# Modularity in Grasping

The Shadow Robot Company

Who we are

- Established in 1997
- Creators of the Shadow Dexterous Hand
- Robotic grasping and manipulation SMEs
- Robotic system integrators
- 35 staff in hardware, software, production etc.
- Global distribution network
- Global involvement in collaborative projects
- Industrial and academic collaboration
- Recent focus: teleoperation

Dexterous Hand

- 24 Joints
- 20 Degrees of Freedom
- 2 antagonistic tendons per DoF
- 0.2° joint resolution
- 0.5 seconds open-to-closed
- 1kHz control loop over ethercat
- 100Hz additional sensor data bus
- Mass 4.2 kg, payload 4kg
- Mounting plates for all common arms
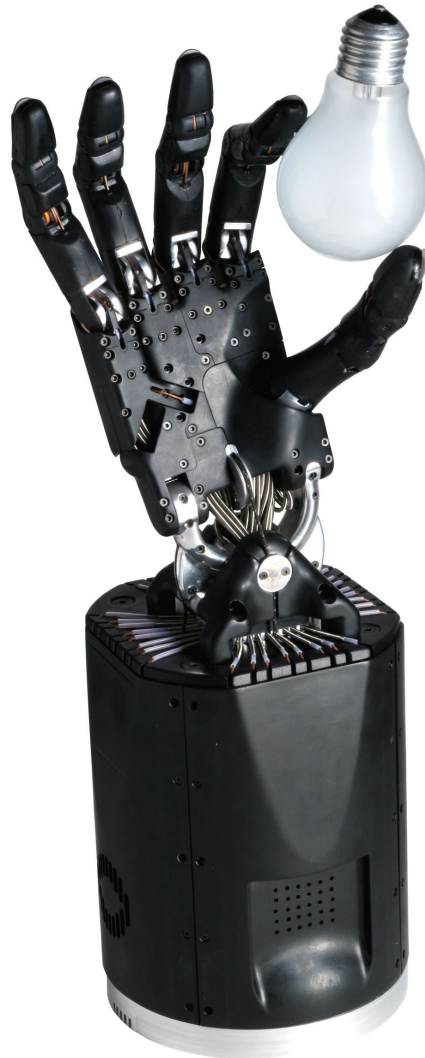
Dexterous Hand Lite

- 16 joints, 13 DoF
- Mass 2.4kg (57% full hand)
- Payload 2kg (50% full hand)
- Shared with full hand:
  - All finger components
  - Subset of forearms components
 - All software (different robot description etc.)

Left- and Right-Handed Variants

- All hand models are available in left- and right-handed variants
- Majority of components shared, except:
  - Palm chassis
  - Little finger palm flexion
- Same software

Modular Sensors

- All models can be fitted with different sensor fingertips
- Default is PST (simple pressure) sensor
- Syntouch Biotac SPs are a common upgrade
- Uses common, in-hand data bus
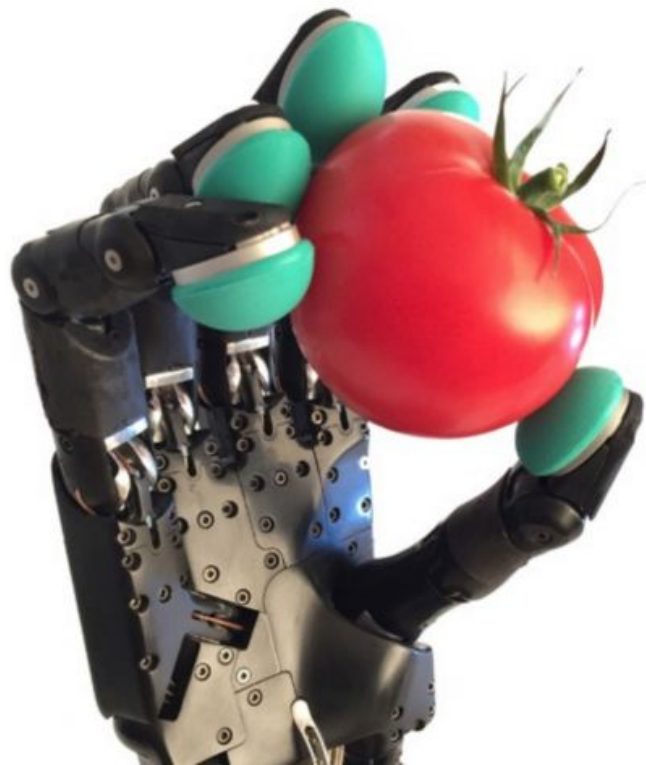
Modular Grasper

- Geometrically simpler
- 9 DoF, 1kHz control
- Per-joint 10kHz torque sense/control
- More for industry than research
- Stable, predictable grasps
- Wide grasping envelope
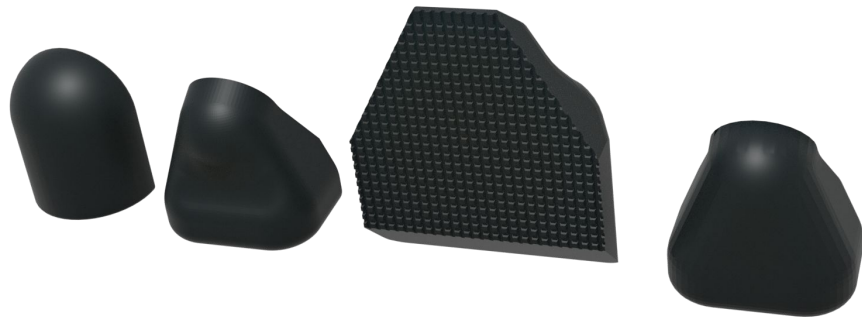- Mounting plates for all common arms

Modular Fingertips

- Adaptable to different tasks
  - Scale
  - Temperature
  - Compliance
- Simple mounting (one screw)
- Ideal use of 3D printing
- Combine different tips for unique grasps

Modular Fingers

- Supports any number of fingers (within reason...)
  - Palm chassis change required
- Finger count initialised on start-up
- Software allows feedback and control of any connected fingers
- General purpose data buses allow modular sensors and peripherals

Smart Grasping System

- System as a module
- Hand drivers and grasp library pre-packaged
- Optionally in a docker container
- ROS and RESTful HTTP interfaces to:
  - Add or edit grasp definitions
  - Request grasp execution with various parameters
- Programmatic or manual interface

Shadow
Smart Grasping System

RESTFUL API

- API Overview
- Grasps
- Execute grasps
- Create grasp

API Overview

The REST APIs provide programmatic access to read and write data to access the robot using the Smart Grasping System. Here there is an overview at the API methods available:

Title	Get the position for all joints of a robot
URL	/joint_positions
Method	GET
URL Params	
Data Params	
Success Response	Code: 200 Content: [{ "name": [string] "position": [float] "effort": [float] "velocity": [float] }, ...]
Error Response	Code: 503 Content: { error : "Robot unavailable" }
Input Example (browser)	http://0.0.0.0:8080/joint_positions
Input Example (bash)	curl -i -H "Accept: application/json" -H "Content-Type: application/json" -X GET http://0.0.0.0:8080/joint_positions
Input Example (python)	import urllib2 check_received_joint_states = None

System Modularity

Depending on requirements, our systems commonly allow interchangeable:

- Graspers
- Arms
- Sensors e.g. RGB(D) Cameras
- User interfaces (e.g. different data gloves)
- Compute hosts (i.e. nodes can be distributed)

Cup stacking with a haptic telerobot.

Thank you for listening!

You can find more information on our website, **shadowrobot.com**

Any questions?