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Abstract
Mobile gaze trackers embedded in smartphones or tablets provide a powerful personal link to game devices, head-mounted micro-displays, pc´s, and TV's. This link may offer a main road to the mass market for gaze interaction, we suggest.

Author Keywords
Gaze, gaze interaction, smartphones, mobility, games, micro-display, smarthome

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
The development of eye tracking devices still remains a niche technology. The relatively high cost of commercial systems is likely due to the low volume of sold devices. This has been characterized as the chicken and egg problem (e.g., which comes first: low demand limiting research and development, or lacking research and development leading to limited demand) and was already noticed by Bolt more than 20 years ago [1] and by Jacob and Karn [4]. As long as the eye tracking industry only sells a few thousand systems a year it limits investments into the engineering research and development required for a good, inexpensive unit.

Figure 1: Cradle with a built-in camera and light sources designed to fit a modern smartphone.

Ideally, a mass-market demand would lower the cost of a system to a fraction of what it is today. One way of achieving this is by including the technology in popular consumer products such as game consoles, laptops and modern smartphones. In order to lower the cost of the system, the demand within the existing user base (e.g., people with motor skill disabilities,, market research, cognitive psychology etc.) should either be dramatically increased or new user groups should be found [3].

In order to achieve this, developers must create one or more killer apps to boost the market. Recent years have seen increased interest in non-traditional input modalities, particularly in the games market. For example, the Wii game console uses whole body movement as input. We believe that the potential for eye movement measures to increase immersion in game play is clear, and achievable. Such applications of eye tracking would greatly increase the sale-ability of gaze trackers, particularly low-cost systems and systems based on existing hardware such as web- or phone-cams.

Mobile gaze tracking from a smartphone or a tablet may become an important link to entertainment and smart-home systems. Imagine that the private smartphone holds our individual eye data (i.e., calibration data, iris pattern, etc.) and provide you gaze interaction with relevant other devices through a common protocol (e.g., Bluetooth or Wi-Fi). In this paper, we would like to suggest a couple of use-cases for gaze interaction delivered from smartphones.

Gaze interaction through smartphones

New generations of mobile phones are essentially small laptop computers with multiple processors and built-in camera(s). Miluzzo et al. [6] demonstrated the concept of gaze interaction with smartphones by implementing a simple real-time eye tracking algorithm on a Nokia N810, using the camera's built-in low-resolution camera.

We envision that owners of different types of smartphones in the near future may be able to buy a $50 cradle consisting of a built-in camera and infrared light sources as sketched in Figure 1. This setup demonstrates the potential of working as a small, independent, flexible eye-tracking system. This could, for example, be coupled with a computer using a standard-size monitor with more available screen estate and larger interactive elements. Here, we envision that the user simply just needs to turn on the phone's gaze tracking software and then place the phone below the monitor, effectively turning the PC into a fully functional eye tracking system. This would, for instance, allow for combined use of gaze and mouse on the PC (i.e., the MAGIC pointer concept suggested by Zhai et. al. [10]) and for gaming with gaze.

Gaze games

We believe that the gaming industry holds a key potential to create mass-market applications using eye-tracking as input. In the near future, remakes of well-known casual games could reappear with support for gaze control (e.g., Angry Birds, Breakout). For the vast majority of gamers, this novelty will be appealing and entertaining - but potentially tiresome after some hours of play, if limited to gaze-only control only.

Gaze control in games could be applied either directly or indirectly. Directly means controlling objects on the screen, indirectly means that gaze is recorded and

Figure 2: Playing your old favorite game on a smartphone or tablet could become the killer app for gaze interaction. This person plays Fruit Ninja with his eyes on a tablet.

interpreted without immediate visual feedback. Gamers may have a hard time accepting the limited accuracy provided by the eye tracker. In our opinion, game developers need to break away from the idea that gaze can only be used for direct pixel-precise pointing (e.g., as a sniper in a 3D shooter) and start using gaze as an indirect passive input in combination with traditional controls. Gaze can be used to communicate the attention from the player to the game engine or other gamers, and thus be used strategically in the gameplay design.

The concept of indirect gaze-awareness is not new in gaze-based research but it still has to be proven in mainstream applications such as gaming. Imagine a detective game where the player is able to intimidate witnesses, annoy the bad guy or even impress a beautiful girl, just by the way he looks at the screen. Imagine, that the actor you look at most in an opening scene becomes the main character in the coming scenes [9]. Or, imagine a first person shooter game where the system's agents can be more or less good at hiding based on knowing where the player is looking.

Smart-home assistive technologies

Eye-tracking technology on a smartphone also has the potential and flexibility to interact with everyday gaze-enabled objects and change their state just by looking at them. Vertegaal [8] notes how the future of gaze aware interfaces is not limited to interactive elements on the computer, but rather to any object around us.

Pointing at inanimate objects in the environment is a useful and simple way of inferring meaning on to inanimate objects or to guide the hand and sight of someone else. Pointing to a glass of water can infer the meaning of being thirsty. Pointing to a shelf in a bookcase can guide the hand of someone to pick up a specific book or CD. Eye tracking systems which place the gaze direction of the user in their direct environment, could facilitate direct object eye pointing If every item in the user's environment could be recognised by image recognition the user could simply eye point (look) at an item of interest and the system could convey this interest to the user's surroundings. This form of interaction could also translate into environmental control tasks, such as turning on the TV or a lamp simply by looking at the object [5]. One possible way to achieve this would be by use of smart glasses.

Gaze and smart glasses

We expect gaze interaction via wearable displays to have a major impact on the spread of gaze interaction in the mainstream market. Wearable displays, although rarely used yet, are likely to become lightweight and discrete, minimizing their power consumption. Developers of gaze tracking systems have also begun exploring this avenue (e.g. San Agustin et. al. [7], Bulling and Gellersen [2]). Gaze interaction via wearable displays may be of relevance to a range of professionals. Doctors, for instance, could interact with medical records and images by gaze-attentive technology while examining a patient. Everyday gaze interactive wearable displays would replace the majority of activities that we currently perform with our fingers on a mobile phone, only there would be no need to pick it up or search for it in a pocket – the display would be right before our eyes and our hands would be free. Still, gaze data analysis and interface control would be conducted from the smartphone we carry with us–remotely connected to the smart glasses.

Conclusion

In this paper we have argued that the smartphone should be considered as the core unit of future personalized gaze tracking, that you carry with you at all times providing gaze interaction with external screens and smart glasses. For this to happen, we suggest to develop a snap-on cradle to be developed for mobile phones and tablets. Eventually, we expect that manufacturers of mobile devices will include gaze-tracking facilities in their products.

References

[1] Bolt, R.A. Conversing with computers. *Technology Review*. 1985, 88 (2), 35–43.

[2] Bulling, A. and Gellersen, H. 2010. Toward mobile eye-based human-computer interaction. *Pervasive Computing, IEEE*. 9, 4 (2010), 8–12.

[3] Hansen, J.P., Hansen, D.W., Johansen, A.S. and Elversjö, J. 2005. Mainstreaming Gaze Interaction Towards a Mass Market for the Benefit of All. *Universal Access in HCI: Exploring New Interaction Environments*. 7, (2005).

[4] Jacob, R.J.K. and Karn, K.S. 2003. Eye tracking in human-computer interaction and usability research: Ready to deliver the promises. *Mind*. 2, 3 (2003), 4.

[5] Mardanbegi, D. and Hansen, D.W. 2011. Mobile gaze-based screen interaction in 3D environments. *Proceedings of the 1st Conference on Novel Gaze-Controlled Applications* (New York, NY, USA, 2011), 2:1–2:4.

[6] Miluzzo, E., Wang, T. and Campbell, A.T. 2010. EyePhone: activating mobile phones with your eyes. *Proceedings of the second ACM SIGCOMM workshop on Networking, systems, and applications on mobile handhelds* (New York, NY, USA, 2010), 15–20.

[7] San Agustin, J., Hansen, J.P., Hansen, D.W. and Skovsgaard, H. 2009. Low-cost gaze pointing and EMG clicking. *CHI '09 Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2009), 3247–3252.

[8] Vertegaal, R. 2003. Attentive user interfaces. *Communications of the ACM*. 46, 3 (2003), 30–33.

[9] Vesterby, T., Voss, J.C., Hansen, J.P., Glenstrup, A.J., Hansen, D.W. and Rudolph, M. 2005. Gaze-guided viewing of interactive movies. *Digital Creativity*. 16, 04 (2005), 193–204.

[10] Zhai, S., Morimoto, C. and Ihde, S. 1999. Manual and gaze input cascaded (MAGIC) pointing. *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit* (1999), 246–253.