NRI: Task-Based Assistance For Software-Enabled Biomedical Devices

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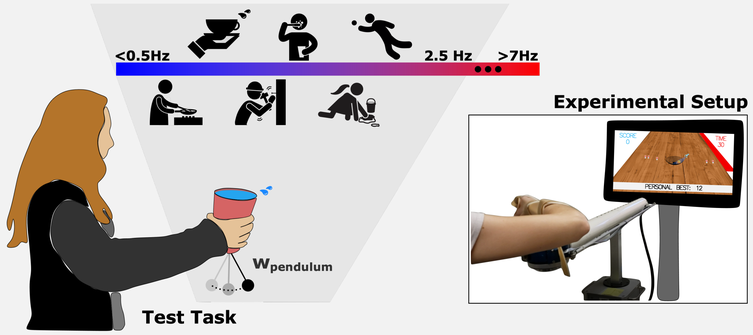
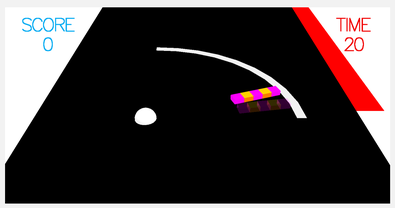
Recovery of dynamic motor function after neuromotor impairments depends on our ability to quantitatively assess dynamic movement and to understand the cause of its degradation. While prior work has investigated how neuromotor deficits affect static and quasi-static performance metrics—such as reaching range—little emphasis has been put on understanding how these changes affect functional dynamic tasks. We propose a novel method for measuring ability to generate a dynamic response—fast movements with controlled motion initiation, termination, and changes in direction. We couple it with an upper-limb assistive robot capable of modulating shoulder abduction (SABD) loading, shown to increase the recruitment of indirect contralesional motor pathways in post-stroke individuals. In experiments on the paretic upper limb we find that stroke causes a decline in dynamic response. Moreover, stroke survivors' ability to generate high-frequency functional movements decreases with increased SABD loading in a manner not seen in controls, suggesting reliance on indirect motor pathways adversely affects dynamic response.

Quantifying dynamic response is helpful for understanding functional deficit

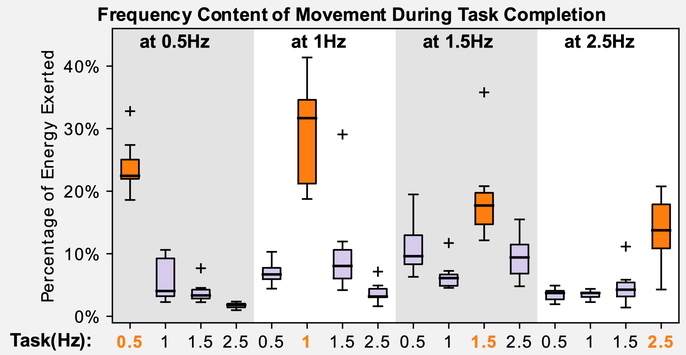


Ball-in-bowl task:

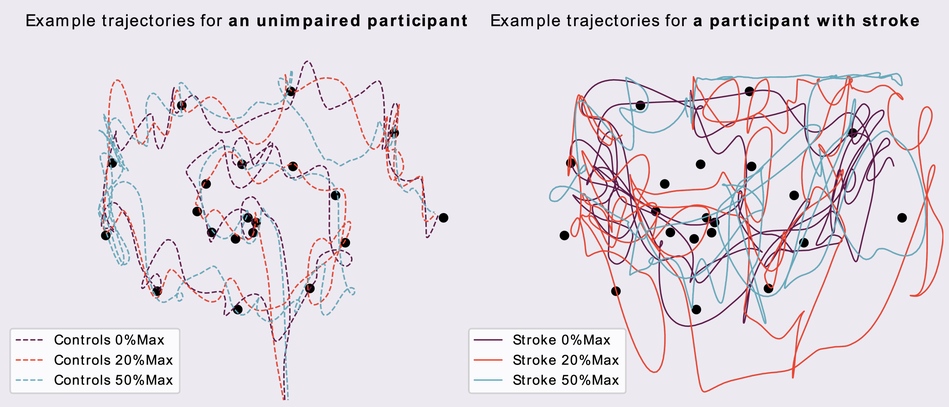
Nail-and hammer task:



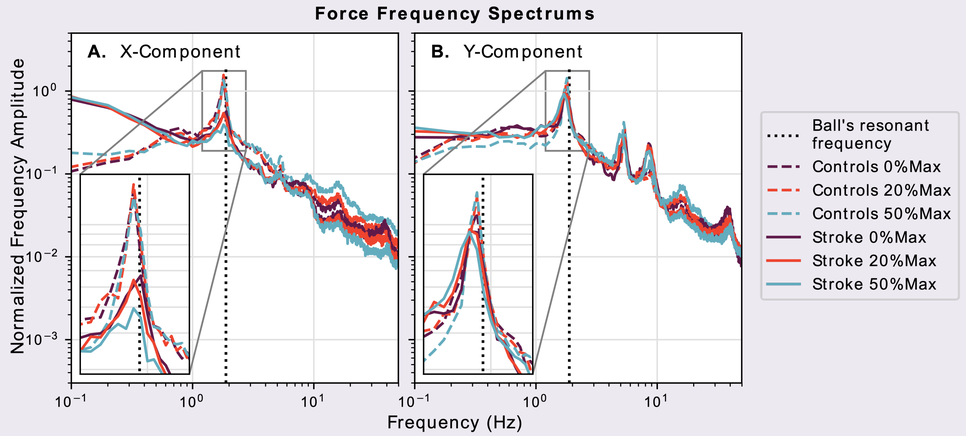
Our method measures dynamic response at specific frequencies

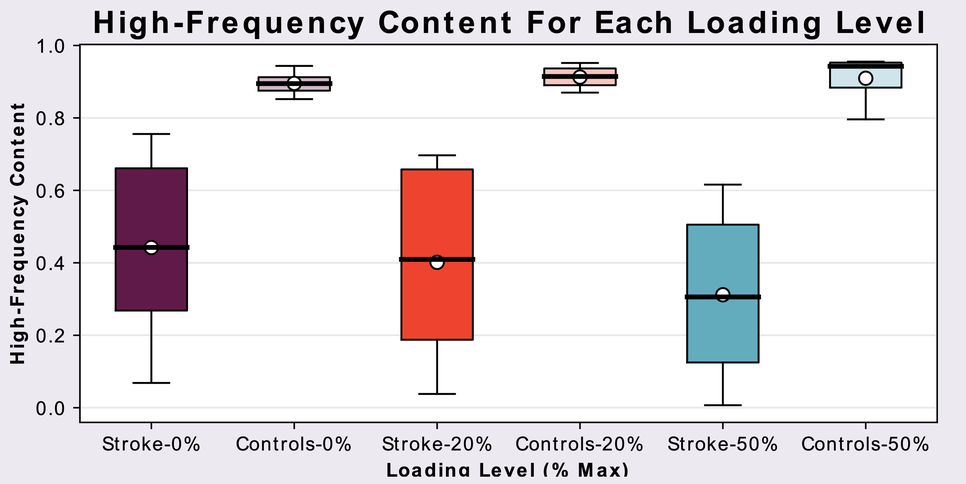


Stroke impacts ability to generate dynamic response



Dynamic deficit post stroke is likely caused by an increased reliance on indirect motor pathways





Our method can help quantify and understand the cause of functional deficits in individuals with neuromotor impairments and form the basis for targeted rehabilitation for improving motion bandwidth. Given dynamic motion plays a key role in activities of daily living, such as brushing teeth, catching a falling object, or moving a cup of water without spilling, we can use our approach to improve overall upper-limb functionality after neuromotor events, such as stroke.

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