Hybrid Active-Passive Actuation For Human-Robot Collaboration and Rehabilitation

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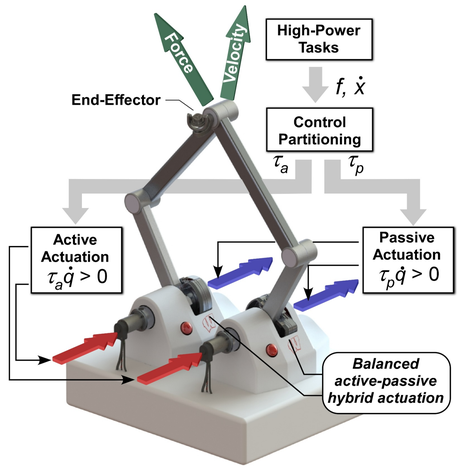
Concept

Human-Interactive Robots

Safe • Strong • High-Performance

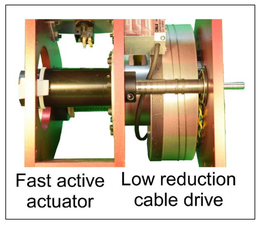


Objectives:

- Low Active Output Impedance (Safe to Humans)
- High Passive Output Impedance (Stiff to Humans)
- High Force Bandwidth (Accurate Haptic Fields)

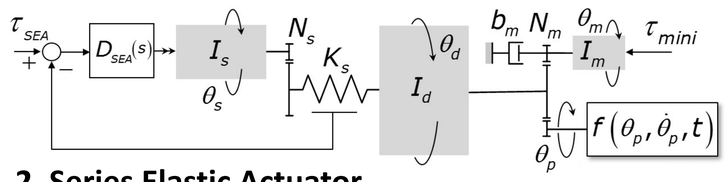
Hybrid Active-Passive Actuation

Combining the Benefits of Different Actuators

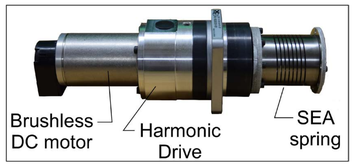


- High Bandwidth
- Low Inertia

1. Fast Lightweight Actuator



2. Series Elastic Actuator



- High Force
- Passive Compliance

3. Passive Actuator

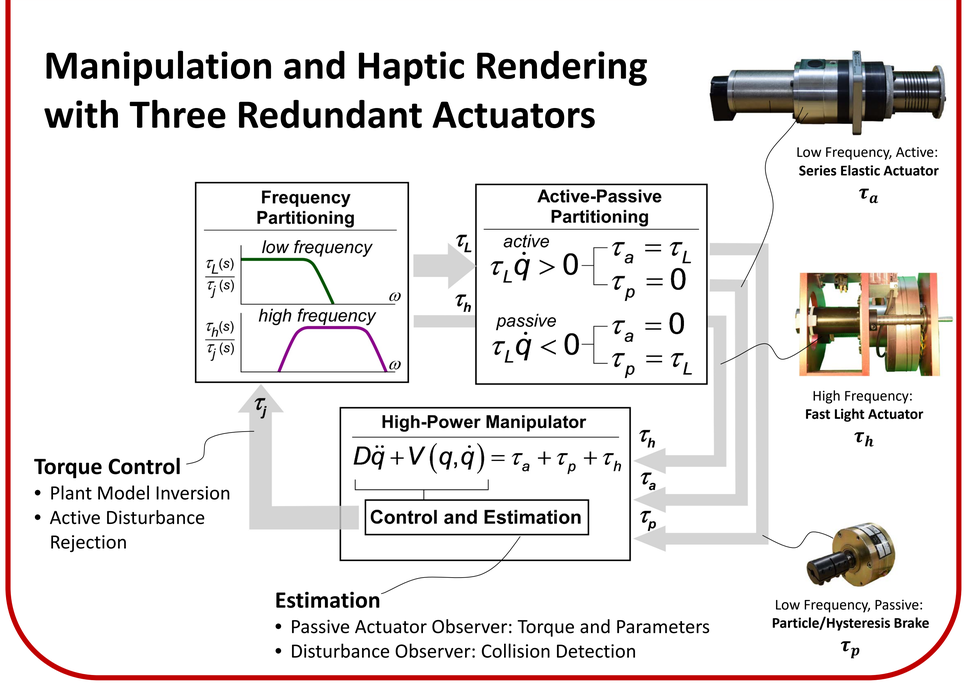
- High Stiffness
- High Power Absorption

One-DOF Hybrid Active-Passive Testbed

- Performance Testing
- Design Refinement
- Controls Development

Control and Estimation

Manipulation and Haptic Rendering with Three Redundant Actuators



Torque Control

- Plant Model Inversion
- Active Disturbance Rejection

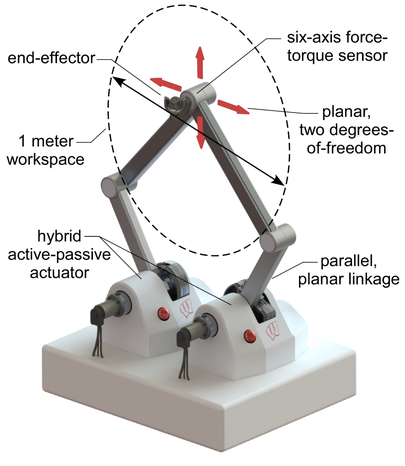
Estimation

- Passive Actuator Observer: Torque and Parameters
- Disturbance Observer: Collision Detection

Test Application: Rehabilitation Robotics

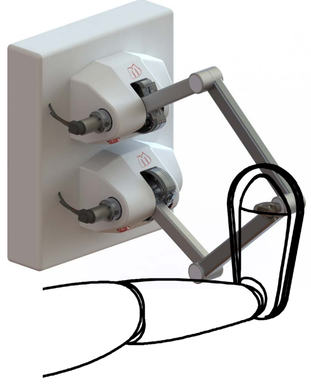
Safe, High-Power Leg Rehabilitation

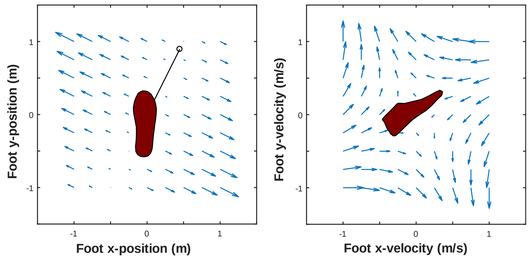
Two-DOF Hybrid Parallel Manipulator



Foot Reaching Tasks

- Volitional Movement
- Multiple Planes





Haptic Force Fields for Movement Rehabilitation

- Error Augmentation
- Viscous Curl
- Assist-as-Needed
- Virtual Channel
- Guided Exploration

UW BADGER Lab
Biomechatronics, Assistive Devices, Gait Engineering, & Rehabilitation

reach robotics engineering, applied controls and haptics lab

UW Neuromuscular Coordination Laboratory

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