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Capacitive Face Cushion for Smartphone-Based Virtual Reality Headsets

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Capacitive Face Cushion for Smartphone-Based Virtual Reality Headsets

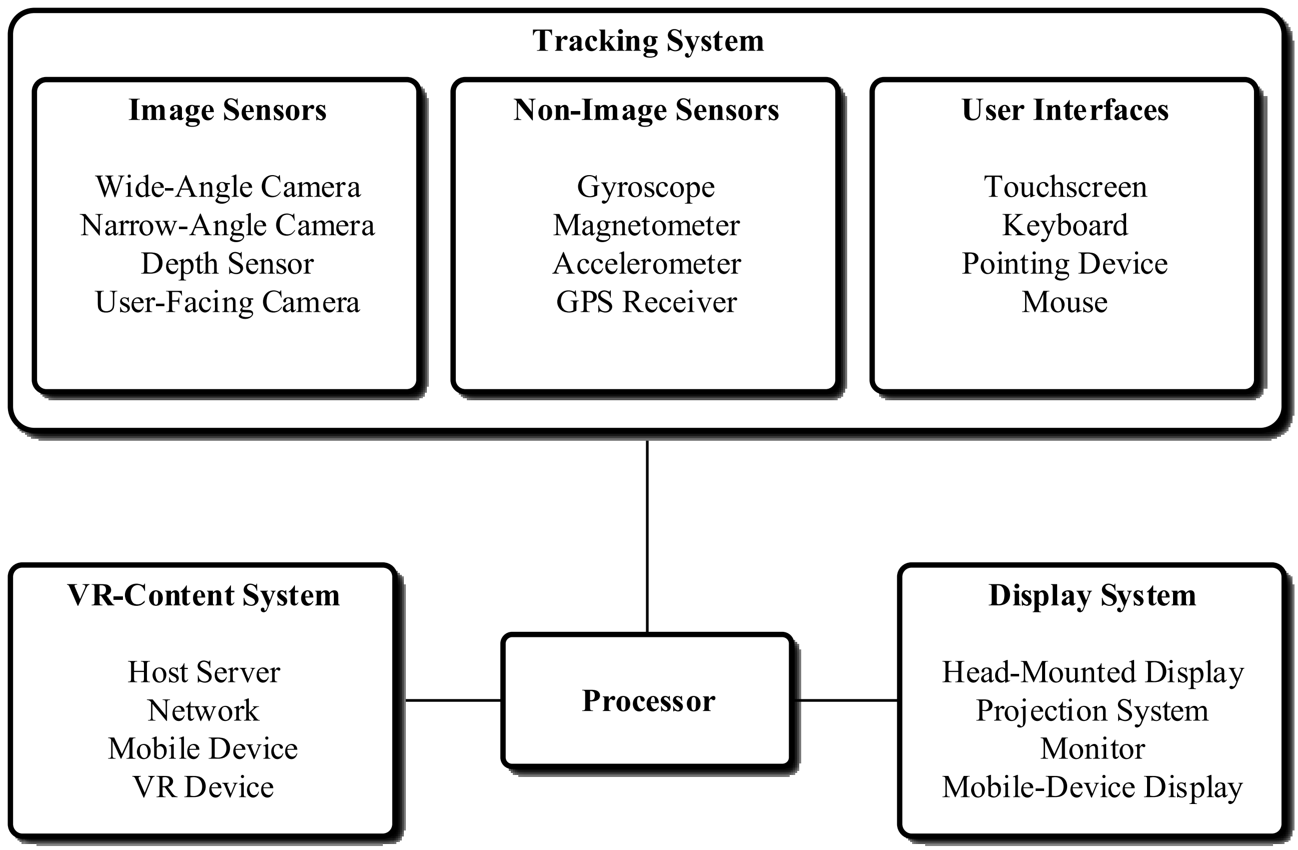
Abstract:

A virtual reality (VR) headset face cushion that includes a capacitive fabric is described. The capacitive fabric is connected to a smartphone's touchscreen placed within the VR headset. The connection allows the smartphone to determine whether the user is wearing the headset by detecting the difference between the capacitance when the face cushion is touching the user's face and when it is not touching the user's face. When the smartphone detects that the user is not wearing the headset, it can pause the VR application and/or dim the smartphone screen, which increases battery life and improves the user's experience.

Keywords: virtual reality, augmented reality, head-mounted display, HMD, goggles, headset, mobile phone, smartphone, touchscreen, face, cushion, capacitive fabric, conductive fabric, power conservation, battery life

Background:

Virtual reality (VR) environments rely on display, tracking, and VR-content systems. Through these systems, realistic images, sounds, and sometimes other sensations simulate a user's physical presence in an artificial environment. Each of these three systems are illustrated below in Fig. 1.



VR System

Fig. 1

The systems described in Fig. 1 may be implemented in one or more of various computing devices that can support VR applications, such as servers, desktop computers, VR goggles, computing spectacles, laptops, or mobile devices. These devices include a processor that can manage, control, and coordinate operations of the display, tracking, and VR-content systems. The devices also include memory and interfaces. These interfaces connect the memory with the systems using various buses and other connection methods as appropriate.

The display system enables a user to “look around” within the virtual world. The display system can include a head-mounted display, a projection system within a virtual-reality room, a monitor, or a mobile device’s display, either held by a user or placed in a head-mounted device.

The VR-content system provides content that defines the VR environment, such as images and sounds. The VR-content system provides the content using a host server, a network-based device, a mobile device, or a dedicated virtual reality device, to name a few.

The tracking system enables the user to interact with and navigate through the VR environment, using sensors and user interfaces. The sensors may include image sensors such as a wide-angle camera, a narrow-angle camera, a user-facing camera, and a depth sensor. Non-image sensors may also be used, including gyroscopes, magnetometers, accelerometers, GPS sensors, retina/pupil detectors, pressure sensors, biometric sensors, temperature sensors, humidity sensors, optical or radio-frequency sensors that track the user's location or movement (*e.g.*, user's fingers, arms, or body), and ambient light sensors. The sensors can be used to create and maintain virtual environments, integrate "real world" features into the virtual environment, properly orient virtual objects (including those that represent real objects, such as a mouse or pointing device) in the virtual environment, and account for the user's body position and motion.

The user interfaces may be integrated with or connected to the computing device and enable the user to interact with the VR environment. The user interfaces may include a touchscreen, a keyboard, a pointing device, a mouse or trackball device, a joystick or other game controller, a camera, a microphone, or an audio device with user controls. The user interfaces allow a user to interact with the virtual environment by performing an action, which causes a corresponding action in the VR environment (*e.g.,* raising an arm, walking, or speaking).

The tracking system may also include output devices that provide visual, audio, or tactile feedback to the user (*e.g.*, vibration motors or coils, piezoelectric devices, electrostatic devices, LEDs, strobes, and speakers). For example, output devices may provide feedback in the form of blinking and/or flashing lights or strobes, audible alarms or other sounds, songs or other audio files, increased or decreased resistance of a control on a user interface device, or vibration of a physical component, such as a head-mounted display, a pointing device, or another user interface device.

Fig. 1 illustrates the display, tracking, and VR-content systems as disparate entities in part to show the communications between them, though they may be integrated, *e.g.*, a smartphone mounted in a VR receiver, or operate separately in communication with other systems. These communications can be internal, wireless, or wired. Through these illustrated systems, a user can be immersed in a VR environment. While these illustrated systems are described in the VR context, they can be used, in whole or in part, to augment the physical world. This augmentation, called “augmented reality” or AR, includes audio, video, or images that overlay or are presented in combination with the real world or images of the real world. Examples include visual or audio overlays to computing spectacles (*e.g.,* some real world-VR world video games or information overlays to a real-time image on a mobile device) or an automobile’s windshield (*e.g.,* a heads-up display) to name just a few possibilities.

Providing a high-quality VR experience for a smartphone-based VR headset that does not include its own electronics can be difficult because that kind of headset does not currently detect whether it is being worn. If the smartphone continues to operate a VR application while the user is not wearing the headset, battery life and usability may be degraded. If the battery charge is depleted while the user is away, the unit may have to be charged when the user planned to use it, which can prevent the user from enjoying the application while the smart charges or reduce the quality of the experience because a charging cord limits mobility. Additionally, if the smartphone and VR application continue to operate, the user may miss out on game play time, or other VR experiences, further reducing the quality of the VR experience.

Some existing solutions for self-contained VR headsets that include integrated optics and electronics use optical sensors to determine when a user puts on or removes the headset. This solution is typically not available for smartphone-based headsets, even those with a camera on the touchscreen side of the device, because the construction of the headset's enclosure and optics prevents the camera from being used as an optical sensor.

Description:

In some implementations of the virtual reality (VR) system described in Fig. 1, a VR headset face cushion that includes a capacitive fabric is provided to address the problem of detecting when a user of a smartphone-based VR headset has removed the headset. The capacitive fabric is connected to the smartphone's touchscreen. The connection allows the smartphone to determine whether the user is wearing the headset by detecting the difference between the capacitance when the face cushion is touching the user's face and when it is not touching the user's face. When the smartphone detects that the user is not wearing the headset, it can pause the VR application and/or dim the smartphone screen, which increases battery life and improves the user's experience.

Fig. 2 illustrates an example configuration of the capacitive face cushion for VR headsets. The example configuration includes a VR headset, a smartphone with a touchscreen, a face cushion with capacitive fabric, and an electrical connection between the capacitive elements of the face cushion and the touchscreen. The optical assembly of the VR headset is omitted for clarity.

When the capacitive face cushion is touching the user's skin, the electrical connection allows the touchscreen to detect the contact and determine that the user is wearing the headset. If the user removes the headset, but does not pause or turn off the VR application running on the smartphone, the electrical connection enables the smartphone to detect a change in capacitance caused when the capacitive face cushion is no longer in contact with the user's face. In turn, detecting the change in capacitance allows the smartphone to determine that the user has removed the VR headset and the smartphone can adjust operation of the VR application.

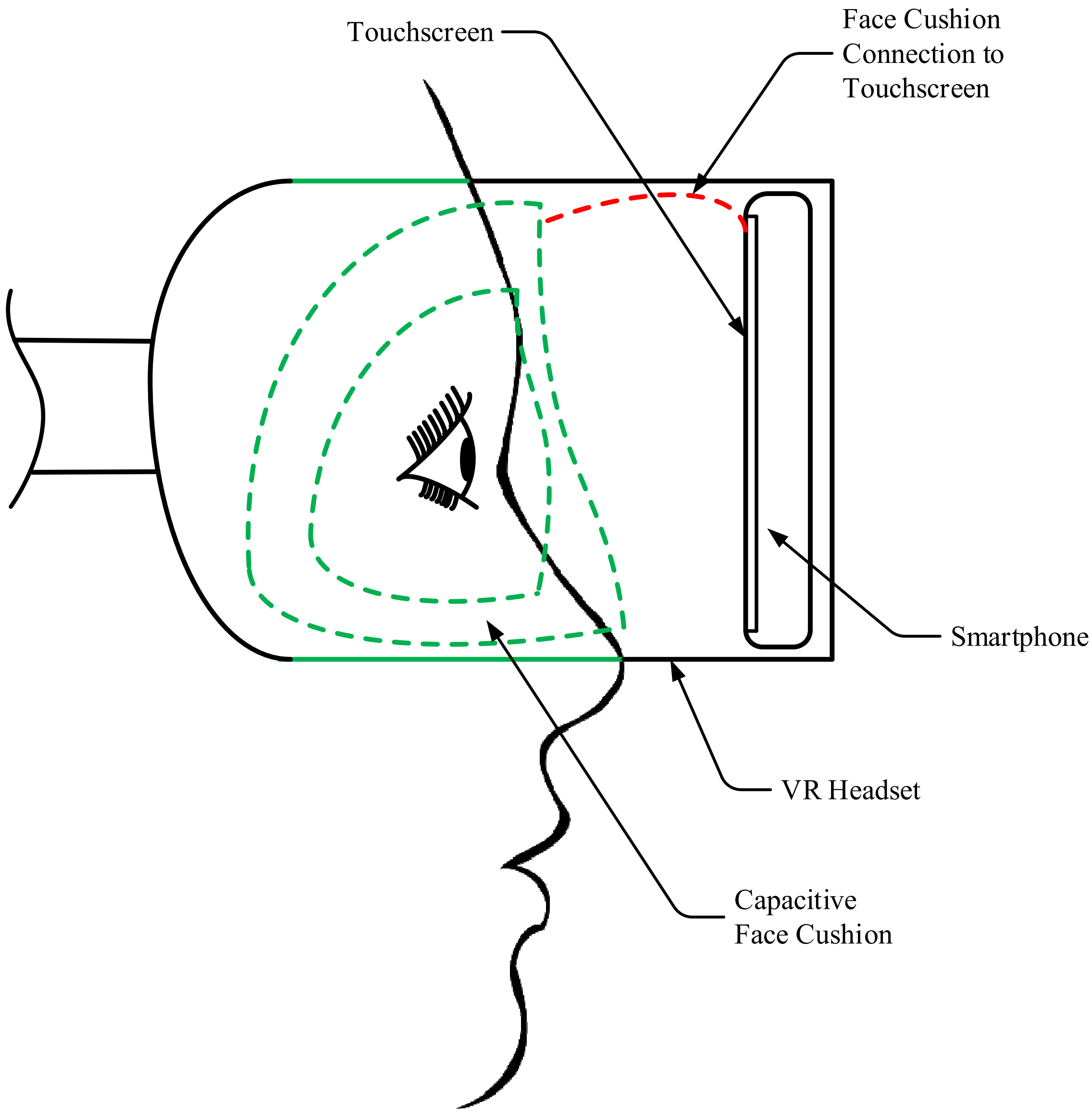


Fig. 2

Figs. 2 and 3 illustrate example implementations of the capacitive face cushion. In Fig. 3, the face cushion is shown as a single piece with a capacitive fabric covering the surface that touches the user's face. The capacitive fabric may be made using a variety of conductive fibers, such as copper, indium, or graphite. In the example depicted in Fig. 3, the electrical connection that connects the capacitive face cushion and the touchscreen is represented by a gold wire protruding from the face cushion.

Fig. 3

Fig. 4 illustrates another implementation of the capacitive face cushion. Rather than the entire surface being made from a capacitive fabric, the face cushion may include capacitive elements in particular areas. As shown in Fig. 4 by gold dashed lines, capacitive threads are exposed on the top and right side of the face cushion. In other configurations, capacitive dots may be attached to the face cushion, as shown on the lower left side of Fig. 4. Combinations of fibers, dots, or other mechanisms for detecting changes in capacitance may be used. As noted, the capacitive contact may be made from materials such as copper, indium, or graphite.

Fig. 4

The electrical connection in Fig. 4 is depicted as conductive tape, represented by a gold tab extending from the left side of the face cushion. Additional details related to the location and configuration of the electrical connection between the capacitive face cushion and the touchscreen are described with reference to Figs. 4 and 5. While Figs. 2 and 3 show the capacitive face cushion as a single piece, in other configurations the capacitive face cushion may take other shapes, be made from multiple pieces, or be attached to the exterior housing of the VR headset.

Figs. 4 and 5 illustrate example implementations of the electrical connection between the capacitive face cushion and the touchscreen. In Fig. 5, an exploded view of a smartphone-based VR headset is shown with capacitive threads on the surface of the face cushion. A conductive fiber extends from behind the face cushion, through the VR headset assembly and to the smartphone receiver. The conductive fiber is fixed in a location that creates a connection with the smartphone's touchscreen when the smartphone is secured into the VR headset.

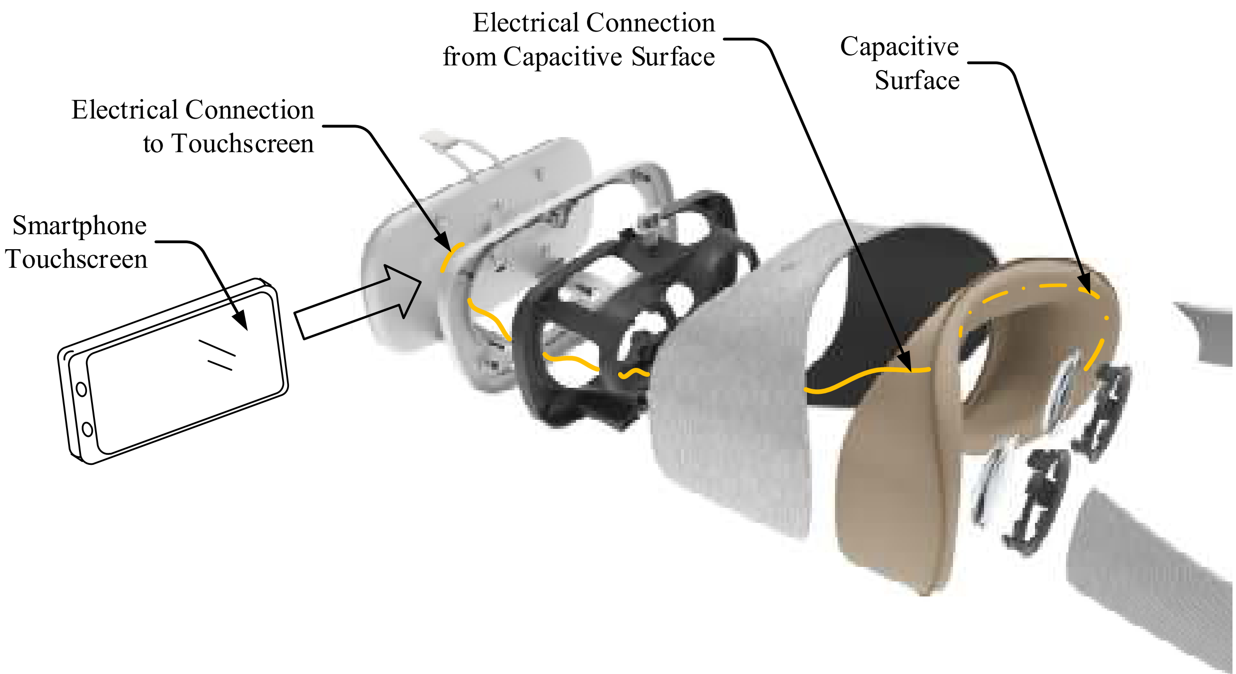


Fig. 5

Fig. 6 also depicts an exploded view of a smartphone-based VR headset with capacitive threads on the surface of the face cushion. In the example of Fig. 6, a conductive tab extends from behind the face cushion. Another conductive tab is fixed to the interior of the smartphone receiver in the VR headset. The conductive tabs create a connection between the smartphone's touchscreen and the capacitive face cushion when the smartphone is secured into the VR headset. In either of Figs.

4 or 5, the connection between the touchscreen and the face cushion may be made from another part of the face cushion (*e.g.*, from the top, bottom, or right side).

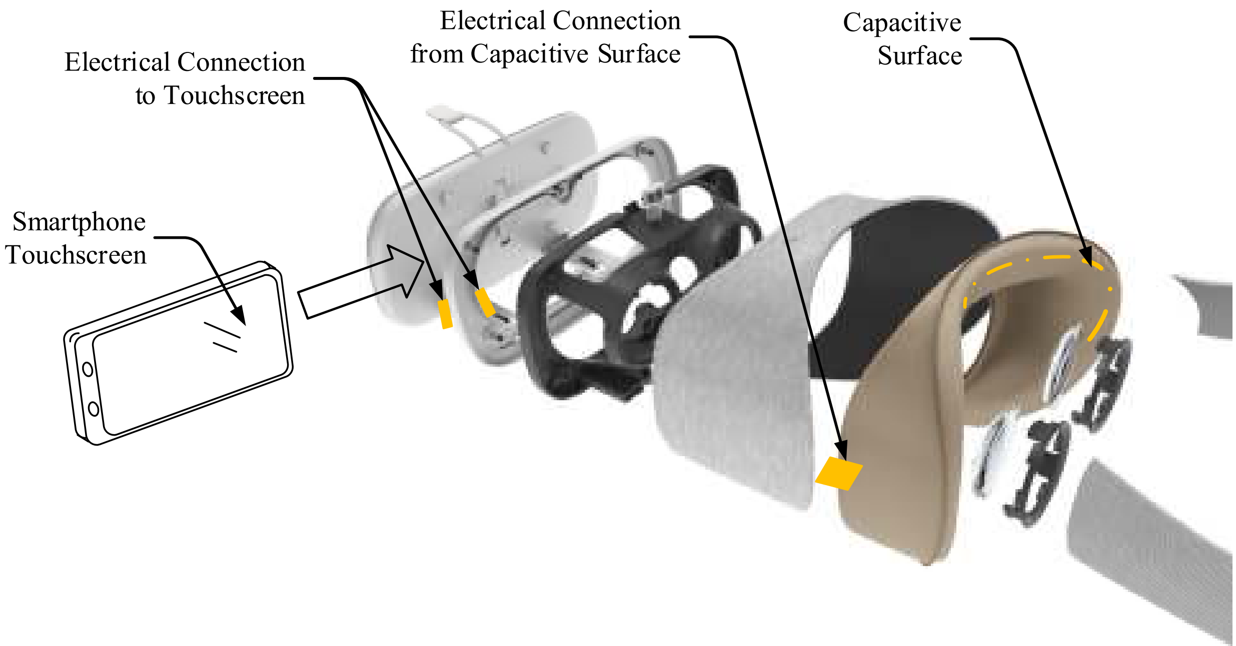


Fig. 6

Besides conductive fibers or tabs, as shown in Figs. 4 and 5, the electrical connection may be made in a variety of other ways. For example, conductive fabric that runs through the headset assembly or conductive fasteners that physically attach the parts of the assembly together.

The described devices and techniques for a capacitive face cushion enable a smartphone-based VR headset to determine whether a user is wearing the headset by detecting the difference between the capacitance when the face cushion is touching the user's face and when it is not touching the user's face. When the smartphone detects that the user is not wearing the headset, it can pause the VR application and/or dim the smartphone screen, which increases battery life and improves the user's experience.