Available online at www.sciencedirect.com

ScienceDirect

IFAC Papers Online CONFERENCE PAPER ARCHIVE

IFAC-PapersOnLine 49-19 (2016) 289–294

Graphical Notification to Maintain Good Posture during Visual Display Terminal Work

Kazuyoshi Murata*. Yu Shibuya**

**Aoyama Gakuin University, Kanagawa, Japan*
(e-mail: kmurata@si.aoyama.ac.jp).
***Kyoto Institute of Technology, Kyoto, Japan*
(e-mail: shibuya@kit.ac.jp)

Abstract: Visual Display terminal (VDT) work typically results in low-level static back, shoulder and neck muscles loading, as well as static spine loading. Improving sitting posture can reduce such loadings. We developed a posture notification system to make a user aware of poor posture by displaying illustrations of problematic posture. The proposed system encourages motivation through competition using a feature that allows users to share their sitting posture and posture score with other users. In an experiment, six participants were asked to perform everyday VDT work using the proposed system. The experimental results indicated that the proposed system made participants aware of their poor posture. However, the proposed system was not effective at motivating participants to maintain good posture. To motivate participants to maintain a good posture, we must adopt additional self-competition and normalization features.

Keywords: VDT work, Sitting posture, Graphical notification, Competition, Maintaining motivation

1. INTRODUCTION

Many office workers spend their days facing a visual display terminal (VDT). VDT work typically results in low-level static back, shoulder, and neck muscles loading, as well as static spine loading (Kingma and van Dieën (2009)). These loadings increase the risk of developing muscular disorders (Vissera and van Dieën (2006)) or lower back injury (Taieb-Maimon et al. (2011)). Improving sitting posture on the basis of a guideline such as Good Working Positions (Good Working Positions, Occupational Safety & Health Administration), is one way to decrease these risks. However, maintaining good posture is often difficult for many VDT workers, even if they know that following such guidelines is good for their health. Often, they follow guidelines initially; however, later, their postures worsen unknowingly, e.g. slouching. There are two reasons why they cannot maintain good sitting posture.

- Users cannot be consciously aware of their own posture.
- Even if users are aware of their posture, they are not motivated to maintain good posture.

In this study, we have developed a prototype of posture notification system to solve these problems, i.e. being aware of poor posture and motivating users to maintain good posture. The proposed system has two features. The first feature is a graphical notification of sitting posture. Four conditions related to sitting posture in a workspace are used to determine good sitting posture. These conditions are taken from the Guidelines for Industrial Health Controls of VDT Operation (Guidelines for Industrial Health Controls of VDT Operations), published by the Japan International Center for Occupational Safety and Health:

- the viewing distance is approximately 40 centimeters or greater;
- the top edge of the display is approximately equal to or slightly below eye level;
- the operator sits back in the chair with their back appropriately squared to the chair back;
- the operator's shoes are in contact with the floor.

The proposed system detects whether a user's sitting posture meets these conditions and notifies the user of the result to make them aware of their posture. The second feature encourages competition. Users and their colleagues can share sitting posture information using the proposed system. This can encourage competition among users and motivate users to maintain good posture. We have conducted an experiment to confirm the effects of the proposed system on sitting posture in a VDT workplace. In this paper, we explain the features of the proposed system and its implementation. In addition, we describe our experiment and discuss the results.

2. RELATED WORKS

Presenting a self-posture image to a user is effective for improving sitting posture in VDT workplaces (Taieb-Maimon et al. (2011)). To make users notice and improve their sitting posture, the proposed system displays an illustration of their sitting posture. Interrupting a peripheral task can disrupt task performance and can affect the

10.1016/j.ifacol.2016.10.551

emotional state of a user (Bailey et al. (2001)). Thus, highly intrusive notifications, e.g. pop-up dialogs, should be avoided. Haller et al. presented three different notifications for posture guidance during VDT work, i.e. graphical, physical, and vibrotactile feedback (Haller et al. (2011)). The results of their evaluation showed that the vibrotactile feedback caused a huge intrusion. In contrast, the physical feedback was less disruptive than other feedback; however, it was not noticeable by the user. Arroyo et al. showed that interruption by changing temperature has greater detrimental effect on both disruptiveness and performance than interruption by light intensity (Arroyo and Selker (2003)). The proposed system adopts graphical notifications to increase noticeability and reduce disruption.

Gamification is a term that describes the use of video game elements in non-gaming systems (Deterding et al. (2011a)). One element of gamification is competition (Yee (2006)). Competition is used to maintain user motivation to engage in monotonous activities. For example, Kuramoto used competition to improve user motivation in repetitive daily activities or exercises (Kuramoto (2009)). The proposed system also uses competition to maintain user motivation to sustain good sitting posture.

To monitor and improve sitting posture in a VDT workplace, Schrempf et al. proposed an intelligent office chair that classifies the user's sitting posture (Schrempf et al. (2011)). In addition, several studies have used an office chairs with sensors to detect sitting posture ((Daian et al. (2007), Mutlu et al. (2007), Zhen and Morrell (2010)). The proposed system also uses an office chair with sensors to detect user posture. Furthermore, the proposed system uses the Microsoft Kinect to detect user's face position.

3. GRAPHICAL NOTIFICATION OF SITTING POSTURE

Fig. 1 shows an example of the proposed system's sitting posture graphical notification. This illustration identifies problematic spots according to the conditions for good sitting posture. These problematic spots are marked by a red circle on the posture illustration. Furthermore, as shown in Fig. 1(b), information to correct the problematic spot is displayed in a text message. Fig. 1(a) is displayed when the user has good posture, and Fig. 1(c) is displayed when the user is not performing VDT work.

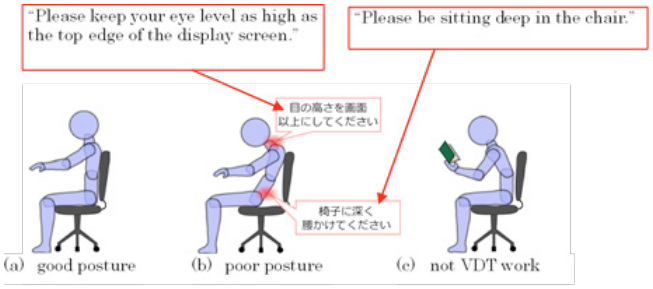

Fig. 1. Sitting posture.

This illustration is placed at the lower right of the screen. It is displayed in the forefront of every graphical representation on the screen. In addition, the opacity of the illustration is set to 30%; thus, users can observe screen elements that are behind the illustration. If desired, the user can position the illustration anywhere on the screen.

The sitting posture illustration in the proposed system is always displayed on the screen. However, the illustration does not require any mouse or keyboard operations. The user does not need to perform additional operations, such as clicking an OK button. Therefore it is assumed that the illustration will not affect the user's main task.

4. COMPETITION

The user can improve poor posture by responding to the posture illustration. However, posture tend to become poor over time. Therefore maintaining motivation is required to maintain appropriate sitting posture.

In the proposed system, the proportion of time that the user has maintained good posture in the last hour is defined as "posture score." The posture score is displayed on a leaderboard, as shown in Fig. 2. The leaderboard is displayed with the posture illustration. A leaderboard is a typical example of a game interface design element (Deterding et al. (2011b)). The leaderboard is used to encourage competition among users. Each user's score is sorted in descending order and presented in a bar graph. Thus, it is easy to compare scores among users.

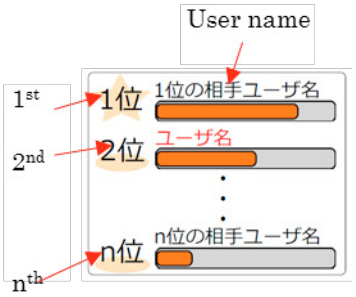

Fig. 2. Posture score.

In addition to the posture score, the proposed system allows participants to view other users' sitting posture illustrations. The posture illustration makes the user conscious of the fact that other users can observe their sitting posture. Thus, the user is motivated to demonstrate good posture. Note that a user's problematic spots marked by red circle and text messages are not displayed on the other user's posture illustration.

5. IMPLEMENTATION

The proposed system consists of two components, i.e. the notification and posture detection component.

5.1 Notification Component

The notification component displays the posture illustration and posture score. Fig. 3 shows three combination patterns available in the proposed system. The Posture-only pattern shows only the self-posture illustration. The Posture-score pattern shows only the user's own posture illustration and