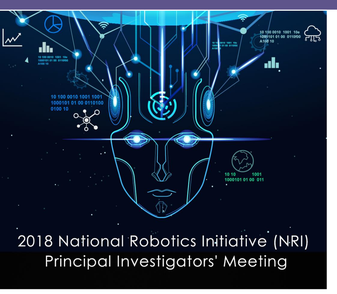

Novel Neural Control of Multifunctional Prosthetic Arms based on Internal Musculoskeletal Biomechanical Model

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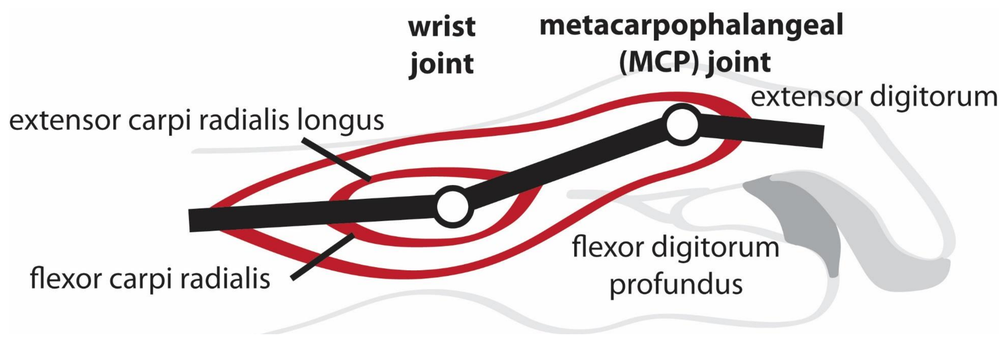
Challenges for Prosthesis Control

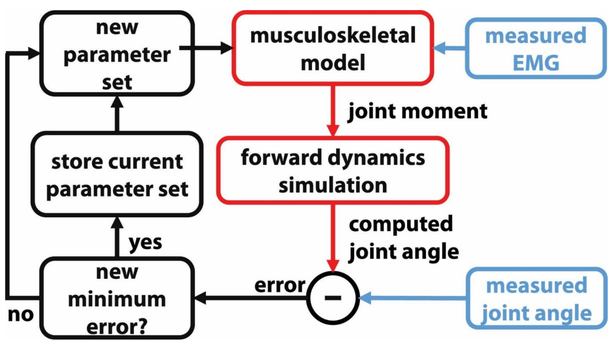
Electromyography-based pattern recognition (EMG-PR), recently commercialized and considered the state-of-the-art in upper limb prosthesis control, predicts *discrete* movement classes that differ from the fluid, continuous multi-joint movements of biological limbs.

Recently, we proposed a musculoskeletal model to simultaneously predict hand (MCP) and wrist (flexion/extension) movements from EMG signals [1-2]. Based on data recorded from 6 able-bodied subjects, we developed a generic musculoskeletal model by averaging the model parameter values across all subjects and all trials [3]. Based on the 2-DOF model, we added a wrist pronation/supination DOF and a corresponding antagonist muscle pair to the musculoskeletal model to simultaneously estimate motion for a hand DOF (MCP) and two wrist DOFs (flexion/extension and pronation/supination) from EMG signals [5].

2-DOF Model Framework



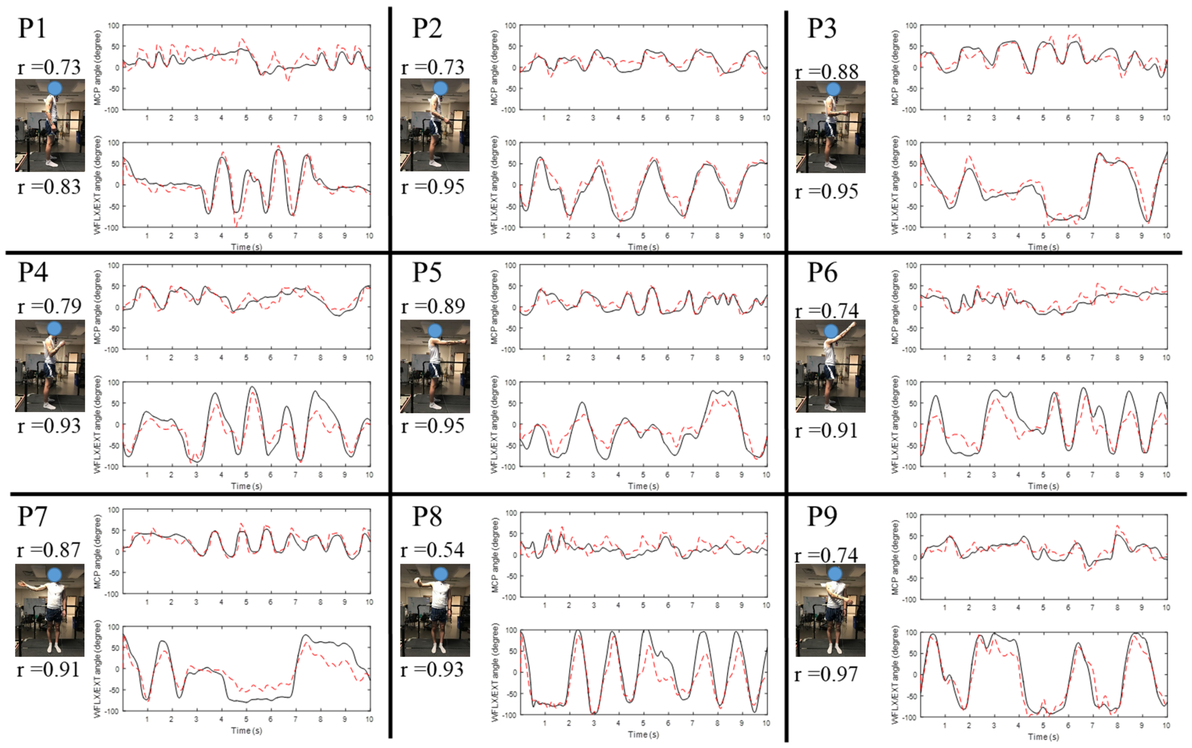
Parameter Optimization



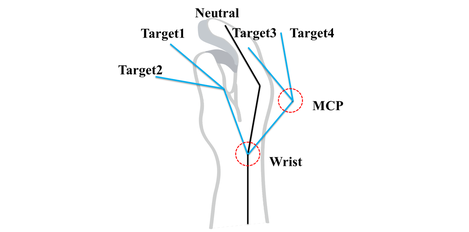
Parameter Constraints

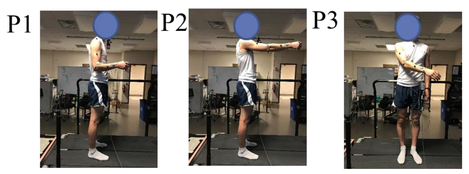
parameter	lower bound	upper bound
optimal muscle length (m)	0.01	0.5
max. isometric muscle force (N)	10	1000
parallel elastic stiffness (Nm)	10	1000
moment arm, wrist (m)	0	0.05
moment arm, MCP (m)	0	0.05
muscle length (neutral posture)	0.75	1.25

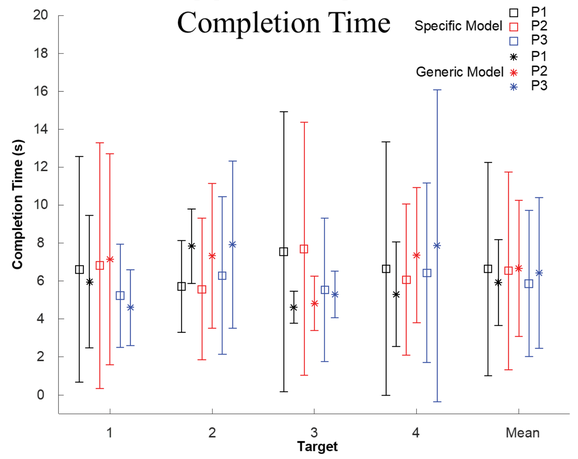
Off-line, the 2-DOF musculoskeletal model was robust against upper limb posture changes.

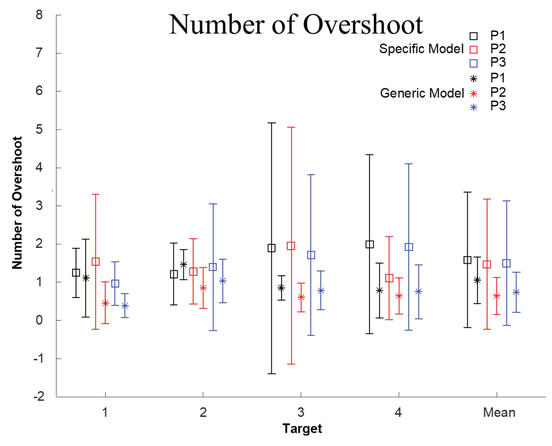


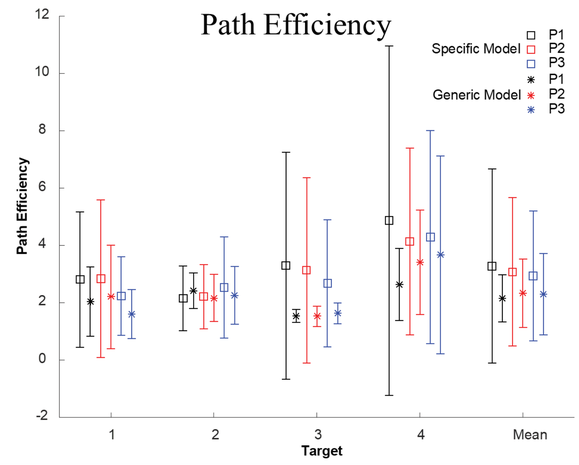
On-line, the generic 2-DOF musculoskeletal model was robust for real-time target matching tasks in different upper limb postures.



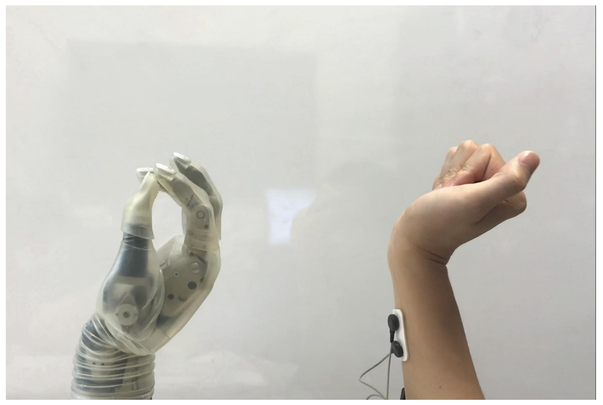


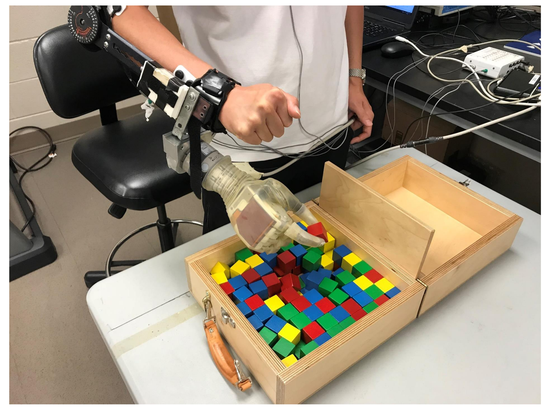






Real-time control on DEKA hand using the generic musculoskeletal model.





Future Work

- Further develop and evaluate the model for individuals with amputation.
- Implement the model for real-time prosthesis control of testing functional tasks.
- Compare real-time performance between EMG-PR and musculoskeletal model controls.

DEKA hand control platform (open/close, wrist flex/extend, wrist rotation)

Weight: 3 .08 Lbs

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Acknowledgements

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