A Study on Reducing Entropy Rate of Adaptive Streaming Bitrate Fluctuation

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Abstract. This study presents a method using fuzzy logic and a mathematics moving average technique, to reduce mobile video quality fluctuation in DASH. First, we calculate the moving average of the bandwidth and buffer values for a given period. On the basis of differences between real and average values, we propose a fuzzy logic system to deduce the value of the video quality representation for the next request. Besides, we use the entropy rate of a bandwidth measurement sequence to measure the predictable or stabilization of our method. As a result, the experiment shows that the method significantly reduces the fluctuation, the use of bandwidth also approaches to the actual bandwidth asymptotically.

Keywords: HEVC, 3D Multi-view, Multi-path, Adaptive streaming, P2P, Video streaming.

1 Introduction

Media streaming over the internet became an essential part of every service providers. On the one hand, it virtualizes an expression of what does it mean, how does it do as human mind rather familiar with figures and video than wording expression. On the other hand, it provides recreational facilities in a short period since internet users are busy with their daily life schedule. Recently, the internet transmission technologies have had many improvements to deliver video and audio events across the Internet in real-time for user efficiently. Most of them are focusing on three factors: 1) video/audio compression algorithms; 2) improvements in broadband wired and wireless networks; 3) optimizing delivering method of streaming servers.

Though the development of delivery multimedia over the Internet has many improvements, users always require not only continuous video playback at the client, but they also demand a high-quality of video with a wide spatial resolution and depth

in color. As reported from [4], all the services that utilize networks such as video distribution services like YouTube, Hulu, terrestrial digital television (TV), the three-dimensional TV, Internet Protocol Television (IPTV) have exceeded expectations for communication network services and continue to grow. In the recent years, optical technology has been striking in the use of network transmissions, such as a 104-times increase in transmission capacity and an over 106-times increase in the product of signal bandwidth and transmission distance.
In this paper, we focus on a method of improvement in a server to maximize bandwidth usage and minimize the fluctuation of mobile video streaming solution by employing entropy rate as a short of our research [1]. In Section II provides related research. Section III presents our proposed method which discusses the working flow and the major components. Following up is Section IV with an experiment where we build a server on NodeJS [12], and a mobile client runs on Android. Finally, we conclude our work with the future work of the research.

The rest of paper is organized as follows. In section 2, we present related works which interest in entropy and entropy rate. In Section 3, we introduce the system. In section 4, we describe our experiment and discuss the results achieved. Section 5 presents our findings with future research directions.

2 Related Works

Using entropy to characterize per-application network traffic, the authors [2] estimated the entropy of difference streaming scenarios and divided them into categories of entropy measurement from the lowest to the highest. The entropy rate of a sequence is a measure of how predictable a sequence is based on past observations. Invariant streaming sequence probably has entropy rate equals to zero. Meanwhile, an independent sequence of streaming has entropy rate with a value one as an example of coin tossing. By the above logic, they observed the past sequence of these streaming and deducted new information of the outcome in the next streaming sequence.

3 System Overview

We introduce two mathematic techniques. First, we use a moving average [3] to estimate average bandwidth at the current request of a client. Secondly, we use fuzzy logic [4] to infer whether bandwidth is increased or decreased. We then predict a bandwidth value of the client and request time when the client sends a request to get a segment from a server.

The fuzzy system has three main calculation processes. First, we form real input values of the system, and this process is referred to as fuzzification. Then user or expert's experiential knowledge is used as if and then rules to calculate the output, and this process is called inference. Finally, the system defuses the input value to calculate the output system which is the decision of response segment, and this process is also known as defuzzification. Figure 1 depicts the detail of the system.

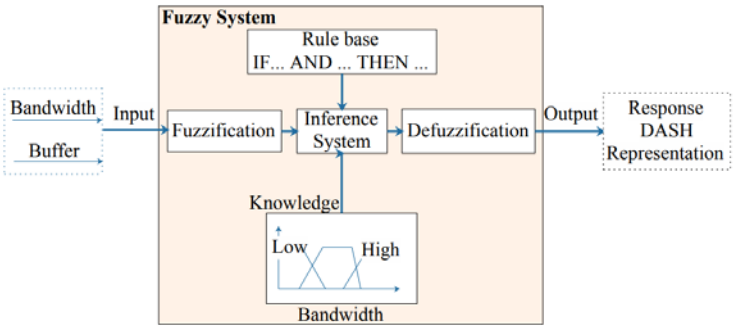

Figure 1: Overview of the proposed fuzzy system.

In this paper, we only focus on the server, all the traffic measurements and calculation is implemented on the server. On the mobile client, we use the current implementation of DASH streaming on Android which makes segment request and plays out the video.

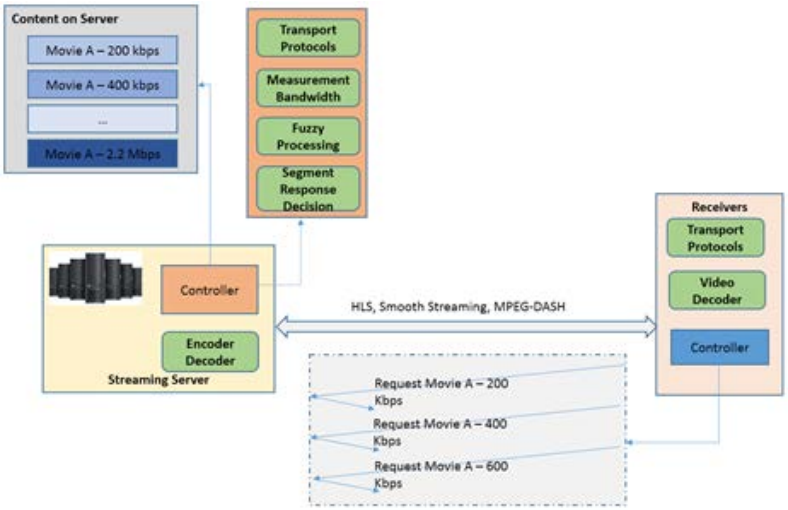

Figure 2: Overview of the proposed streaming system.

The proposed system is based on DASH streaming system structure as shown in Figure 2. We use the original system and add a control segment component response. The client detects bandwidth and CPU capacity in real time and adjusts the quality of a video stream accordingly. It switches between streaming the different encodings depending on available resources. Each time before responding to a request from the client, instead of directly points out the location of the client's request resolution, the server calculates and decides optimized segment.

4 Experiment and Discussion

The server listens to a request from a client and responds an optimized video resolution segment. A client runs on an Android mobile application which supports adaptive streaming. We tested the system in two scenarios. First, we connect the mobile user with a Wi-Fi 5G to have a video streaming with the server. We then go away and move closer to the Wi-Fi to have a bandwidth fluctuation. Second, a mobile user has subscribed to 4G service in South Korea. It also moves around an urban area and a remote area.

As a result, we got the download speed of the client fluctuates in a range as shown in Figure 3 with the red line. The blue line depicts the moving average measurement. The green line illustrates the bandwidth a prediction of our proposed method. Recall that, the moving average only measure the mean of the given values. That is a reason why the green line is a bit longer than the blue line. In this experiment, we only anticipate the average bandwidth before one step of the bandwidth measurement. We can also predict the bandwidth more than one step in which each predicting value is based on the previously predicted value. As a result, the green line does not vary much as the original implementation bandwidth in the red line, and it closes to the average measurement.

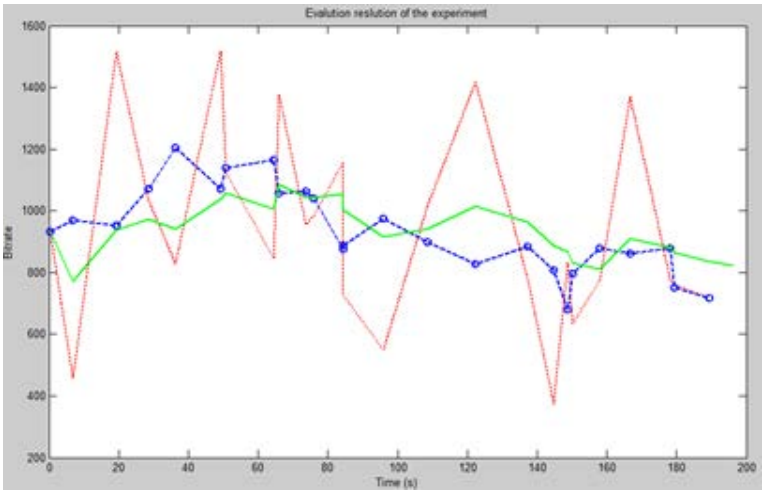

Figure 3: Bandwidth fluctuation and result of bandwidth prediction.

5 Conclusion

In this paper, we presented the fuzzy-based method to reduce the mobile video quality fluctuation of the high-quality video-streaming in dynamic adaptive streaming over HTTP. For future work, we intend to investigate more in the ultra-high definition

multimedia transmission for a mobile device over the network by cooperating the proposed method with the most recent advantage video compression techniques.

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