Patient Supervision During Endeffector Based Robot Assisted Rehabilitation of Upper Extremities
M. Hennes¹, K. Bollue², H. Arenbeck², D. Abel², C. Disselhorst-Klug¹
¹) Department of Rehabilitation & Prevention Engineering, Institute of Applied Medical Engineering, Helmholtz-Institute Aachen, RWTH Aachen University, Aachen, Germany
²) Institute of Control Engineering, RWTH Aachen University, Aachen, Germany
email: hennes@hia.rwth-aachen.de

Introduction
About 250,000 people in Germany suffer from stroke each year. One way to assist patients during their rehabilitation process is an endeffector based robot assisted system. A 7 degree of freedom robot is mounted on the patient’s hand. During a teaching phase the physiotherapist guides the patient’s hand to perform an everyday movement. During this phase the robot passively follows the patient’s hand and records its endeffector position. After the teaching phase the therapist leaves and the exercise phase starts. The robot continuously replays the recorded trajectory and thus guides the patient’s hand like the physiotherapist. This approach strongly encourages patients to do self-motivated training. However supervision of the patient is missing because compensation movements and neurological events like spasticity can occur which cannot be detected by the robot.

Methods
Data of four 3D-acceleration-sensors which are mounted on the patient’s torso, upper arm, forearm and hand is recorded during the teaching and exercise phase. Furthermore data of a 6 degree of freedom force-torque sensor at the robot endeffector is recorded simultaneously. Mathematical features which describe the differences between the two phases are extracted from the sensor data of the teaching and exercise phase. A fuzzy logic system then analyses the features from the acceleration signals to evaluate the patient’s movement (compensation movements) and the features out of the force-torque data to detect events like spasticity and fatigue. Hence detection of compensation movements and detection of neurological events (spasticity) on the one hand and data of the current patient’s state (e.g. fatigue) on the other hand becomes possible.

Conclusion
Patient supervision is necessary during endeffector based robot assisted rehabilitation. A combination of acceleration sensors and a force torque sensor analysed by a fuzzy logic system allows the evaluation of the patient’s movement as well as the detection of neurological events.