A Hybrid 2D-3D Tangible Interface for Virtual Reality

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ABSTRACT

Virtual Reality (VR) controllers are widely used for easy object selection and manipulation as a primary 3D input method in the virtual environment. Mobile devices with touchscreens like smartphones or tablets provide precise 2D tangible inputs. This research combines a VR controller and a touch-based smartphone to create a novel hybrid 2D-3D interface for enhanced VR interaction. We present the interface design and its implementation and also demonstrate four featured scenarios with the hybrid interface.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **Interaction design theory, concepts and paradigms**; **Smartphones**.

KEYWORDS

Smartphone, VR controller, hybrid interface, Virtual Reality

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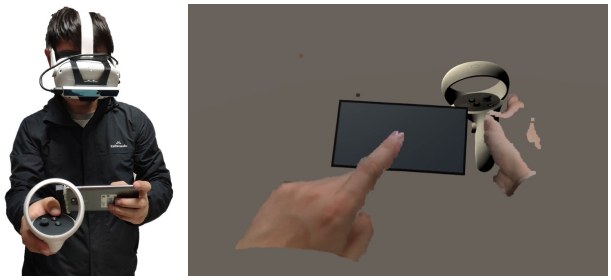

Figure 1: Left) A 3D printing structure connects a smartphone and a VR controller for 3D alignment, and a depth camera is mounted on the front panel of a VR headset to capture the hands. Right) Users are enabled to operate the VR controller and the smartphone for hybrid 2D-3D tangible interaction.

1 INTRODUCTION

The smartphone with a built-in touchscreen for control input and multimedia output has become an essential daily-used mobile device. Some research work explored bringing the mobile phone into Virtual Reality (VR) and operating the corresponding virtual screen of the phone in VR [Takashina et al. 2018]. With an additional camera mounted in front of the head-mounted display (HMD), the user can see a 2D hand image from a live window [Alaee et al. 2018] or a 3D hand point cloud [Desai et al. 2017].

Most recent research attached a customized VR controller to a smartphone for its 3D tracking, and also mounted an RGB-Depth camera on the headset to capture a dense 3D hand point cloud [Bai et al. 2021; Zhang et al. 2020]. This type of setup provides stable and robust phone localization and enables a natural and full-featured operation experience in VR. However, the disassembled controller was only used for tracking purpose, and was not integrated with the smartphone-based interaction yet.

In this research, we develop a novel input method combining the controller and the full-featured smartphone to create a hybrid 2D-3D tangible interface in VR for virtual object manipulation. We design a phone case-like structure to firmly connect a smartphone with a controller without a bulky configuration. The controller not only provides 3D registration but also performs as an input device. The user can operate the hybrid interface with both hands to provide 2D precise touch input and 3D spatial input simultaneously, as shown in Figure 1. We present a few VR interaction scenarios that could take advantage of our hybrid interface to support rich interactions within the virtual environment.

2 DESIGN AND IMPLEMENTATION

The VR controller has real-time spatial tracking with a high refresh rate. They could provide finger-based physical inputs with embedded triggers, buttons, and joysticks. The smartphone has a significant advantage on multimedia display and rich graphical user

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