Display Content Adaptation Using a Force Sensitive Office Chair

Andreas Riener, Johannes Kepler University Linz, Austria

ABSTRACT

In this paper, the author introduces a novel method for non-invasive, implicit human-computer interaction based on dynamically evaluated sitting postures. The research question addressed is whether or not the proposed system is able to allow for non-obtrusive screen content adaptation in a reading situation. To this end, the author has integrated force sensor array mats into a traditional office chair, providing sitting postures/gestures of the person seated in real time. In detail, variations in the center of pressure were used for application control, starting more generally with usability assessment of cursor control, breaking them down to simple(r) pan and zoom of screen content. Preliminary studies have indicated that such a system cannot get close to the performance/accuracy of keyboard or mouse, however its general usability, e.g., for handicapped persons or for less dynamic screen content adaptation, has been demonstrated and some future potential has been recognized.

Keywords: Ambient Intelligence, Dynamic Screen Content Adaptation, Force Sensor Arrays, HCI, Sitting Postures/Gestures

1. AMI TECHNOLOGY IN AN OFFICE ENVIRONMENT

Traditionally, office work is concerned with (1) using the keyboard for input operations and (2) precise point, click, and drag&drop operations using the computer mouse. However, as more and more people spending their working day in front of the screen, beside the “processing-centered tasks” a new class of interaction gains more and more importance: The computer (screen) as “reading device” for scientific papers, e-books, newspapers, and other information-rich information. While conventional computer work requires frequent user inputs, the usage as an electronic reading device often comes along with a “relaxed”, reclined sitting posture, with hands – most the time – away from both keyboard and mouse. In this “mode of operation”, however, scarce interaction with the computer, e.g., for moving invisible screen areas into focus, for turning pages, for magnifying interesting data, and so on, has to be necessarily enabled.

To address this problem, i.e., leaving the reader in a comfortable sitting posture but at the same time allowing him/her for convenient (limited) application control, the utilization of ambient...
intelligence (AmI) technology is expected to serve as a feasible solution. According to (Crutzen, 2006), one of the characteristics of AmI technology is that smart objects will make our whole lives relaxed and enjoyable – AmI will be capable of (1) meeting needs, (2) anticipating and responding intelligently to spoken or gestured wishes, and (3) desires without conscious mediation. To pick up on this vision, we propose a non-invasive, natural behaving sitting posture controlled input/feedback system integrated into a common office chair, and providing the computer user with implicit functionalities for controlling the screen content on display. The operating principle is thereby based upon the proven fact that people naturally lean towards items and adjusts their position in order to better inspect them (Harrison & Dey, 2008).

The research question addressed in this work is:

RQ: whether or not it is possible to (conveniently) use a non-invasive, implicit sitting posture acquisition system integrated into a common office seat for unobtrusive, non-disruptive screen content adaptation (e.g., zoom, pan) in a relaxed, probably reclined, reading situation.

1.1. Related Approaches

Since Doug Engelbart’s, “Mother of All Demos” (Engelbart, 1968), where he demonstrated the computer mouse (Engelbart, 1970) to the public for the first time, many research groups all over the world have investigated alternative approaches for interacting with the computer employing different levels of accuracy and workload. Harrison and Dey (2008) were, to our best knowledge, the first who recognized the need for inconspicuous, implicit assistance in the considered tasks. Their system “Lean and Zoom” follows a camera-based approach for magnifying screen content based on the measured face-screen distance. Even though this system shows good performance and demonstrates ease of use, the usability is to some extent restrictive as the user has – on desired magnification – to move the whole body towards the screen and furthermore, the utilization of cameras is in general somehow problematic. For example, cameras have to be calibrated before usage in order to estimate correct camera parameters like metric information (Sauer et al., 2006), both angle and distance to the camera are limited (Sippl et al., 2010) (this is particularly true for Webcams integrated into computer screens), they are susceptible to varying lighting conditions, reliable distance/position detection is often compromised already by small motions of the head (Sippl et al., 2010), computer vision algorithms to be applied are, in relation to the finally used control commands, too complex, etc.

Other feasible approaches for unobtrusive detection of body movement, gestures/postures, or any other expressive body language to be used for implicit interaction with the computer are, admittedly all with their specific drawbacks, eye movement (Jacob, 1990) or gaze gestures (Drewes et al., 2007; Drewes & Schmidt, 2007; Sippl et al., 2010; Luca et al., 2007). Common to all technologies using movements of the eye are a number of limitations, such as contact lenses or spectacles, lighting conditions (brightness, shadows), or posture and movement of the head. The “Midas-touch problem” (Jacob, 1990) indicates that reducing the dwell time when inspecting the displays leads to unstable system behavior, however, increasing the dwell time too much prevents undisturbing, “relaxed“ usage. In addition, the eye is normally used for triggering output – using it as “input sensor” is unnatural and may result in further conflicts or even user distraction.

Recently, increasing effort has been put into research focused on electrooculography (EOG) (Bulling et al., 2008, 2011), and electroencephalography (EEG) (Choi & Lee 2006; Knezik & Drahansky 2007; Felzer & Nordmann, 2008). The approach is to use the changing electrical potential of brain waves generated by the eye movements or detected during EEG measurements. However, also here are a number of limitations preventing the universal application of these techniques such as that the eye can rapidly get tired incapacitating further
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