Potential Aims and Research Questions

1. What are the abnormally couple joint torques in stroke? Lower limb?

2. Does supporting the large weight-supporting muscles allows more selective recruitment of existing pathways that are more specific? Thereby strengthening the neural connections in existing high resolution pathways before requiring the recruitment of these large muscle groups for weight support?

3. Would supporting the reaching/drawing task with MDA naturally lead to less support closer to the body and more support away from the body?

4. Can we build initial joint distributions of subjects and antagonize them away from that?

5. Hyperacitve stretch reflex a factor in voluntary motion?

6. How do we use a perturbation during voluntary motion (e.g. target reaching) to determine if the stretch reflex is hyperactive?

7. In healthy subjects, is there reflex modulation based on type of task? Force goal vs. position goal?

8. Nonlinear system ID

Master’s thesis: MDA experiments & MDA stability with SAC

ergodic metrics for tasks

ergodic metrics as goals for quasistatic and dynamic tasks.

Ergodicity as an objective of MDA will allow multiple objectives for tasks with multiple strategies.

ergodicity

koopman system ID

ballistic arm motions vs quasistatic motions

ballistic arm motions might be critical for balance, defense for catching an object or ones self in the case of a fall. Also for making cane walking/ assisted walking easier. Could move from four point walker to cane for instance

Handling of perturbations/ reflex modulation

The open loop problem—stroke subjects cannot do torque matching in their upper limb

automation of tasks defined on ergodic objective fxns

Research Objectives

1. Use an ergodic control objective to create a human-in-the-loop system that is robust to strategies and can be initialized with a record and replay strategy. By applying an ergodic control objective to MDA, can we further improve operator learning for tasks with multiple strategies (i.e. locomotion, or drawing)?

2. Can we automate therapeutic agonist and antagonist robotic forces such that existing high resolution pathways are upregulated without recruiting less effective low resolution systems to deliver targeted therapeutic goals?

3. Can the ergodic metric be used in a broader sense to evaluate subject performance in tasks and identify/characterize deficits? (i.e. abonormal joint coupling, contributions of stretch reflex at higher velocities) How can one use this performance metric to modulate the relationship between the robot and the operator?

4. Given an operator that may have some deficits, can we develop an algorithm to evaluate those deficits, define a target strategy based on the characterization of those deficits and at least semi-autonomously support the selection and performance of a therapeutic task that targets the perceived deficits.

Aim 1: Ergodic Measure MDA assists subjects more robustly than error-driven controller (specifically x, y,z from the literature—either best science of most popular).

--spatial statistical measures vs error in time measures

Aim 2: EM MDA improves neuromodulation over strength based schedule. Focus on dynamic assistance vs scheduled assistance.

Aim 3: The ergodic measure more robustly discriminates between x & y than z. Moreover,...