Title:

A methodology based on machine learning and data science for assessing the movement quality.

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Topics:

- Movement analysis methodology.
- Coordination and motor control.

Preferred presentation method: oral presentation.

Introduction:

Machine learning, data science techniques, and IMU sensors open the door to an automatized and exhaustive analysis in patients' rehabilitations allowing to provide effective rehabilitation in a cost-efficient manner. Many different approaches have been raised with applications such as the recognition of different activities (Jalal, Quaid, Ud Din Tahir, & Kim, 2020) and data analysis for identifying the repetitions number and the movement quality (Roos, Button, Sparkes, & Deursen, 2014). A novel methodology was designed for extracting meaningful information from the IMU data followed by an activity recognition process and deep analysis of the movements.

Research questions:

- Is it feasible to create a full-fledged methodology to track the patients' movements, identify the activity, and assess its quality?
- Are the machine learning algorithms able to classify different activities performed by the patients?
- Is it possible to extract statistical metrics based on patient´s movements to spot anomalies?

Methods:

A two-step methodology is suggested:

- The usage of a random forest classifier for identifying between three activities: standing still, walking the stairs, and normal walking.
- The extraction of different statistical metrics (mean, median, minimum, maximum) and the data trends to detect the number of repetitions and to give information about movement quality. The methodology was tested using the following dataset (Luo et al., 2020) containing data from 30 patients. For validating the classification process,

ten trials were selected from different patients to perform 10 folds cross-validation. For validating the movement analysis, the results were compared to infer the correct number of repetitions, and the movement quality metrics were compared.

Results:

After performing cross-validation, the random forest had over 80% of accuracy classifying activities. Additionally, the quality assessment task could identify correctly the steps providing useful information: movement velocity, time, fluctuations in the sagittal plane...

Discussion:

The usage of machine learning algorithms allows making a fully automatized and continuous learning approach. The good results of the solution and the robustness of the random forest indicates that the solution could work reasonably well in a real case scenario.

References:

Jalal, A., Quaid, M. A. K., Ud Din Tahir, S. B., & Kim, K. (2020). A study of accelerometer and gyroscope measurements in physical life-log activities detection systems. *Sensors (Switzerland)*, *20*(22), 1–23. https://doi.org/10.3390/s20226670

Luo, Y., Coppola, S. M., Dixon, P. C., Li, S., Dennerlein, J. T., & Hu, B. (2020). A database of human gait performance on irregular and uneven surfaces collected by wearable sensors. *Scientific Data*, *7*(1), 1–9. https://doi.org/10.1038/s41597-020-0563-y

Roos, P. E., Button, K., Sparkes, V., & Deursen, R. W. M. Van. (2014). Altered biomechanical strategies and medio-lateral control of the knee represent incomplete recovery of individuals with injury during single leg hop. *Journal of Biomechanics*, *47*(3), 675–680. https://doi.org/10.1016/j.jbiomech.2013.11.046