Pelvic Obliquity Recording with Robotic Gait Rehabilitation (RGR) Trainer

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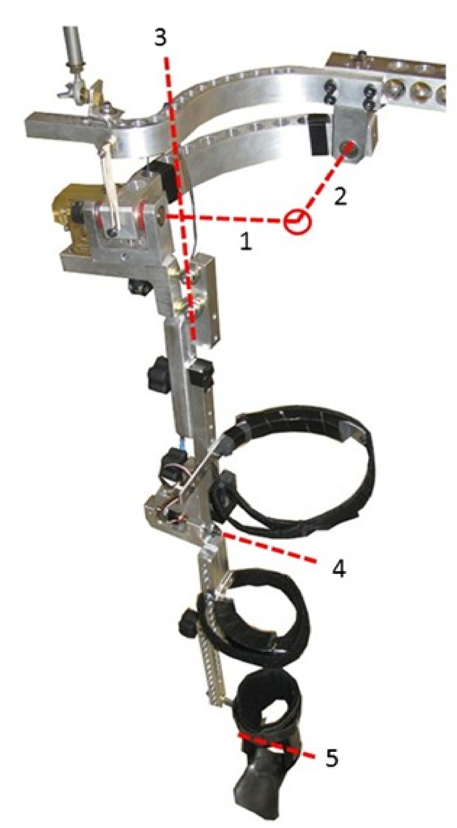
ABSTRACT

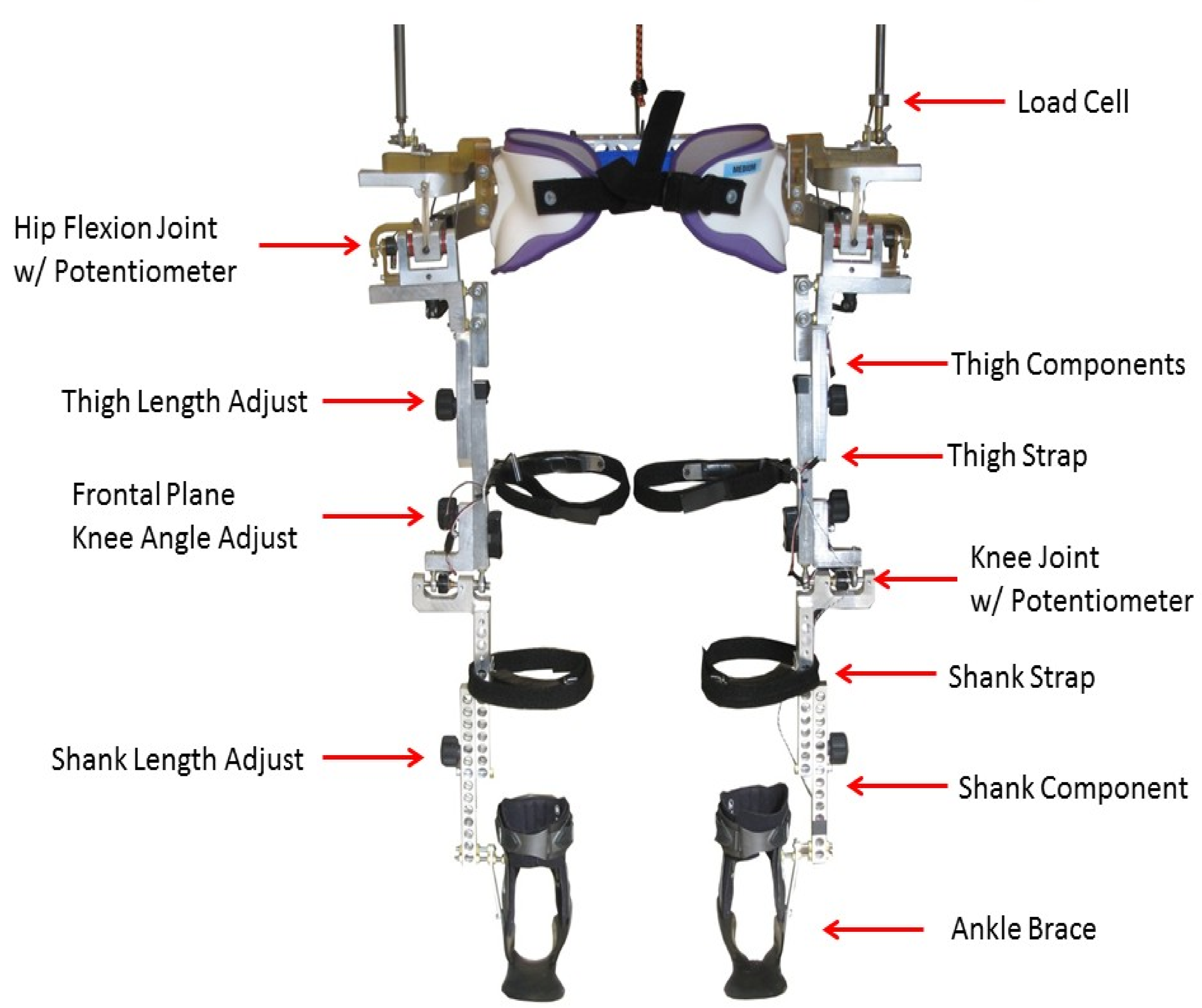
The Robotic Gait Rehabilitation (RGR) Trainer was designed to address secondary gait deviations in stroke survivors undergoing neuro-rehabilitation. An impedance-controlled actuator generates forces, which are transferred to the patient's lower body via an exoskeleton. The high backdrivability of the actuation system and the simple mechanical design of the RGR Trainer make it possible to record gait parameters and to accurately apply corrective force-fields onto the body.

HUMAN-ROBOT INTERFACE

The force field generated by the RGR Trainer is transferred to the body via a lower body exoskeleton, which features remote center of rotation joints. The DOFs are:

1. Hip flexion/extension
2. Hip abduction/adduction
3. Hip internal/external rotation
4. Knee flexion/extension
5. Ankle dorsiflexion/plantarflexion

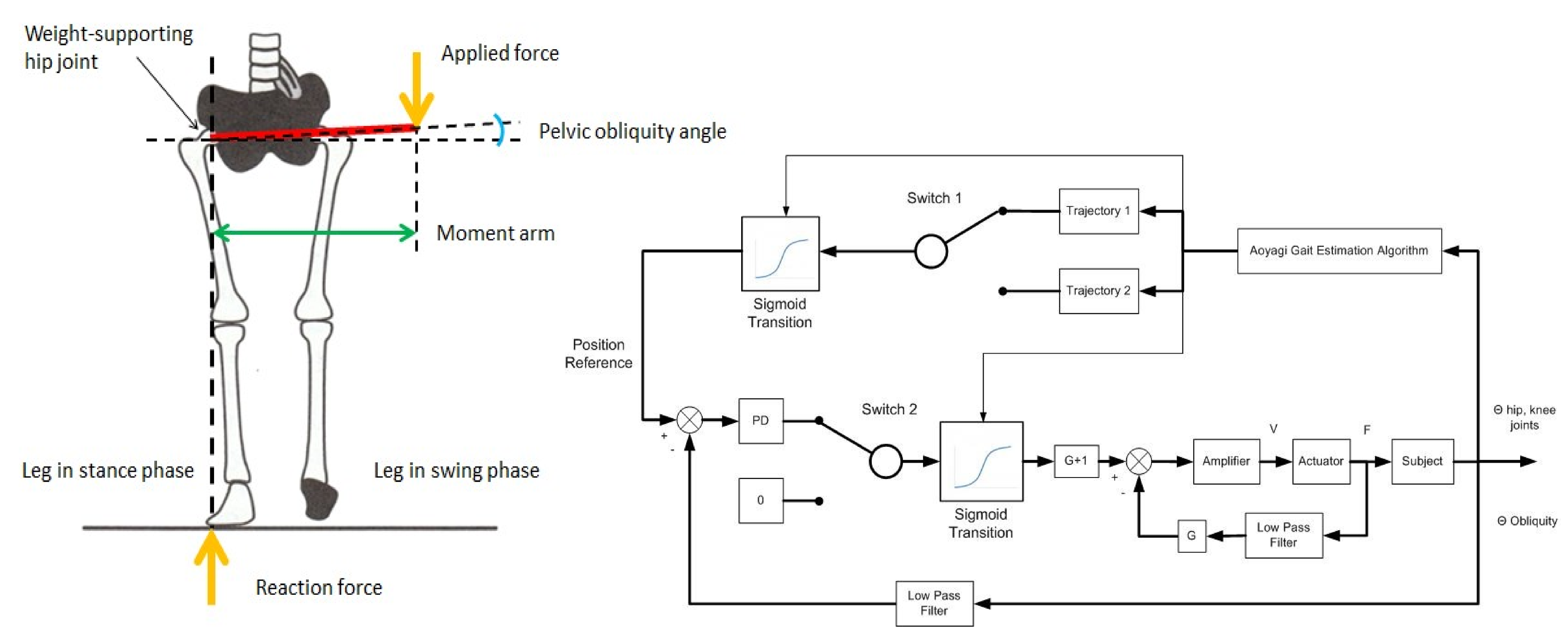


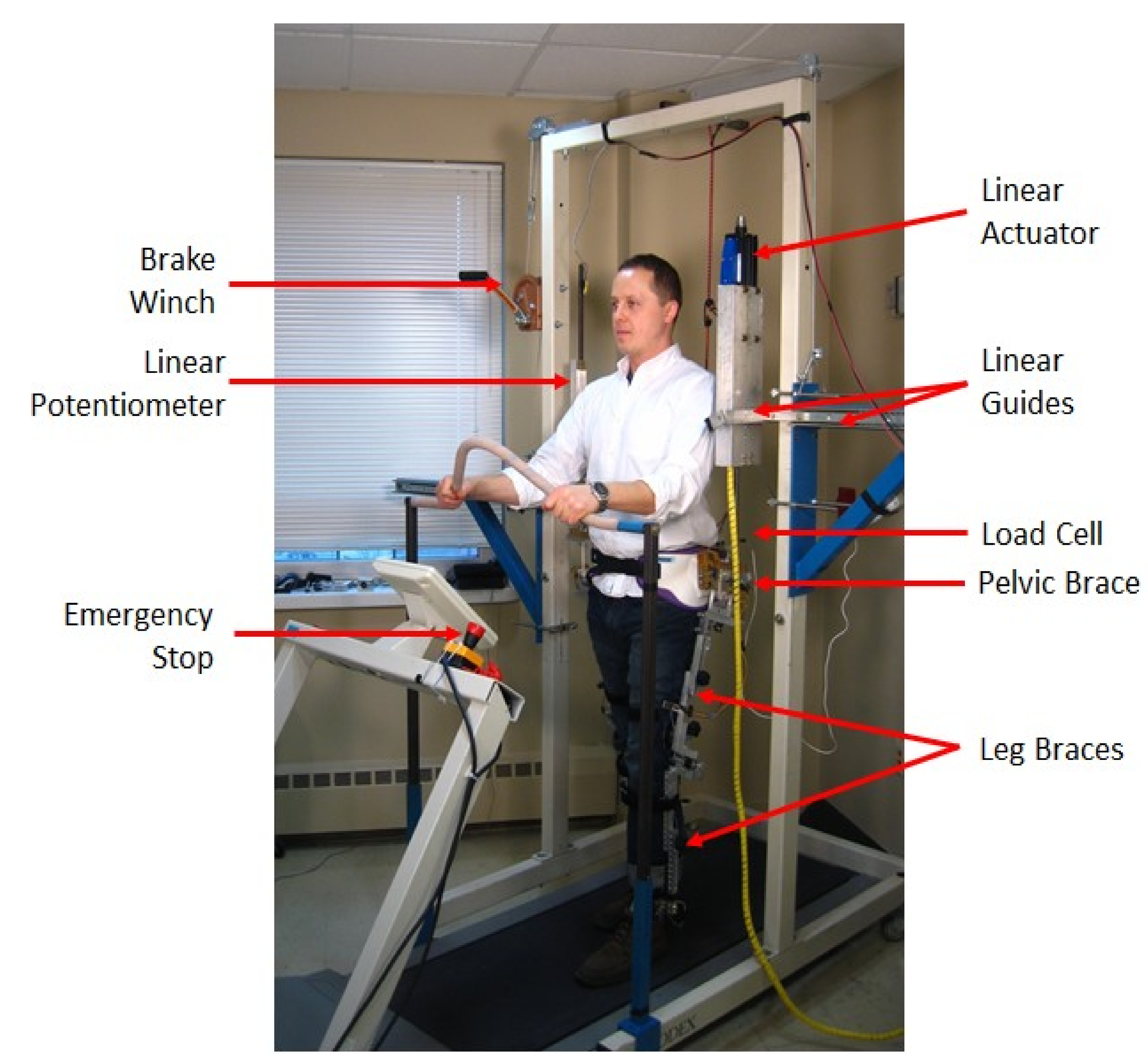


RGR TRAINER – BRIEF DESCRIPTION

This device creates a force field around the subject's pelvis through the Human – Robot Interface (HRI) using a single linear actuator. The actuator is impedance – controlled, with force feedback from a load cell and pelvic obliquity as position feedback. This creates a virtual spring/mass/damper around the pelvis. Corrective forces are applied onto the subject only when his affected (by hemiparesis) leg is off the ground.

In the gait-retraining mode, deviations between pelvic obliquity and reference trajectory result in generation of corrective forces. In backdriven mode, the force loop of the controller acts to minimize the interaction forces between the subject and the device.

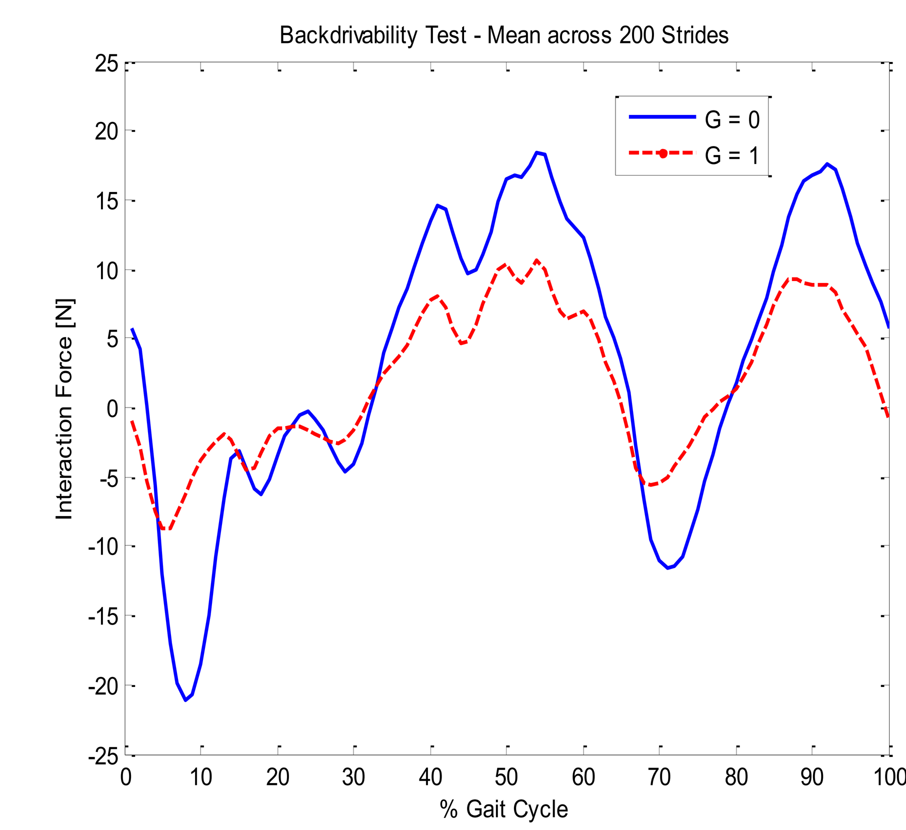




BACKDRIVABILITY TESTING

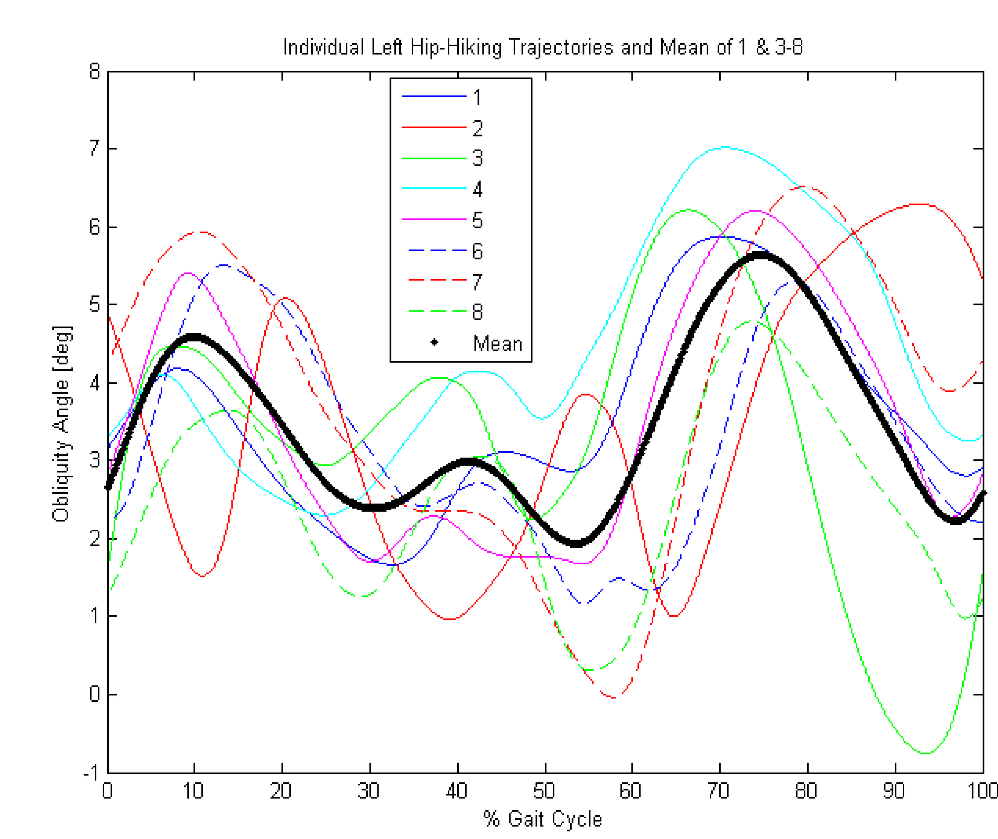
Protocol. The RGR Trainer's backdrivabiliy was tested under two conditions: with force controller gain set to G=0 and G=1. A healthy subject ambulated at his comfortable walking speed of 3km/h and completed 200 strides under each condition.

Results. Under the G=0 condition, the mean interaction forces across the 200 strides (measured by load cell) were +/-20N. Under G=1 condition the interaction forces were 50% lower (+/-10N).



TRAJECTORY RECORDING

The high backdrivability of the RGR Trainer's actuation system makes it possible to record pelvic obliquity trajectories. In preparation for gait-retraining experiments, simulated hip-hiking trajectories were recorded from 8 healthy subjects. A mean across 200 strides and 7 subjects (in bold) was used in subsequent gait retraining studies.



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