Evolution of Input Devices for VR Collaboration Apps

Aidan Kehoe

Logitech Ireland, akehoe@logitech.com

Jean Duquenne

École Polytechnique Fédérale de Lausanne, jean.duquenne@epfl.ch

Mathieu Meisser

Logitech Switzerland, mmeisser@logitech.com

Mark McGill

University of Glasgow, Mark.McGill@glasgow.ac.uk

This position paper discusses the potential for the use of tracked hands and a 6DoF stylus in VR collaboration apps.

1 INTRODUCTION

Since the release of the original Oculus Rift and HTC Vive systems, there has seen a proliferation of multi-user apps for VR platforms that enable remote communication and collaboration. While there is a core set of common functionalities across these apps, there are several distinct categories of apps. There are apps that are more social in nature (AltSpaceVR, RecRoom), those that target business meetings (Glue, MeetInVR, Spatial) and apps that support larger events and conferences (ENGAGE, Oculus Venues); Mozilla Hubs could be considered to span several of these categories. In addition, several design and engineering apps that were previously single user, have now evolved to incorporate multi-user review and collaboration features too (Gravity Sketch, flyingshapes, Autodesk VRED, IrisVR Prospect, MindeskVR, etc.). Many of these apps have also added capabilities so that non-VR users can join the collaboration session from laptop or mobile devices.

2 INPUT DEVICES IN VR COLLABORATION APPS

Most collaboration apps use the 6DoF controllers as a proxy for the user's hands; instead of rendering a controller model in VR these apps instead show a representation of hands. As the user moves around the controller in space, rendered hands will move in the VR environment. Controller inputs via buttons and analog axes (Touchpad, Joysticks) also allow the user to be more expressive with a limited range of hand gestures, e.g., point with index finger, create a thumbs up gesture, etc. This expressive capability can result in more natural and effective communication [1].

2.1 Hands in VR Collaboration

Hand tracking is now available as an integral part of some VR HMDs, most notably the Oculus Quest. Originally released in 2019 as a beta feature, users can now to interact with the operating system and some apps using a small vocabulary of gestures including point, click, scroll and a reserved gesture to invoke the system menu (equivalent to pressing the Oculus button on the controller). There is a Hand Tracking SDK available to developers, and it may be a more common interaction modality in collaborative apps in the future.

We recently conducted a user study with 10 participants to compare the performance of hand tracking on Quest versus the Oculus Touch controller for direct interaction tasks (not raycasting) using an ISO 9241-9 style evaluation. Mean hand throughput (4.97 bit per second, SD = 0.74) was 12% slower than the Touch controller (5.64 bps, SD = 0.56). The difference was statistically significant ($F_{1,9}$ = 6.46, $p < 0.5$). During post study interviews, positive comments from the participants related to the hands being natural, intuitive, magical and "cool". Some of the negative comments related to the hands being slow or laggy, sometimes showing an incorrect pose (fingers often too curved), occasional loss of tracking and jitter in the hand model.

While our user study highlighted significant performance issues with the hands (OS release V22), but we can expect this to improve over time. Beyond the core tracking performance, there are also open questions with respect to how to best support additional interactions typically required for VR collaboration apps (grab, teleport, scale, etc.). While there are several intriguing capabilities for hand interaction in libraries such as MRTK [2], there remain challenges to support VR collaboration app interactions in a robust, performant and natural manner.

2.2 Stylus in VR Collaboration

In real world collaboration sessions, there are almost always pens, whiteboards and Post-its. VR collaboration apps replicate some of this functionality and often have virtual Post-its and virtual whiteboards. Users can also sketch using the standard controllers. However, it is a challenge to write using a pistol grip controller. A precision stylus grip has been shown to outperform traditional VR power grip controllers [3]. The use of a stylus also allows for the possibility for the user to sketch or write on a mapped physical 2D surface in VR, which also results in better quality output than drawing on a virtual plane [4]. A stylus leverages existing muscle memory and skill, enabling the user to create more expressive sketches, and capture writing that is recognizable as belonging to its author. Logitech VR Ink Pilot Edition is a VR stylus for the Vive/Valve platform [5]. To date it has been primarily used in design and creativity applications. However, going forward we believe there is an important role for such a peripheral in VR collaboration apps.

SUMMARY

To date most VR collaboration apps are designed to be used with the standard platform controller, and typically the controllers are used as a proxy for hands. As these applications evolve, we believe there is a need to support additional input devices, specifically hands and stylus. This involves additional complexity for the developer in supporting multiple different input methods and the associated re-thinking of control set mappings. However, we believe a stylus type device is needed to deliver on the promise of effective collaboration sessions that incorporate elements such 3D sketching, Post-its and collaborative whiteboarding.

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