UBI: User Body Interface for Wearable and Touch Panel Device

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 Ubicomp/ISWC'15 Adjunct , September 07-11, 2015, Osaka, Japan
ACM 978-1-4503-3575-1/15/09. http://dx.doi.org/10.1145/2800835.2800854

Abstract

This study designed an interaction technique for transferring digital information between a wearable device and a touch panel device. To this end, we developed a prototype system, referred to as a User Body Interface (UBI), that enables easy bidirectional data transmission using a human body communication technique. As a proof of principle, we demonstrate how this system works during an image exchange scenario. Using the prototype UBI system, a user can transmit image data files bidirectionally between devices using only simple touch operations.

Author Keywords

Human body communication; Wearable; Touch Displays

ACM Classification Keywords

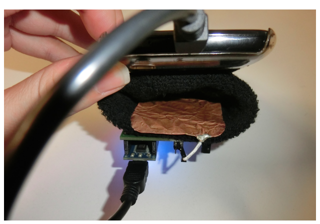
H.5.2 [Information interfaces and presentation]: User Interfaces; Interaction Styles.

Introduction

We developed a novel system called a User Body Interface (UBI) that easily transfers digital information between two devices using the human body as a conduit. This new system provides an easy method of connecting and establishing a communication link between a wearable device and a touch panel device. We present the details of the interaction technique used in this system[1]. This technique relies

Figure 1: Overview of the proposed method: transfer of digital information by touching an interactive screen.

(a) Wearing the device.



(b) Inside of the device.

Figure 2: The prototype wearable device.

on the human body communication protocols proposed by Zimmerman[2], which use the human body as part of an electronic circuit.

The goal of our work was to design an interaction technique to accomplish the transfer of digital information between a wearable device and a touch panel device. This system is summarized in Figure 1. Icons that represent information such as text or images are displayed on the large touch panel screen. The user wears a wearable device on his or her wrist, which also has a small touch screen like that of a smartphone. The user can easily access information on the large touch screen by touching an icon with his or her finger. Alternatively, to transfer information from the wearable device to the large screen, the user first selects an icon on the wearable device and then touches the large screen.

The advantages of our system and this interaction technique are as follows. First, the user can interact with the system without any difficult network connection configuration. By using the human body as a conduit, the system can directly transmit and receive electrical signals between devices via the human body. Therefore, in this system, when the user touches the screen, the devices that are touching the user's body can immediately begin transmitting or receiving information. Second, our bidirectional communication method is easy for the user to grasp since the only required action is to touch a target icon on a screen. With this single action the system will know which icon the user intends to take from the screen (by the location of the user's touch operation), while concurrently the user will be making a connection with the device that will receive the target data.

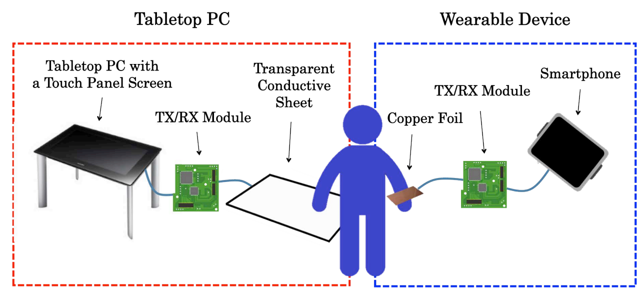


Figure 3: Overview of the data communication link established after the user touches the tabletop PC display.

Prototype Implementation

Overview

Figure 3 shows an overview of the prototype system. The system consists of two parts: a device worn by the user (Figure 3 (right)) and a tabletop personal computer (PC) with a touch panel screen (Figure 3 (left)). When the user interacts with the tabletop PC, these two parts become connected via the user's body, thereby establishing a communication link. This electrical circuit can then be used for bidirectional communication between the wearable device and the tabletop PC.

Wearable Devices

The prototype wearable device designed to be worn on the wrist is shown in Figure 2 (a), while a smartphone (Samsung Galaxy S II LTE) is used for interacting with the user. The inside of the wearable device is fitted with copper foil and this connected to the smartphone via an external transmit/receive (TX/RX) module, which allows signals to pass through the human body (Figure 2 (b)).

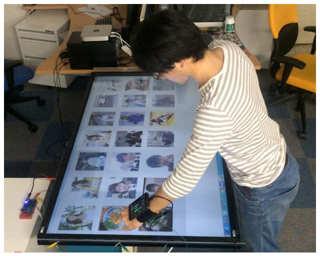


Figure 4: A tabletop PC with a touch panel screen and the TX/RX circuit board.

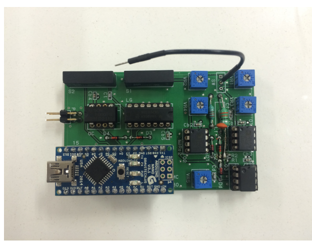


Figure 5: The TX/RX module.

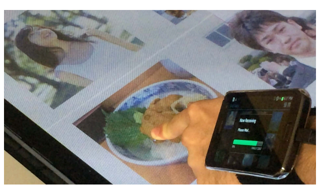


Figure 6: Transferring an image file from the tabletop PC to the wearable device.

Tabletop PC with a Touch Panel

The tabletop PC, equipped with a touch panel screen (Figure 4), communicates with the wearable device via the screen surface while the user is touching it. The touch panel screen is covered with transparent conductive sheets that are connected to the PC via a TX/RX module. Ultimately, the entire screen will to be covered with conductive sheets, but for this prototype system, only part of the screen is covered. A PQ Labs Multi-Touch sensor frame[1] is used to detect the user's touch gestures on the $60''$ display. In order to avoid interference between the display unit and touch operation, infrared sensors are used to detect the point of contact.

TX/RX Module

Figure 5 shows the TX/RX module that is used for both the tabletop PC and wearable device. We fabricated custom-printed circuit boards to accommodate the TX/RX circuits. Transmission signals are sent using amplitude-shift keying (ASK) modulation. Received signals are amplified, demodulated, and read by an Arduino microcontroller. The signal path is half-duplex; therefore only one circuit operates in TX or RX mode at any one time. For example, when data are transmitted from the tabletop PC to the wearable device, the TX module of the PC and the RX module of the wearable are activated.

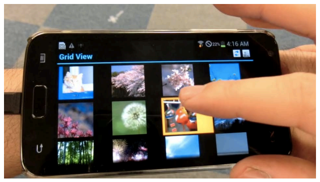
Currently, the wearable device and the tabletop PC are connected not only through the user's body, but also via the ground cables of the device because disconnecting the ground cables makes the system unstable. We are currently improving the stability of the system so that it will work without a ground connection.

[1] http://multitouch.com

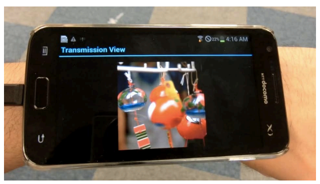
Proof of Principle: Image Data Exchange

To demonstrate how the prototype system works, we transferred image files between devices as a proof of principle exercise. To begin, the screen of the tabletop displays thumbnails of image files on the PC (Figure 4). Similarly, the screen of the wearable device displays thumbnails of image files on the device (Figure 2 (a)). To transfer an image file from the tabletop PC to the wearable device, the user simply touches the image file icon on the tabletop PC touch panel. This operation is recognized by the touch panel sensor, triggering the transmission of the selected file. The user is required to maintain contact with the touchscreen until the transmission process is completed. During transmission, a progress indicator is displayed on the screen of the wearable device (Figure 6). After transmission has been completed, the received image is displayed on the screen of the wearable device.

To send an image file from the wearable device to the tabletop PC, the user first selects an image by touching the relevant icon on the screen of the wearable (Figure 7 (a)). Then, the wearable device shifts to the transmission standby state (Figure 7 (b)). The device waits until a connection with the tabletop PC is established before transmitting the data. Next, when the user touches the background area of the touchscreen, the tabletop PC sends the "Connection Packet" to the wearable device. Once the "Connection Packet" is received, the wearable device sends the selected image data file to the PC (Figure 7 (c)). During transmission, a progress indicator is displayed on the screen of the wearable device. If the transmission is successful, the transmitted image is displayed on the screen of the tabletop PC.



(a) The user selected the relevant icon.



(b) The transmission standby state.

(c) Transferring an image file.

Figure 7: The process of transferring an image file from the wearable device to the tabletop PC.

Related Work

Several studies have focused on information transfer methods [3] [4]. Using these techniques, a user can transfer information in an intuitive way, but since the actual data transmission is achieved via a wireless network, the user needs to have the connection configured in advance. To overcome this, several studies have attempted to connect multiple devices by physically bumping them together [5] [6]. DiamondTouch [7] is a technology that uses front-projected displays and human body communication to recognize a user's identity, as well as how a user is touching a tabletop surface. CapNFC [8] enables ubiquitous interaction with everyday objects in a short-range spatial context. These technology are similar to our prototype system, but our work has focused on the information transfer between the tabletop PC and the user's wearable device, as well as the necessary interaction technique to accomplish this transfer.

Conclusion and Future Work

We proposed an interface for a wearable and touch panel device that uses human body communication. We also developed a prototype system that can send and receive image data files between a tabletop PC and a wearable device. On-going work is focused on improving our circuit design to create a faster, more stable information transfer path between devices.

Acknowledgements

We would like to thank Associate Professor Kazuhiro Shouno for his helpful advices.

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