論　文　要　旨
Thesis Abstract

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主論文題名　（Title）

BIOLOGICAL INFORMATION BASED QOE MANAGEMENT IN ADAPTIVE STREAMING SERVICES

内容の要旨　（Abstract）

The introduction of adaptive streaming technologies, especially HTTP adaptive streaming (HAS) has significantly improved the video quality perceived by end-user, making video service becomes one of the most dominant services on the Internet. Due to the limitation of network resource supply (e.g., available bandwidth), for profit improvement, service providers have to take into account Quality of Experience (QoE) management by which QoE stands for perceived video quality will be frequently monitored and maintained with optimal network resource utilization. However, with the growth in the availability of multimedia services, coupled with the technological advances in compression and streaming, it is witnessing a great demand for video contents with high quality. Meanwhile, the number of subscribers is also continuously increasing. These situations put more pressure on the existing network infrastructures, requiring an upgrade. However, when the service providers attempt to upgrade their systems, it might reach to the physical limits. Thus, there is a growing need of more efficient QoE management system in adaptive streaming services.

In this dissertation, a biological information based QoE management framework has been proposed. Thereby, a balance between network resource utilization and the resulting QoE is guaranteed. The achieved results are outlined in the following:

- First, one of the requirements of QoE monitoring is to perform early detection of QoE deterioration. The design of QoE monitoring usually comprises of two major steps: Selecting appropriate monitoring factors and selecting suitable monitoring interval. In this research, adaption logic factors comprising of playback buffer, video rate and QoS parameters, have been investigated. Both playback buffer and video rate can only be obtained on a chunk-by-chunk basic that relies on the timestamp of two successive video requests. In addition, video rate is usually selected based on a throughput estimation over a long time period. Thus, the deteriorations will be perceived by the end-user before control action is generated. Meanwhile, QoS can be monitored with flexible self-defined interval that does not depend on chunk-by-chunk basic, becoming a suitable monitoring factor for early detection purpose. This study aims at determining such the appropriate self-defined

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- interval of QoS monitoring. In adaptive streaming, playback buffer is a situational indicator for video rate adaption. The results of an experiment demonstrated that the first deterioration of playback buffer always provides an accurate prediction of video rate deterioration. Therefore, monitoring QoS with suitable interval can accurately capture the first deterioration of playback buffer, benefiting early detection of video rate or QoE deterioration. The monitoring interval is then proposed to be equal to video chunk size. By using the proposed interval, the balance between computational cost and ratio of video rate deterioration has been achieved.

- Second, in QoE control, threshold plays an important role in deciding when control action should be triggered. However, similar to monitoring interval, it has not been carefully investigated yet. In literature, QoE threshold is usually picked up as the fair level or the middle level in 5-scale Mean Opinion Score (MOS) (the most common QoE indicator) without reasonable explanation. It motivated us to propose a novel method to determine the appropriate value of QoE threshold. In this research, by clarifying the drawback of existing approaches in determining threshold, a novel collaborative approach using psychophysiology and psychophysics was proposed to ascertain an appropriate QoE threshold. Consequently, the experimental results demonstrate that using the proposed threshold can save at least 4.85% of available bandwidth per control compared to the use of fair one.

- Third, in QoE control, bandwidth allocation is commonly used as control action. In order to accurately allocate bandwidth to the users, some existing works calculate the needed bandwidth based on target video rate. However, the determination of target video rate is still a challenge, where contemporary researchers simply pick up the target video rate from a list of available video rate at server. Therefore, we proposed a method to determine the target video rate from expected subjective MOS level by leveraging a regression model which expresses the relation between video rate and subjective QoE. The evaluative results show that once being lower than threshold, estimated QoE will be automatically recovered to the expected level, while more bandwidth can be saved per control.

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