SCALABLE MULTIMEDIA CODING FOR STREAMING LECTURE CONTENT IN E-LEARNING SYSTEM

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ABSTRACT
A new framework SMCeL (Scalable Multimedia Coding for e-Learning) that allows scalable multimedia content transmission by estimating the bandwidth of the client's network is proposed. By evaluating the network condition, the multimedia content is delivered. Scalable multimedia coding (SMC) is the encoding of a high quality multimedia bitstream which in turn contains one or more subset bistreams. A subset stream is achieved by dropping either video packets or transmitting only the audio packets to reduce the bandwidth constraint for the subset bitstream. Hence, the multimedia lecture content is delivered according to the network condition of the client which enables the client (student) to view the main content of the lecture even in poor network conditions.
Keywords: Multimedia streaming, Streaming media (SM), Bandwidth

INTRODUCTION

Multimedia streaming applications are becoming increasingly popular in everyday life. In this fast pace world, multimedia is in increasing demand as the mobile devices have gained its popularity in the last few years. Wireless multimedia streaming is still a challenging task because of the change of wireless networks, bandwidth constraints, packet loss, and other computing capabilities of the mobile clients.

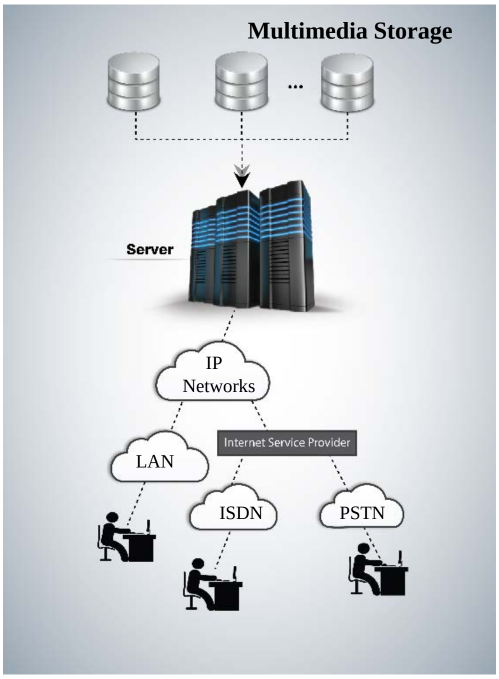

Fig. 1: Users can access the multimedia database over networks for streaming multimedia content

Streaming is defined as the process of playing a particular file while it is still downloading. Multimedia streaming is where a user views or hears the multimedia content while it is still being downloaded. This can be referred as 'Streaming Media' (SM) (Fig. 1). There are a lot of multimedia content available for a various range of applications including video conferencing, remote learning, multimedia presentations, video archives and libraries and so on.

When the user sends a request to display the multimedia content that is stores on a remote server, the data are retrieved from the server over a network and is sent to the client for display. There are two ways in which the data is passed onto the client for display.

- Store and Display model
- Remote Streaming model

In case of 'Store and display', the SM objects are downloaded entirely from the server to the local storage before the display process is initiated whereas in the 'remote streaming' the data are retrieved from the server over a network and are displayed to the client while it is still being downloaded. Both the models that have been mentioned above have their own advantages and disadvantages.

Advantages of Streaming over Store and display model:

- No need to wait for the whole file to be downloaded
- No copies of the data will be stored locally
- No storage requirements at the client side
- Suitable for live events

Limitations of Streaming:

- Playback solely depends on the network connection of the client
- Slower playback
- Lost/damaged packets might cause coarse playback of video

The focus here is on the limitation of the streaming that requires the streaming going on even in the poor network condition without any intrusion in the playback.

The remainder of this paper is organized as follows: Related studies deals with an overview of the existing system and explains the novelty of the proposed system (SMCeL). The next section presents the proposed system with the help of the relevant diagrams. The algorithm that has been employed in the SMCeL framework is followed. The results of the simulation and an insight in to the advantages of the proposed system is discussed under results and discussion. Finally, a summary of the paper and also discussion about the future scopes are dealt.

RELATED STUDIES

Previous research works that has been carried out by Reibman et al (2003), Benzler et al (2000), Wang et al (2003), Schierl et al (2007) and Chou et al (2004) focuses on the video quality adaptation according to the network conditions but none of them are specially designed for educational multimedia content. Since Multimedia streaming is necessary in developing e-learning and mobile learning systems (Dorai et al (2001), Leung et al (2003) and Liu et al (2002)). There have been lot of research work carried on scalable video coding (Reibman et al (2003), Benzler et al (2000), Wang et al (2003), Schierl et al (2007) and Chou et al (2004)) network bandwidth allocation (Legout et al (2001) and Chou et al (2004)), and video streaming which is discussed in papers by Won et al (2014), Kennedy et al (2011), Falik et al (2010) and Pudlewski et al (2011).

In Scalable video coding, the network conditions of the client is analysed and thus depending on the available bandwidth, the enhancement layers are added onto the base layer which means, a client with a poor bandwidth receives a low quality video and the client with a higher bandwidth receives a better quality video with all the enhancement layers.
For different network conditions, different quality video is being delivered in the case of scalable video coding explained in the following papers by Reibman et al (2003), Benzler et al (2000), Wang et al (2003), Schierl et al (2007), Chou et al (2004), Li et al (2008), Wu et al (2001) and Lu et al (2013).

In wireless streaming of lecture multimedia content, it is important that the main content of the lecture is being delivered to the client. For example, even for the client with a poor network bandwidth, the content of the lecture has to be somehow delivered.

Considering the above issue, a framework of encoding multimedia content as different subsets is provided, also determination of what content has to be delivered to the client depending on the network conditions of the client. Different versions of the lecture multimedia content will be available while encoding it to the storage server.

- Video & Audio (High rate network connection)
- Text (with low resolution) & Audio (Low rate network connection)
- Only Audio (with low quality) (Very poor network connection)

SMCeL framework (Proposed Method)

A framework is designed considering the fact that there would be varying network conditions across different clients. The figure 2 explains the overall architecture of the proposed system. The multimedia lecture content is encoded in different forms to the local storage server which is then transferred to the web server. The clients who request to access the multimedia content would receive the version of the lecture content which is suitable for their network condition.

The idea behind the proposed system is that the client (students) who have poor network condition should also be available to the lecture content available online. Thus there are different version of the content available in the local storage. The multimedia lecture content is made available to all the clients irrespective of the network condition. Hence all the clients (students) will be able to have an access to the lecture content they need.

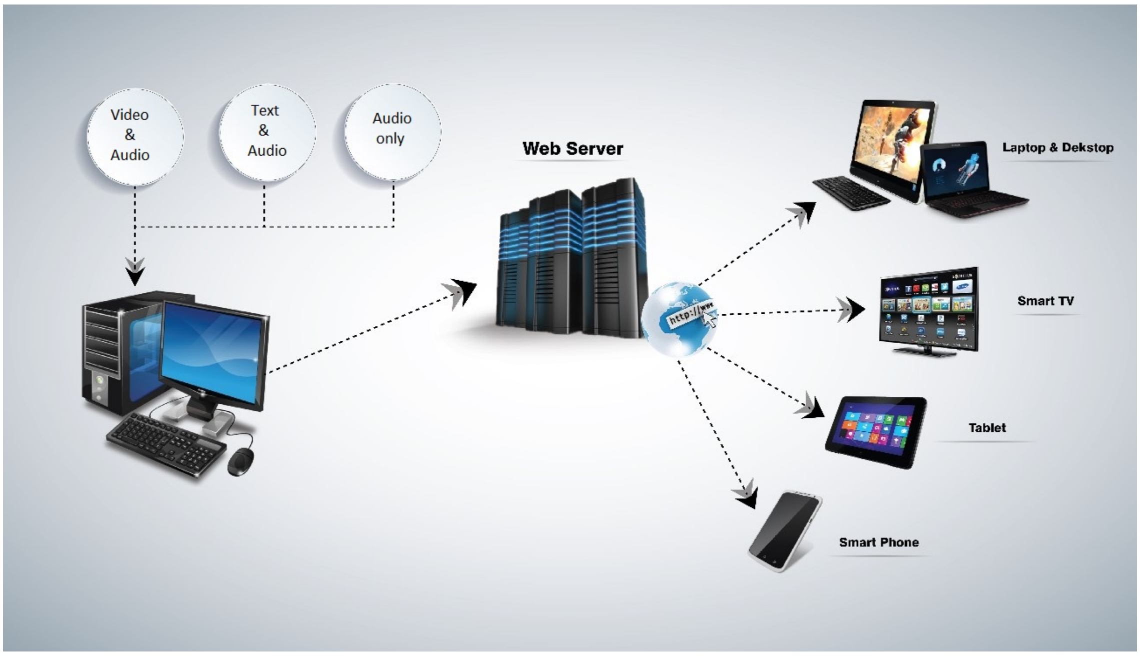

Fig 2: SMCeL Architecture

There are two stages in the proposed system: the encoding stage and the decoding stage. Fig. 3 explains the encoding stage. In this stage, the multimedia content is being encoded to the server and is available in different versions.
At the given transmission time t, the network bandwidth Tc of the Client is estimated. A threshold Ti is set so as to decide on the client's network condition.

- Condition 1: If Tc is greater than Ti (Tc>Ti) then the first quality video as well as audio will be transmitted to the client.
- Condition 2: If Tc is lesser than the Ti (Tc<Ti) then only the text and the audio of the lecture content is made available to the client. The threshold Ti is set low that only in poor condition this condition is applied.
- Condition 3: A new threshold value Tn is set as the worst case scenario, if Tc is lesser than Tn (Tc<Tn) then the video packets are dropped and only audio is delivered to the client.

ALGORITHM

Phase 1:

In this phase, the determination of the multimedia content that has to be transmitted to the client is performed. As explained in the previous section, each threshold *Ti* is associated to the multimedia content to be sent. This phase is executed periodically, to check if a new threshold has been reached.

End phase 1.

Phase2:

In this section the algorithm is used to find out what multimedia content would be suitable to be transmitted across to the clients.

The following steps are performed:

Step 1 Encoding different versions of multimedia lecture content
Step 2 Analyse the network condition of the receiver
Step 3 Decision making performed on the multimedia content to be sent
Step 4 Sending of data to the destination.

End Phase 2

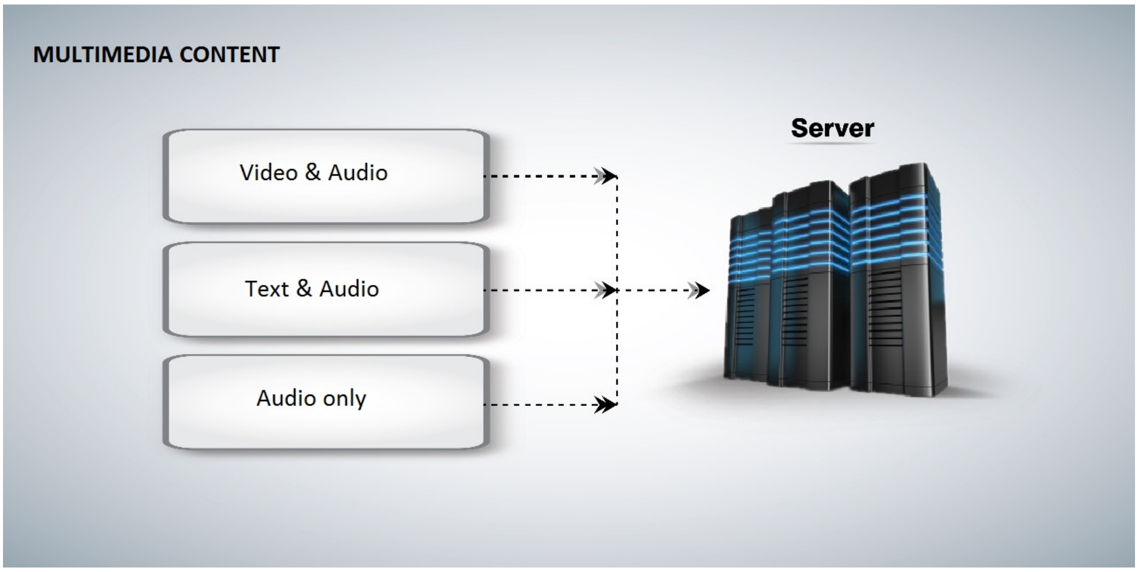

Fig. 3: Encoding multimedia content to the server

The third condition is considered in the worst case condition in which the client/student is in need of the content, for example, if he/she has an exam coming up and needs the lecture content then there is at least the audio delivered to the student than giving nothing.

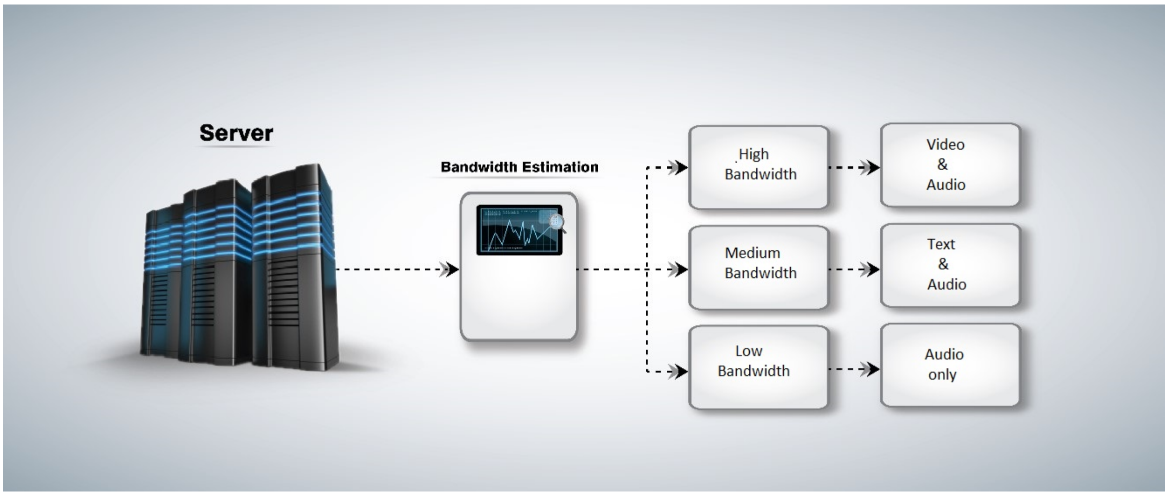

Fig. 4: Decoding multimedia content depending on the client's network conditions

RESULTS & DISCUSSION

The main aim of this research proposal is to make the lecture content available to the students irrespective of the poor network conditions. We consider the scenario in which the student requires the lecture content, for example, during an assessment time and stuck with a poor bandwidth, hence unable to go through the content. In this case, the core lecture content is aimed at somehow being delivered to the student.

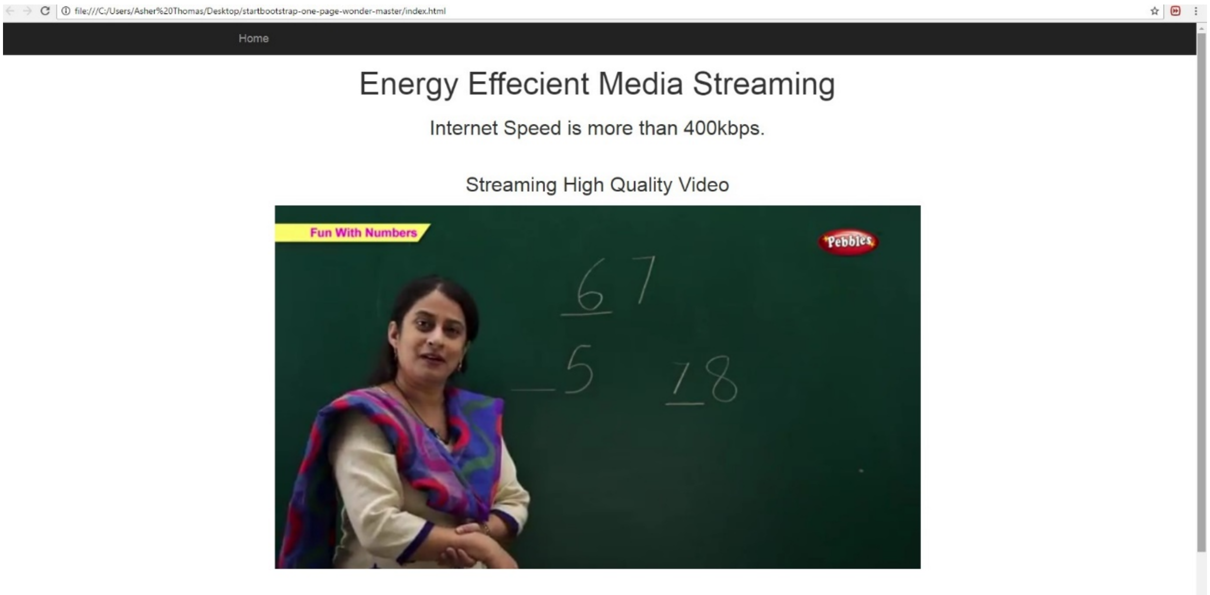

Fig 5: Multimedia streaming in high speed network condition

Fig 6: Streaming only audio for poor network condition.

The prototype of the SMCeL design suggested is shown in the figures (Figure 5 &6). This proves the effectiveness of the system that delivers the multimedia lecture content according to the network conditions of the student.

CONCLUSION & FUTURE DIRECTIONS

In this paper, SMCeL framework has been presented which is scalable multimedia content transmission of lecture videos over wireless networks. Real time evaluation of network condition and scalable multimedia content transmission are provided. Different multimedia content transmission for varying network conditions of the clients is provided.
The system could be further improved by analysing the energy consumption characteristics and employing packet scheduling algorithms to bring about energy efficiency in the proposed framework. The efficiency of multimedia streaming system for education will be further investigated and its social effect on students will also be covered as future work of this paper.

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