5 seconds during recording the stream. The algorithm at the server will automatically adjust the quality of streaming under recording and update the audio-video bitrate of the output FLV file. The function of streaming adaptation works as follows:

$$bw = Fsize/Ttime \tag{5.3}$$

where

bw - is the bandwidth value

F_{size} - is the file size on bytes at the server that clients will download it when selecting the automatic streaming option to track their network speed,

T_{time} - is the total time needed to download the file from the server on seconds

Furthermore, in order to make the streaming broadcasting and recording of the lecturer more stable based on the bandwidth speed value, we decided to use the

TABLE 5.2: Streaming qualities for recording the lecturer stream

Streaming Parameters	**Streaming Qualities**		
	Low	Medium	High
Video resolution(pixels)	160x120	320x240	640x480
Video compression rate (%)	50	50	30
Video frame rate (fps)	5	5	5
Audio sampling rate (kHz)	8	8	8
Audio bitrate (kbps)	12.8	12.8	12.8

average bandwidth in making the streaming quality decision using the following equation:

$$AvgBW(Kbps) = \frac{\sum_{i=1}^{5} BW}{5} \tag{5.4}$$

Where, AvgBW is the average value of the bandwidth in 5 process time i.e., 5 times of 5 seconds operation which means the decision of quality selection will be done in an average time of 25 seconds to ensure stability of the streaming data.

Moreover, the presenter can select the streaming quality manually instead of automatic, by selecting whether audio only, low, medium, or high quality that are offered by the E-meeting system and the recording will be adjusted automatically based on the user quality selection. The qualities parameters supported by the system during recording are presented in Table 5.2.

Figure 5.10 shows the different among the streaming qualities designed for the automated authoring system. (a) is the low quality streaming which is designed to support students under the low speed Internet environment. (b) is the normal quality and (c) is the high quality streaming of the system. The automatic quality decision will automatically stream one of these three qualities or only audio based on the Internet speed during the lecture. This streaming adaptation process can be simplified in a couple of stpes as shown in Figure 5.11

These events are in a loop during the presentation period and processed in real-time by the server using the CG algorithm until the lecturer stop the authoring on the client side. Thus, the algorithm will finalize the presentation, call the program

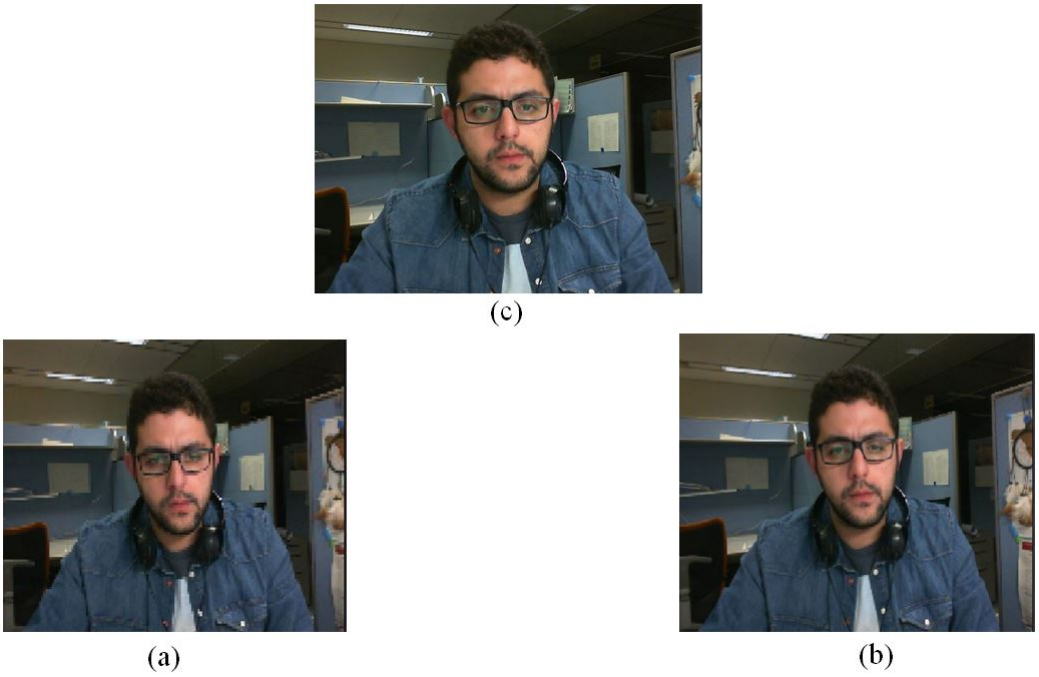


FIGURE 5.10: Streaming qualities on the automated authoring system

Input: Change Streaming Quality
Output: AV stream bitrate
Step.1: Detect event type on client side.
Step.2: Calculate lecturer bandwidth, BW.
Step.3: Generate average bandwidth value, AvgBW.
Step.4: Apply suitable streaming parameters based on the AvgBW value.
Step.5: Update AV stream bitrate and save as an FLV file at the

FIGURE 5.11: Step by step algorithm for streaming data adaptation

Add Slide Si to update the data of the last slide presented. Next, the server will run an archive script to compress the folder "lecture" that include all the data files to generate a learning package as CourseXX.ZIP, save it at the server and end the algorithm. The package can be exported and imported to the learning module at anytime and anywhere. The algorithm technique in authoring is different form others, since it does not exactly cut the video file but instead it use the time position marks. Thus, the system authoring becomes faster and reduce the work load on the server. Moreover, the output based on the marked time positions is easier to edit and manipulate.

5.8 Learning Content Data Structure

Fig 5.12 shows the created data structure of the learning package by the automated authoring system. As presented in subsection 5.5 the root of the data structure is the content ID which is connected to the rest of nodes that are also connected to their childes presenting a unit block of data. content_description contains general information of the course such as title, abstract, reference and author name. In slide_description each slide is an independent unit with five fields and a pointer to the next slide in the structure. Fields are the slide (image or video embedded), title, description, cursor data and the video timing data $T_{start} : T_{stop}$. For instance, During presentation lecturer jumped form Slide 1 to slide i in the list of slides, and then to slide N. We note that for slide N, it include only the video timing data which reveal that lecturer did not include any cursor data on that slide. These slides manipulations are captured in real-time by the CG algorithm during the presentation and data is written for each slides into the XML documents that manage the data structure. Hence, generates the output learning package data structure that can be edited or playback by any browser through the Internet. Data type includes slides image, video embedded, cursor and lecturer video which are the main data components of the learning package. These data are linked to the slide ID, data files and the streaming directory to be read. Therefore, the learning contents modules are all connected and stored in separated files instead of one file. It is considered to be the best method for managing the metadata files during authoring and playback operations.

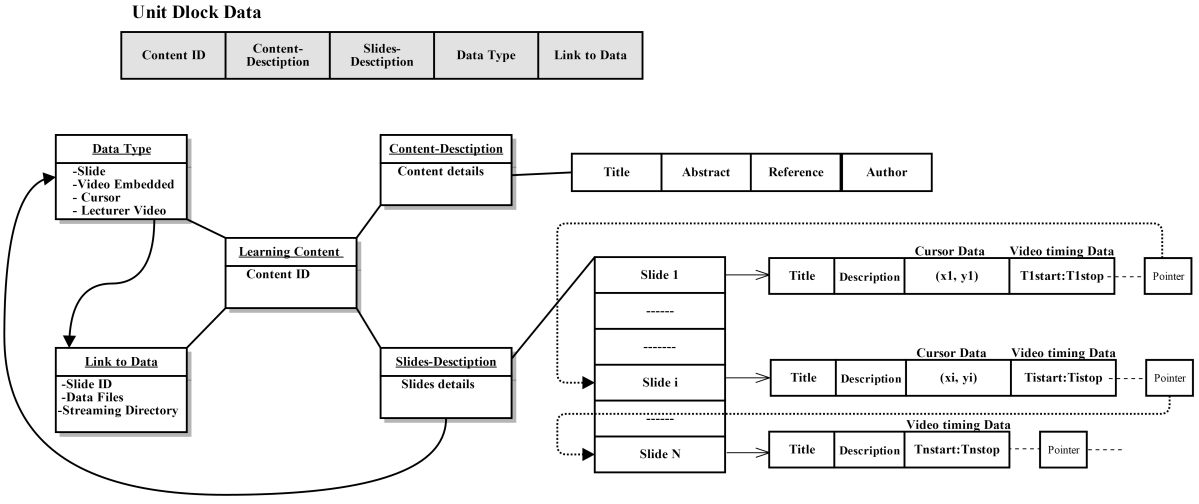


FIGURE 5.12: Created data structure by the automated authoring system

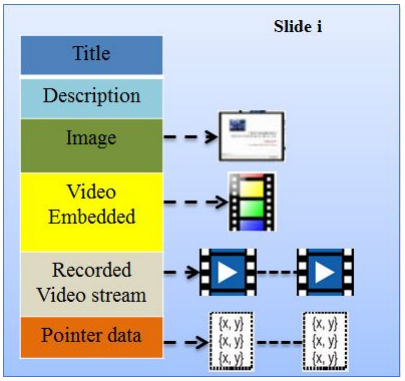


FIGURE 5.13: A practical example of a slide block unit.

Fig 5.13 shows an example of a slide i block unit. Slide i include information such as title, description, image file or Video embedded file, the video recorded timing data that can be multiplied in case the slide was duplicated and the same for the cursor pointer.

The three types of XML file used to save the recorded presentation data in the learning content package are as follows: content_description.xml , slides_description.xml, and pointer_data.xml.

- content_description.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<description>
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  Education
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   was established in 1988 as Japan s first independent
   graduate university without undergraduate courses
 </abstract>
 <author>
  Mohamed Osamnia
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5.9 Authoring Procedure of the Automated Authoring System

We summary the implementation section by reviewing the simple procedures of the automated authoring system in generating rich E-learning contents. Before the meeting presentation, the lecturer need to prepare their slides documents and upload to the system using the meeting editor interface. The interface allow to add slides details such as title, description which will be automatically added to the data structure of the learning content. Once the presentation starts, whether presenter or chairman can control the authoring to start the background processing. In the meeting system, we have four different type of users : lecturer (able to control the presentation slides), chairman (able to control the presentations order as in a conference), admin (control users device and management) and listeners (listen and engage in discussions). Therefore, we allowed two users to be able to control the authoring procedures i.e., lecturer and chairman. In case the lecturer is busy presenting his/her slides, then it is better to let the chairman take in charge the authoring controls (start, pause, resume, stop). Otherwise, in another scenario where the system will be used only by one user (lecturer) to create his/her learning contents, the lecturer can control since only one user is connected and no need for chairman role. During the presentation, the lecturer can freely change slides in any order, insert cursor or adjust their streaming quality. Once the presentation is finished, stopping the automated authoring system will generate a learning package at the server automatically and immediately. Lecturers can access to the meeting server to download their contents at anytime and anywhere. The content will be exported and imported to the learning module, where lecturer can still edit and apply some modification on the content before saving and publish it on the server to be viewed. These contents can be used as a reference of the lecture for those who could not attend it, or those who could not understand some specific points or for those who missed some parts of the presentation for example.

Chapter 6

Other Contribution to WebELS Meeting

The WebELS Meeting is a real-time multimedia communications systems designed to support online meeting functions working as a Software-as-a-Service (SaaS) cloud model. In implementing the SaaS model, the server has two modules for group-based user management, and virtual room and software management. The main purpose of WebELS Meeting is to provide real-time communications system to support higher education by means of information scale. The system can be used in a variety of real-time communications such as (1) online meeting for multipoint voice and video conferencing system with shared multimedia slide presentation among group member and guest users, (2) online conference for real-time distribution of academic conference with user privileges for presenter, chairman and admin, and (3) online lecture for real-time broadcasting of presenter video and multimedia slide presentation to listeners. However, several issues were discussed and considered to make the system more suitable to use for areas where Internet speed is low such as in developing countries. Moreover, the slide presentation document type shared in the meeting was not enough for some professors and needed to support more types. For instance, some professors in the engineering field wished to use a video document type to share among the connected users during the presentation for further and better explanations and also the use of image types that can be uploaded on the fly or during post-editing of the presentation content.

6.1 Automatic Streaming Adaptation

VIDEO traffic will account for more than 90% of the global Internet traffic in 2014 according to a recent report published by Cisco [123]. Such a tremendous growth is fed by video streaming applications such as YouTube, which delivers user generated video content, or NetFlix, which streams movies and already accounts for more than 20% of the US Internet traffic. Another ongoing trend that is feeding this growth is the ever-increasing number of smartphones and tablet devices accessing the Internet by using 3G/4G wireless mobile connections [123]. Today, the content producer has to undertake the challenging task of providing the user with a seamless multimedia experience at the maximum obtainable quality of experience (QoE) given the user device heterogeneity. To this purpose, multimedia content is required to be adaptive in order to match a wide set of variables such as user screen resolution, CPU load, network available bandwidth, and power consumption [124].

However, in the existent E-meeting systems it is mostly an ignored feature though its importance in supporting the users demand for flexible communication and collaboration through the Internet. This function was extremely needed on the E-meeting system especially based on our meeting trials with different countries where Internet speed is still under development. In those trials, users sometimes did not know which quality is needed to use to share their audio/video streaming and by mistake choose high quality which require higher Internet than their network speed. Thus, we noticed many frozen on the stream and sometimes disconnection of users what disturb the meeting discussion.

Therefore, we designed a new function on the E-meeting system to support the above issues and provide a world wide tele-communication system, especially for developing countries compared to what exist in the market now. Thus, the function can detect the bandwidth speed of the connected users in real-time and automatically once it is selected. On the client side we defined the approximate bandwidth required for each streaming quality i.e., audio only, low quality, medium quality and high quality. Hence, the client application will decide what streaming quality is needed based on the bandwidth speed calculated and send a request to the server to adjust the streaming quality for the selected user.

6.1.1 Function Design and Implementation

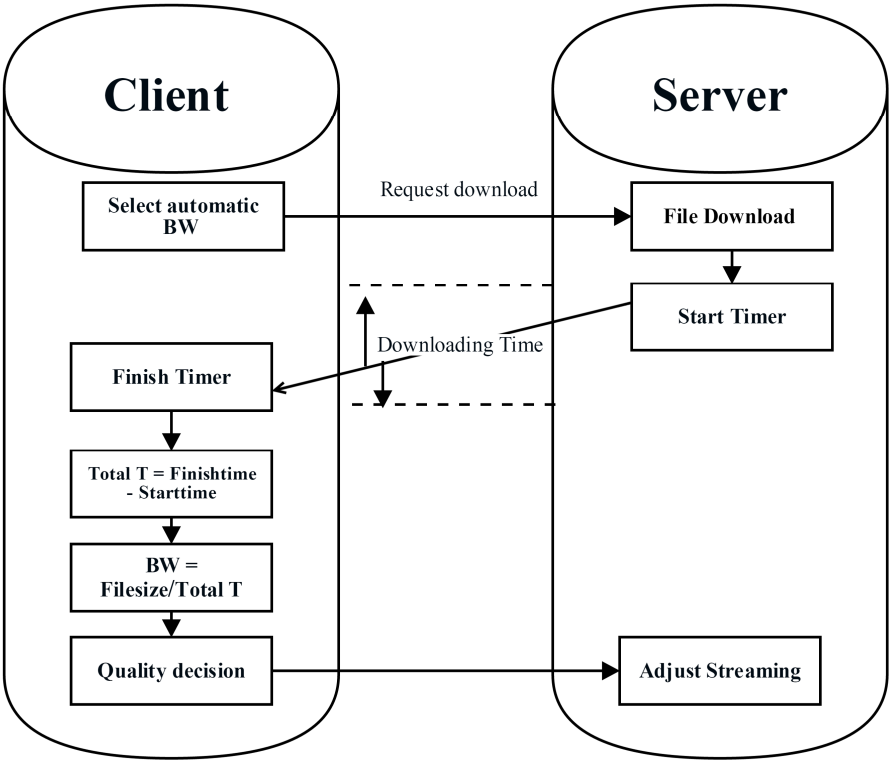


FIGURE 6.1: Automatic bandwidth detection methodology

In computer networks, a bandwidth is often used as a synonym for data transfer rate, the amount of data that can be carried from one point to another in a given time period [125]. To achieve the concept, we developed the test cycle to calculate the network bandwidth during the online E-meeting activity. This function is utilized for keeping the stability of meetings in the unstable network environment. Figure 6.1 shows the methodology of the function development. On the client side, once the user select the automatic streaming function it will enable the system to take in charge the user streaming quality adjustment. The function will send a request to download a small size file saved on the server side. This file is for goal to track the time needed by client to download it from the server. Thus once it is downloaded on the client application, we can calculate the total time needed as $Total_{time} = Finish_{time} - Start_{time}$. Once we get the total time needed to download the file from the server to the client, then we can calculate the user bandwidth speed as follows:

$$BW = Filesize/TotalT \tag{6.1}$$

where

BW - is the bandwidth value

$File_{size}$ - is the file size on bytes at the server that clients will download it when selecting the automatic streaming option to track their network speed,

$Total_T$ - is the total time needed to download the file from the server on seconds

Furthermore, in order to make the streaming broadcasting and recording of the lecturer more stable based on the bandwidth speed value, we decided to use the average bandwidth in making the streaming quality decision using the following equation:

$$AvgBW(Kbps) = \frac{\sum_{i=1}^{5} BW}{5} \tag{6.2}$$

Where, AvgBW is the average value of the bandwidth in 5 process time i.e., 5 times of 5 seconds operation which means the decision of quality selection will be done in an average time of 25 seconds to ensure stability of the streaming data. Once the quality is decided based on the BW value, the client send a request to the server to adjust the streaming parameters.

6.1.2 Streaming Quality Decision

Using the automatic streaming function will enable the system to measure and calculate the users bandwidth speed as shown in the previous section. Once the BW value is calculated then , the application on the client side will follow the theory-based decision shown in Figure 6.2 to decide what quality to be used. Based on the decision flowchart, if $BW < 50Kbps$ then the system will be able only to support the audio stream and camera will be automatically turned off. Thus, the user can still be able to attend the meeting and engage in the discussion even without using video data, since audio is more important in this case. If

$50 =< BW < 100Kbps$, the system will stream the low quality. Moreover, if $100 =< BW < 20Kbps$ the system can support to stream normal quality for the user. Otherwise, if the user Internet speed is more than 200 Kbps $BW > 200Kbps$ then the high quality will be selected for streaming.

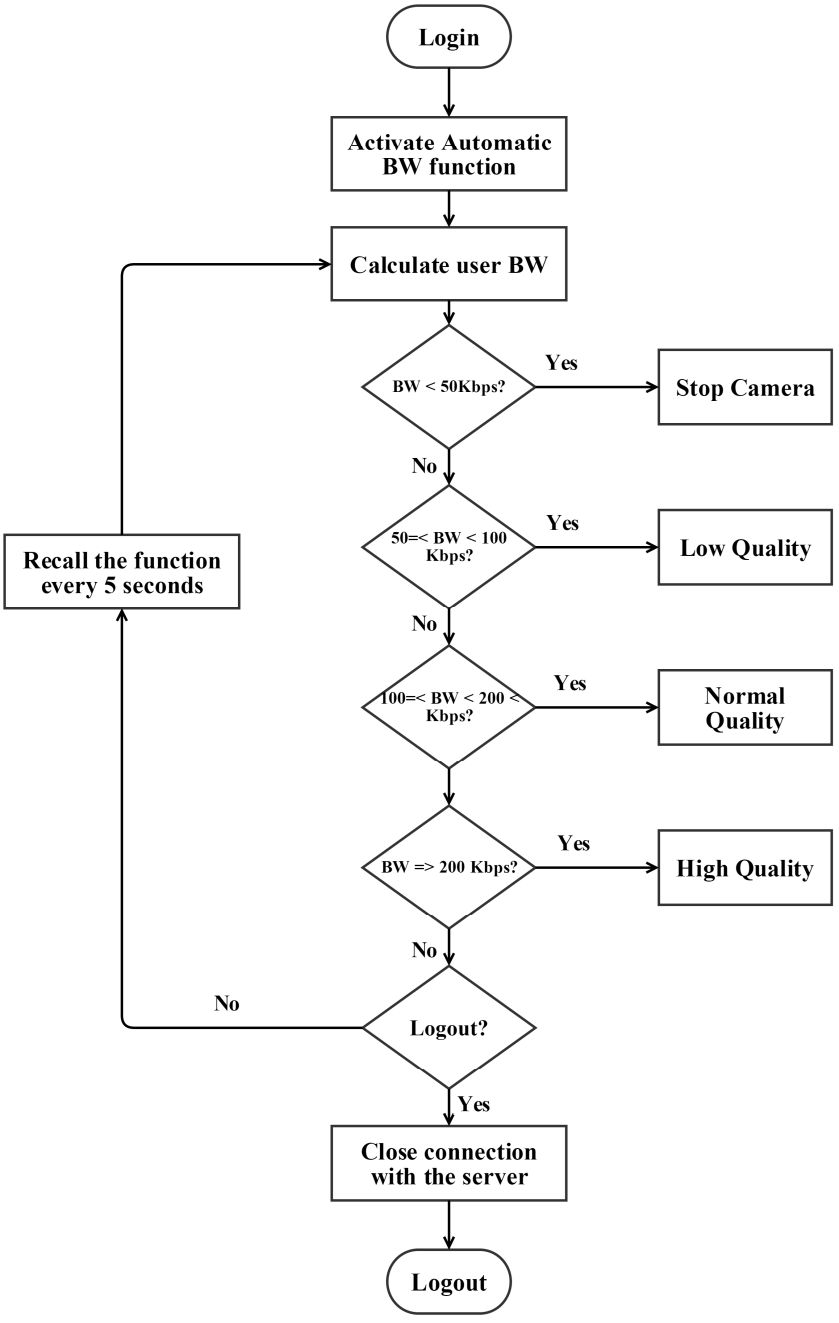


FIGURE 6.2: Streaming quality decision flowchart

6.2 Video Embedded Synchronization

Generally, the E-meeting systems that support the on-line presentations use PDF or PPT formats as the standard documents for the on-line presentations such as BBB [104], OpenMeeting [105], Polycom [126]. In case of the postgraduate students, in some specific field of studies such us robotics, engineering, etc. the above document types might be not enough. Thus, we proposed the video clip format, which is very important for enabling a rich distance discussion. We developed a new and feature in the E-meeting module to make the system support on-line video clip presentations and more documents type to be used for the on-line presentation. It is possible to upload a variety of video clips format such as (mov, avi, wmv, mpg, ogg, mp4, flv) or Image files. At the server side, all the video clips will be converted to FLV format, and image files will be whether saved or converted to the proper format to be used based on their type. We also defined the conversion parameters to an acceptable rate to support the low-speed Internet environments.

6.2.1 Flash-based Document Uploading for Online Presentation

To create a virtual classroom, it is necessary to create a content by uploading various types of documents. Users just need to create their own presentation document using their personal computers, and upload the presentation document to the WebELS Meeting server. This process require only opening a browser and connect to the Internet, without the need of any special software. WebELS meeting content authoring is made by using the flash-based multimedia content editor in Figure 6.3.

The first step is shown in Figure 6.3 (a), the user have to fill in the title of the content and if needed insert a password to protect the content for privacy. Then, browse to upload the document that can be PDF, presentation (odp, sx, ppt, pptx), document (odt, sxw, doc, docx), or only image file (png, jpg, tiff, bmp). Since WebELS Meeting was designed to support low-speed Internet, the user can select the output of conversion of the selected document. We developed three conversion outputs to support different bandwidth environments, such as PNG (low quality image, for Internet speed of 100Kbps and below), JPG (medium quality image, for Internet speed between 100Kbps and 1Mbps) and SVG (High quality

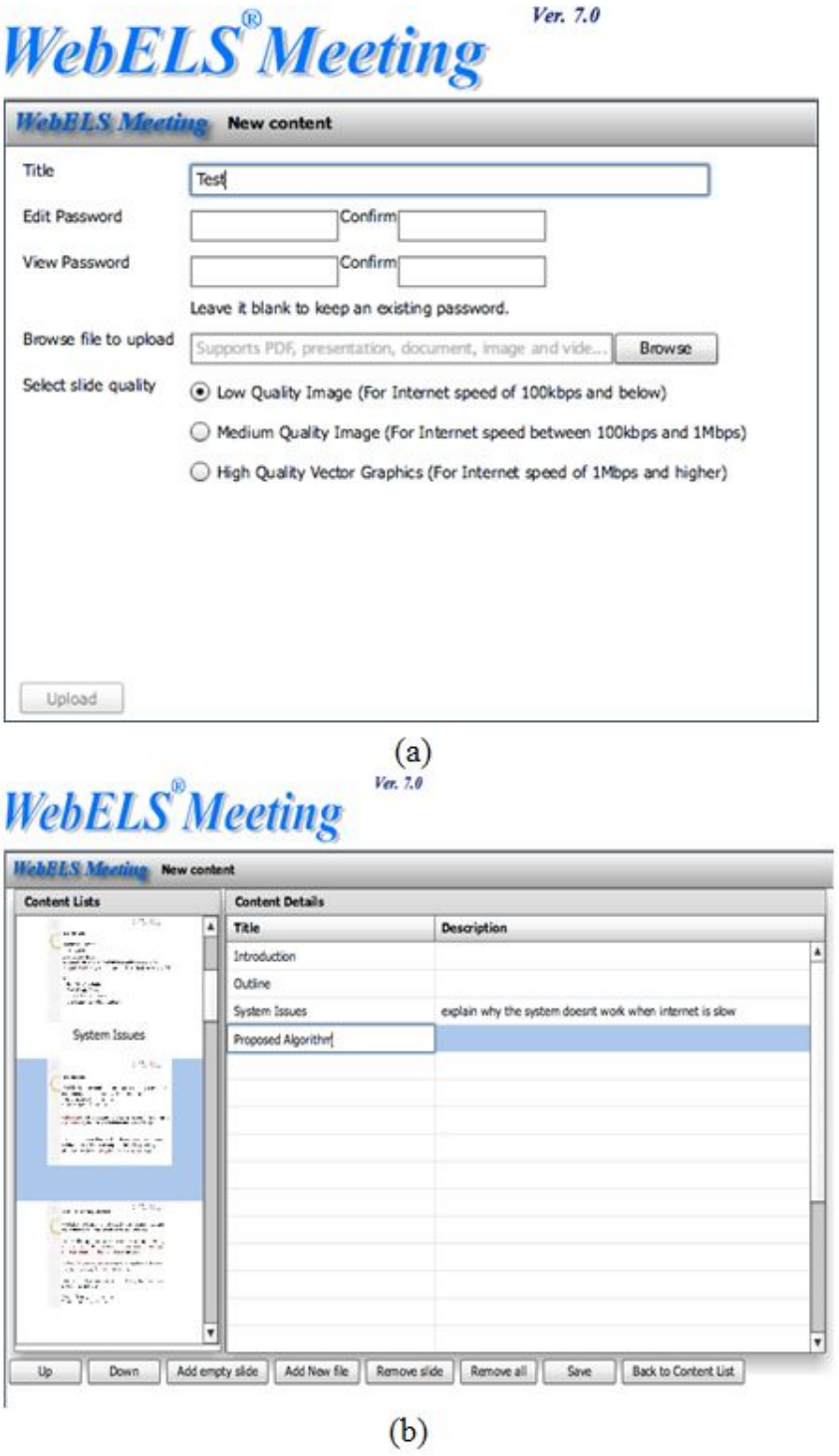


FIGURE 6.3: Uploading process

vector graphics, for Internet speed of 1Mbps and higher). At the server-side, the program will choose the proper conversion tools (e.g, Ghostscript application for PDF, presentation, and document, PDF2SVG for SVG format, etc.). The conversion process is based on specific parameters of conversion according to the user

output selection. Flexibility of XML-based storage allows the uploaded document materials to be delivered in many different ways.

The second step is when the conversion process is done at the server side, another interface of the content authoring will be downloaded from the server to the user machine. Figure 6.3 (b) shows, the interface containing the slide images and videos converted at the server side. The user can edit the slides, images by inserting a title or description for each slide. Furthermore, the user can change the order of slides up or down, and also can add empty slides, or remove slides which are important features to edit the multimedia content. In case a user would like to insert another document file (image, video, PDF, etc.) within the content creation process, it is possible to do it without going back to the first interface of authoring. This interface was enriched by "Add File" function that can enable browsing any file in the users computer. Thus, it will upload a document and execute the conversion process at the server side. The uploaded document will be downloaded to the user machine, in order to create the final multimedia content which contains all the types of uploaded documents. Once the content is created, a virtual room at the server side is automatically generated, where the participants simultaneously via the Internet in the same place, convene and discuss the same content.

Moreover, these data will be included into the template of the learning package on the server side. The template will be generated for each new content created include the initial information inserted by presenter and will be added to the learning content package details in case the lecturer wish to capture the presentation for later reviewing by student.

6.2.2 Function Design and Implementation

The new feature in the Flash-based E-meeting system, enable uploading any type of video clips to be used for on-line presentation. In order to develop that, both client and server sides were modified to respond to the new feature characteristics.

At the server side, we enlarged the uploading file variety to support the video files, we generated a new function that converts all type of video clips to FLV formats with a specific parameters to support the playback in the low-speed Internet environment. Each video converted in the server side will be stored in the

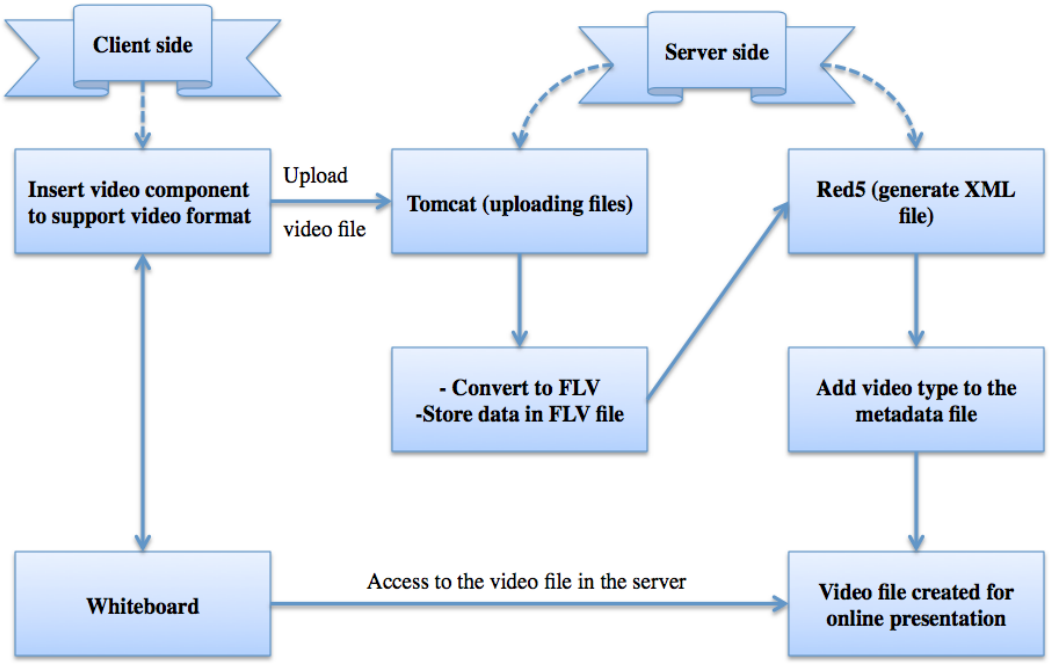


FIGURE 6.4: Uploading of video embedded process into the E-meeting system

FLV directory, which is linked to the streams file in the Red 5 server to enable the streaming playback. The server side will detect the type of the new file uploaded which is video, and generate XML file for the on-line presentation content. To enable the client application to play the video clip stored in the server side, we added the video component to the whiteboard of the WebELS Meeting system. The whiteboard will switched from image component to video component based on the file type in the XML file at the server side. If the next slide is video type, the video component will be displayed to playback the video embedded stored at the server side. This process is shown in Figure 6.4.

6.2.3 Synchronization and Annotation

Once the on-line presentation content is created, a virtual room is automatically generated where participants convene via Internet in the same place, the same time, discussing the same content. The presenter who has the control on the slides, he/she can also control the playback of the video embedded. The video embedded was implemented not only for live streaming from the server for one user, instead the presenter can use the play/pause control on the video which will be synchronized among the other participants In the same virtual room. Since WebELS Meeting based on client-server architecture, any event in the client side

is shared among the other participants through the server including the play/pause of the video embedded. Figure 6.5 shows an example of an on-line presentation using video embedded for discussion in the Flash-based E-meeting system, on the WebELS platform. With a simple button command, the presenter can play/pause the video embedded to be synchronized among the other users. Furthermore, the presenter can use the annotation and zooming features to enrich the discussion. Writing comments on the video embedded or zooming don't influence the playback of the video clip. The new feature was developed to be suitable to work under low-speed Internet, therefore the video embedded synchronization, annotation, and zooming are all transferred from presenter to the other users through the server in real-time smoothly.

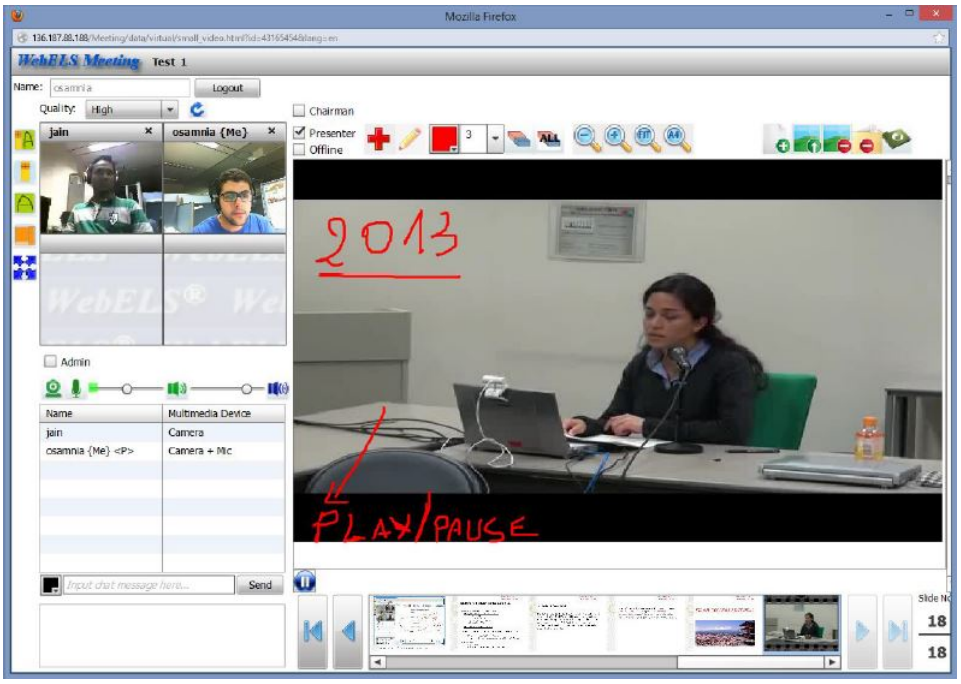


FIGURE 6.5: Example of using video embedded for online presentation

6.3 Conclusion

The contribution brought to the WebELS Meeting in developing both functions i.e., automatic streaming decision and video embedded synchronization improved the quality of the online presentation through the WebELS Meeting system. For unstable network speed users such as in developing countries, the system could automatically handle their streaming during the meeting to keep its stability. Moreover, enriching the documents types format to be used for discussion through the

Internet was very helpful for users in different fields to benefits from a strong authoring tool to create their presentation materials that can be shared online with other connected users using the WebELS Meeting platform.

Chapter 7

Experimental Evaluation and Results

7.1 System Evaluation and Discussion

In this section, we present the system evaluation in term of authoring performance and system practical application. For authoring performance, we evaluated the usage of bandwidth Internet and CPU the client (lecturer) while using the system in an online lecture by 1 to 4 connected users. This is for purpose to evaluate the computational performance of the proposed system in the automated real-time environments. The CPU usage as well as the Internet consumption are two major factors that might enable or disable many users from adopting an E-learning technology. Moreover, to stress more on the advantage of our novel automated authoring system compared to the existing technologies, we have designed a comparative study. The comparison is based on several indicators of content development among several famous existing technologies. The comparison table shows the differences between our approach and the related studies and a clarification description is added to each indicator. Then we presented a practical use of the proposed system in an official seminar to prove its functionality and usefulness in local and international seminars and lectures.

7.1.1 Authoring Performance

We prepared a server machine and installed the proposed system onto that server for the evaluation. The server is driven by Linux operating system on the Virtual Machine server with Intel Xeon Dual-Core @2.33 GHz CPU and 4 GB of RAM. The evaluation scenario is to capture and track the lecturer bandwidth requirement and CPU usage during activating the system on the online lecture. To do so, we have used the resource monitor on Windows to track both the bandwidth and CPU used by a specific process on the machine. Thus, we evaluated the system while being used only by the lecturer to create the learning content, then 2 connected users, 3 and 4 online users. The lecturer environment is a desktop PC working on Windows 8.1, i5-3450 CPU @ 3.10GHz, 64-bit, connected to the Internet through Mozilla Firefox browser version 37.0.1 and an HD webcamera to support the audio/video streaming. As discussed above (Section 5.7) the system supports different streaming qualities during authoring that can be handled automatically or manually. Thus, we have tested both the bandwidth and CPU usage of lecturer using 4 different quality settings i.e., audio only, low quality, medium quality and high quality. Results are shown in Fig **??** and Fig 7.2.

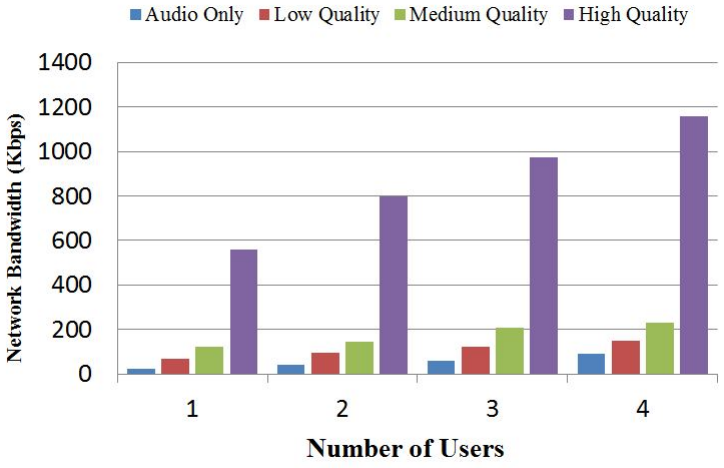


FIGURE 7.1: Average bandwidth consumption by the lecturer while using the automated authoring placed on an online lecture system in different scenarios

Bandwidth utilization depends on the data size transmitted over a period of time between the client and the server. Based on the data in Fig 7.1 the bandwidth requirement for using the automated authoring system depends on the number of users and the streaming quality selected. If the lecturer use only the audio to explain his/her presentation and activating the automated authoring

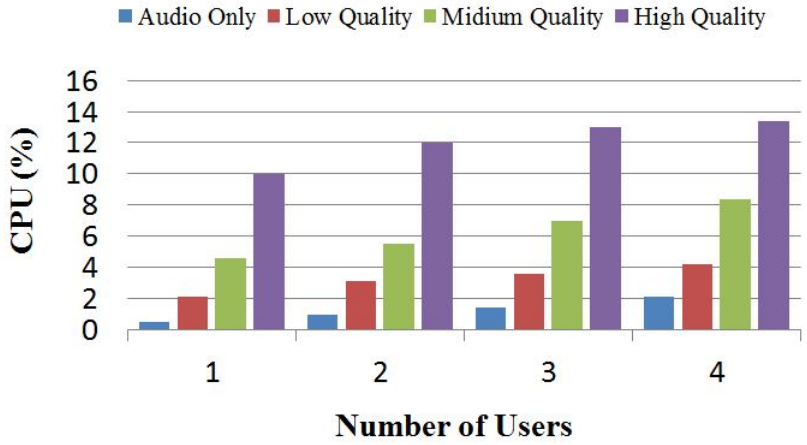


FIGURE 7.2: Average CPU usage by the lecturer during using the automated authoring placed on an online lecture system in different scenarios

system, the bandwidth required is very small since it needs only around 24 kbps for one user (lecturer) and 92.8 kbps for 4 users connected in real-time using only their audio. Using a low quality streaming requires a bandwidth of 68 kbps for one user and around 148 kbps in the case of 4 users are connected in an online meeting sharing their audio and video through a low quality. Medium quality bandwidth requirement is around 120 kbps for one connected user and 232 kbps for 4 connected users in the E-meeting sharing the same presentation while the background processing is generating the learning content. For high quality it consume more bandwidth eventually to use, around 560 kbps for one user and around 1.16 Mbps is needed to support 4 connected users sharing a high audio-video quality and capturing the presentation at the same time. Moreover, due to the video-codec algorithm, video stream bandwidth fluctuates, i.e., gets higher when the image is in motion and gets lower when it is almost steady. The obtained results shows that the proposed system require less bandwidth speed even when using high quality compared with the BBB system [104] since their capturing is based on screensharing which require higher speed of Internet. These qualities can be selected automatically by the system based on the lecturer Internet speed while recording, since by selecting a conservative video quality for distribution, number of concurrent users can be increased largely in broadcast mode.

Fig 7.2 shows, the CPU usage on the lecturer PC while using the system in different environment. This evaluation scenario is similar to the one of tracking the bandwidth speed. The CPU usage data shows the system does not effect the user machine performance during the online presentation and the automated

authoring system is activated. Even using high quality streaming by 4 connected users and suing the background authoring process, we found that the CPU usage on the lecturer PC was about 13.5%. This evaluation study showed also that bandwidth and CPU requirement increased when using the automated authoring system comparing to when using the E-meeting in only broadcasting a lecture [2]. However, there was no significant side effect on the meeting system performance on both client and server when the proposed system is activated.

The automated authoring system was developed to provide a world wide solution for the content development issues especially in developing countries. Therefore, we carefully designed it to be able to work in different bandwidth environments, easy-to-use for non-IT users, reduce file size, eliminate third part software installation, provide a cloud service solution and to create rich E-learning courses to support the globalization of education.

7.1.2 Comparative Study

In this section, we have performed a comparative study between our proposed system and other related systems to stress the advantages and disadvantages of our research. In the experiment scenario we tested three different systems i.e., Camtasia, BBB (BigBlueButton) and OpenMeetings. During the experiment, we have used a chronometer to calculate the time requirement to create an e-content using the three systems. Moreover, we have compared different features related to automatic E-learning content development based on several indicators among the systems in the study. Furthermore, we included another interesting research on content development named the SG (Slide Generation) approach proposed by Hirzallah, in the comparative study. Table 7.1 shows the indicators used for this study and the results obtained. Those indicators were proposed at first by Peter Ziewer [127], who extracted and merged various aspects of existing catalogues in previous rsearch of Lauer and Ottmann [128] and Meterns and Rolf [129] to a final catalogue of several items. In addition, the author of this thesis has generated new indicators which are essential in designing an automated authoring system [130]. Those indicators does not claim to be complete and suitable for all kinds of evaluation, but reveals the most important aspects of the content automations systems.

	Indicator	Sub-indicator	Proposed system	Camtasia	SG approach	BBB/OpenMeetings
I 1	Live video		✓	✗	✗	✓
I 2	Time to create the content		32 min	50 min	Max length 20 min	1 hour
I 3	System type (cost)		Open Source	Proprietary	Open Source	Open Source
I 4	Metadata		✓	✗	✗	✗
I 5	Captured data	Lecture Video	✓	✓	✓	✓
		JPEG Slide	✓	✓	✓	✓
		SVG slide	✓	✗	✗	✗
		Cursor positioning	✓	✗	✓	✓
		Annotation	✗	✓	✓	✓
I 6	Capturing technique	Slide-video synchronization	✓	✗	✗	✗
		Screensharing	✗	✓	✓	✓
I 7	Bandwidth management	Min BW (4 online users)	232 Kbps	Offline	Offline	1 Mbps
		Automatic streaming adaptation	✓	✗	✗	✗
I 8	Computing resource	General Case	Low	High	High	High
		Example of 1 user	4.2%	25%	30%	15%
I 9	Post-processing	Insert new slide	✓	✗	✗	✗
		Remove slide	✓	✗	✗	✗
		Reposition slide	✓	✗	✗	✗
		Record new video for specific slide	✓	✗	✗	✗
		Remove video from specific slide	✓	✗	✗	✗
I 10	Educational platform	Content privacy access	✓	✗	✓	✗
		Group based learning	✓	✗	✓	✗
		Meeting and Learning combination	✓	✗	✗	✗

TABLE 7.1: Comparative study with related systems for automatic course creation based on several indicators

Indicator 1: Live video The live video indicator stands for the live broadcast of the lecture. Our proposed system along with the BigBlueButton and OpenMeetings supports the online lecturing while the other systems work in offline mode i.e., Camtasia and SG approach. Thus, people can attend and learn the lecture materials live while the system generates e-content for later reviewing.

Indicator 2: Time to create the content In our experiment scenario, we have used Camtasia, BBB and OpenMeetings to capture a lecture of 30 min length. While the SG approach can only generates courses with a maximum of 20 min length. As shown in table 3, the time consumed to generate an e-content using our proposed system was about 32 min. It is almost the same time of the lecture, including a short time for exporting the content to the learning module. Our proposed system is by all mean fast in generating E-learning contents since the whole process is automatic using the CG algorithm. However, the lectures captured using both BBB and OpenMeethings required about 1hour to be generated. The extra time was due to the complex content data processing after the lecture recording was finished.

Indicator 3: System type (Cost) The cost in developing e-content is by far one of the most challenging issues in E-learning, especially in developing countries [14]. Thus, in our research we focused on developing an advanced open source type

automated authoring system to enhance the content development process world widely. In our comparative study the SG approach, BBB and OpenMeetings are existing works that comes close to our approach and also are open source platforms. However, there are several other authoring tools for developing e-contents which we could not use due to their cost requirements. The Camtasia application, we could install it on our machine for testing as a free version for 30 days, since it is not free and requires specific cost to be used.

Indicator 4: Metadata The CG (Course Generation) algorithm in our proposed system generates Metadata that save and manipulate the e-content details. As presented in the implementation chapter, the slide details, video data, cursor data, and slide-video synchronization data are written in different Metadata files. This technique allows our system to generate the e-content faster and make it flexible to be edited/modified [130]. In the other systems presented in our comparative study table does not support such a feature, but instead the content output they generates is video format file.

Indicator 5: Captured data Video data now is one of the most important elements in E-learning courses, thus most tools and systems are supporting the video streaming. Our novel automated authoring tool along with the other related systems in the comparative study, record the lecturer video stream through a webcamera or a video camera device. The proposed system support both JPEG and SVG format for slides data and record the cursor positioning during the lecture. Since the related systems are based on screensharing technology, they could support the annotation feature where lecturer could write some data and information on the slides [3]. We are planning to include this feature to our system in the near future.

Indicator 6: Capturing technique The e-content generation method developed in our proposed system set it different from the other related systems. Our approach novelty is the automatic slide-video synchronization using the CG algorithm. The authoring technique is different from others, since it does not exactly cut the video file, but uses the time position marks instead. Thus, the authoring system becomes faster and reduces the server workload. The CG algorithm generates a precise synchronization data between the lecturer video stream and the slides data presented in the lecture using some criterion such as changing time, duplication. On the other side, most of the existing systems are based on

the screensharing technology to capture the meeting or to create courses on local machines.

Indicator 7: Bandwidth management Developing authoring tools should take in consideration the users in low bandwidth environment to be used widely. Based on the system evaluation, our proposed system can support an online meeting of 4 users sharing a medium streaming quality while the background processing generates an e-content using a minimum bandwidth of 232 Kbps. While in other systems like BBB and OpenMeetings it requires up to 1 Mbps of bandwidth, this is simply due to their capturing technique that consumes a high bandwidth. The Camtasia system and the SG approach works on the local machine of users which does not involve the bandwidth consumption.

Indicator 8: Computing resource Based on our system evaluation related to CPU consumption, we noticed that when using a medium quality streaming by one user and using the background authoring process, the CPU usage on the lecturer PC was about 4.2%. This can be explained to the fact that our proposed system processing takes place on the server side, leaving the computer less taxed. However, the other related systems using the screensharing technique requires more computational resources since it worked on the users local machine and it was about 15% for only one connected user, which means the CPU resources can be largely increased when the number of connected users sharing streaming data increase. Regarding the Camtasia and SG approach, thy work on the users machine in an offline mode and require high CPU usage, like we have consumed about 25% while testing the Camtasia on our machine. The SG approach research paper described that one of its disadvantage is the requirements of high performance computer for a smooth processing.

Indicator 9: Post-processing The post-editing and processing is a major concern for developing E-learning automation tools [129]. This indicator gives a large advantage to our proposed system compared to the existing ones for automatic e-content development. As mentioned above, the capturing technique and metadata developed for the system allow it to generate editable e-contents. Once the system creates the E-learning content from the online lecture as a background processing, the lecturer/instructor can still have the possibility to modify their course materials. For instance, lecturers could add/remove specific slides or reposition it, remove a video or record a new video data for a specific slide and other advanced features. Nonetheless, to do any of these features on a created e-content

using the other related systems requires the instructors to recreate the content from the beginning. Thus, the process could be time consuming and complicated. Therefore,

Indicator 10: Educational platform The novel automated authoring system was developed within the WebELS (Web-based E-learning System) platform. The platform is originally designed to support higher education especially in Ph.D program, integrating two modules Learning and Meeting as an all-in-one system. Thus, the proposed system is a part of an educational platform, where instructors can control their students group, have more content access privacy. Moreover, the automated authoring system merges and combines both Learning and Meeting modules proving advance features to support higher education activities. BBB and OpenMeetings and other similar systems are dedicated only as a meeting solution, thus there is no content access privacy or group based learning features on their generated E-learning courses. We can say here that our proposed system is breakthrough solution to solve the hard barriers in developing E-learning contents combing Meeting and Learning activities at once.

7.1.3 Practical Usage Example

Our main experience was gained during the production of a series of online lectures on a variety of topics in the e-Communication Consortium seminar (eCC) [131]. The eCC is a monthly seminar where several professors from different universities in Japan discuss a variety of subjects related to science and technology. After several uses of the proposed system in testing and lectures in the eCC seminar, we selected one lecture for this study. A Professor of Sophia University (Tokyo, Japan) gave a lecture about the technology trends in the electronic textbook. The lecturer used a notebook PC includes a webcamera to use the course generation system for creating an e-content based on his lecture. The lecturer used a medium quality of streaming defined in Table 2 to broadcast his stream with the online users. The content was based on a 45 slides presentation document and a lecture of 90 min length. Fig 7.3 shows the eCC seminar lecture that was hold at the National Institute of Informatics for the case study. Fig 7.4 shows the e-content created using the proposed system by the end of the presentation successfully.

The time consumed by the proposed system to create the e-content was almost the same time needed for the lecture. The synchronization data in our

proposed algorithm is managed by the server in an automatic mode and create an exact and precise synchronization between slide, cursor and video. During the lecture, the professor needed to go back to some previous slides to represent it, this was manipulated by duplicating the slide as shown in the data structure section. Furthermore, the use of the system by the lecturer required only a browser connected to the Internet without the need for software or hardware installation. The e-content file size generated by our system was about 180 MB which allow users to save more storage space in the server. After the seminar, we got positive feedback from the Professor who gave the lecture as well as the attended Professors. We demonstrated the e-content created by the system once the Professor finished his lecture. The Professor mentioned that, this system could help him to create more E-learning contents easily and in a shorter time. A Professor from Tokyo University was impressed by the simplicity of the system in creating the e-contents comparing it with the process to develop contents on the MOOC platform, which requires a special team unit to create and edit the contents beside the high cost to use it [132]. Online users who attended the lecture from different locations reported that they could follow the presentation smoothly, and accessing to the e-contents after the seminar helped them to better understand the lecture materials.

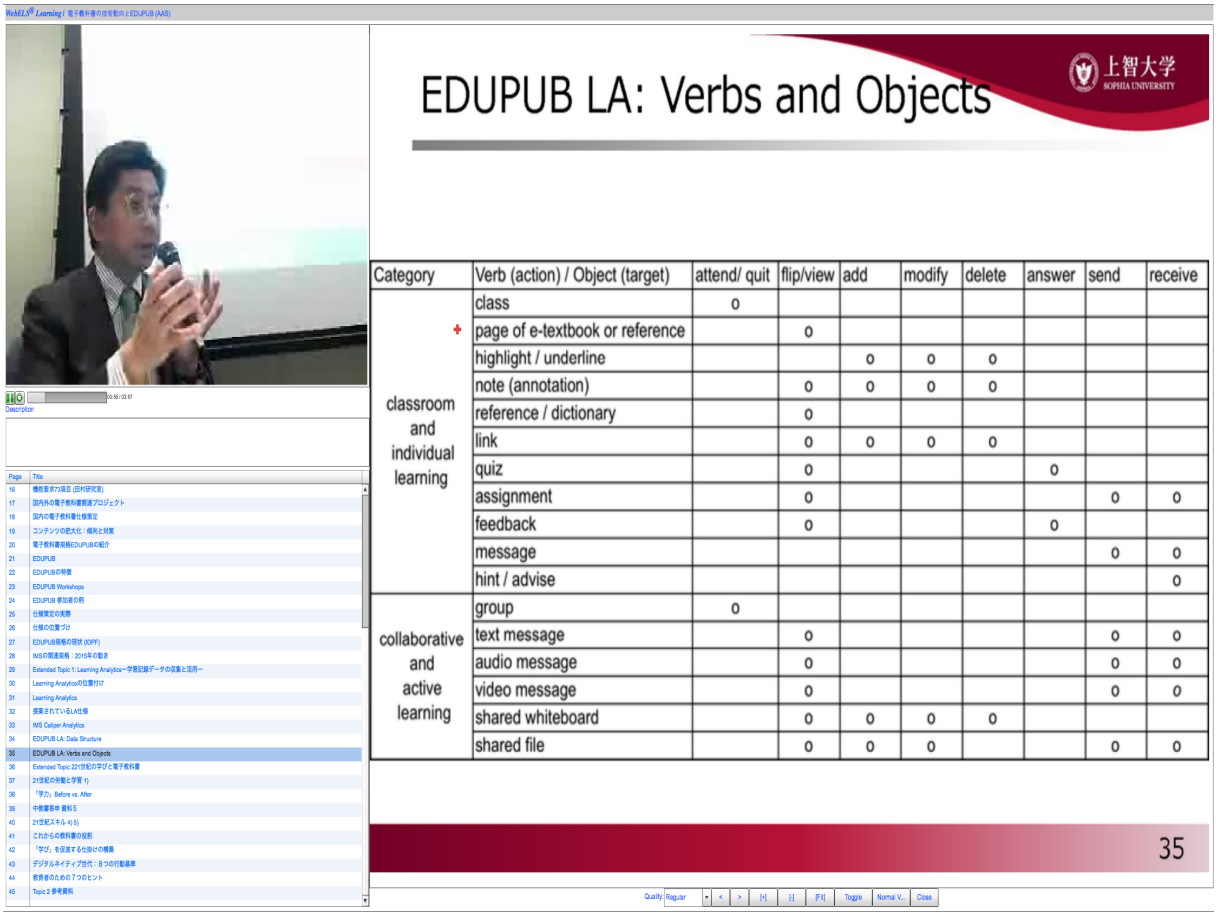
Moreover, the system has been used in some international collaboration presentations between Japan, Thailand, China and Algeria under the collaboration of the SSB project [133]. These presentations were captured using our proposed system to evaluate it performance in countries where the Internet infrastructure is not yet developed and the results of the system were successful in creating several E-learning contents to support the international cooperation for sustainable development.

7.1.4 International Collaboration

The Sahara Solar Breeder (SSB) Project under the program of SATREPS jointly administered by Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA) is a bold undertaking with promising goal to provide half of the world's electricity by 2050 [133]. The project is jointly implemented by Japanese and Algerian universities to use the abundant solar energy and sand in the Sahara desert to build silicon manufacturing plants and solar

FIGURE 7.3: The eCC seminar lecture used for the practical usage at the National Institute of Informatics live online lecture and (b) e-content created by the system at the end of the lecture

power plants, to deliver the generated power to distant locations using superconductors. To uphold this international cooperation for sustainable development of new energy engineering, education and research exchange programs were established and adopting the WebELS platform for distance education. Due to the fact that Japan and Algeria are separated geographically as well as there is an eight hour time difference between the two countries, the distance education and collaboration are essential for successful implementation of this project. Through the project, one WebELS server was installed at the University of Science and Technology in Oran (USTO) and one at the University of Saida. The open online lectures between Japan and Algeria using our lecturing platform were an important factor supporting the international collaboration between the two countries, being an effective tool for exchanging scientific ideas and transferring knowledge between the researchers. The version of the platform, initially used in this project supported only online live presentations. Some students were unable to understand specific discussion points, while some others couldn't attend the lecture due to personal reasons. Also, because of the time difference between the locations and the lack of Internet access for students in Algeria, several students missed the



Category	Verb (action) / Object (target)	attend/ quit	flip/view	add	modify	delete	answer	send	receive
classroom and individual learning	class	o							
	page of e-textbook or reference		o						
	highlight / underline			o	o	o			
	note (annotation)		o	o	o	o			
	reference / dictionary		o						
	link		o	o	o	o			
	quiz		o				o		
	assignment		o					o	o
	feedback		o				o		
	message							o	o
	hint / advise								o
collaborative and active learning	group	o							
	text message		o					o	o
	audio message		o					o	o
	video message		o					o	o
	shared whiteboard		o	o	o	o			
	shared file		o	o	o			o	o

FIGURE 7.4: The e-content created by the automated authopring system by the end of the eCC seminar lecture

chance to attend open lectures by Japanese professors. To mitigate these issues we developed the automated course generation functionality from the live broadcast. This gave the Algerian students a possibility to access the e-contents of the Japanese professors created by the system in a more flexible way i.e., to review the lectures whenever they are able to do it. On the other side, the professors gained a possibility to save their time by reusing the previously created e-contents as reference materials for their lectures. Hence, the motivation of our research in developing the proposed system focuses on both supporting the international cooperation for sustainable development *and* to faster of e-content development process. An important outcome of this research is bringing E-learning technologies into developing countries of Africa through the WebELS platform.

7.2 The Automated Authoring System Advantages and Disadvantages

In this section the author shows some of the advantages and disadvantages of the proposed automated authoring system. The advantages of the system in higher education could not be evaluated by a large number of users in this study since it was not the core focus of this research, however we plan to cover this topic in a coming research project. Those advantages are based on the author understanding of the use this new technology in E-learning by both instructors and students. These points could be agreed by some users and could be disagreed by others, however we would like to put the light on some of them in the following subsection.

7.2.1 System Advantages for Instructors/Professors

As described in the introduction, one of the research contributions of the research in the field of E-learning was to enable professors and instructors to benefits from an advanced authoring too for content development. The development of learning courses is by far a costly and time consuming process as showed in the previous chapters. Therefore, the author of this thesis believes that the developed automated authoring systems will be able and not limited to offer several benefits for instructors and lecturers as follows:

- **Minimize work load** : Teachers can save the course and upload it anytime to the learning server if students requested it, therefore no need for presenting the same content again and again.
- **Ease of use** : Teachers just need to make the online presentation and system will automatically generate the learning courses at the end.
- **Course access control** : Once the learning courses exported and imported to the Learning module of the WebELS ,only authorised students will have access to the learning resources of the teachers.
- **Saving time** : Teachers might refer to the recording courses for answering students question or for students who missed online presentation reference.

- **Post-editing** : Teachers can edit their content for better improving and removing some specific parts that have copyright.
- **Personal interaction** : The system enable the interaction between the instructor and remote students, recreating physical classroom experience.
- **Online or Offline authoring** : Professors can use the system to generate learning courses during the online presentation or in an offline mode without students.

7.2.2 System Advantages for Students

Supporting students in taking a part of the "lifelong" learning is another key of the research objective. Moreover, enabling students to access the courses materials whenever and wherever it is convenient for them so they cannot be any longer constricted. Thus, the author of this thesis belives that the developed automated authoring system will be able to provide the following advantages for students:

- **Learning anywhere and anytime** : Students can view the recorded presentation according to their own time schedule in a more informal relaxed environment.
- **Fill the gap** : Difference in learning abilities among students can create gaps in learning in a classroom environment or during the online presentation.
- **Retrain learning curve** : Studies have indicated that more than 50% of the students forget the contents of the lectures delivered in a classroom within two to three days.
- **Mastering difficult concepts** : It helps students to master concepts they find difficult because they can listen to the teaching again.
- **Catching up** : Students happen to miss the online presentation have a chance to learn what have been covered.
- **Online or on-demand** : Student can learn by attending the online presentation of the teachers and involve in the discussion or by reviewing the presentation on-demand or both.

- **Viewer interface** : The interface used to playback the courses offer a variety of tools that help students to choose specific discussion parts, zooming text, toggle video and slide, cursor indicator of talking point.

7.2.3 System Disadvantages and Limitations

Although the system received many encouraged feedback's from the users, the automated authoring system developed in this thesis has some drawbacks and disadvantages in the present form. The system does not capture the annotation data that lecturers draw on slides in some scenarios. The instructors have to do the process of import/export to move the created contents from Meeting module to Learning module. Although this process can take just few minutes, but we planning to design an automatic merge of contents. The system can support only up to 20 users sharing audio/video stream during the online lecture while the background process is active, however thousands of users can access to the server to review the created e-contents. Moreover, the new trend of E-learning in the current stage is the use of M-learning which stands for mobile learning. Now with the advance of mobile devices and its availability for many users, people started using several tasks using their mobile devices and education is included too. Thus, the automated authoring system should address such a change and be compatible with the mobile devices.

7.3 Discussion

The evaluation shows that the proposed system successfully created rich E-learning contents in a shorter time which is a very important factor in all means. As reviewed in the related works, instructors need so much efforts and interaction with the tools to create their learning content, or by using meeting capturing they need to be able to support high speed Internet required by those system to use their screenshare technology which might have security issues. Moreover, the lecture capturing software's and tools exist are by far very costing and time consuming from the stage of capturing to deploy the contents on the web to be reviewed. Therefore, the proposed system offer a new authoring method of synchronization compared to those exist already in the state of the art by means of fully automated

process. Thus, due to the use of the cooperative event-driven technology that enable real-time interaction and collaboration between client and server during the authoring procedures. This collaboration indeed facilitate the content development for instructors with less efforts, since the server is capable to manage the whole synchronisation and data manipulation procedures by receiving event signals from client during the presentation to proceed it as a background modules. This method can solve several content developments issues such as time consumption, high cost, hardware and software requirements, man power, etc. The authoring performance were evaluated by means of bandwidth and CPU usage during using the system by the lecturers. The performance of the system is based on the number of connected users and the streaming quality selected. Therefore, selecting the automatic streaming adaptation feature will enable the users to benefits from the system even under the low speed Internet environments. The evaluation results, demonstrated that the system indeed can be used even under a speed of 100 kbps.

The overall experience demonstrates that the Automated Authoring System is indeed a feasible way to combine apparently different tasks: teaching in class, online presentation, and multimedia authoring in a one single activity. The resulting AAS documents they are as good as courseware produced by current authoring systems with much less time, efforts and cost. Moreover, the AAS contents are integrated into a Web-based teaching and learning environments, which is an important step on the long way to making teaching and learning more time and space independent.

Chapter 8

Conclusion and Future Work

8.1 Summary

Content development process has become the most challenging task in E-learning. The process outcome ranges from being sophisticated and expensive. In this thesis , we presented the concept, design and the implementation of a new automated authoring based on a cooperative event-driven technology to address these issues. The system targets lecturers and students in the higher education, for the flexibility and globalization of post-graduate studies. The system generates learning contents automatically based on a real-time presentation, synchronizing the lecturer video stream and the slides presentation by means of video clip timing based on a series of events. Consequently, the implementation chapters presented the course generation algorithm that support the client-server collaboration during authoring based on the cooperative event-driven. The system integrates two different modules of the WebELS platform i.e., E-meeting and E-learning. The automated authoring can be activated during the online presentation in the E-meeting module, where it will generate automatically a learning package at the server by the end of the presentation. The playback function in the E-learning module is used to review the content stored at the server side by learners, who could not attend the real-time presentation or for further understanding of the lecture. The presented system was implemented on the cloud-computing environment to ensure reliability. The practicality of the system use in actual lectures and the comparisons with other authoring tools based on several categories of content development demonstrates it's effectiveness and usefulness in creating rich E-learning contents. Therefore,

by adopting this system, more e-Lectures will be available in less time at a lower price than what most institutes would expect.

8.2 Contributions

This thesis presents a novel automated authoring system based on cloud cooperative event-driven technology for a web-based E-learning system in higher education, and a contribution to the WebELS meeting system when used in the unstable network environment and for the engineering presentations.

The novel automated authoring system embedded into an online lecturing platform. The proposed system is invented to support flexibility and globalization of higher education especially for Ph.D education. The automated authoring system was implemented using Flash technology that communicate with video streaming server by Red5 streaming server. It generates rich E-learning contents automatically as a background processing. The system is based on a cloud cooperative event-driven technology, which stands for the online communication and collaboration between client and server during the authoring process. The event-driven is initialized by lecturer while giving the online presentation such as control presentation slides (next, previous, last, first, random slide selection), cursor movements on the slides and changing streaming quality of audio video to support different bandwidth environments. When the event engine listeners are initialized on the server side to execute and proceed the authoring procedures such as slide-video synchronization, capture cursor data, adjust streaming quality of the recorded video , etc. The proposed system allow online interaction among the connected users during the online presentation, e.g., professor and students, while generating the E-learning content on the server side. The proposed system integrated two different modules of the WebELs platform i.e., WebELs learning and WebELS meeting to be an "all-in-one" platform that support higher education activities and lifelong learning. The new automated authoring tool is implemented on a cloud computing environment to ensure its reliability. Cloud computing is a strategic technology that uses the Internet and central remote servers to maintain data and use applications without personal software installation. This strategic system allows more efficient computing by centralizing storage, memory, processing and bandwidth . Thus, our research contribution aims in developing the automated authoring system based on cooperative event-driven is to solve some

major E-learning issues such as content development and courseware production efficiently.

The performance and usefulness of the proposed authoring system have been proven by practical uses in e-CC seminars and SSB collaboration project. The authoring performance were evaluated by means of bandwidth and CPU usage during using the system by the lecturers. The performance of the system is based on the number of connected users and the streaming quality selected. Therefore, selecting the automatic streaming adaptation feature will enable the users to benefits from the system even under the low speed Internet environments. The evaluation results, demonstrated that the system indeed can be used even under a speed of 100 kbps. The proposed system has been also used in an official seminar of the e-Communication Consortium to evaluate the system in an actual situations after a lot of experimental testing. In these lectures, some Professors gave a presentation using one PC notebook include a webcamera to use the automated authoring system (AAS) for recording their stream and generating the e-content.

The overall experience demonstrates that the Automated Authoring System is indeed a feasible way to combine apparently different tasks: teaching in class, online presentation, and multimedia authoring in a one single activity. The resulting AAS documents they are as good as courseware produced by current authoring systems with much less time, efforts and cost. Moreover, the AAS contents are integrated into a Web-based teaching and learning environments, which is an important step on the long way to making teaching and learning more time and space independent.

Regarding to the contributions on the WebELS meeting system, the function of the automatic streaming adaptation is to be used for managing the online connected users streaming quality automatically by the system to keep the stability of the communication even under the low speed Internet environment. For the meeting mode of engineers, we noticed that in several scenarios the video document type is needed for discussion and better presentations. Therefore, the video embedded synchronization function was to improve and enforce the WebELS Meeting features in supporting different communication scenario and to enable users to use any kind of document for their presentation taking in consideration always the low-speed Internet environments. The WebELS Meeting system was implemented as a SaaS concept to minimize IT investment costs.

8.3 Limitations and Future Work

We plan to make the system more automatic in creating the learning contents. Thus, the system will automatically save the created presentation on the meeting module on the learning module without any users interactions by means of import/export functions. The annotation data is sometimes used by many professors, thus the automated authoring system will include the online annotation capturing to be added to the learning content. Furthermore, we are investigating the business needs of recording all the connected users so we can enable the proposed system to support such a feature.

One of the most important features in the new trend of E-learning and e-communication is the mobile learning. Therefore, the system should be also able to work for mobile devices to support both attending online presentations and playback learning contents. We planning to design and develop a mobile version of the system to allow users to use any device to learning anytime and anywhere. Moreover, we plan to change the Flash technology and replace it with the HTML5 technology to keep up with the latest technology and support the mobile learning.

Appendix A

About Author

Name	Mohamed Osamnia
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Appendix B

Related Publications

Refereed Journal Papers

1. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "A Novel Automated Course Generation System Embedded in the Online Lecturing Platform for Higher Education", (13 pages), Computer Application in Engineering Education, Wiley, 2016. DOI: 10.1002/cae.21734

International Conference papers (peer-reviewed)

1. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "An Automated Authoring by Means of Integrating e-Meeting and e-Learning to support Higher Education Under the WebELS Platform", Proc. IEEE Conference on e-Learning, e-Management and e-Services, Melbourne, Australia, pp.76-81, Dec. 2014. DOI: 10.1109/IC3e.2014.7081245

2. **M. Osamnia**, S. Chunwijitra, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "A cloud-based automated authoring system to support e-learning in higher education under low-speed internet", Proc. International Conference On Future Trends In Information and Communication Engineering, Bangkok, Thailand, pp.6-12, May. 2014. DOI: 10.15224/ 978-1-63248-015-6-11

3. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "A cloud-based multi-functional e-meeting system by flash-based multimedia technology for higher education on the webels system", Proc. International Conference on Advances in Multimedia Information, Nanjing, China, pp.1-12, Dec. 2013. DOI: 10.1007/978-3-319-03731

Misc

1. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "Integrating Online Presentation and Courseware Production to Support Higher Education on the WebELS Platform", Proc. IEICE technical report on software science, Okinawa, Japan, Mar. 2015.(non refereed)

2. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "A Cloud-based Automated Authoring System to Support E-learning in Higher Education Under Low-Speed Internet", Proc. International Journal of Advances in Computer Science and Its Applications, pp.1-7. May. 2014, Vol.4, issue 3, ISSN 2250-3765. (abstract refereed)

3. **M. Osamnia**, A.J. Berena, S. Chunwijitra, H. Okada and H. Ueno, "Automatic adaptation of streaming data for webels meeting for low-speed Internet", Proc. IEICE technical report on service Computing, pp.25-30. Jun. 2013, Vol. 113, no. 86, SC2013-5.(non refereed)

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