technische universität dortmund

computer science 12

Bachelor/Master Thesis

Framework for Delivering VR Contents Over Wireless Network

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Virtual Reality (VR) is a computer-generated environment with scenes and objects that appear to be real, making the user feel they are immersed in their surroundings. In recent years, many researches and commercial products focus on wireless VR, which enables users to access VR experiences without being tethered to a physical location. The market value of untethered VR over wireless network is expected to reach 87.97 billion dollars by 2025 [3], which reflects its growing demand and popularity.

In untethered VR, the objects in VR scenes are generated on the server, and stream to the user device, e.g., a head-mounted device (HMD), over wireless network. The inputs from the user, such as the head movements and hand gestures, are sent back to the servers for computing the interactions between the user and the virtual objects. One of the key features need to be considered in untethered VR is the real-time property. To prevent motion sickness and improve user experience, the response time from user input to display output must be limited to 20 ms [1]. With huge volume of data to be transferred and stringent latency requirements but only limited bandwidth in wireless network, it pose a challenge for an untethered VR experience.

OpenUVR [1] is an open-source framework that uses commodity hardware components to satisfy the demands of interactive, real-time VR applications over a wireless network. OpenUVR improves end-to-end latency that is critical to real-time, interactive action titles. OpenUVR also eliminates unnecessary memory copies, which further reduces the delay in real-time VR applications.

Still, wireless network plays a crucial role in terms of latency in untethered VR. In order to achieve the latency requirement, wireless networks must be designed to deliver high-speed, low-latency connectivity to the VR user. This is important to ensure smooth, seamless, and real-time user experiences. To this end, NS-3 [2], an open-source discrete-event network simulator for Internet systems, can be used as a tool for understanding the behavior of a network and its relation between various components on the user side in UVR applications.

In this thesis[1], the objective is to build a framework based on OpenUVR for evaluating the performance of VR applications under different network scenarios. The student should first get familiar with the OpenUVR framework. After that, the student is expected to integrate OpenUVR with ns-3 to simulate different network scenarios. Finally, a systematical analysis on how different factors affect the performance of a VR application, e.g., latency, should be carried out. Students should note that, the involved source code in this thesis will be publicly released and should be fully documented to comply the rationale of open-source software development.

Required Skills:

- Knowledgeable of C and C++ programming

- Knowledgeable of network architecture

- Knowledgeable of development boards such as Raspberry Pi

Acquired Skills after the thesis:

- Knowledge about the state-of-the-art VR technique.

- Knowledge about evaluating the performance of VR applications over internet.

References:

[1] A. Rohloff, et al., "OpenUVR: an Open-Source System Framework for Untethered Virtual Reality Applications," in 2021 IEEE 27th Real-Time and Embedded Technology and Applications Symposium (RTAS), Nashville, TN, USA, 2021 pp. 223-236.

[2] Riley, G. F. & Henderson, T. R. (2010). "The ns-3 Network Simulator." In K. Wehrle, M. Günes & J. Gross (ed.), Modeling and Tools for Network Simulation (pp. 15-34) . Springer . ISBN: 978-3-642-12330-6.

[3] Guo, et al., Power-efficient wireless streaming of multi-quality tiled 360 VR video in MIMO-OFDMA systems," IEEE Transactions on Wireless Communications, 2021.

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[1]Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.