Automated classification of activities of daily living from IMU data in adolescents using a deep learning model

Background Adolescent idiopathic scoliosis (AIS) is a complex 3D spinal deformity with a poorly understood pathogenesis. The causes of the initial deformity remain unknown, as does the question of why the curvature progresses in some patients and not in others. Detailed knowledge of the forces acting on the growth plates of the spine could contribute to a better understanding of the pathomechanisms and thus improve prevention and treatment strategies. Therefore, it is crucial to quantify the activity level of AIS patients. A precise monitoring of the daily activity of these patients could provide insight into how the intensity, duration and type of exercise affect the progression of this disease. In addition, this information can be incorporated into numerical, patient-specific models that consider not only the patient's anatomy, but also the loadings placed on the spine during daily activities.

Activity trackers play a crucial role in monitoring physical activities, providing valuable insights into health and fitness. Accelerometers, commonly used in these trackers, measure motion and can effectively capture various activities. Gyroscopes, when combined with accelerometers, enable the measurement of six degrees of freedom (6 DOF), capturing both linear and rotational movements. These sensors are small and highly practical, allowing for the measurement of data over multiple days. Recent advancements in deep learning offer new opportunities to classify activities with higher accuracy, utilizing complex models to interpret accelerometer and gyroscope data. While extensive work has been done to develop and validate activity classification for adult subjects, it is essential to extend these efforts to ensure accurate predictions for young adolescents (ages 10-18).

Aim This project aims at developing an activity classification system based on deep learning to determine the activity of adolescent subjects.

Materials and Methods In this project, the student will train a machine learning or deep learning model using data from two Axivity sensors (www.axivity.com) to classify activities such as walking, standing, or running). First data will be collected on a cohort of subjects from target age groups. The student will design the testing protocol and participate to the data acquisition. The student will also determine if using 6 degrees of freedom (DOF) sensors improves accuracy compared to a previous study that used 3 DOF sensors. Additionally, the student will train a hidden Markov model (HMM) to evaluate if significant corrections can further enhance model performance, and quantify the overall accuracy of the predictions.

Nature of the Thesis:
Literature reviews: 10%
Data collection: 20%
ML/DL model training and comparison: 60%
Hidden Markov model, training and test: 10%

Requirements:
Knowledge of Python: mandatory
Knowledge of ML and DL: recommended
Interest in activity classification and motion tracking

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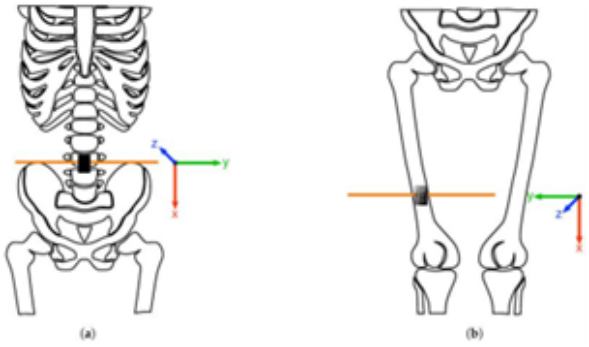

Fig 1 : Placement of sensors on the patient. Image from study (Logacjov er al. Sensors (Basel), 21(23), 7853.)