

A Flash-Based Lecture Recording System and its Integration with LMS

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Abstract— Lecture Recording system is an integral component in blended learning that has advanced into more flexible and well integrated systems with Virtual Learning Environments (VLE). However, currently available lecture recording systems suffer many problems inhibiting their effective deployment for blended learning. In this paper, we present a design and implementation of a Flash-based lecture recording system that enables (a) classroom recording using a simple equipment setup with minimum burden to lecturers, (b) editing the timeline of the lecture-record and bookmarking using metadata, and (c) integration with the assets in LMS. This lecture recording system is an indispensable element in implementing a full blend of synchronous and asynchronous learning pedagogies where students are allowed to participate in a lecture without venue and time constraints, repeat viewing difficult segments of the lecture, and catch up missed classes. We have implemented this system as a core element of the UMELMS (<http://www.umelms.com>) project in Ritsumeikan Asia Pacific University in Japan.

Index Terms—lecture recording, LMS, UMELMS, blended learning, virtual learning environment, Flash based.

I. INTRODUCTION

Lecture recording is an important feature in education systems that allows students to participate a lecture without constraints of venue and time. This allows the students to repeat difficult sections, access missing lectures, and sometimes attend lectures remotely. With the massive development of network infrastructure and multimedia technologies in recent years, the demand on Virtual Learning Environment (VLE) from education firms as well as companies has greatly grown up as VLEs are used as a means to curtail expenses and maximize educational output [16]. In that, use of multimedia in the learning contents has been identified as an important element due to its proven learning and teaching effects. Moreover, multimedia is becoming the main source of information in the age of high speed internet [3] and a promising means of incorporating 3G enabled handheld devices into e-learning. Among the didactic contents present in various multimedia forms, lecture records play an important role in blended learning. Here, the nature of the lecture record will be largely determined by the course contents, teaching and learning pedagogies, network infrastructure and the trend in user habits.

Lecture recording system (LRS) is an emerging tool in VLEs to generate didactic material which is often created and uploaded manually by a recording team (like the current classroom recording system in APU). With costly investment, automated LRSs have been setup in some universities. However, current lecture recording systems in general, need attention to the following major issues:

1. Majority of the commercial lecture recording systems require costly installation, maintenance and need manual operation by the lecturer or a separate camera team.
2. Most of the existing lecture recording systems do not capture the multimodal classroom semantics.
3. Poor integration with learning management system has intrinsic performance limitations in indexing and searching. Further, it causes additional burden on the lecturer to edit and upload the lecture recording to the streaming server.
4. Low accessibility due to poor adaptation to access devices and network heterogeneities.

Due to the above issues, use of lecture recording systems causes a significant burden to the faculty, while the lecture record itself is restricted to an ill-edited video clip of a single-view lecture record. Multi-view lecture record facilitated by many cameras needs costly initial investment and significant running cost that confines its use to large organizations.

The rest of this paper is organized as follows. Section II presents the objective and design rationale of this lecture recording system. Section III presents our implementation in Ritsumeikan Asia Pacific University (APU). Section IV details the deployment and evaluation. Finally conclusion and references are given.

II. DESIGN RATIONALE

A. Design Goals

In this study, the design of a novel lecture recording system that addresses the problems and issues of current systems by implementing following features:

1. **Ubiquitous accessibility:** high accessibility and platform independence that enable the users to access recording system without any constraint of time and venue.

2. **Automated operation:** highly automatic recording and publishing operation minimizes the operational burden on the lecturer. Additionally, lecture record real-time streaming enables students to participate lectures lively.
3. **Content integration:** designed as a part of UMELMS that the authors are developing in Asia Pacific University. Moreover, external metadata association has been used to enhance content management system. This improves the content navigation and searching facility enabling users to locate recorded lectures easily.
4. **Cost effectiveness:** easy to deploy and maintain as the system does not require any sophisticated/costly devices such as dedicated hardware gadgets and can be installed in the classroom as a completely wireless setup avoiding physical constructions in cabling etc.

B. Lecture recording system architecture

Adobe Flash platform has used to implement the lecture recording system because of the following advantages:

1. Flash is the most popular multimedia platform in rich Internet application (RIA) market with 99.3% of internet desktop user have flash installed [11].
2. Platform independent since Flash is available for most popular operation system (OS) such as Windows, Macintosh, and Linux. Large numbers of Flash supported multimedia capturing device are already available and will grown up in future.
3. Flash is highly customizable and programmable with server side support by Flash Media Server (FMS) [18].
4. With real time messaging protocol (RTMP) FMS can stream the record multimedia content in different delivery rates that adapts to the client's network and device requirements.

In order to achieve a flexible system which is easy to maintain and integrate with LMS, this system design essentially adopts a Service Oriented Architecture [19] (SOA) as illustrated in figure Figure 1. .

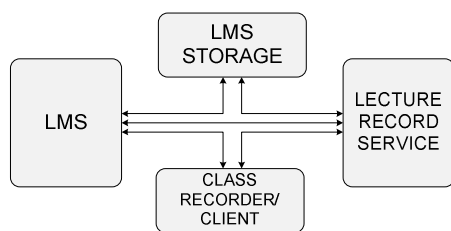


Figure 1. Lecture record as an independent server in SOA

In a generic model, lecture recording system is a service that communicates with the LMS by its API. The details of the components in the above model are as follows:

1. **LMS:** Learning management system, it treats lecture records as assets and communicates with lecture record server by the provided Application Programming Interface (API).

2. **LMS Storage:** usually a file/database server where LMS store its asset, it can be shared with lecture record server.
3. **Lecture record:** lecture recording server which has responsibility with lecture record/streaming request from LMS server as well as from clients.
4. **Class recorder/client:** as a Flash based solution, this system record and stream video in same manner, they both managed by LMS and request Lecture record server for class recording or video play back. Lecture record can be operated through LMS website or standalone software based on Adobe platform.

C. Deployment scenario

Designed as a service that communicates with the LMS through the network, this system has a high flexibility in deployment and modifications. The typical deployment scenario is showed in figure Figure 2. and explained below:

1. **Components:** The completed system setup consists of clients, LMS, and the Lecture recording system. All of them are connected through the network.
2. **Operation without the lecture recording system:** At the default state, any typical LMS runs standalone without any LRS. Installation of a LRS would cost education firms a significant budget and require customizing the existing LMS to interwork with the LRS. Due to this reason, most academic institutions maintain the LRS as an adjunct system independently operating to LMS.
3. **Operation with the lecture recording system:** The lecture recording system we propose is a flexible and low-cost replacement for existing systems that consume a significant time and monetary cost at initial installation. Additionally, the flash-based system facilitates a set of API through which the integration to LMS is possible with slight modifications to LMS. Since high-resolution wireless IP camera's are for video capturing, no extra construction burden on installation. The scene detection for recording, frees the lecturer from extra operational burden.

By using this system, organizations only need to invest a small budget compare with high end system while keeping a good balance between cost and quality, usability and security.

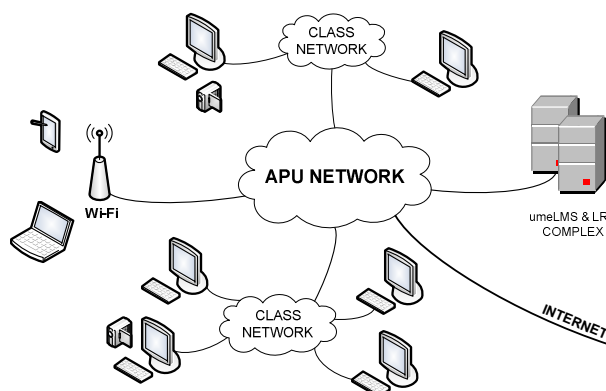


Figure 2. Typical deployment scenario (APU)

III. IMPLEMENTATION

We have integrated the new lecture recording system prototype with UMELMS – a multimedia enhanced LMS that we have been developing in the last one year. In this section, we present the implementation and system operation of this new lecture recording system, at APU.

A. Network facilities of Asia Pacific University

APU is a pretty young and international university located in Japan where nearly 6000 foreign and domestic students are served with a bilingual curriculum. Currently, there are around 2500 PCs in APU used for IT-enabled education, connected through a 100Mbps local network area network. After the planned system upgrade in this year, APU internal network backbone will be improved up to 1Gbps while the external connection will be boosted up to 400Mbps. An 802.11g Wi-Fi network also covered a large area over APU campus. In conclusion, APU's network environment is highly conducive to reap the best from multimedia rich content delivery for education, making it an ideal place to deploy the lecture recording system.

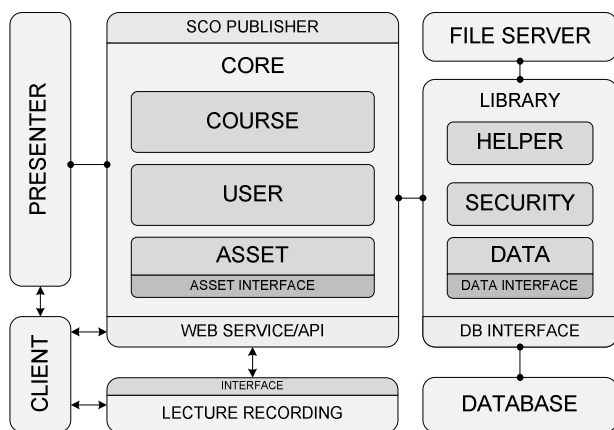


Figure 3. A complete system implement

B. UMELMS

UMELMS stands for Ubiquitous Multimedia Enhanced Learning Management System designed which enforces on the use of enhanced multimedia in its didactic contents and supporting framework for multimedia dissemination for heterogeneous networks and devices. Given below are the principle goals of UMELMS:

1. **Content integration:** As a multimedia enhanced LMS, umeLMS has a generic resource management system which maximizes the compatibility with various multimedia resources in future by implement a universal resource interface. From that, diverse resource scheme can be included and supported by umeLMS later. This feature is very useful to implement new lecture recording system as well as other systems.
2. **Content Object (SCO) model:** Forward supporting SCORM and to support other platform, application as well as export/import resource, we propose a SCO

(Shareable Content Object) publisher which have responsibility with request for standardized resource.

3. **Extensibility:** To maximize the extensibility of system, umeLMS designed with modular architecture. An API available under web service form for external module integration also included. This API was also used to implement new Lecture recording system as an authentication protocol.
4. **Platform independence:** The practical system has build to run on WAMP (Window – Apache – MySQL – PHP) stack, supported PC and limited support for mobile including lecture live streaming, VOD and announcement checking.

C. Lecture recording system implemetation

Having good multimedia framework from umeLMS, we implemented new lecture recording system as a part of umeLMS project in APU. The structure of completed system implement is shown in figure Figure 3.

Following SOA design, lecture recording system has built as a standalone system and “plug-in” to LMS system by adding a new resource scheme at umeLMS according to its resource interface. As a result, UMELMS can communicate with lecture recording system with less effort. In another hand, UMELMS can manage its resource including lecture record in a usual fashion. In addition, making this system as a standalone system also leaves the integration capability open for other system or LMS.

An authentication function available in umeLMS web service has been used to verify the authority of user for requested lecture records.

D. System Operation

Operation of this recording system and its content integration mechanism is as described in figure Figure 4. As mentioned in the last section, UMELMS has adopted a generic resource management mechanism to implement content integration feature. The LMS-Store that stores data and asset of the LMS is interfaced to an array of communication interfaces. In this system, media and metadata is always stored separately, leaving the flexibility to combine one media file with different metadata to produce various versions of on demand streams. It also allows users to edit the time-line of the media using meta-data tagging, which require far less system resources compared to the systems that require direct editing of the multimedia file.

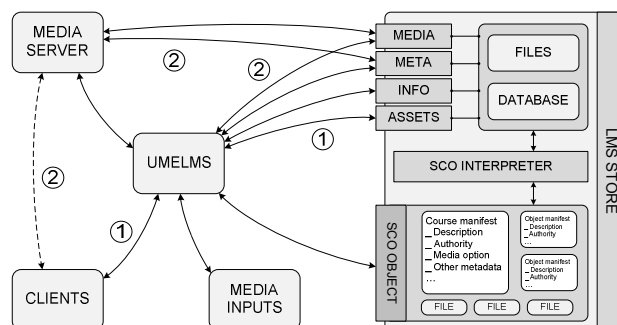


Figure 4. Content integration operation

The work flow of this system can be divided into two phases. In the first phase, client requests LMS to open a new session and receive security and session information as soon as the LMS completes its data look-up. In the latter phase, streaming session is established between the media server and the client. Finally, the media server confirms security authentication with LMS core and receives media as well as metadata from LMS store.

IV. DEPLOYMENT AND EVALUATION

The prototype system has been used to record some of the lectures (ICT courses) in APU. Using this system, the course creators can manage and create new lecture records by a central control panel. The experiments conducted in the APU network environment yield good performance showing the system efficiency in many aspects:

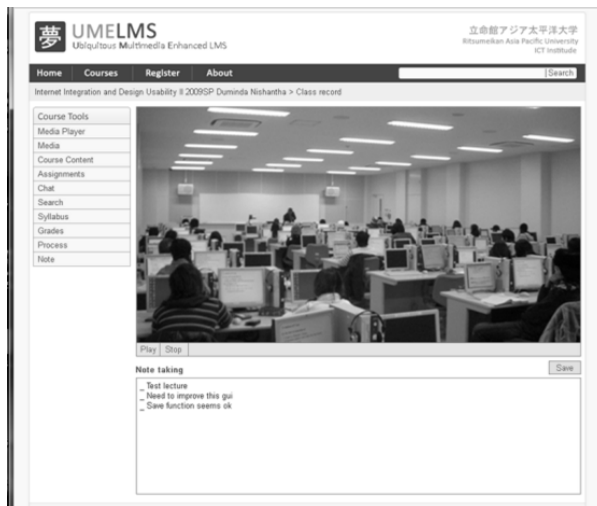


Figure 5. Snapshot of VOD screen

A. Deployment:

The system deployment was straightforward. As shown in figure Figure 2. , all the servers of the LMS are connected with APU network by 1Gbps Ethernet connection. The testing server is equipped with Intel Xeon X3353 2.66GHz, 4GB RAM, Broadcom NetXtreme Gigabit Ethernet, Barracuda ES.2 SATA 3.0-Gb/s 500GB x 2 with real performance at 80MBps. Especially, it does not require any complicated installation in order to perform a new lecture recording. The only requirement to perform a new class record session is a camera connected to a certain computer which can access APU network. The recording process is managed though a web interfaces on the PC with camera connections. In the practical system, a dedicated computer with Adobe platform applications can be used as a part of recording system to manipulate videos before stream them up to server; this process can be done automatically or manually.

B. Evaluation method:

To evaluate this system, we performed lecture recording for one to ten concurrent lectures consequently, and we recorded the system resource usage of Media

Server for each case (since web server is separated from Media Server it requires negligible resources). Comparing with the available resource of testing server, we plot up a resource usage graph as shown in figure Figure 6. The horizontal axis describes number of concurrent recording session while vertical axis describes percentage of system resource usage.

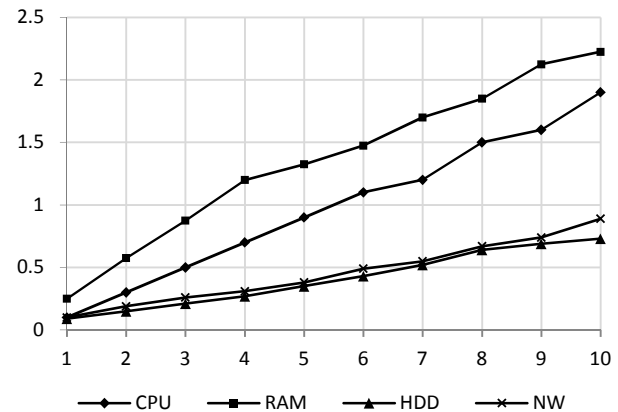


Figure 6. Server resource usage (%)

C. Performance:

Experiments show that the LRS requires 1Mbps bandwidth to handle one streaming session at high quality (720px*405px 24fps). According to our estimation from evaluation results, the archiving server is able to handle approximately 360 concurrent recordings while keeping system workload under 70%. Numbers of concurrent recording sessions are limited to this value mainly because of the memory usage. Detail data is shown in table Table 1.

	CPU	RAM	HDD	NW
1	0.1	0.3	0.09	0.1
2	0.3	0.6	0.15	0.19
3	0.5	0.9	0.21	0.26
4	0.7	1.2	0.27	0.31
5	0.9	1.3	0.35	0.38
6	1.1	1.5	0.43	0.49
7	1.2	1.7	0.52	0.55
8	1.5	1.9	0.64	0.67
9	1.6	2.1	0.69	0.74
10	1.9	2.2	0.73	0.89

Table 1. Server resource usage (%)

D. Usability:

As lecture record is flash based, user can access its contents using a wide range of devices that supports flash. A special mobile version of the lecture record extends the accessibility to hand held devices. The recording process is fully automatic which cut down unnecessary delays caused by manual uploading (figure Figure 7.), making the lecture record as live streaming during the lecture and as on demand streaming after the lecture.

Since this system stores metadata separately from the lecture record and combines them on-the-fly in later use, it allows the user to edit lecture record online only using metadata.

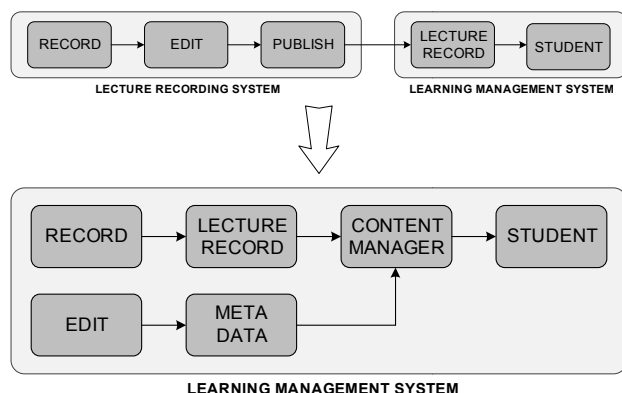


Figure 7. Operation of recording process

Standalone metadata also unleashes the potential of using it for content integration such as session bookmarking, process memory; etc which is essential to establish a user centric study space (UCSS) since multimedia contents in this method can be customized for each user with minimum utilization of system resource.



Figure 8. Online editing of the lecture record control

V. CONCLUSION

In this paper, we introduced the design and development of a Flash Based Lecture Recording System for LMS. By using a modular design, the novel recording system has been successfully integrated in to UMEIMS in Ritumeikan Asia Pacific University in Japan. Together with user friendly design and automatic features, lecturers are kept away from the unnecessary operational burden and requirement of advanced technical knowledge. The meta data based content integration model leverages the development of a user centric personalized study space (UCPSS), which is an important feature for the new generation blended learning systems.

As future works, features such as student annotations, Q&A interaction with the lecturer, discussion boards, and student's feedback to the lecturer are candidates for implementation. We shall also pay significant attention in

supporting the pedagogies in large classrooms using the lecture recording system and its playback metaphors.

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