A Novel Infrared Camera-based Sedentary Time Monitoring Method

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***Abstract*—Prolonged sedentary condition has been proven to have negative impact on health [1]. In this paper, we propose an infrared (IR) camera-based sedentary time monitoring method which first classifies 1) sit-up, 2) sit lean-forward, 3) sit lean-backward, 4) lean-left, 5) lean-right, 6) standing, and 7) leaving the workspace, and measures a subject's total sedentary time as well as his/her patterns of sitting postures. Here, infrared camera is adopted since it works even at dark environment and can protect subject's privacy due to its de-identifiable characteristics. Experimental results show that our proposed method classify 7 postures with 90% classification accuracy.**

I. INTRODUCTION

Prolonged sedentary behavior has been identified as a potential cause of adverse health outcome (i.e. obesity, back pain, diabetes) specifically for office workers [2]. To promote a healthy work environment, prolonged sedentary posture detection/alarm methods are highly demanded and several approach have been taken [3].

In this paper, we propose an infra-red camera-based sedentary posture detection method which detects human sedentary posture time and alarms if sedentary time is longer than pre-determined threshold (more than the time suggested by the *Pomodoro technique* [4]). This approach adopts SURF feature detection from thermal images and classifies postures with a Support Vector Machine (SVM) classifier.

II. MATERIALS AND METHODS

We recruited subjects and asked the recruited subjects to sit on a chair located in front of an office desk. An IR camera is installed on the desk facing a subject with the following postures: 1) sit-up, 2) sit lean-forward, 3) sit lean-backward, 4) lean-left, 5) lean-right, 6) standing, and 7) leaving the workspace. Each posture is maintained for 30 seconds except for 2 minutes of the upright sitting posture. Thermal image is collected from video recording of an infrared camera at a rate of 8 frames per second (fps) as shown in Figure 1.

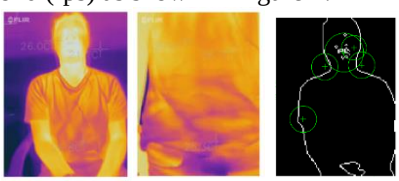

Figure 1. Representative infra-red camera images of a subject. (a) sitting and (b) standing postures, (c) SURF feature points detected on an edge detected image representing sitting condition

SURF detector uses blob detections based on determinant of Hessian Matrix. SURF features are invariant to rotation, scale and partially invariant to illumination and affine transformation [5]. Hence, SURF has been used to detect the distinct features of the preprocessed thermal images of sitting and standing postures. Figure 1c shows the extracted SURF descriptors which are categorized from the images of each category by *k-means clustering*. Each cluster center represents a feature. A multiclass image category classifier is then trained with the extracted bag of features [6] using the multiclass Support Vector Machine (SVM).

III. RESULT

We trained the SVM with 1,033 training data images which consists of 328 sitting, 86 standing, 64 lean forward, 144 lean backward, 137 lean left, 149 lean right, 121 leaving work space images. 20 test cases were considered where the standing, lean backward, lean left, lean right, subject leaving area are classified with 100% accuracy. On the other hand, some of sitting and lean forward posture images are misclassified into lean right postures. Experimental results show that the proposed sedentary time monitoring method classifies seven postures with an accuracy of 90% on average.

IV. CONCLUSION

In this paper, we proposed an automated infrared camera-based sedentary time monitoring method SVM classifier with SURF features. The proposed algorithm gives an classification accuracy of 90% on average

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