Listen to your Heart: Novel Ways of using Respiration and Heartbeat as Inconspicuous Input Modalities

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Abstract

The interactive capabilities of public interactive systems are often not fully exploited, as users often feel uncomfortable to interact with them as they may feel observed by bystanders while interacting. In some contexts, users would like to perform private and inconspicuous interactions with these systems. Performing expressive gestures in the public or using a mobile phone in front of a screen is a clear indicator for others that one wants to interact with the system. In this paper, we explore how systems can leverage the respiration rate and the heartbeat of a user to allow inconspicuous interactions with interactive screens and with mobile devices in the public. We present a system, which implements the idea of the "rotating compass" using the heartbeat of a user to access personal information from a public screen. In addition, we show how respiration can be used to interact with a mobile device in an inconspicuous way in public settings.

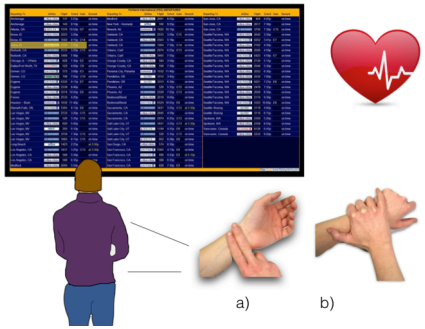

Figure 1: A user looking for a specific flight on a large public display. We used the idea of the "rotating compass" in combination with the heartbeat of the user to sycn private and public information. Ones pulse can be obtain with hand gestures, that cannot easily be detected by bypassers as shown in a and b.

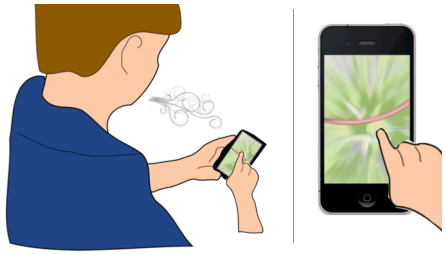

Figure 2: A user zooming in and out a map using his or her respiration rate.

ACM Classification Keywords
H.5.2 [Information Interfaces & Presentation]: User Interfaces - Interaction Styles

Introduction & Motivation

In the area of human-computer interaction (HCI) a large set of different modalities have been explored, that allow users to interact with numerous digital systems. Nowadays, most public installation use "touch" as the main modality to establish interaction between users and the system. The main limitation here is that users have to closely approach the screen and stand in front of it while interacting. Prante et al. [6] proposed different interaction zones for interacting with large public displays (Cell Interaction Zone, Notification Zone, and Ambient Zone). Later, Vogel et al. [12] extend this framework for sharable, interactive public ambient displays. Vogel defined four interaction phases, facilitating transitions from implicit to explicit interaction and from public to personal interaction (personal interaction zone, subtle interaction zone, implicit interaction zone and ambient zone) [3]. To allow interactions outside the personal interaction zone (as defined by Vogel) we have seen various novel gesture-based systems [1,2] or speech-based [5] systems to interact with public screens [3]. Mobile or secondary devices are also frequently used to engage users with interactive systems in public spaces [3]. Most of the approaches have in common, that people that are not interacting with the system can easily observe users interacting with a public interactive system making private interaction with public screens quite hard. This could lead to uncomfortable situations or social stress.

We believe that "biosignals" (as defined as all kinds of signals that can be (continually) measured or monitored from human beings) offer an elegant way to provide a modality that empower users to safeguard their privacy while not infringing on norms of social acceptance. Biosignals are "always on" (they deliver a constant or periodic signal) and nobody would suspect somebody interacting with a digital device when simply breathing in or out (see figure 1 and figure 2).

Related Work

Researchers also exploited the use of different kind of "biosignals" for interaction. For example, Stellmacher et al. [9] explored the combination of gaze- and head-directed input in combination with mobile devices for additional manual touch control. Earlier work by Santella et al. [8] show how Gaze-based interaction can support tasks like photo cropping. Miyauchi et al. [4] used the Kinect to develop a tongue tracking device to control a computer. This system has been used as a tongue training system for children with down syndrome, but also could be used by other people in different contexts. Recently the Nymi wristband device (http://www.getnymi.com/) was featured in various blogs and media. This wristband allows one to authenticate with digital system identity by matching the overall shape of the user's heartwave against a stored pattern of the user. We believe that with the rise of Google Glass, we will also see more systems that can be controlled with just a "blink of an eye". Tan et al. [10] show in general how visual feedback on biosignals of a user can support video-mediated Collaboration. More similar to our approach Tennent et al. [11] modified a first person shooter and made aiming of the gun be perturbed by breathing (meaning that to shoot straight, you have to time breathing with shots, or hold

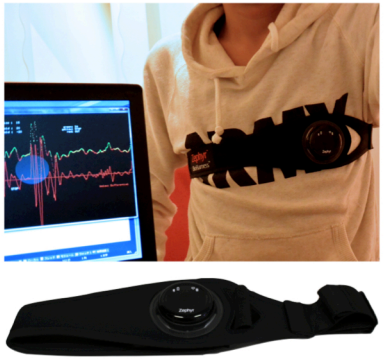

Figure 3: The Zephyr BioHarness™ 3 and our software in use by a user. Normally the device is worn under ones clothes.

your breath). In contrast to related work, where the respiration rate or the heartbeat was mainly used to acquire additional information about a user's affective state, we use them as a modality to interact with an interactive system. In the reminder, we present two concepts and early working prototypes that allow various forms of inconspicuous interactions in public places.

"Listen to your heart" Synchronized information displays by using ones heartbeat

Rukzio et al. [7] presented the initial idea of the "rotating compass": On a public screen different pieces of information, e.g. a rotating compass needle, are shown. The core idea is that a user synchronizes his private mobile device with the screen and gets a private cue, e.g. his mobile phone vibrates in synchronization with the indicated direction of the compass needle on the public screen. This has the benefit that multiple users can use the public screen to access their information. Rather using the vibration of the mobile device, which still can be heard by nearby bypassers, we use the beat of the users heart to sync the cue with the information shown on the public screen. Assume a situation that a person stands in front of a public screen with multiple blinking messages. He checks his own pulse and search a message that blinks synchronized (e.g. on every 2nd heartbeat) with his heartbeat. As the phase and frequency of the beat is unique, users could acquire personalized information while preserving their privacy (as touching ones own arm, is quite common). By changing the phase and frequency of the blinking according to a person's heartbeat, one can easily identify his or her private messages on the public screen. This first envisioned interaction technique is visualized in figure 1.

"Every breath you take" Using respiration for coarse or multimodal interactions

Similar to the work of Stellmacher et al. [9], we have prototyped a second novel interaction concept using the respiration of a user to interact with a system. Respiration is one of the different modalities that people are able to easily control and even to steer multiple parameters, e.g. timing and how deep they breathe in. Of course, similar to the first interaction concept, one needs to assure, that accidental use is prohibited (know as the Midas touch problem). Using multi-modal interaction, one could easily overcome this limitation (e.g. breathing in combination with touch or gaze input). In this section, we propose an interaction concept using the respiration (rate) of a user. Basically, respiration can be used as a two-way (e.g. breathe in/out) input method or as a continuous input method (e.g. changing intensity). These characteristics can be easily mapped to a zoom in/out function in a map application on a mobile device. For example, "breathe in" is mapped into "zoom in" and vise versa. A user can zoom in/out the map on a smartphone display by simply breathing in or out. This can be combined with a touch gesture to indicate the zoom center as shown in figure 2. In our proposed system, respiration is mapped to zooming action, while a touch fixes the position of the center of zooming. Then, users can easily control the amount of zooming while fixing the center, by changing the duration of their respiration-rate or intensity. One could also think of various other interaction techniques, e.g. "blowing away a notification message" and similar interactions that are triggered by the respiration rate of the user.

Implementation

We already implemented a first prototype that to demonstrate the proposed interactions. We used a Zephyr BioHarness™ 3 to prototype our envisioned interaction concepts. It is a compact wearable physiological monitoring module that enables capturing and transmitting of comprehensive physiological data of a user via Bluetooth. It senses acceleration (50Hz), Breathing rate (1Hz), Heart rate (1Hz). The Figure 4 shows the BioHarness and our developed software. The graph and the size of the gray circle in the center of the display shows the wearer's state of breathing. Our interface software can be easily used to prototype different interactions with public screens and mobile devices.

Conclusion & Future Work

In this position paper we presented two novel interaction concepts for inconspicuous interaction in public spaces. We hope that this work, that already exists as a prototype, can stimulate discussions at the workshop. In the future, we plan to further improve our prototype and we are planning to conduct first studies to get more insights how usable such a technique would be in the future. We may have some early results ready to present at the CHI workshop.

References

[1] Cauchard, J. R., Löchtefeld, M., Irani, P., Schöning, J., Krüger, A., Fraser, M., & Subramanian, S. (2011). Visual separation in mobile multi-display environments. In Proc. of UIST (pp. 451-460). ACM.

[2] Carter, S., Churchill, E., Denoue, L., Helfman, J., & Nelson, L. (2004). Digital graffiti: public annotation of multimedia content. In Proc. of EA CHI'04 (pp. 1207-1210). ACM.

[3] Daiber, F., Krüger, A., Schöning, J., & Müller, J. (2012). Context-Sensitive Display Environments. In Ubiquitous Display Environments (pp. 31-51). Springer Berlin Heidelberg.

[4] Miyauchi, M., Kimura, T., & Nojima, T. (2013). A tongue training system for children with down syndrome. In Proc. of UIST (pp. 373-376). ACM.

[5] Pfalzgraf, A., Pfleger, N., Schehl, J., & Steigner, J. (2008). ODP-Ontology-based Dialogue Platform. Technical Report, 2008, SemVox GmbH. http://www. semvox. de/whitepapers/odp_whitepaper. pdf.

[6] Prante, T., Röcker, C., Streitz, N., Stenzel, R., Magerkurth, C., Van Alphen, D., & Plewe, D. (2003). Hello. wall–beyond ambient displays. In *Adjunct Proc. of Ubicomp* (pp. 277-278).

[7] Rukzio, E., Schmidt, A., & Krüger, A. (2005). The rotating compass: a novel interaction technique for mobile navigation. In Proc. of EA CHI'05 (pp. 1761-1764). ACM.

[8] Santella, A., Agrawala, M., DeCarlo, D., Salesin, D., & Cohen, M. (2006). Gaze-based interaction for semi-automatic photo cropping. In Proc. of CHI (pp. 771-780). ACM.

[9] Stellmach, S., & Dachselt, R. (2013). Still looking: investigating seamless gaze-supported selection, positioning, and manipulation of distant targets. In Prof. of CHI (pp. 285-294). ACM.

[10] Tan, S., Schöning, J., Luyten, K., & Coninx, K.: Investigating the Effects of using Biofeedback as Visual Stress Indicator during Video-mediated Collaboration. In Prof. of CHI, (2014)

[11] Tennent, P., Rowland, D., Marshall, J., Egglestone, S. R., Harrison, A., Jaime, Z., Walker, B. & Benford, S. (2011). Breathalising games: understanding the potential of breath control in game interfaces. In Prof. of ACE (pp. 58 - 66). ACM.

[12] Vogel, D., & Balakrishnan, R. (2004). Interactive public ambient displays: transitioning from implicit to explicit, public to personal, interaction with multiple users. In Proc. of UIST (pp. 137-146). ACM.