Web-based Interactive Virtual Classroom using HTML5-based Technology

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Abstract – Virtual Classroom is an advance learning tools that allows students to communicate with instructors in real-time over the network. There are various benefits using virtual classroom such as optimized cost, distance learning, and flexibility which able to access material anytime anywhere. However, the difficulty of interaction between instructor and student is a clear disadvantage of current online learning system. In this paper, we present a new approach of online learning called web-based interactive virtual classroom that allows students and instructors to communicate with multiple face-to-face video conferences. Equipped with various systems that general virtual classroom must have including presentation tools, online whiteboard, real-time video and screen sharing. The application also provides more with outstanding interactive features such as quiz system, group system and can be extendable. Experimental results reveal our software work perfectly and provide enough functionality. The integration between improved e-learning and virtual classroom is highly introduced in our final outcome.

Keywords: Interactive classroom, virtual classroom, multiple video conferences, e-learning, collaborative learning, mobile learning, ubiquitous learning, web-based application, HTML5 technology

I. INTRODUCTION

The rapid growth of Internet technologies has driven to the proliferation of software that provides high flexibility of accessing anytime anywhere and with any devices. The Internet software nowadays are more complex, higher performance, and very fast growing of data that 90% of Internet data are just added within the past two years through various web services. The advantages of web-based software are easy to access, data retention, and ready to use which is most of them do not required more plug-in installation. In education, the Internet has been considered as an alternative learning method for a long time since the establishment of WWW platform. Recently, most of schools and universities have at least employing a system which commonly call E-learning to provide fast educational materials for the students and better classroom management system. Another advance approach of online learning is virtual classroom.

A virtual classroom is acceptable to be an advance learning tools that allow students to face-to-face with instructors in real-time over the Internet. Learn the benefits include active engagement and online participation tools. The trend of virtual classroom toward the increasing of the quality of content is provisioned by the current Internet technology such as cloud computing, high speed internet, fully-featured mobile device. The development of existing virtual classroom generally employs multiple synchronous technologies, such as video conferencing, presentation tools, and online whiteboard, which are common and well-fitted to remote students with the ability to collaborate in real time.

As we observed the current state of online learning from various softwares, we found that most of the problem is about “low interaction” between students and instructors. Compare to traditional learning style, there are full of socialized interaction that create the experience of participant more engaging and help to preserve the flow of learning process. The concept of socialized interaction is based on the premise that our understanding of the content is socially constructed through viral communication and grounded interactions with the content especially with other students. Most of current online learners found that online classrooms including static contents, videos, and podcasts are less motivation and have difficulty for concentration. It is not the same as standing face to face with an instructor and having his/her clarify a problem. Even the content providers have made various ways of services available for interaction between students and information; likewise some providers also allow learner channels to post the message in order to discuss with others. However, the learners prefer more interaction, ease of engaging with other students and instant feedback from the instructors. The lack of face-to-face interactions with other students and the instructor can be a clear disadvantage of current online learning system.

In this paper, we present new approach of online learning called web-based interactive virtual classroom that allows students and instructors to communicate within multiple face-to-face video conferences. Equipped with various systems that general virtual classroom must have including presentation tools, online whiteboard, real-time video and screen sharing. There are more outstanding interactive features such as quiz system, group system, and be able to extend as we create framework for easily generate real-time participation tools. Moreover, our system does not support only for virtual classroom but also support for offline system.
II. BACKGROUND

Our software is mainly run on web-based application, so the platform to create this system is focusing on web technology.

Node.js and Websocket: We utilize Node.js [1] to create server-side system, thus our software is wholly written using JavaScript language. Node.js is a software platform that is used to build scalable networking (server-side) applications. Node utilizes JavaScript as its scripting language using the V8 JavaScript runtime. Node allows non-blocking I/O and event-driven model to handle high throughput and performance. We implement Node.js to create several functions in server-side including web application framework, AJAX, and MySQL database. Node.js [1] is well-support WebSocket [2], a new TCP-based protocol. We employ WebSocket in order to support real-time approach system. WebSocket [2] is designed to improve request/response model and enable full-duplex communication. We use Socket.io to apply WebSocket with Node.js.

WebRTC: Instead of using Adobe Flash or Microsoft Silverlight, this project utilizes new technology called WebRTC to create video conference system. Applying WebRTC for development, users do not need to install any extension plug-in in order to use our software because WebRTC run natively on the browser. WebRTC [3] is an API definition being drafted by the W3C to enable browser-to-browser applications for voice calling, video chat, and peer-to-peer (P2P) file sharing [6] without external plugins. Comparing WebRTC with Flash, WebRTC is better in term of the audio and video quality, and automatic real-time adjustment based on network connection speed. Another advantage of WebRTC over Flash is most of mobile devices disregarding flash because flash create heavy load CPU utilization while mobile devices have very low CPU processor. But WebRTC are now support in android chrome stable version.

Web Service: We integrate Google Drive and YouTube to support online material system. Google Drive API gives an efficient way and is reliable to create file management and sharing pool of file such documents and presentation without external storage. YouTube API provides a high performance system for video sharing. API (Application program interface) is widely used in web development. API works as a web-based framework, which allows the developers expose service data or content to the browser, which is easily defined in HTTP build and useful for external service integration.

III. RELATED WORK

In this section we provide an overview of existing research to support the concept of application. In 1991, Deshpande [5] showed research first about an interactive virtual classroom-multimedia for distance learning system including online whiteboard and conventional video, then 2001 improved work for a real-time interactive virtual classroom multimedia distance learning system has released and reviewed.

Back to 1996, Sankar [7] showed video-conferencing in a classroom, introducing case studies and video conferencing-based projects to supplement lectures in teaching a graduate level telecommunication management course.

Then 1997, Byoung Oh [6] showed an application sharing object and behavior for collaboration-based system. Application sharing allows the joint working based on a single-user application. The user can share a program running on a computer with other people who are geographically separated.

In Thailand, Surachai [8] showed the real-time classroom system with two-way communication for distance learning in 2006.

IV. SYSTEM STRUCTURE ANALYSIS

As Web-based Interactive Virtual Classroom (WebIVC) is our approach to integrate e-learning and virtual classroom, WebIVC is allowed multiple accesses on devices and web-based software without additional plugin or tool (Figure 1). The system of WebIVC consists of five main components: authentication, classroom, conference, participation tools, and summary reports. It is supported the REST API to request and response between functions.

![Figure 1, Overview of target audience](image)

The relationship and interaction among the five components can be described as follow:

1. **Authentication:** This component is responsible for determining whether the user has logged into the system. User authentication is done through the user account. We utilize Social site API to support this process because it provides fast way and most efficiency for simple authentication system. After login to the system, user will land the first page called user profile. In the user profile page, user will get his/her information such as which classroom he/she is participating, notification, and so on.

2. **Classroom:** A major component consists of five functions including Classroom management, Participant management, Message board, Google Drive, and YouTube. In the classroom component, software allows user to manipulate classroom information and also gives a role to each participant. Message board consists of posts and comments. User can post various media such as simple plaintext, pictures, videos, and toward presentations and documents. It communicates with server-side using AJAX technique. Also with Google Drive, we use AJAX to first check Google Drive authentication. To use Google Drive API, we need to register Google Developer Console in order to get credential information, which consists of Client ID, Client, secret, Email, and Redirect URIs. However, it is different for YouTube Player API, no credential session required but able to fully control video except uploading.

3. **Web Conference:** An important component to support virtual classroom and various real-time media such as online presentation, video synchronized, and attendance checking. The main function in this component is multiple face-to-face video conferences. WebRTC [3] supports only two peers to sharing conference. In order to support multiple or more than two peers, we need to apply some algorithms like: Conference A-B, B-C,
and C-A. As the result, we can get multiple face-to-face video conferences. Before two peers can share video conference, they are required to exchange communicative information via a main web server to know each other. This process we call JSEP (JavaScript Session Establishment Protocol), which is similar to Offer/Answer model. The communication is doing through SDP (Session Description Protocol). After successfully exchanging, two peers can set up local and remote description where they can see each other. As we may expect for P2P connection issue, interactive connectivity establishment (ICE) is greatly introduced to solve the problem of different IP address for data exchange via network address translation (NAT) [4]. In addition, we apply STUN/TURN server [3] if ICE method is failed. In order to share screen using WebRTC, the web server must support SSL (Secure Socket Layer). Screen sharing only works on SSL domains, which as the application must be access through HTTPS.

4. Participation Tool: The function that plays a major role as user interactive features. It enables real-time chatting, whiteboard, emoticon, quiz and group system among the users. In addition, we have created a framework for easily building a participation tool. Ideally, we are able to generate extension file (.js) and add filename into the database. So the system now knows the new participation tool. The main file can be imported into sub file to do OOP programming. And in the main file, we must specify send-receive event with the system will automatically wrap a packet and send to the server, and then server will forward to another user. This approach is aim to creating real-time application.

5. Summary Report: Most of WebIVC activities are recorded into statistical report for analysis purpose. For example: visitor rate, student ranking, attendance checking, etc.

V. IMPLEMENTATION

We designed the application based on system model. The system mainly implements between client side and server side. The module program is a collection of features and interactive tool which are controlled by module operation and can be extended as various functions (Figure 2).

![Figure 2, System overview of WebIVC](image)

Technically, this software is developed based on JavaScript language in both client and server side. We apply jQuery as common library to develop JavaScript along with HTML and CSS. The most part of JavaScript is compiled into CoffeeScript which presents simple form of syntax and less complexity for usage and edit. In server side, Node.js [1] responds to create web server and contacts with database (MySQL 5.6.14). Node.js [1] also enables API services such as video player from YouTube API, Google Drive file storage from Google Drive API, user authentication from site API. The transmission of data and media file is established in client side by supporting API. In addition, WebRTC API [3] is used to create video conference function. The exchange of data in application is shown in session description via the main server and Node.js status. JSON is common data format exchanging between client and server (Figure 3). For the interface, HTML5 provides useful library such Express.js (extended library of Node.js) which responds to website setting. Template and session management are introduced in Express.js. Stylus also plays a major role as external language to enhance web-based design and application layout.

![Figure 3, Architecture overview of WebIVC](image)

We designed an experimental situation by setting up the machine with local connection. MacBook Pro (2009) Mountain Lion was our local host for networking establishment. The other machines are MacBook Pro (2011) Mountain Lion, HP G42 Notebook PC, and ASUS X42J was considered as sub machines connected directly in same local network. We also used LG Nexus 4 as Android mobile to test the usage of application between computer machine and mobile. The application was tested on both Google Chrome and Firefox browser as far as WebRTC supported. The host machine must be enabled node server.js in order to run the server and camera tools are used to test web conference feature. The first machine was assigned as teacher and followed by student. Our study was planned to focus on observation of the performance of web conference, participation tools, and limitations of application.
VI. EXPERIMENTAL RESULT

We first present the results of each function of application based on our latest experiment. Our result shows that teacher (host machine) assigns into classroom and appears in main box surrounded by sub boxes as students. Terminal prompt at the bottom right also show the exchange of data in JSON format while the conference is connecting. Whiteboard function can be used during classroom. The teacher has permission to set marker type as the students can perceive the result of whiteboard in real time. This function supports in learning material such as presentation slide. (Figure 4)

Figure 4, Interface of web conference and whiteboard function

Our system applies Web service from YouTube and Google Drive. Figure 5 shows interface of web conference that allows YouTube player displayed on both teacher and student side. The bottom section displays list of retrieved videos as recommended videos for learning. Google Drive API also allows the user to manage, edit, retrieve, or even remove file without establishment of external storage as we take advantage of free data storage from Google Drive.

Figure 5, Screenshots show the usage of API service in WebIVC

Moreover, we introduce quiz system, group system, and screen sharing as supporting participation tools. In quiz system, the teacher can select type of quiz and question which will be sent directly to all active students and receive the answer back after the timer ends. The group system also set and separate students into groups. The teacher can assign the group work or access in conference individually based on each active group (Figure 6).

Figure 6, Interfaces of quiz system and group system

Consider on our setup and experiment. Most of functions can work in real time based on connection. Latency is expected in some case. Our result shows at least 10 users can assign into application at the same time. The number could be extended on our future optimization.

VII. CONCLUSION AND FUTURE WORK

This software is mainly designed to aim at the integration of e-learning experience and virtual classroom by applying additional interactive tools. All features are organized and performed as web-based application including socialized interactive tools. The new web-based technologies, WebRTC and WebSocket are introduced to create real-time communication and enable API services. The experiments showed that WebIVC could help to improve online class experience and increase user engagement. Finally, we also plan on further development to optimize communication cost and eliminate system limitation.

In discussion, our software can perform learning functions as we expected. The application provides satisfied results of current interaction and support in both PC machine and mobile. However, this software on mobile requires user to access application on web browser. We also expect that the connection and interactive speed may be vary depend on location and limited user is still in our optimization.

In the future, we plan to improve interactive tool framework system and increase various useful participation tools to achieve goal of user engagement. We aim to increase function for whiteboard system. And message board must be able to post with several of media to support lesson in offline environment.

REFERENCES


