Technical Disclosure Commons

June 10, 2019

Multi-camera arrays to detect posture

Jonathan D. Hurwitz

Christina L. Gilbert

Follow this and additional works at: https://www.tdcommons.org/dpubs_series

Multi-camera arrays to detect posture

ABSTRACT

This disclosure describes techniques that, with user permission, automatically detect the posture of a user of a personal computer. The user's posture is detected using hardware typically found on a desktop or laptop PC, e.g., cameras, without requiring extra sensors or other additional hardware. If the detected posture is determined to be poor, the user is alerted. By detecting and alerting the user of poor posture, the techniques can help forestall health problems. The techniques are implemented with user permission. Users are provided with options to turn off posture detection.

KEYWORDS

- Posture detection
- Multi-camera array
- Pose detection
- Pose correction
- Pose alert
- Object detection

BACKGROUND

The posture of users working on laptops or desktops often degrades with the length of the work-session. As users work longer, they tend to slouch. Over a period of time, postural problems can result in health problems such as muscle imbalances, circulation problems, permanent spinal curvature, etc.

DESCRIPTION

Per techniques of this disclosure, images of the user, obtained with user permission, e.g., captured by one or more cameras, are used to compute distances between different parts of the human body. When the user permits, the computed distances are used to determine the user's posture. Good posture is characterized by the ratio of distances of specific combinations of body parts being within certain thresholds. Changes in the distance or distance-ratios between body parts are indicative of changes in posture. If the user has provided permission to receive alerts related to posture, an alert is provided to the user when a change to a poorer posture is detected.
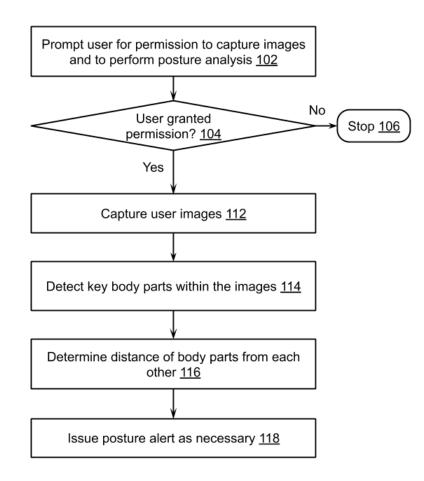

Fig. 1: Determining posture of a user using an array of cameras

Fig. 1 illustrates determining the posture of a user using a camera or an array of cameras with user permission. A prompt is provided to the user for user permission to capture images and to perform posture analysis (102). The user response is evaluated (104). If the user denies permission, no images are captured and the process for posture analysis is not performed (106).

If the user provides permission, cameras of the array capture images of the user (112). Key body parts (114), e.g., eyes, shoulders, nose, neck, ears, etc. within each image are detected using object detection and image classification techniques. The distances of the body parts from each camera, and from the plane of the screen are computed using trigonometric relationships as further described below. Distances between body parts are also computed (116). Examples of computed distances include distances from the cameras to the nose; distances from the cameras to the chest; distance between the nose and the chest; etc. Users are provided with options to choose the distance metrics that are used for posture computation, e.g., the user can choose a subset of distances as described herein.

If the distances, or their ratios meet predetermined threshold distances, a posture alert is provided to the user (118), e.g., a suggestion that the user sit up straight. For example, the left jaw to left clavicle distance (and/or the right jaw to right clavicle distance) reducing or falling below a certain threshold is indicative of poor posture. Similarly, the nose-to-chest distance is indicative of posture. Good posture exhibits larger jaw-to-clavicle and nose-to-chest distances, since the head is higher.

Distance thresholds that determine the boundary between good and bad posture are obtained from a baseline model that is created by averaging good-posture poses across a large section of the population, classified based on, e.g., gender, age, etc. Such determination is based on data obtained from users that provide permission for use of posture data for a baseline model.

Alternately or in addition, a baseline model can be established on a per-user basis, e.g., by obtaining a baseline good posture pose, e.g., at the beginning of a work session, from which baseline distances are identified. Such a per-user baseline model is constructed with specific user permission to use user images for model construction. The posture adjustment notification to the user can be issued via any device such as a desktop, laptop, browser, wearable or mobile device, etc. Sound, haptics, visual cues, etc. may be used to alert the user.

The captured user images are utilized only for posture determination. The user is provided with controls regarding whether and how the images and/or posture data are stored. For example, the user can choose to not store images; in this case, each image is deleted immediately upon determination of the posture. In another example, the user can choose to store images temporarily. Similarly, the user can choose to store posture data (e.g., to be able to view changes in posture over time) or to not retain posture data.
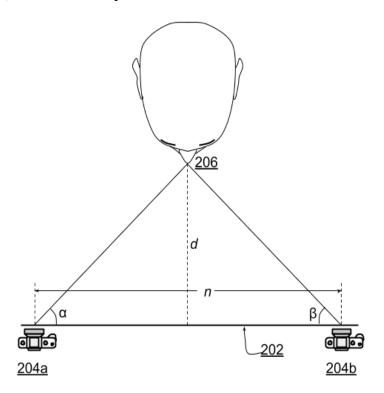
Fig. 2: Determining the distance of a body part from the screen of a laptop or desktop

Fig. 2 illustrates an example trigonometry-based technique to determine the distance of a body part (206) from the plane of the screen (202) of a laptop, desktop, or other device that is coplanar with cameras. Cameras (204a-b) capture an image of the user. Fig. 2 illustrates the case of two cameras, but the technique applies to an array of an arbitrary number of cameras.

In the two-camera case, the distance between the cameras is denoted as n. The angle between the body part and the plane of the screen subtended at the two cameras is denoted respectively by α and β. The unknown distance between the body part and the perpendicular from the body part to the line connecting the two cameras is denoted by d.

From trigonometry,

$$n = \frac{d}{\tan \alpha} + \frac{d}{\tan \beta}.$$

Re-arranging, and using basic trigonometric relationships,

$$d = n \frac{\sin \alpha \sin \beta}{\sin(\alpha + \beta)}.$$

The above formula can be used to determine the distances of detected body parts from the plane of the cameras. Alternatively, distances within an image of the user can be estimated based on the relative sizes of objects within the image, or on the user's movement within the image.

In this manner, with user permission, the techniques of this disclosure can detect and alert users of their posture using hardware that is typically available on laptops, desktop all-in-ones, monitors, etc. without requiring the purchase of additional hardware. The techniques also apply to calibrated camera arrays, e.g., standalone webcams without a screen. The techniques determine the distance of the user from the camera, and hence are also advantageously applicable to video conferencing.

Alternative techniques to detect and alert users of their posture can make use of wearable devices, e.g., sensors, accelerometers, etc. that can be used to detect posture. Techniques that help maintain good posture or prevent bad posture include the wearing of back braces.

To determine the mean values, a model can be trained, or an average can be obtained, and these values can be utilized during detection, without storing the actual components. Model training is performed with user permission. Further, if a user's own baseline is used to adjust a model, the data is obtained with user permission, and stored in an access-restricted manner.

Further to the descriptions above, a user is provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein enable collection of user information (e.g., information about a user's social network, social actions or activities, profession, a user's preferences, or a user's current location), and if the user is sent content or communications from a server. In addition, certain data is treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity is treated so that no personally identifiable information can be determined for the user, or a user's geographic location is generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user has control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques that, with user permission, automatically detect the posture of a user of a personal computer. The user's posture is detected using hardware typically found on a desktop or laptop PC, e.g., cameras, without requiring extra sensors or other additional hardware. If the detected posture is determined to be poor, the user is alerted. By

detecting and alerting the user of poor posture, the techniques can help forestall health problems.

The techniques are implemented with user permission. Users are provided with options to turn

off posture detection.