Understanding Movement Variability of Simplistic Gestures Using an Inertial Sensor

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Problem

Variability is an inherent characteristic of human movement [1]. Humans usually perform the same action slightly differently trial by trial. For these reason we are interested in studying methods that can give insight into measuring the variably between individuals and between repetitions of the same movement.

Movement variability is presented when users interact with displays. For instance, Zaiti et al. [2] explored kinematic variations of leap gestures such as gesture volume, gesture length, finger-to-palm distance and articulation speed. We however consider that the freedom that inertial sensors offer is ideal for both comfortable and unconstrained interaction with displays.

We believe that this preliminary research could provide useful diagnostic information in activity recognition, e.g. in terms of detecting changes in the way in which activities are performed over the course of training, practice or rehabilitation.

Materials and Methods

Raw time-series data is collected from triaxial accelerometer (a_x, a_y, a_z) and triaxial gyroscope (g_x, g_y, g_z) sensors. Then, a N samples length time-series, for instance a_x, is used to obtain the time-delay embedded matrix, $E\{a_x\}$, with a dimension of m rows and $N-(m-1)\tau$ columns [3]. Finally, PCA is applied to $E\{a_x\}$ to compute the percentage of cumulative energy (PCE) [4].

The method is applied to each time-series for both the six momevents and six participants.

Conclusion and Outlook

Although the time-delay embedding technique is subject to different values of embedded parameters (m and τ) according to the length and complexity of the time-series, the technique is useful to statistically present the inherent features of variability between six participants for six different movements.

Appreciating variability in human activity can not only provide useful diagnostic information but also offers an approach to considering the manner in which people interact with pervasive displays. For example, each of the gestures in this study could be performed in ways which signifies different states of enthusiasm, boredom, tiredness or confusion.

We are going to collect data from female and male participants of different ages attaching more sensors and applying classification algorithms.

References

[1] K. M. Newell. and D. M. Corcos Variability and motor control, United States of America: Human Kinetics Publishers, 1993.

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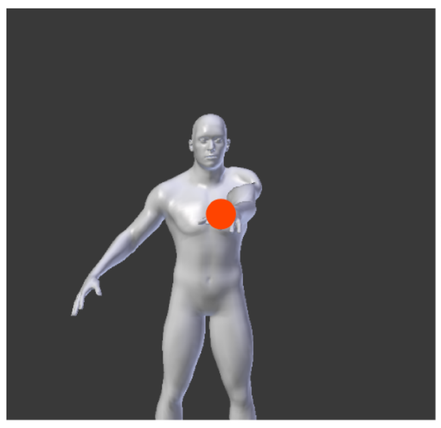
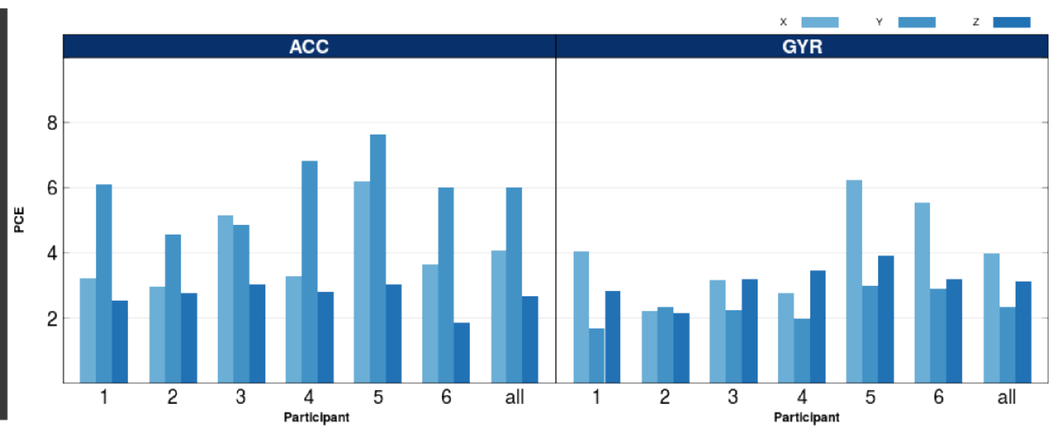
Variability of Simplistic Movements

Six simple movements were performed by six participants wearing an intertial sensor on their right wrist, each movement were continuously repeated for 20 seconds. The values of percentage of cumulative energy (PCE) are presented for triaxial accelerometer (ACC) and triaxial gyroscope (GYR) sensors accross partipants and their average denoted by all.

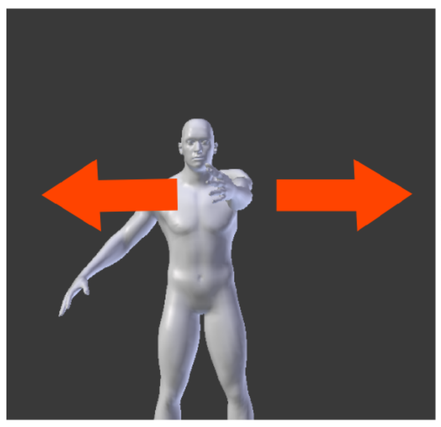
It is apparent that static, circular and 8-shape movements show a constant trend between participants; however, such trend is not evident for horizontal, vertical and diagonal movements.

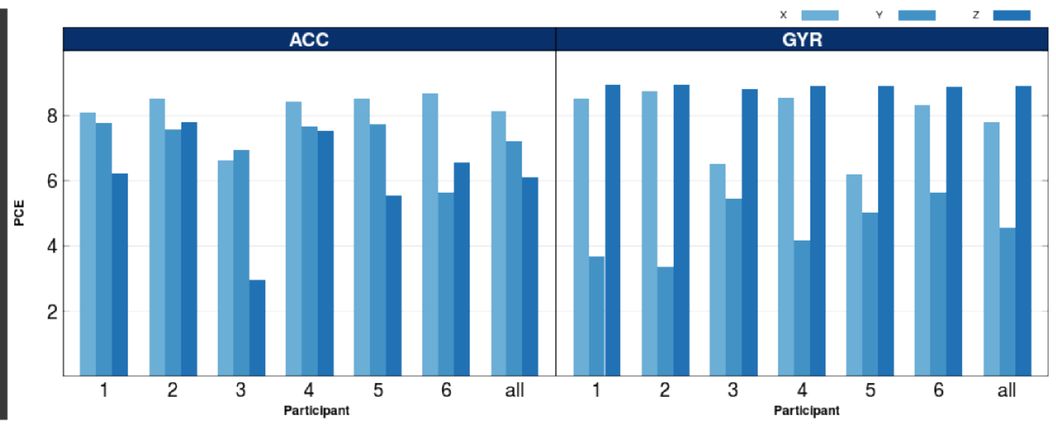
Static



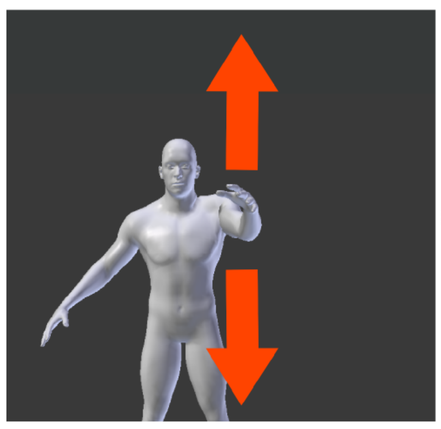


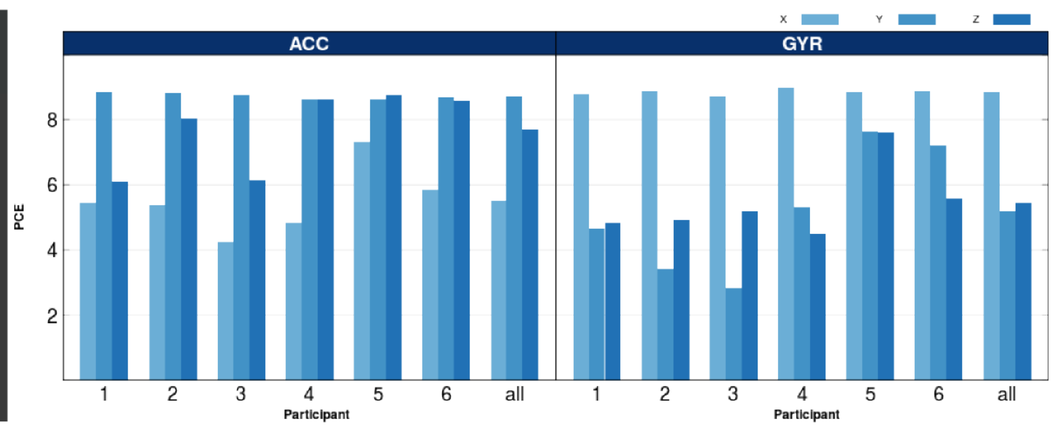
Horizontal



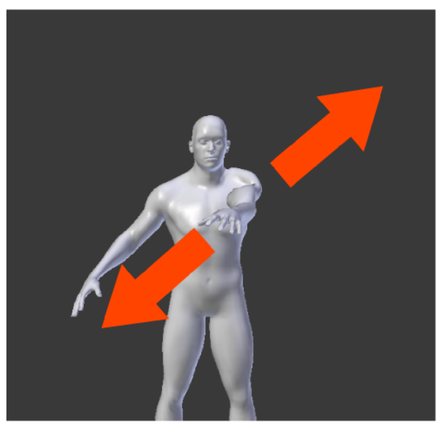


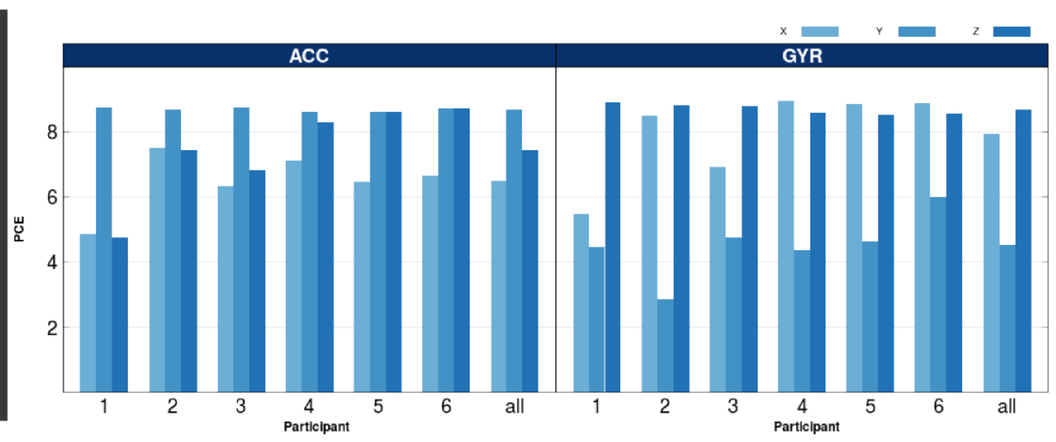
Vertical



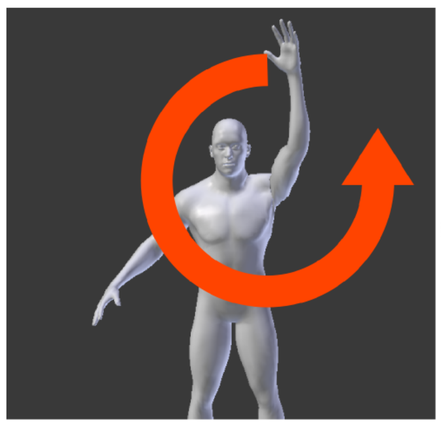


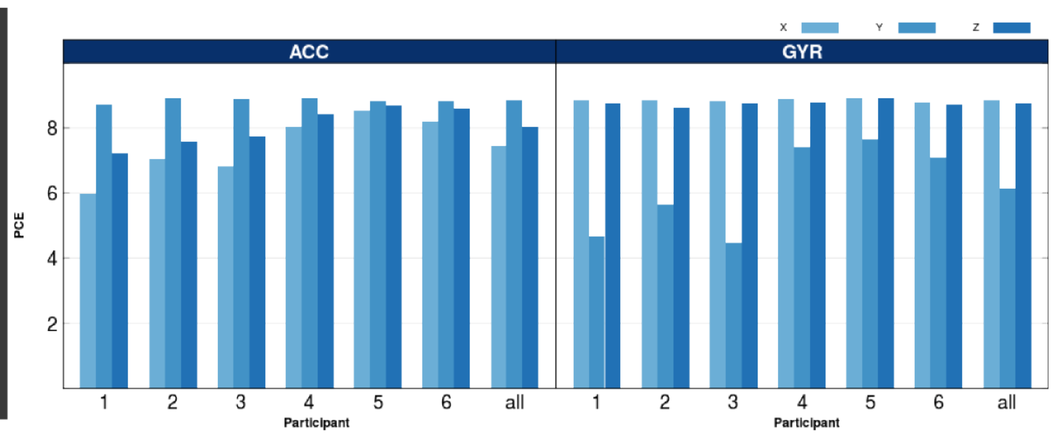
Diagonal





Circular





8-shape