There is more to Interaction with Public Displays than Kinect: Using Wearables to Interact with Public Displays

Stefan Schneegass
University of Stuttgart
Pfaffenwaldring 5A, 70569 Stuttgart
stefan.schneegass@vis.uni-stuttgart.de

ABSTRACT
Public display research is highly influenced by available consumer devices such as the Microsoft Kinect that shape current interaction techniques. These interaction techniques have inherent drawbacks such as a necessity for a specific distance to the display. In contrast, research on wearable devices provides solutions that have the capability to overcome these drawbacks. In addition to that, entirely new interaction techniques can be developed with wearable devices. In this paper, we introduce potential input devices as well as challenges of using wearable devices to interact with public displays.

Author Keywords
Wearable Computing; Smart Garments; Interaction with Public Displays.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces

INTRODUCTION
Current interaction techniques for public displays mainly focus on either touch or mid-air gesture input [2]. Touch input is the most common input method for displays deployed in the wild [7]. Users need to approach the display and touch the screen to enter information which, on the one hand, blocks parts of the display for the others and, on the other hand, allows other users to read the (potentially private) information. Since the advent of the Microsoft Kinect, research mainly used depth cameras to track the user's movement and gestures (e.g., [1]). However, there are constraints of depth cameras that need to be taken into account. Depth cameras need a line of sight to the part of the user's body that needs to be tracked. Public displays are mostly placed in areas in which many people pass by potentially occluding the interacting user. Further, subtle gestures might not be recognized since the user might perform these gestures not facing the camera.

Concurrently with the advert of public displays, the number of wearable devices available at the mass market is increasing. In addition to the number of available devices, the capability of these is increasing. Coming from simple accelerometer, modern wearable gadgets include, for example, physiological sensors that provide sophisticated information about the user. These devices can, on the one hand, substitute current and, on the other hand, be used to create new input techniques. While these devices may not be suitable for explicit interaction with public displays, research introduces different wearable sensors that yield this capabilities. In this work, we will outline different wearable devices that can be utilized to enrich the interaction with public displays.

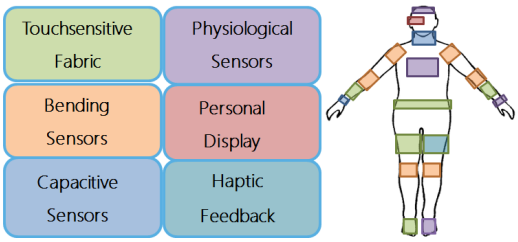

Figure 1: Overview of different wearable sensors and actuators technologies and their location on the human body.

USING WEARABLES TO INTERACT IN PUBLIC SPACES
Wearable devices and smart garments can be used for many different input techniques that are currently used for public displays. To realize novel input techniques, wearable devices located all over the users body can be utilized (cf., Figure 1). Additionally, the common input techniques can be realized with wearable devices as well.

Full Body Gesture
Full-body gestures are commonly detected using depth cameras such as the Microsoft Kinect requiring a direct line of sight between camera and user. In contrast, smart garments can be used to detect the user's joint angle [5] using, for example, stretch sensors. Combining these sensors for each joint, results in similar information as known from the Kinect. There are different examples of garments that allow the detection of posture and gesture [3].

Subtle Gestures
In addition to full body gestures, research explored subtle gestures, for example to select an item [11], in the context of public displays. Using wearables, these kind of gestures can be detected using wristbands or sensors integrated into the cuff of a shirt. Wristbands using capacitive sensors or accelerometer based movement sensing detect subtle hand movements of the user. Especially capacitive sensing is capable of detecting finger movements when attached to the wrist [9].

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Touch Input

In contrast to touch enabled displays, wearable devices do not offer the possibility to directly touch the content. However, there are solutions that allow indirect touch interaction by using trousers [5] or other garments [13] as input device. Feedback to the user can be presented using electronic muscle stimulation [8]. While the interaction needs to be redefined to deal with this new requirement, the drawbacks of occluding the display while using the touch input is tackled.

Implicit Interaction

Currently, most work dealing with implicit interaction is focusing on the location of the user [12] or their gaze direction [6]. Wearable devices open up new possibilities to design implicit interaction between display and user. Many different physiological values such as heart rate, respiration rate, or body temperature can be used to enrich the interaction.

OPEN CHALLENGES

There are still a couple of challenges that need to be tackled to use wearable devices for interaction with public displays.

Connection

While depth sensing cameras are directly attached to the display, the connection between users and display is automatically done as soon as the users position themselves in front of the camera. To utilize wearables, this connection needs to be manually established so that the input from the user‘s wearable is send to the display. Nevertheless, first approaches that tackle this issue have already be presented (e.g., [10]).

Multiuser Input

Current interaction techniques are capable of dealing with multiple users at the same time, for instance, by displaying the silhouette of the user in the background [1]. Interaction utilizing wearable devices need new approaches to deal with this issue. As soon as more than a single user is interacting with the display, the display needs to communicate back to the user who is in control. This might be solved by showing user-defined icons on the display.

Equip the User with Wearable Devices

In contrast to attaching sensors to a display, every user needs to be equipped with wearable devices. The user needs to put on every day the device to be able to interact with displays. In the future, these devices will be seamless integrated into garments so that the user just needs to put on his daily clothes [4].

BENEFITS OF WEARABLE DEVICES

While there are some challenges that need to be addressed, there are also benefits that come along with using wearable devices. First, wearable devices allow providing tactile feedback to the user (e.g., vibrational) in addition to visual feedback currently used with public displays. Second, even current off-the-shelf devices are capable of sensing physiological data of the user. This data can be used for implicit interaction either on its own or in combination with explicit input. Third, the gestures that needs to be performed can be calibrated to the users properties and preferences (cf., [10]). These benefits allow for the enhancement of interaction techniques beyond the current state of the art.

CONCLUSION

Research in the area of interactive public displays nowadays mainly focus on equipping the display with sensors. While this currently allows to easily design new interaction possibilities, research limits itself to the limitation of these sensors. Thus, current research often follows available devices rather than shaping independently the interaction. In this work, we propose using wearable devices creating new ways of interacting with public displays. We show the advantages of wearables gadget or garment and discuss challenges and opportunities.

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