

QoE Comparison of Competition Avoidance Methods for Management of Shared Object in Networked Real-Time Game with Haptic Media

Yuji Kusunose*

Yutaka Ishibashi†

Norishige Fukushima‡

Shinji Sugawara§

Department of Scientific and Engineering Simulation
Nagoya Institute of Technology

ABSTRACT

In this paper, we investigate competition avoidance methods for management of a shared object in a networked real-time game with haptic media. For competition avoidance, we deal with a priority method and a combined method of AtoZ (Allocated Topographical Zone) and CDP (Count Down Protocol). We also clarify the influence of network delay on QoE (Quality of Experience) for the two methods.

Keywords: Networked real-time game, Haptic media, Competition avoidance, Network delay, QoE

1 INTRODUCTION

It is expected that using haptic media in networked real-time games gives players a higher sense of immersion. However, the consistency and causality may be disturbed owing to network delay, delay jitter, and packet loss in a QoS (Quality of Service) non-guaranteed network like the Internet.

The authors investigated the influence of network delay on QoE (Quality of Experience) in a networked air hockey game with haptic media [1]. For consistency and causality, they employed the adaptive Δ -causality control scheme with adaptive dead-reckoning (referred to as Adaptive DR + Adaptive Δ). However, they demonstrated that disagreement of the owner of a shared object occurs when the network delay is large. To solve this problem, we need a competition avoidance method.

In this paper, we treat a priority method and a combined method of AtoZ (Allocated Topographical Zone) and CDP (Count Down Protocol) [2], [3] (called AtoZ + CDP) for competition avoidance. Then, we compare the two methods by QoE assessment in the networked air hockey game with haptic media. We also investigate the influence of network delay on QoE.

2 NETWORKED AIR HOCKEY GAME WITH HAPTIC MEDIA

In the game, two users fight against each other. Each user operates his/her mallet with a haptic interface device, and he/she hits a puck toward his/her opponent's goal. Each terminal uses PHANToM Omni (just called PHANToM) as the haptic interface device. When a mallet touches the puck, a player of the mallet feels force feedback. The game is based on a peer-to-peer (P2P) model. The owner of the puck, who has hit the puck last, calculates the position and velocity of the puck. A terminal which is not the owner of the puck outputs the puck at a position which has been received from the owner. When the owner of the puck is different between the terminals, we use the priority method or AtoZ + CDP for competition avoidance. For consistency and causality, we use Adaptive DR + Adaptive Δ in each method. In this scheme, the output time of position information is given by the generation time of the information plus Δ (> 0) ms. The value of Δ is dynamically changed according to the network delay and satisfies the following relation: $0 < \Delta_L \leq \Delta \leq \Delta_H$.

3 COMPETITION AVOIDANCE METHODS

3.1 Priority Method

In this method, if the owner of the puck is different between the two terminals for a fixed time (set to $2\Delta_H$ ms in this paper), one termi-

*e-mail: kusunose-y@mcl.nitech.ac.jp

†e-mail: ishibas@nitech.ac.jp

‡e-mail: fukushima@nitech.ac.jp

§e-mail: shinji@nitech.ac.jp

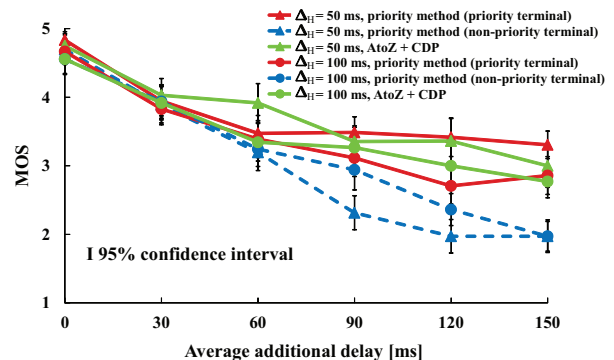


Figure 1: MOS of comprehensive quality.

nal (called the *priority terminal*) which is determined in advance becomes the owner of the puck, and the other terminal (the *non-priority terminal*) conforms the position of the puck to that of the priority terminal. Then, a warp (momentary and large movement) immediately after a pause of the puck occurs at the non-priority terminal; thus, the output quality of the puck deteriorates.

3.2 AtoZ + CDP

AtoZ is used to determine which terminal can access to the puck most quickly by taking account of the positions and velocities of the mallets. The determined terminal acquires the ownership of the puck when the owner of the puck is different between the two terminals.

CDP is a protocol used when the puck exists in a field called Dead Zone, where the owner of the puck cannot be uniquely determined owing to the influence of network delay in AtoZ. The basic idea of CDP is that a terminal resigns the ownership of the puck until the terminal receives the information that the other terminal manages the puck. If the owner of the puck is different between the terminals after using AtoZ + CDP, we use the priority method. The reader is referred to [2] and [3] for details of AtoZ and CDP.

4 ASSESSMENT METHOD AND RESULTS

We show the mean opinion score (MOS) of comprehensive quality [1] in Fig. 1, where the average MOS value is plotted in AtoZ + CDP since there was almost no difference in MOS between the two terminals. From this figure, we see that the fairness between the terminals is ruined when the network delay is large in the priority method, while we can keep the fairness and MOS high in AtoZ + CDP.

5 CONCLUSION

In this paper, we made a comparison between the priority method and AtoZ + CDP in a networked real-time game with haptic media. As a result, we demonstrated that the fairness between terminals is ruined when the network delay is large in the priority method, while we can keep the fairness and MOS high in AtoZ + CDP.

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