A 3-dof Pneumatically-Actuated Robotic System for Complex Reaching Tasks in Rodents Compatible with Electrophysiology

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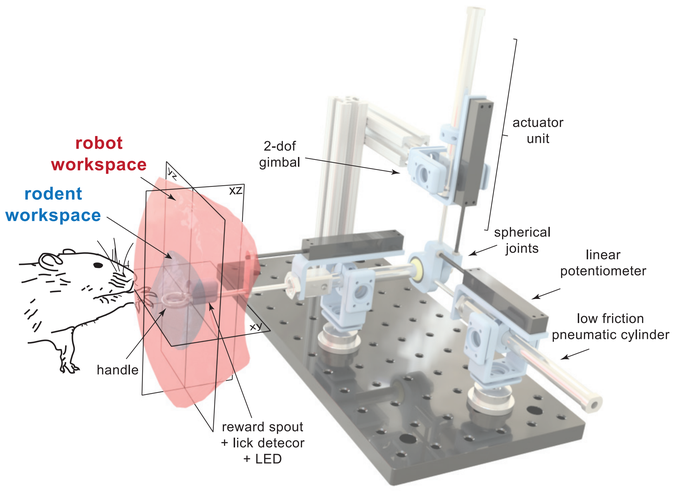
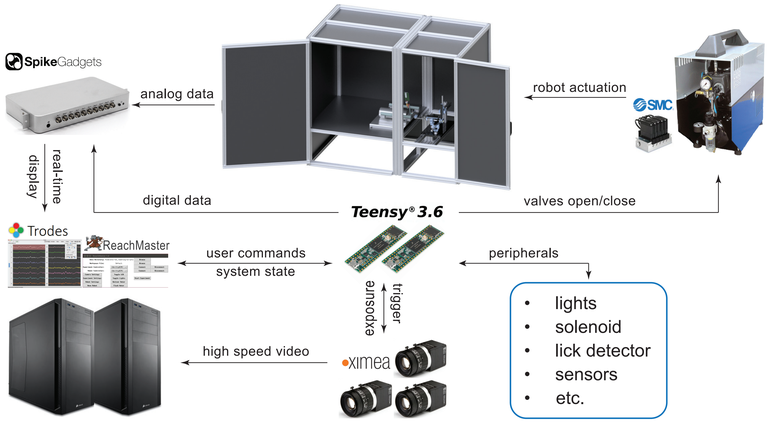
Introduction

We developed a pneumatically-actuated robotic system that supports a variety of rodent reaching tasks. The robot utilizes a modular design that enables up to 3 rotational degrees of freedom, and is able to accurately and rapidly position rewards within a large workspace in front of freely moving, or restrained animals. The target handle and reward spout are fixed in close spatial proximity, allowing rats to naturally learn to reach for the handle with minimal training. The use of high-speed on/off valves allows for fast, dynamic perturbations in varying directions during the reach. Both robot and behavioral kinematics are recorded using a cominbation of poteniometers and recent markerless tracking solutions (Mathis et al, *Nat. Neuro*. 2018). We demonstrate that rats display a variety of of complex kinematic sequences while performing directional reaches to static targets. We further demonstrate the feasibility of reaching to dynamically moving and perturbed targets.

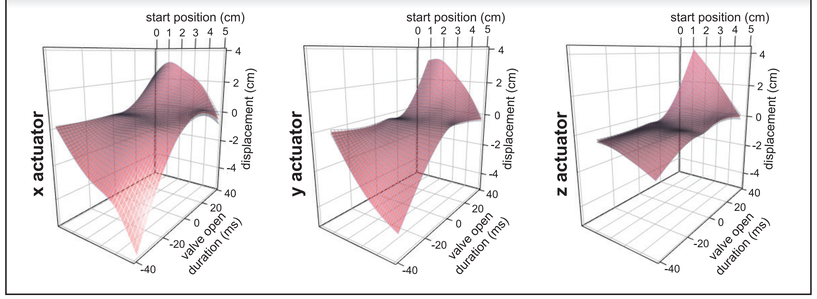
Design and kinematics of 3-dof robot



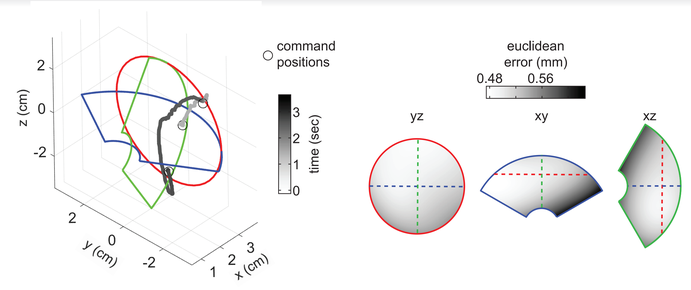
Integration w/ experimental control system



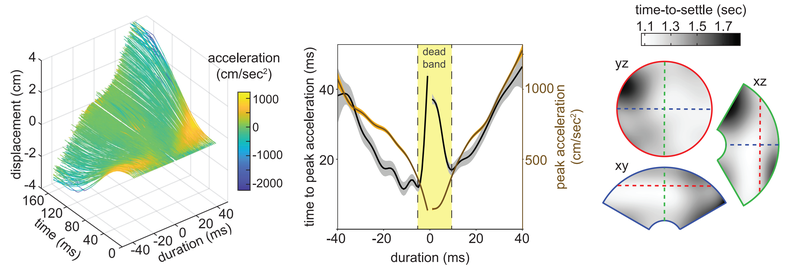
Data-driven control strategy



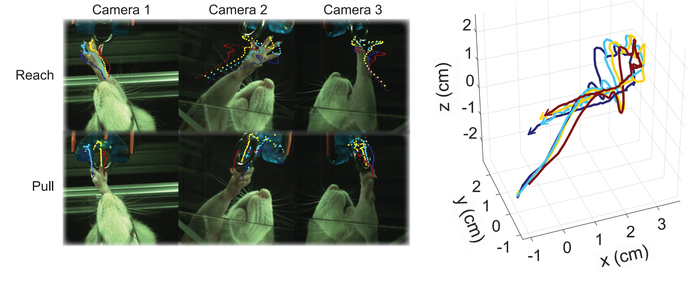
~0.5 mm position accuracy



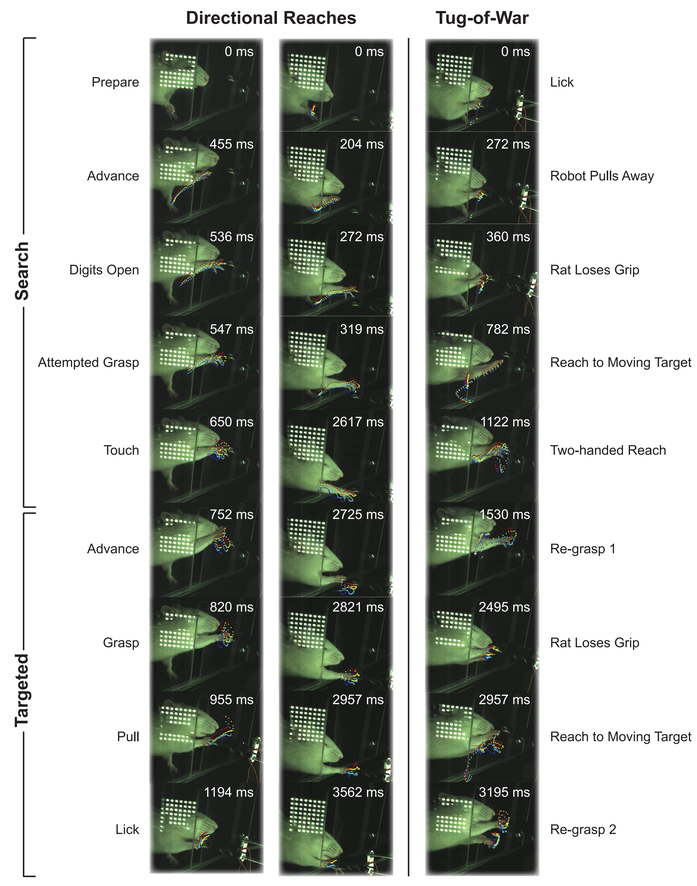
Rapid control timescales



Markerless tracking in 3D w/ DeepLabCut



Task examples



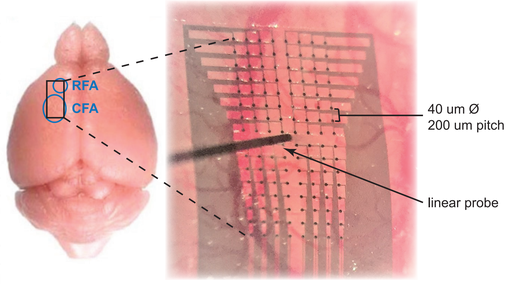
Ongoing and Future Work

Behavior

- Are distinct behavioral sub-components differentially modulated by task dimension and complexity?
- Implement more structured task variants (i.e., cued responses, delay periods, etc.)

Distributed cortical control of reaching

- How are kinematics representations differentiallly coordinated across RFA/CFA w/ increasing task dimension and complexity?
- How is delay period-related activity differentially coordinated across RFA/CFA w/ increasing task dimension and complexity?



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