Posture Training with Real-time Visual Feedback

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CHI 2013 Extended Abstracts, April 27–May 2, 2013, Paris, France.
ACM 978-1-4503-1952-2/13/04.

Abstract
Our posture affects us in a number of surprising and unexpected ways, by influencing how we handle stress and how confident we feel. But it is difficult for people to main good posture. We present a non-invasive posture training system using an Xbox Kinect sensor. We provide real-time visual feedback at two levels of fidelity.

Author Keywords
Posture; biofeedback

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

Introduction
The posture we hold affects us in a variety of ways. Office workers spend about 2000 hours every year sitting, often in poor postures. People who work in customer service spend an equivalent amount of time standing in a variety of ways that can be damaging to their backs. Furthermore, good posture has been shown to have positive effects on behaviour, by increasing pain tolerance [1], reducing stress [3], and increasing confidence in one's own thoughts [2].

Figure 1. The display and hardware.

For most people, maintaining correct posture is extremely difficult. When we sit at computer desks, we slouch, hunch, and lean on the desk in front of us. Because we sit so poorly, simple actions like moving our mouse or typing on a keyboard become more strenuous over time, and posture related problems become increasingly more severe until we are unable to sit comfortably. Studies have shown that roughly 40% of office workers are likely to suffer back problems [4], and while we cannot associate all of these cases with poor posture (ergonomics certainly plays a role), it is easy to imagine that many of these cases are related to posture.

Existing techniques to detect posture require specialized equipment. Mutlu et al. [7] detect seated postures using sensors placed on a chair. While it is non-invasive, it still requires a chair carefully outfitted with sensors and, of course, doesn't support standing postures. Mattmann et al. created strain-sensitive textiles to detect posture [6]; this requires users wear special clothing to have their posture monitored. Even with accurate posture detection, most people are unaware of their posture or how to change it. Zheng et al. [8] also used an ergonomic chair that provides vibrotactile feedback to guide correct posture. Haller et al. [5] investigated three ways (graphical, vibrotactile and physical) of interrupting people to improve their posture, and found that vibrotactile feedback was intrusive over the long term.

We have developed a system to detect posture non-invasively using the Microsoft Xbox Kinect sensor. This does not require people to attach sensors to their bodies or wear uncomfortable sensors. Using the Kinect, our system provides real-time visual posture feedback using two levels of fidelity (general and specific feedback), targeting specific areas of the body. Because people are generally comfortable observing their own appearance and behavior in mirrors, we present posture feedback using a display that resembles a mirror.

Posture Training System

We will now describe the posture training system, by first explaining how we use the Xbox Kinect to detect posture, and then provide real-time visual feedback.

Non-Invasive Posture Detection

Existing techniques for posture training include using special clothing with sensors [6] and chairs with embedded sensors [7]. However, we decided to use the Microsoft Kinect sensor to detect posture. We chose this because it is inexpensive commodity hardware that is readily available. Additionally, it is a non-invasive way to detect posture using skeletal tracking. Unlike other systems that require people to wear clothing or attach sensors directly to their bodies, the Kinect doesn't require any contact with the body. We used the PrimeSense OpenNI driver to interface with the Kinect.

In order to support individual differences and training for different types of postures (i.e., standing vs. sitting), we require users to calibrate against the desired posture. We track x, y, and z coordinates for the head, neck, shoulders, torso and hands. With these skeletal locations, we calculate the angles between the following joints: (a) from the neck to the head, to ensure the head is located in line with the neck; (b) from the torso to the neck, to ensure the neck is located in line with the torso; (c) from the left to right shoulder, to ensure the shoulders are not twisted and

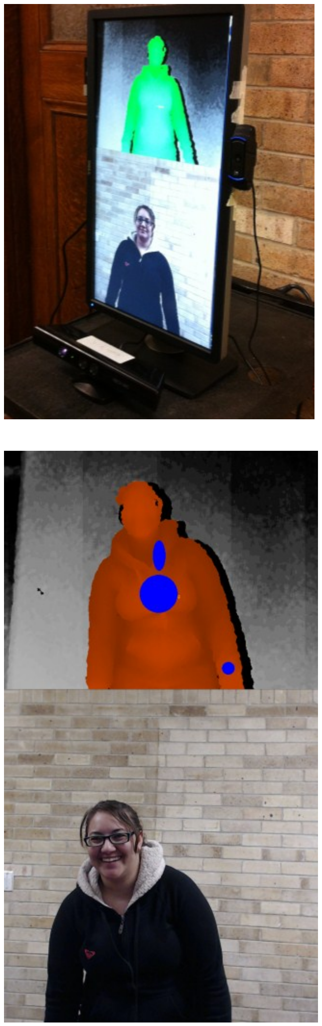

Figure 2. The specific feedback system (ARM).

are in line with the torso. This method also detects lateral tilt of the spine using the torso, neck and head joints. We also track the hands so we can detect when the arms are not within a desired range, depending on the calibrated posture. For example, we can use this to detect when the arms are crossed at the chest or at the side in line with the body.

Real-Time Visual Posture Feedback

We provide real-time visual posture feedback in two ways by varying the fidelity of the feedback. In both cases, we use a 24” widescreen LCD mounted in portrait orientation that provides a mirrored image of the user using a high-resolution webcam. This method of providing feedback was chosen because people are familiar with using a mirror to observe and correct their posture.

GENERAL POSTURE MIRROR

We created a low fidelity posture mirror that provides general posture feedback. Using the mirrored display as a base, this technique assesses the overall quality of the posture as compared to the calibrated posture. We overlay on the mirror an animated mist texture to represent the quality of the posture. The opacity of the mist depends on the aggregated differences between the current and calibrated postures. For example, with a posture that closely matches the calibrated posture, the mist is invisible and the user’s live mirror view is clear. However, as the user’s posture deviates, the opacity of the mist decreases until it is completely opaque and the live mirror view is obscured (see Figure 3). This technique was chosen because it could be used in applications where specific feedback is not necessary or would be distracting. Unlike the specific mirror (below), one cannot accurately tell where their posture deviates from the one they calibrated.

AUGMENTED REALITY POSTURE MIRROR

We created a high fidelity augmented reality posture mirror (ARM) to provide specific feedback targeted at areas of the body that are not in line with the calibrated posture. The ARM shows a depth image of the user above a live mirror image of the user (see Figure 2). The depth image uses the Kinect depth image with areas of the user’s body that do not match their desired calibration highlighted (see Figure 2). For example, if the user’s neck and torso are not aligned, this area of their body is highlighted with a coloured sphere overlaid on the depth image. In this way, the user can see both a clear image of themselves as if they were looking in a mirror to view their posture, with the augmented-reality overlay above with specific posture feedback.

Using Posture Feedback to Improve Posture

Our method for non-invasively detecting posture using the Xbox Kinect sensor can be integrated into existing posture training systems. Because of our calibration process, we are able to accommodate individual differences in posture, as well as facilitate training of postures outside the range of ergonomics (i.e., dance or yoga poses). Additionally, our method works for both sitting and standing postures. Integrated with desktop software to facilitate reminders or alerts when the user’s posture deviates from that of the calibrated goal, our method would enable a low-cost, non-invasive way to help users improve their posture when working on their computers at a desk.

Figure 3. The general feedback system clouds over when the user's posture is bad.

Furthermore, we created two techniques for providing real-time visual posture feedback with varying levels of fidelity. On our mirrored display, we provide general, non-specific feedback of the overall quality of the posture (low fidelity) or an augmented-reality image with specific feedback (high fidelity). Integrated with posture improvement software, these techniques would provide an enhanced means of helping people train for their specific posture goal.

Future Work

We would like to perform a field study and deploy the Kinect posture detection system with a desktop-based ARM for continuous use with office workers. This will investigate the efficacy of our low-cost solution to detect posture. Furthermore, we will compare our visualized posture feedback technique to other approaches. We would like to understand whether the targeted visual feedback of the ARM helps people better identify how to improve their posture.

Acknowledgements

We thank all the members of the HCI lab at the University of Saskatchewan, particularly Jared Cechanowicz. Thanks to the GRAND NCE for funding.

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