Real-time e-learning platform

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Background

As an impact of early stages of e-learning, universities and lecturers are used to communicate with students online, share and provide access to learning materials, external resources etc. As a result of further more use of e-learning, web based video courses are being published and can access over internet.

Many platforms have been implemented on this domain to accomplish above requirements. Those services are implemented focusing a wide range of end users other than e-Learning requirements for universities. As the awareness of availability of these technologies spread among universities, many universities have taken measures to incorporate these technologies in their teaching-learning process.

Universities have taken measures to livestream lectures for the accessibility of both on-campus and off-site students [5]. Most recently there is a growing demand for self-paced e-learning where students can follow the learning materials at their own pace. This is important because every student has a different pace of catching-up with the teaching where some of them can be considered as fast learners while others may be slow. The ideal current solution is to provide interactive content using different approaches such as video streams, quizzes, polls, etc...

Research Problem

The most common teaching and learning practice adopted by many enterprises has always been a classroom with one or more instructors and learners meeting physically and in real-time. But in this teaching model, there are several drawbacks which will be addressed as problems within this research.

A classroom based learning experience means the class schedule is predetermined and not subject to change. Students must shape their personal schedules around school instead of the other way around. If plans unexpectedly change or an emergency comes up, the student cannot adjust the class schedule to turn in the work at a different time. This is one of the main problems that this research will find solutions for.

Content non-reusability is another problem that can be found in classroom learning. Memorizing or writing all the necessary content while listening to a lecture is difficult. Therefore, students might miss many important points that the lecturer is pointing out during a lecture.

Objective

- Real-time lecturer tracking using PTZ Camera
- Real time video streaming and recording
- Text , voice , video based questioning with whiteboard
- Video playback and statistics

Competitors

Features	Eduscope	BigMarker	RTELP
Real-time streaming	Yes	Yes	Yes
Adaptive Bitrate enabled video player	No	No	Yes
Lecture tracking	Yes	No	Yes
Vector based Whiteboard	No	Yes	Yes
Text-based lecturer student interactions	Yes	Yes	Yes
Video-based lecturer student interactions	No	No	Yes
Starting a poll	No	Yes	Yes
Statistics and analysis of usage of content	No	No	Yes
Secure video player with content protection	No	No	Yes

Methodology

A PTZ camera is used to capture and track the lecturer using a person identification algorithm. The video feed from the camera is passed to the lecturer's computer and sent to the server for streaming.

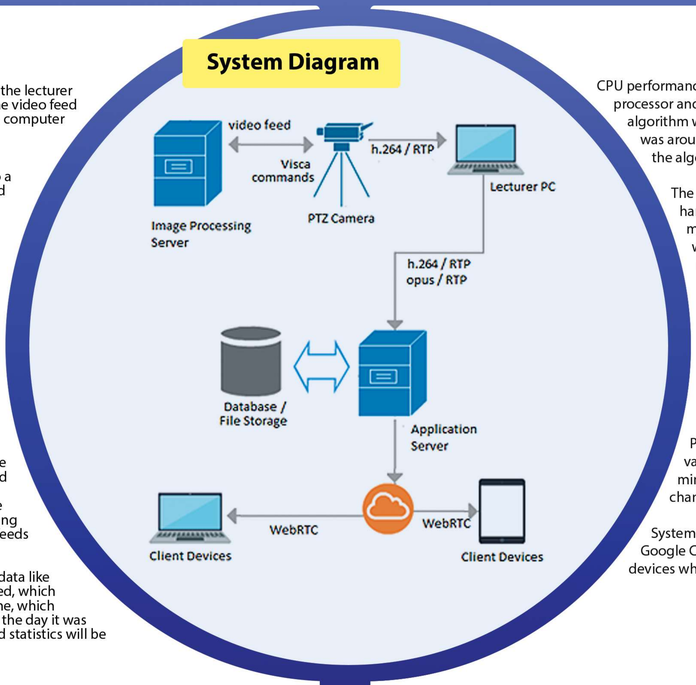
Server is able to stream multiple lectures simultaneously. Each lecture is assigned to a session where multiple users can join. Load balancing and resource allocation are handled per session considering the demand for the session. These details are monitored and controlled by a management console.

In the student's interface of the web application, there is a media player with multiple views for camera feed, projector screen feed, whiteboard, chat window and student question video feed (only when available). The layout of the player is a dynamic one allowing the student to maximize any view as he/she likes.

In real-time, students can participate in the chat, ask questions and use the whiteboard after permission is given by the lecturer. But in playbacks, these whiteboard and chat will replicate the original experience by automatically animating the whiteboard and scrolling the chat on seeking the playback timeline. At any time, all the feeds are in sync.

In the background, player collects various data like which parts of the video played and skipped, which video feed was maximized at any given time, which device was used to play and which time of the day it was played, etc. These data will be analyzed and statistics will be displayed in the management console.

System Diagram



Hardware Requirements

Future Works

Current system does not support adaptive bitrate while live streaming. In order to accommodate that on client side where client is capable of controlling the quality of the streams depending on their network bandwidth, WebRTC simulcast is to be introduced. Simulcast is an approach which uses different independent versions of the same stream range from low quality to original full quality streams.

Results

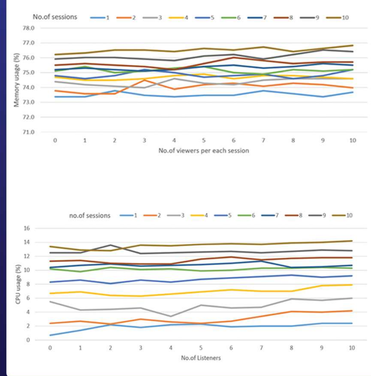
CPU performance of the tracking algorithm using core i5 processor and 8GB ram was around 8FPS. Same algorithm was tested in NVidia GTX 1050 and the FPS was around 20. GPU performance is sufficient to run the algorithm in real time.

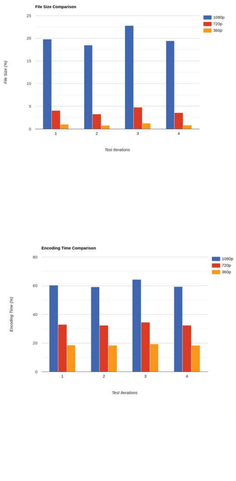
The livestream component was capable of handling simultaneous streams while maintaining the quality of the streams and with very low latency depending on the network bandwidth allocated for the system.

Functionalities of the whiteboard and chat features were functioning as expected. Application is capable of communicating between lecturer's end and the students end of the application with minimum latency.

Playback videos responded to the variations of the network as expected with a minimum buffer delay. Automatic bitrate changes occur smoothly.

System also supports all major browsers such as Google Chrome, Mozilla Firefox and Safari and devices which had above mentioned browsers.





Conclusion

The goal of this research is to find the best solution for a e-learning platform which addresses the difficulties face by students, lecturers and administration in traditional class room scenarios.

In case students miss any lecture, they can use the application to watch lecture stream in real time or revise lectures at any time. Special annotations in the offline playback would ease the student memorization of difficult or unclear part and the player with adaptive bit rate provide playback with no lag in a slow network that led to watch the lecture without any interrupt. Also with the use of special features like poll, chat in live streaming student's motivation and the attraction towards the lecture will be increased.

Technologies

React, FFmpeg, TensorFlow, mpeg-DASH, PyTorch, socket.io, MySQL, WebRTC, node.js, NVIDIA CUDA, aws, OpenCV

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