A Preliminary Evaluation of a Computer Vision-Based System to Detect Effects of Aromatherapy During High School Classes via Movement Analysis

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Abstract. In this paper we present a pilot study on non-intrusive visual observation and estimation of affective parameter using recorded videos (RGB). We aim at estimating student engagement analyzing upper-body movement comparing two different classroom settings: with the introduction of aromatherapy during the class vs standard lesson. Following previous studies on how aromatherapy can alter movement behaviour, we chose Lavender essential oil. We used computer vision techniques for pose estimation and developed software modules for the extraction of movement features from media data. Data show significant increases in overall velocity and acceleration when the participants are exposed to the aromatherapy condition. Significant decreases in neck flexion angle has been also observed, that shows students had a straighter head posture (i.e. sitting up straighter). No significant differences were observed for the overall kinetic energy of the joints and spinal extension.

Keywords: Movement analysis · Aromatherapy · Pose estimation

1 Introduction

In this paper we present a pilot study in the framework of Project "Effect of olfactory stimulation on extending concentration behavior patterns in high school students". The main objectives are: (1) investigate the effect of essentials oils on movement behaviour of high school students during the lessons; (2) application of computer vision techniques for data processing and analysis of movement features to detect the effect of aromatherapy. We chose to use Lavender essential oil because of its powerful antioxidant, antimicrobial, calming and anti depressive properties [2]. Four high school students (out of 15 students in the class) were recruited and attended the classes in two different conditions: (i) without and (ii) with exposure to lavender oil (necklace with essential oil).

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Academic life in Korean high schools is very stressful, this influences students that have consequently poor academic performance which is reported to be a major trigger for depression, anxiety, and suicidal intentions [3] and vice-versa [4]. The use of essential oils has been reported in medical studies [5] for various therapeutic methods for treating physical and emotional well-being [6].

Lefter and associates has investigated applying novel methods of measuring stress from human to human interactions and audiovisual recordings [7]. A distinct advantage of methods [7] for measuring stress are the non-invasive measurement technique, which can be applicable in numerous situations. Therefore, we aim to investigate if computer vision techniques applied to video recordings of an actual classroom in high school are feasible to detect differences in movement behaviour. In this study the experimental settings are based on non-intrusive data collection through HD video camera. For post processing of the recorded data we use OpenPose [1] for estimation of position of joints, Matlab for processing positional data and tracking of the subjects, EyesWeb XMI for the extraction of movement features. Finally, we perform statistical analysis on the movement features to see the difference between with and without essential oil lessons.

2 Experimental and Computational Details

2.1 Participants, Testing Procedure and Equipment

The National Universities Institutional Review Board (IRB) approved all procedures for this study. A high school class of 15 students participated in experimental recordings, during an extra-curricular class (subject: Social Studies). 4 of the students volunteered and agreed to be further analyzed in the framework of the study with the consent of the parents. The settings of the experimental recordings were held ecologically, as a usual high school class.

The subjects were studied during two separate days: one day without aromatherapy, and one with lavender aromatherapy. The two conditions were separated by a week of pause. The recorded subjects, teacher and room settings were the same for both days. The duration of the class was 90 min. On the second day of recordings, participants wore a lavender essential oil filled necklace during the whole class. Both classes were recorded with four high definition cameras installed in four different sides of the classroom, adequately covering the required space. Videos were recorded at full-HD (1920×1080) resolution and 100 Frames per second.

2.2 Data Processing

To analyze subjects' movements we used Convolutional Pose Machines (CPM) developed by The Carnegie Mellon University (CMU) [1] for pose estimation (Fig. 1a). CMP is a novel technique, that consists of a deep neural network for estimating articulated poses [1]. We extracted the position of 14 body parts, related to upper-part of the body: nose, neck, right and left shoulders, elbows,

wrists, hips, and eyes for each frame see Fig. 1(b). With CPM output we performed tracking and matching of subjects based on the minimum Euclidean distance of the body centroid, taking into account the assumption that people are siting and do not move from their places. In this step, we computed and filtered the positional data of the X, Y coordinated of 14 jointed named previously, for each participant separately. The extracted skeletal data, then is used for calculation of meaningful movement features, from low-level to higher level.

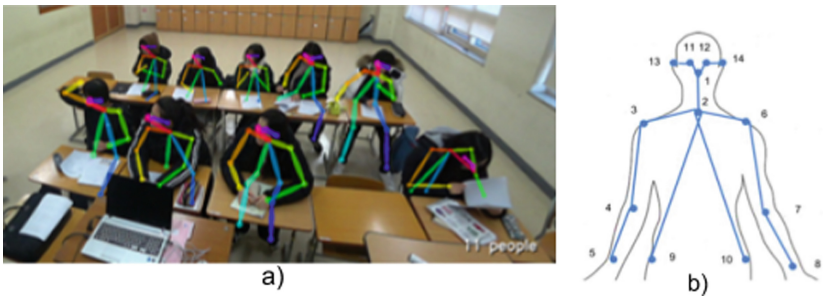

Fig. 1. (a) Application of CMP (b) Locations of 14 joints

2.3 Movement Features Extraction

Considering the limitations of the movements that can be executed during the school, we focused our analysis on upper-body movements. First we extracted low-level motion features at a small time scale (i.e., observable frame-by-frame), such as velocity, acceleration and kinetic energy. We perform the movement feature extraction using EyesWeb XMI[1]. EyesWeb XMI was used to read positional data, generate bi-dimensional points (x, y) for each joint and for the calculation of kinematic values and features. For this preliminary study, we extracted two geometrical features of the upper-body: the spinal extension and neck angle between the head and torso. The straightness of the back of a student is varying during the class, depending on many factors such as: attention, tiredness, focus, interest etc. In order to measure the extension of the back, the distance between the position of the neck and the mid-point of the hips is computed for each given frame. Movements such as look up to the teacher or look down on the book involve the head to be moving up and down, therefore changing the angle between head and torso. To analyze such movements we computed the angle between two vectors: the first connecting the barycenter of the head and the neck, and the second connecting neck and the barycenter of the hips.

[1] (http://www.infomus.org/eyesweb_eng.php) is a development software, that supports multimodal analysis and processing of non-verbal expressive gestures.

3 Results

In this preliminary study the overall velocity, acceleration and energy of neck, left and right shoulder, left and right elbow and left and right wrist were analyzed. There were significant differences in the overall acceleration and velocity of upper-body joints between the two conditions: with and without aromatherapy $[F(1, 54) = 4.53,\ p = 0.037]$ and $[F(1, 54) = 4.10,\ p = 0.047]$ respectively. However, there was no difference $[F(1, 54) = 1.10,\ p = 0.32)$ reported for the energy as there were substantially large standard deviations between each of the participants. There was a significant difference between the neck flexion angle between the two conditions $[F(1, 30) = 3.61,\ p = 0.065]$. However, the spinal extension doesn't differ significantly $[F(1, 30) = 0.50,\ p = 0.48]$.

4 Discussions and Conclusion

When participants were exposed to lavender essential oil, data shows significant increases in overall velocity and acceleration. Based on detailed observation of the recordings the student's faster moves may be explained as re-engagement of attention on the teacher. A decrease in neck flexion angle was also observed: students had a straighter head posture (i.e. sitting up straighter), which could be indicating that they were paying more attention to the teacher. This study highlights that relatively low cost cameras can provide a sufficient level of quality to use this data for estimating the positions and perform movement analysis of multiple participants in a classroom setting.

In conclusion, this study shows the possibility of using movement qualities, such as kinematic and geometric movement features, extracted ecologically using non-invasive equipment, as a novel method to measure change of movement behaviour due to aromatherapy. Future studies will involve a wider set of movement features and a bigger number of participants.

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