

ASSESSMENT OF UPPER EXTREMITY MOVEMENT KINETICS

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INTRODUCTION

Clinical gait analysis is today the standard procedure for assessment of lower extremity kinematics and kinetics. For upper extremity movement, since it is more complex than gait, a procedure for kinetic analysis of an unconstrained movement has still not been standardized. The measurement of external forces during an arbitrary arm movement as well as the lack of kinetic models are some of the problems in upper extremity movement analysis [1].

In this work, a procedure for determination of net joint forces and torques in arbitrary upper extremity movement has been presented.

METHODS

For calculation of net joint forces and torques via inverse dynamics, the assessment of kinematic data, external forces and anthropometric parameters is necessary.

Joint angles for hand, elbow and shoulder were calculated via a rigid body model for the upper extremities [2]. In order to predefine the movement and increase the reproducibility, a 5-DoF robot-arm presented a predefined 3D path that a subject should perform. External forces and torques were measured using a 6-DoF force sensor attached at the robot's end-effector. A force-feedback was used to predefine and help maintaining the desired force vector.



Figure 1: Measurement set-up.

Anthropometric data were obtained using the body segment parameters table [3].

Flexion/Extension in a shoulder joint was measured three times without external loads and using a force-feedback with a task to pull up (10N opposite to the gravity direction).

RESULTS AND DISCUSSION

Figure 1 (left) is showing the joint angle in flexion/extension axis, external force (zero) and net joint forces and torques in the shoulder joint. The shoulder movement in flexion/extension axis without external loads causes the forces in abduction/adduction and rotation axis and torque in the flexion/extension axis. The influence of external loads has been shown on Figure 1 (right). External force of 10N leads to the increase of the net joint forces as well as the torque in shoulder joint.

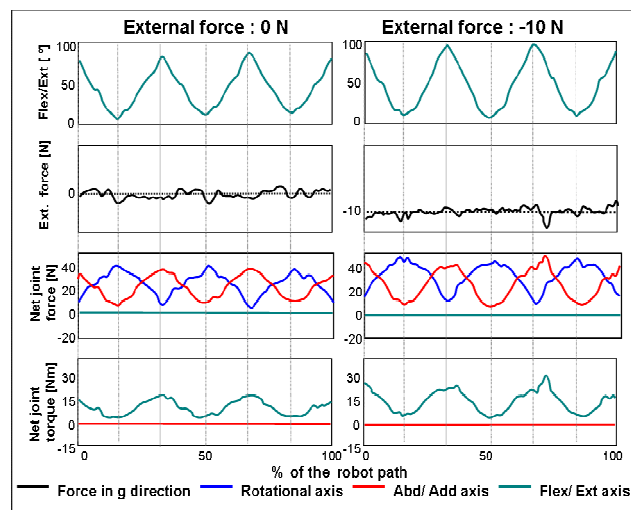


Figure 1: Shoulder Flex/Ext angle, external force, net joint forces and net joint torques without (left) and with 10N external force (right).

Furthermore, a measurement was performed by a patient with an internally rotated shoulder. Figure 2 is showing that the pathology in shoulder movement can be seen in kinetic data as an additional force in flexion/extension axis which leads to the pathological joint loads and additional torque in abduction/adduction axis that has to be compensated via muscles.

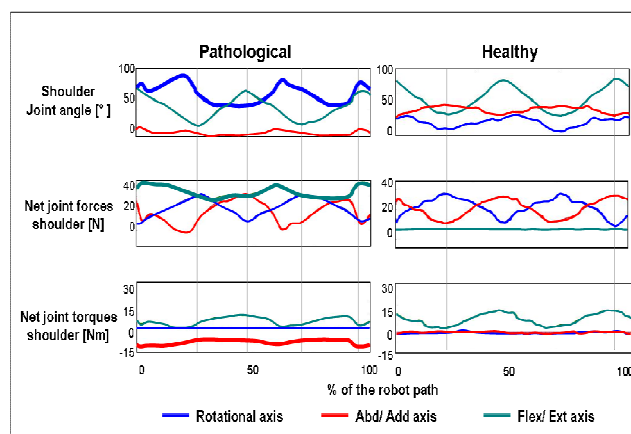


Figure 2: Example of pathology in joint forces and torques (left) compared to a healthy subject (right).

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