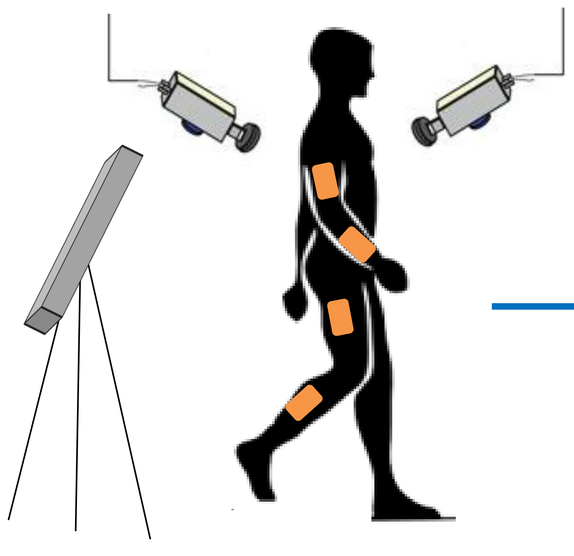
POLITECNICO DI TORINO

Department of Mechanical and Aerospace Engineering
Ph.D. Mechanical Engineering XXXIV ciclo
Ph.D. student: Elisa Digo
Tutor: Laura Gastaldi

BIOMECHANICAL ANALYSIS FOR HUMAN ADAPTIVE MECHATRONICS

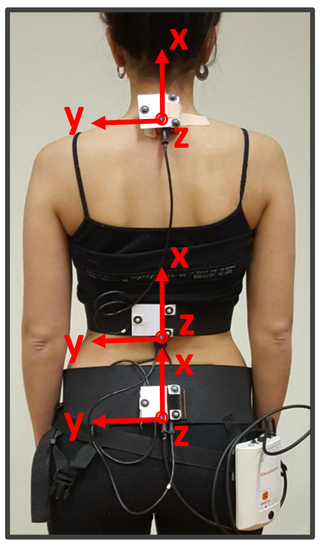


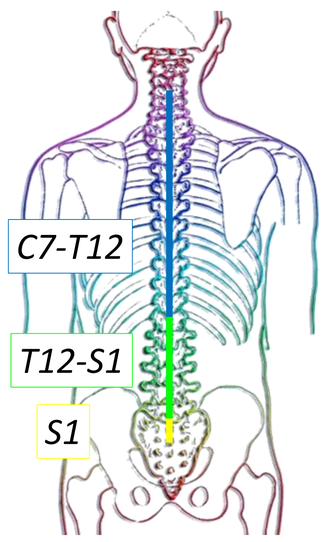
State of the art

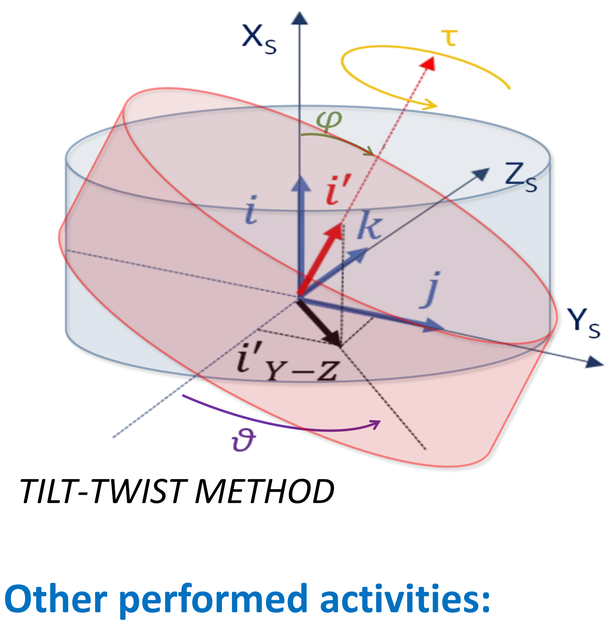
Surveys on Human Adaptive Mechatronics (HAM) in industrial environment. Human biomechanical variables obtained from the motion analysis represent the input signals for a mechatronic system. The machine adapts itself to human movement, improving the mutual cooperation.

Experimental approach: applications

Evaluation of spine posture during gait with inertial sensors





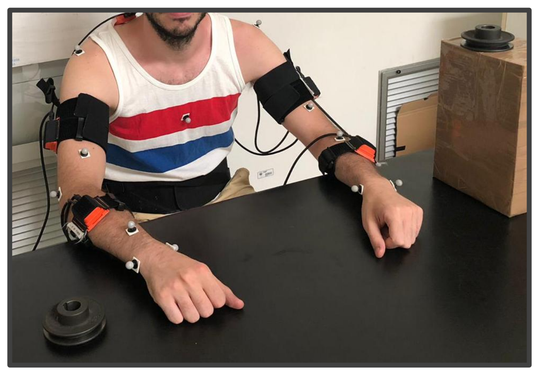


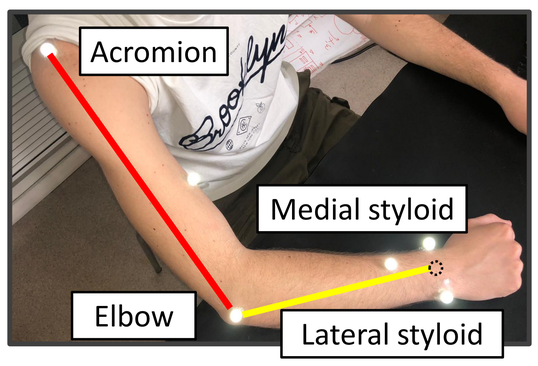
TILT-TWIST METHOD

- Instrumentation: inertial sensors (MTx Xsens) and optical system (V120:Trio Optitrack)
- Protocol: walking trials at self-selected speed
- Data analysis:
  - ✓ Segmentation of spine with multi-body approach
  - ✓ Calculation of relative angles between vertebral segments from rotational matrices
- Results: assessment of spine kinematics

Motion analysis of upper limbs with inertial and optical systems

- Instrumentation: inertial sensors (MTx Xsens) and optical system (V120:Trio Optitrack)
- Protocol: different tasks of moving and repositioning an object on a table
- Data analysis:
  - ✓ Reconstruction of upper limb stick diagram from markers
  - ✓ Definition of segments reference frames





- Future plans: Identification and extraction of biomechanical features of the user for the development of human movement prediction algorithms and adaptive control logics of the machine.

Other performed activities:

- Comparison of inertial sensors setups and algorithms for the estimation of gait spatio-temporal parameters in healthy and elderly subjects
- Calculation of gait spatio-temporal parameters in patients with Parkinson's disease and Deep Brain Stimulation implants
- Evaluation of a bio-feedback influence on the gesture of handcycling
- Evaluation of influence of gender and walking speed in vertebral ROM estimated with inertial sensors during gait

Publications:

- Digo, E., Pierro, G., Pastorelli, S., & Gastaldi, L. (2019, June). Tilt-Twist Method Using Inertial Sensors to Assess Spinal Posture During Gait. In International Conference on Robotics in Alpe-Adria Danube Region (pp. 384-392). Springer, Cham.
- Panero, E., Digo, E., Agostini, V., & Gastaldi, L. (2018, June). Comparison of different motion capture setups for gait analysis: validation of spatio-temporal parameters estimation. In 2018 IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-6). IEEE.
- Bistolfi, A., Ferracini, R., Galletta, C., Tosto, F., Sgarminato, V., Digo, E. et al. (2017). Regeneration of articular cartilage: Scaffold used in orthopedic surgery. A short handbook of available products for regenerative joints surgery. *Clin. Sci. Res. Rep*, *1*, 1-7.