Creating a Mobile Head-mounted Display with Proprietary Controllers for Interactive Virtual Reality Content

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ABSTRACT

A method to create a mobile head-mounted display (HMD) a proprietary controller for interactive virtual reality (VR) content is proposed. The proposed method uses an interface cartridge printed with a conductive pattern. This allows the user to operate a smartphone by touching on the face of the mobile HMD. In addition, the user can easily create a mobile HMD and interface cartridge using a laser cutter and inkjet printer. Changing the form of the conductive pattern allows the user to create a variety of controllers. The proposed method can realize an environment that can deliver a variety of interactions with VR content.

Author Keywords

Interface Cartridge; Mobile HMD; Conductive Ink.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

In recent years, head-mounted displays (HMD), such as Oculus Rift and Samsung Gear VR, have become increasingly popular. Such devices allow users not only to experience virtual reality (VR) easily but also to create and deliver VR content. Acceleration sensors in HMD devices enable movement of the observation point in a VR world and allow users to experience highly immersive VR content. In addition, the sensors enable head tracking and realize an interface that provides rich user interactions. For example, Oculus Rift with LeapMotion can use hand gestures to control VR content. Gear VR has a touch pad that can be used to control VR content.

We propose another method to create a mobile HMD with a proprietary controller for interactive VR content (Figure 1). Google Cardboard [1] is a mobile HMD with a particularly simple structure. Essentially, it is a cardboard box with optical lenses. Google Cardboard uses a smartphone display. Simply by installing VR applications on a smartphone, users can have the same quality VR experience as that offered by Oculus and Gear VR. Therefore, we can realize VR interactivity for this type of HMD by using smartphone sensors or the touch panel. For example, Google Cardboard has a magnetic interface for VR content control. It has a magnet ring on the side of the HMD and senses the movement of the magnet using a smartphone sensor. It also has a near field communication (NFC) tag for launching an application. Recently, another type of Google Cardboard has been released; it has a physical button interface on the top of the HMD box. When the user pushes this button, touch-input can be activated on the touch panel through conductive material on the button. Note that users have to consider the limitations of the HMD devices when creating VR applications.

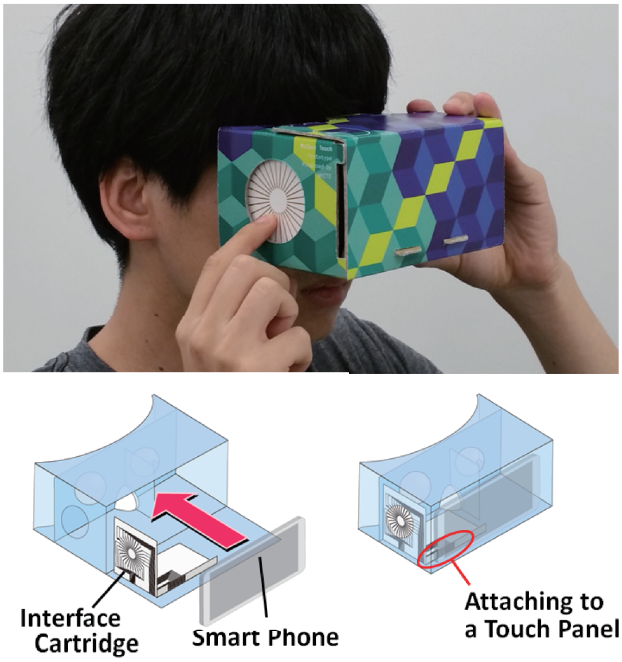

Figure 1. Mobile HMD with Proprietary Controller.

Other devices, such as Acoustruments, can extend the functionality of a smartphone interface to enable use with a mobile HMD [1]. This device allows the user to operate a smartphone without directly touching the touch panel. The Acous-

[1]https://www.google.com/get/cardboard/

truments product video shows that the device can be used with a mobile HMD device made of cardboard [2].

Our proposed method can be realized by putting an interface cartridge printed with a conductive pattern into the mobile HMD. The user can easily create an interface cartridge by using an inkjet printer with conductive ink. This allows the user to design not only VR content but also a proprietary controller that can be used with particular VR content. In addition, delivering the applications and the HMD developed figure and controller pattern data realizes an environment in which users can easily have a VR experience.

PROPOSED METHOD

The proposed method uses an inkjet-printed conductive pattern. This allows the user to operate a smartphone that is external to the mobile HMD. We used the Extension Sticker method to create the conductive pattern [2]. A conductive pattern has multiple thin lines. By activating the conductive pattern, continuous touch input can be generated on the smartphone. This allows the user to control the VR contents by tapping or scrolling on the face of the mobile HMD. In addition, changing the form of the conductive pattern allows a variety of interactions in response to user gesture input.

Interface Cartridge

The proposed method uses a conductive pattern printed on a piece of cardboard as a controller for the mobile HMD. We refer to this as an interface cartridge. The interface cartridge is folded and inserted into the mobile HMD. One side of the conductive pattern can be connected to a with touch panel (Figure 1, Bottom). Changing the interface cartridge allows other types of controllers to be used. In addition, including a QR code or NFC tag enables easy access to application URLs. The user can use the device in the same way as they would use a video game cartridge.

APPLICATION

Here we describe application examples that can be realized using the proposed method. Changing the form or a portion of the conductive pattern can realize various interactions related to specific VR content.

A dial controller can be used for interactions that require rotation actions. For example, a dial controller can be used to assign forward and backward rotation actions to an accelerator and brake, respectively, or for hand-wheel control in car racing game content. In addition, the proposed method can realize fishing games. The method allows the user to control a fishing rod using an acceleration sensor, and reel in a fish using a rotation operation. A dial controller can also be used to search for a video interface or select an interface for music. In addition, scrolling operations on the interface cartridge allows the user to perform swipe interactions on the side or back of the HMD box. For example, throwing interactions can be realized by a swiping action on the side of the HMD box.

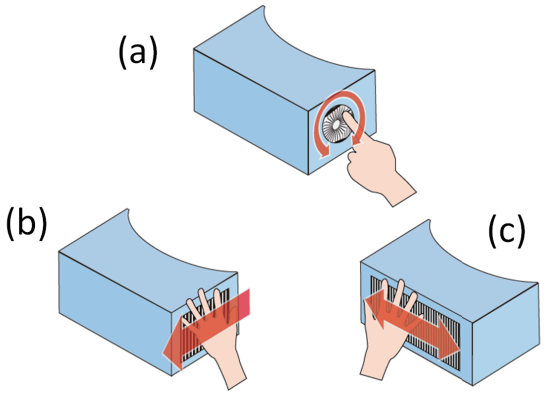

Figure 2. (a) Rotating action, (b) Swiping action on the side of the HMD, (c) Swiping action on the back of the HMD.

DISCUSSION

In this paper, we propose a method for creating a mobile HMD with proprietary controllers for interactive VR content.

To create high immersive interactive VR content, it is necessary to provide a controller that works with particularly content. For example, to realize a fishing game, we can use rotation actions as the input gesture (Figure 2 a), to realize a throwing interaction, we can use a swiping hand movement as the input gesture (Figure 2 b), and to flip a page or open a window, we can use a side-to-side hand movement (Figure 2 c). The proposed method allows users to easily create an interface cartridge using an inkjet printer with conductive ink. However, we found that the conductive lines could break when the interface cartridge was folded. Therefore, we checked robustness against folding for several conductive materials (silver, carbon, and aluminum). The results of this test confirmed that carbon or silver were most suitable. In addition, users can create an HMD box using a laser cutter. The user can also design the exterior of the HMD.

Therefore, the proposed method allows application developers to deliver their applications with a mobile HMD with proprietary controllers. In addition, because the HMD is made of cardboard, applications developers also can design the exterior of HMD.

The proposed method allows the user to be creative. They can design all aspects of VR content, including the application, hardware, and user interactions. We believe that the proposed method can contribute to the realization of an environment that allows many people to participate in interactive VR experiences.

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[2]Acoustruments: http://www.disneyresearch.com/publication/acoustruments/