

0. Why QoE important? Definition of and Bonus from QoE.

1. Why delay. QoE Study and system instance.

2. Related works on 2D - The lack of delay-related works.

3. The specification of 3D? As the rule of telephone is 150ms, it is various in 2D. Maybe the variety of tasks caused this problem.

Currently, QoE studies in telepresence concentrate on 2D: countless works on video-mediated communication, some on robotic [,] and pseudo-3D [,] telepresence. On the other hand, previous works about 3DTI do not focus on QoE study. A part of them includes user experiment [,] but only for their own practicability.

For the possible popularization of 3D telepresence in the near future, we argue that a series of QoE researches are required. In this paper, we focus on the study of delay. Below is a brief review of latency in telepresence.

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Below are NOTES: Delay indeed MATTER

[错误! 未找到引用源。]. 2015. JackInHead] is an immersive telepresence system which allows remote users to explore the scene from the local user's view. In this work, the video and audio streams are transmitted via difference protocols. Sometime the video was delayed, which caused a lot of miscommunication.

[错误! 未找到引用源。]. 2017. Movement matters] conducted a study on effects of motion and mimicked movement in robotic telepresence. However, they could not figure out whether delay may affect perceptions of the movement or not.

[错误! 未找到引用源。]. 2013. Group2Group] In this group to group telepresence. The end to end latency is 300 to 500ms, which is much more than the golden rule of 150ms.

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Below are NOTES: Studies on latency

[错误! 未找到引用源。]. 2014. Understanding How Network Performance Affects User Experience of Remote Guidance] have done a preliminary user study on How QoS (include latency) affects UX in tele-collaboration. Result shows that the networks with high latency or packet loss received the worst QoE score. However, previous works have shown that QoE in telecommunication is task dependent. So the external validity of this paper should be verified in future works.

[错误! 未找到引用源。]. 2003. One way transmission time] For audio-only communication, 150ms have been established as an industry standard for and acceptable delay.

[2005. The Well-Tempered Conversation: Interactivity, Delay and Perceptual VoIP Quality] is a QoE study for telephone conversation by analyzing the conversation state like who is talking or both the two users are talking or silent.

[2014. Asymmetric delay in video-mediated group discussion] Delay has been found as one of the most crucial factors determining the QoE in synchronous video-mediated communication.

[2013. Qualinet White Paper on Definitions of Quality of Experience] and [A QoE Testbed for socially-aware Video-mediated Group Communication] are theoretical models established that QoE is shaped mainly by three aspects: the system, the user and the context. These two paper also pointed out the importance of delay. The white paper defines QoE as: the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state.

The influence factor: human IF, system IFs and context IFs.

[2012. Video increases the perception of naturalness during remote interactions with latency] this paper suggest that delay had a weaker impact on perception of naturalness when both audio and video channels were available, for delays up to 500ms, than when only the audio channel. Visual telecommunication systems are popular because they support more natural forms of interaction than telephones and text-based chat rooms.

[Understanding latency in IP telephone] and [Supporting real-time traffic: Preparing your IP network for video conferencing] suggest that audio delays be below 200ms.

[1978. A Simplest Systematics for the Organization of Turn-Taking for Conversation] Turn talking model.

[2009. Quality of experience in distributed interactive multimedia environments] described a user-centric QoE conceptual framework for the area of distributed interactive multimedia environments.

[2013. Augmented Sport: Exploring Collective User Experience] as for the DIME Cognitive Perception model, Telepresence represents users' perceptual Sense of Being within the Distributed Interactive Multimedia Environment that is in 3D LIVE the Mixed Reality environment.

[Transmission systems and media, digital systems and networks] For telecommunications, a latency which is longer than 400ms is unacceptable. Currently, 150ms is used as a rule of thumb, a value drawn by telecommunication research. The most applications would be acceptable within 150ms. For more immersive telecommunications such as 3D conferencing, a latency of 100ms would be better.

[Exploiting Contextual Information to Enable Efficient] In the dissemination phase of 3DTI, the tradeoffs happen

between bandwidth/delay restrictions of the network, and the acceptance ratio for user subscriptions.

[Distortion Score based Pose Selection for 3D Tele-Immersion] claims that large delays/latencies introduced during the transmission of these data can lead to poor quality of experience of 3DTI systems. But no study to prove it.

[Holoportation] 70ms latency is noticed in VR condition but not in AR one.

[Definitions of terms related to quality service. 2008] QoS is defined by the ITU as “Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service”. QoE is defined as “the overall acceptability of an application or service, as perceived subjectively by the end- user”.