Ambivalence: Simultaneous Tactile Experiences of Using and Recycling Smartphones

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Abstract

This demonstration is built on the postcolonial scholar, Homi Bhabha's idea of '*ambivalence*' [1], and exhibits experiences of "smooth" and "rough" tactile feelings simultaneously to convey to a typical smartphone user the struggles of electronic waste (e-waste) workers when they dismantle, test, and recycle broken electronic devices [4], [7]. The demonstration consists of two components: 1) a mobile game that imitates e-waste workers' routine tasks, and 2) a smart glove that reacts correspondingly to the player's moves in the game by simulating unpleasant feelings.

This demonstration introduces the harsh and inconvenient experiences that e-waste workers face in recycling practices, along with the familiar smooth tactile experiences in touch-based interactive devices. The co-presence and concurrent experiences of "smooth" and "rough" create an 'ambivalence' and allow the user to reflect on the stark differences between the two worlds of interactions with mobile phones. This demonstration is aimed to later develop empathetic connections between people with different privileges and backgrounds.

Author Keywords

Ambivalnece; E-waste; Electronic Waste; Empathy; Tactile Interaction; Simultaneous Feelings; Recycling; Postcolonial
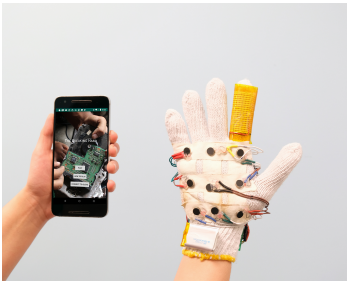
Figure 1: An overview of the Ambivalence prototype consisting of a mobile game application and a smart glove.

Introduction

Creating empathy between two groups of people from two different backgrounds remains as an active research problem in interaction design, HCI, and related fields with various important applications - ranging from xenophobia and refugee crisis to domestic violence. The fundamental challenge lies in allowing a person to get the experience of the 'other'. However, in postcolonial study, scholars have argued that the colonial subjects often experience two different worlds together, which Homi Bhabha has called "ambivalence" [1]. While such experiences are often created by a long history of 'meaning making' that is hard to replicate over an interactive system, we try to render that theoretical spirit to material experience in this project. We build on our ongoing research on understanding the work of electronic waste workers in Bangladesh whose work involves artful and often painful manual interactions with broken mobile phones - a tactile experience unknown to many who are merely privileged users of those phones [7]. The objective of this project is to let the users know the pain of recycling and be more careful about their consumption of electronic technologies - an important call by sustainability researchers.

Background and Related Work

Our work is built on Homi Bhabha's famous work *"The Location of Culture"* where he has brought the idea of "ambivalence" to demonstrate the co-existence of two opposite feelings in the heart of 'colonized' subjects - an experience also shared by migrants, refugees, and many other marginalized communities. Bhabha calls 'ambivalence' a way to connect two different worlds - *"such an image can neither be 'original' - by virtue of the act of repetition that constructs it - nor identical - by virtue of the difference that defines it".* We extend this idea to material experiences to allow a person using a smartphone to realize the pain involved in recycling that very phone in a developing country. This work is built on our ongoing ethnographic exploration in the mobile phone repair and recycle market in Bangladesh that demonstrates the struggles involved in dismantling electronic waste by hand [7].

Tangible User Interface (TUI) communities have long been embedding computing into physical objects [3] and trying to move computing towards a direction where emotions can be conveyed through material experiences. For example, Heo et al. have shown how feelings such as passing a hand-held object through water can be simulated through Virtual Reality (VR) and programmed objects [2]. In line with that effort, our demonstration introduces two simultaneous tactile experiences: (a) one that an electronic waste worker gets while interacting with a broken phone, and (b) one that a user of a smartphone gets while touching the smooth glass-interface of their phone.

There are previous works presenting unpleasant feelings through computer interfaces (*Sputniko* [8], and *PainStation* [6], for example). While these and other similar works inform and inspire our design, there has not been much work in simultaneously presenting two kinds of tactile experiences. In implementing our system, we have benefited from hardware and software tools and techniques used in wearable computing [5] and robotics [9].

Design and Implementation

Our design brings together the idea of a smartphone game and a smart glove (tangible smart wearable interface) that provides seamless feedback as a consequence of the player's
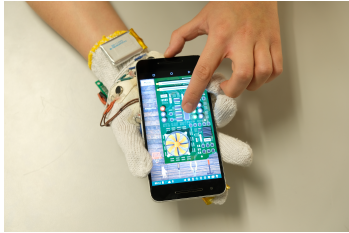
Figure 2: A user interacting with the game while wearing the smart glove.
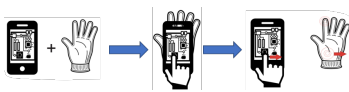

Figure 3: An abstract visualization of Ambivalence proposed design.

moves in the game. The motivation is to integrate game mechanics into the process of dismantling, testing, and breaking electronic objects in order to make the user aware of the work of e-waste workers (so-called "bhangari"s). The game simulates the series of actions that bhangaris perform from receiving a broken device until reusing, recycling, or trashing it. For playing the game, the user holds the mobile phone with the same hand that is wearing the glove. The other hand is free to play the game. The game asks the player to move electronic components on the given broken electronic device, or similar tasks that are necessary for repairing or recycling. When the player moves electronic parts by tapping, swiping, and shaking the phone, their other hand which is wearing the glove feels a corresponding feeling. For example, if the player swipes an IC on the screen from left to right with the free hand, an equivalent rough motion inside the glove gives the other hand an uncomfortable feeling. Therefore, as the player keeps playing the game, they get two kinds of tangible experiences in two hands simultaneously: one very smooth over the screen, and the other one very harsh inside the glove. A visualization of the proposed design can be found in figure 3. Figure 2 shows a user interacting with our full prototype.

The Game
The game is designed for the Android platform. A snapshot of the main activities of the game is shown in figure 4. The landing page has options for starting the game or reading rules of the game. In the beginning, the player sees a motherboard and a set of tools that bhangaris use to break electronic components with (their hands, hammers, pliers, screwdrivers). The player must choose a tool and try to work on a part of the motherboard. If the player is confused, the game gives clues. In the next stage, the player can test a part of the motherboard that they have previously dismantled. In the final stage, the user can reuse, repair,

Figure 4: Different Activities of the game. From left to right, the snapshots show the landing page, the main game activity (dismantling electronic components), the testing activity, and the recycling activity.

or dump the parts as required. Each move of the player is accompanied by a corresponding feedback in the glove.

The Glove
The smart glove gives haptic sensations to the player. The sensations include heat and vibration that occur while shaking the device, rubbing a specific component of an electronic device, tapping a point, or sliding through the game screen. The sensations simulate pressures and movements that an e-waste worker feels during e-waste processing. In addition, audio output is generated from the mobile phone during user's interaction with the device. As for all other feedbacks, a microcontroller (Adafruit Huzzah32) is used for haptics generation. Pressure, vibration, and movement are simulated through vibration motors (ROB-08449) augmented by motor drivers (TB6612FNG). Heat is generated by the rolled heating pads around the fingers of the glove. The entire installation is powered by a lithium-ion battery hidden under fabrics of the glove. Figure 5 shows each of the aforementioned electronic components individually
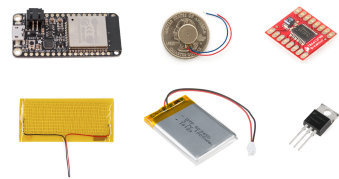
whereas figure 6 demonstrates the final version of the glove prototype.

Discussion and Conclusion

The objective of this demonstration is to convey the sharp differences in two kinds of tactile experiences associated with interaction with computing devices. Mainstream discussions of tangible interface often focus only on the 'smooth' experiences of using functioning tangible interfaces, while thousands of recycle workers in the developing countries physically interact with broken electronics and experience their roughness. The simultaneous production of smooth and rough experiences, hence, offers a room for the user to reflect on this distinction. We argue that such reflection will open a discourse for people to think critically about their use of computing devices and the global problem of electronic waste. At the same time, this will advance the research on designing for empathy in general.

Figure 5: Individual representation of electronic components used in Ambivalence glove prototype. The top row shows the microcontroller, vibration motor, and dual motor driver respectively and the bottom row presents the heating pad, lithium-ion battery, and the N-Channel MOSFET used to control the heat.
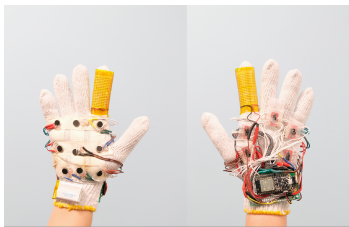

Figure 6: Final overview of the glove prototype from both sides.

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