Related Work Description and Some Notes

Yizheng Gu

Tsinghua University Beijing, China guyz17@mail.tsinghua.edu.cn 2nd Author Name
Affiliation
City, Country
e-mail address

3rd Author NameAffiliation
City, Country
e-mail address

ABSTRACT

While 3D Tele-immersion techniques develop rapidly, the effects of transmission quality on its users remain unexplored. Since the transmission quality such as delay, frame rate, resolution and cost are trade-off nowadays, we argue that it is important to study the user experience in 3D Tele-immersion systems.

Author Keywords

Telepresence, Delay, Network Performance, QOE.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; See http://acm.org/about/class/1998 for the full list of ACM classifiers. This section is required.

INTRODUCTION

注:以下还不是 introduction, 只是我自己做的一些 笔记。

看起来, 3D Tele-immersion 相比于其它更简单的技术而言, 其优势并不是我们想象中那么理所当然, 也许需要在 introduction 中讨论一下。

我似乎忽略了 FOV 等因素。这些因素不属于 transmission quality trade-off,但是对人的认知是 重要的。

我们在实验上的贡献不多说了。我们在技术上的贡献: 1、我们尝试对齐并 merge 两个场景中相同的物体,以提供 shared objects in the virtual scene; 2、我们提供一个可操作的交互过程,来校准两个场景,裁剪无用的背景,凸显公共部分和人物。 3、我们尝试了并对比了许多商用硬件,发现 RealSense 在深度摄像头中最优,发现 Gtx1080Ti 可以实现多少多少的实时性,而HTC Vive 则免去已渲染图像无线传输的不便,我们还公布了经过深度 GPU 优化的代码; 4、这套系统除了网络传输以外,使用了可以在实验室外也能获得的设备,是 practicable 的,而网络传输部分只需要了 2D 视频

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RELATED WORK

Related work 的思路暂定如下: (1) 首先介绍基于Reconstruction的 3DTI 技术 (Tele-immersion) 有哪些,突出其好处,表明基于 Reconstruction的 3DTI 将会成为下一代的远程通信技术; (2) 在之前的工作中,存在对基于 robotic 或者 presed-3D 远程呈现的研究,也有对 Tele-immersion中一些小问题进行的小型 user study,但对 Tele-immersion中最基本的问题,如延迟对用户的影响,还不存在; (3) 为了开展这份工作,我们参考了 Telephone 和 Video conference 中的测量方法,这里总结一下其中的 measurement 方法。或者写QoE 的相关研究。

在 Related work 的写作过程中,第一部分将参考 Holoportation,第二部分待定,第三部分将参考 [General Recommendation on the transmission quality for an entire international telephone connection]。

3DTI technique

In early works, researchers use an array of cameras to construct the virtual scene from physical world.

[Virtual space teleconferencing using a sea of cameras. 1994]

[Virtualized reality: Constructing virtual worlds from real scenes. 1997]

[TELEPORT. 1999] the early immersive telepresence system.

Then, researchers start to improve the capturing of 3D model in real time.

[3D Tele-Collaboration Over Internet2. 2002] researchers assembled the best of available hardware and software technologies to present a 3D tele-immersion with point cloud.

[blue-c. 2003] is an early telepresence system.

[Real World Video Avatar. 2004] transmit and present the figure of a person at a remote location in real time.

[Immersive 3D Environment for remote collaboration. 2008] presented an immersive telepresence system for remote collaboration and training of physical activities.

[Multicamera Real-Time 3D Modeling for Telepresence and remote collaboration. 2010] This system allows to retrieve in real-time a 3D mesh of the observed scene.

[Encumbrance-Free Telepresence System. 2011] presented a 3D telepresence system which is affordable and reproducible, offering the opportunity to deliver it beyond the researcher's lab.

[KinectFusion. 2011] present a system for real-time mapping of arbitrary indoor scenes, using only a moving low-cost depth camera.

[Real-Time Volumetric 3D capture. 2012] described a 3D acquisition system, which is the most similar to our system. Our system is designed based on this previous work, the kernel algorithms of which are Tsdf Volume and Marching Cubes.

[A Volumetric Method for Building Complex. 1996] This paper describes the algorithm of creating the 3D model from range image.

[Marching Cubes. 1987] is a high resolution 3D surface construction algorithm based on TSDF Volume.

Recently, state-of-the art techniques achieve higher rendering quality.

[Fusion4D. 2016] contributed a pipeline for live high-quality reconstructions in real-time.

[Holoportation. 2016] for the first time presents an end-toend system for augmented and virtual reality telepresence. This paper contributes as describing the tele-immersion pipeline in full.

User Study in 3D Telepresence

There are basically three types of techniques in 3D telepresence: Pseudo-3D, Robotic, Reconstruction. The impacts on users were well study in both robotic and embodiment, while the users' feeling in 3d reconstruction based telepresence remained underexplored.

Pseduo-3D

[ImmerseBoard]

[Towards Next Generation 3D Teleconferencing Systems]

[Evaluation of Factors Affecting Distance Perception] identify the most important factors that influence decision making and accuracy of distance perception with an immersive large screen display. The paper presents guidelines for setting up this kind of system.

Robotic

[The Future of Robotic Telepresence]

[Racetime: Telepresence Racing Game with]

[Movement Matters]

[My Student is a Robot]

[Robotic Telepresence at Scale]

[To Beam or Not to Beam]

[JackIn Head] JackIn Head allows remote user to see what the "Body user" can see. "Body user" wears an omnidirectional camera to transmit video to remote user. This paper contributes as an image stabilization technique and a study to this system.

[Augmented reality-aided telepresence system for robot] investigates the use of an immersive telepresence system for industrial robotics. Experiment shows the practicability and effectiveness.

[ChameleonMask: Embodied Physical and Social] uses a real human as a surrogate for the remote user.

[Can you see me now?] study the effects of FOV on users with robotic telepresence systems.

[Bodies in Motion] Mobility significantly increased the user's feelings of presence but decrease task performance.

[Communication Behavior in Embodied Virtual Reality] Maybe it is not robotic, but embodiment.

Reconstruction

[MirageTable] provides a one-to-one 3D telepresence experience by using Kinect and projector. Specially this system allows freehand physical interaction with virtual world.

[Immersive Group-to-Group Telepresence] This work built the first telepresence system which provides a shared space in immersive virtual reality environment. This paper and [Adapting standard video codecs for depth streaming] mention that they do not focus on the compression and transmission bandwidth.

[Room2Room] MSR proposed Room2Room system, which allows room to room naked eye 3d telepresence system with only a Kinect and a projector. They did a study and shows that it is significantly better in completion time and presence compared to Skype.

QoE in Telecommunication

Telephone

[General Recommendation on the transmission quality for an entire international telephone connection] 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.

[The E-model] This model can help ensure that users will be satisfied with end-to-end transmission performance, avoiding over-engineering of networks. It is a tool for assessing the combines effects of variations in several transmission parameters the affect the conversational quality. The output is a scalar rating of transmission quality.

[Objective and Subjective assessment of telecommunication quality] In the annex of this paper it describes a user study to evaluate subjective feedback of telephone call in details.

Video Conference

In 2D telepresence, huge amount of works related to users' feeling has been done.

[Are We in sync?] In synchronization of watching video, 500ms is acceptable with video chat, and 2s is for text chat.

[Beyond Talking Heads] This paper in CSCW 2016 conducted a survey with members of distributed teams to investigate how they host distributed meetings. Nowadays most distributed meetings are hosted with video-based conference. The results suggest that tools and approaches are inadequate for meeting scenarios that require participants to not only converse but also to share different types of multimedia content. Note: 41% video-conference involve 3+ locations.

[Taking Notes or Playing Games?] presents a detailed examination of factors that affect perceptions of multitasking in video conferencing. It proposes a conceptual model for the design of video communication tools.

[Accuracy of Deictic Gestures to Support Telepresence] presents a controlled study to assess the accuracy when user showing a shored object on a wall-sized display. Eye gaze is more important than hand gesture.

[Remote handshaking] touch enhances video-mediated telepresence which partner's action needs to occur but should be invisible in the video.

Quality of Experience

[Augmented Sport. 2013] The Rational Part of UX in telepresence. *Psychology flow*: Concentration, Enjoyment and Sense of control. *Telepresence*: the sense of being or the sense of presence. *Technology Acceptance*: perceived usefulness and perceived easiness.

The Experiential Part of UX. *Social Presence*: social context, online communication and interactivity. *Social Emotion* are emotions that require the representation of the mental states of other people. *Emotional Response*.

This paper also pointed out the special different constructs in 3D LIVE UX and QoE model.

[Understanding How Network Performance Affects. 2014] Much research has been done to support remote collaboration on physical tasks, however, less attention has been paid to investigating how network performance can affect user experience and task performance. This paper examined 5 network scenarios and f metrics including *delay*, *jitter*, *bandwidth* and *packet loss*, and find that packet loss is the most significant in their system.

Delay: up to 400ms for telephone quality speech, maximum 100ms to 500ms for applications with real time sound transmission.

Jitter: the jitter for videoconferencing applications should not exceed 400ms.

QoE questions: Time taken for the task? Repeated instructions? Video/Audio/Overall quality rating?

There is a table of QoS metrics with Ethernet/Satellite/3G/Wi-Fi/Fibre.

[Requirements of Network Applications on the Internet. 2004] Real time sound is the most sensitive data transmission type to jitter.

[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".

[Interactivity Patterns in the QoE in Multi-party Videomediated Conversations with delay. 2014] This paper took not only system factors but also context and user factors into account to investigate the QoE in Multi-party (more than 2) video-mediated conversations. The author suggested that user activity should be considered as a prime adaptation and optimization parameter.

When connecting two computers between New York and Hong Kong, the round delay is up to 776ms for Google+, and 1467ms for Skype.

[Qualinet White Paper on Definition of Quality of Experience. 2012] [A QoE Testbed for Socially-aware Video-mediated Group Communication] QoE is shaped mainly by the system, the user and the context.

[Stevens' Power Law in 3D Tele-immersion. 2014] Given a stimulus A and its responding quantified perception B, Stevens' Power Law indicates that $B = k * A ^ p$. This paper found that this law has no significance of packet loss in 3D Tele-immersion.

[Quality of Experience in Immersive Multimedia. 2015] A clear distinction between low and high IL were observed, whereas the differences between middle and high IL were not significant.

[QoE Modelling for VP9 and H.265 Videos. 2015] This paper introduced novel predictions such as the correlations between video solution etc., and achieve a goodness-of-fit to the subjective assessment data (R>83%).

[VQMT: Video Quality Measurement Tool. 2013] as title say, PSNR, SSIM, etc.

[Exploring QoE for Power Efficiency. 2015] A field study on mobile videos with LCD displays.

FUTURE WORK

Beside delay, there are some other network performance can affect user experience, such as bandwidth (relating to rendering quality), jitter and packet loss. In the future, we will first figure out how should we assign the transmission data when the bandwidth is fixed, i.e., the resolution of depth image and color image flow. Then, we will further investigate jitter and packet loss and try to find out the solutions. Our final target is to totally understand how network performance affects user experience of 3D Tele-Immersion, and give a guideline for its engineering.

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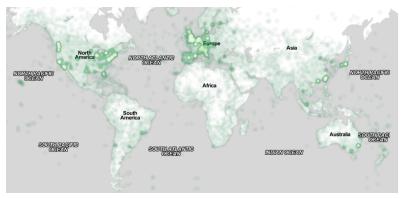


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