

Slides for ICRA 2022 Presentation

Link to paper:

https://sites.gatech.edu/hrl/files/2022/07/design_of_stretch_icra_2022_final_version_author_copy.pdf

Link to presentation video:

<https://youtu.be/tjK-Nd27Tyl>

Link to transcript:

<https://docs.google.com/document/d/1eXYIbWLxRgkvN5G1DXByAvBqotB9VVh3g9PSwT0gaAw/>

Citation:

*Charles C. Kemp, Aaron Edsinger, Henry M. Clever and Blaine Matulevich. **The Design of Stretch: A Compact, Lightweight Mobile Manipulator for Indoor Human Environments**, IEEE International Conference on Robotics and Automation (ICRA), 2022.*

The Design of Stretch: A Compact, Lightweight Mobile Manipulator for Indoor Human Environments

Charles C. Kemp, Aaron Edsinger, Henry M. Clever and Blaine Matulevich



Charlie's Conflict of Interest Statement

Dr. Kemp is both an associate professor at Georgia Tech and the chief technology officer (CTO) of Hello Robot Inc. where he works part time. **He owns equity** in Hello Robot Inc. and is an inventor of Georgia Tech intellectual property (IP) licensed by Hello Robot Inc. Consequently, **he receives royalties** through Georgia Tech for sales made by Hello Robot Inc. He also benefits from increases in the value of Hello Robot Inc.

Summary: If Hello Robot does well, Charlie does well.

Mobile Manipulators Can Provide Meaningful Assistance



research from the Healthcare Robotics Lab (healthcare-robotics.com) at Georgia Tech

Large, Heavy, and Expensive

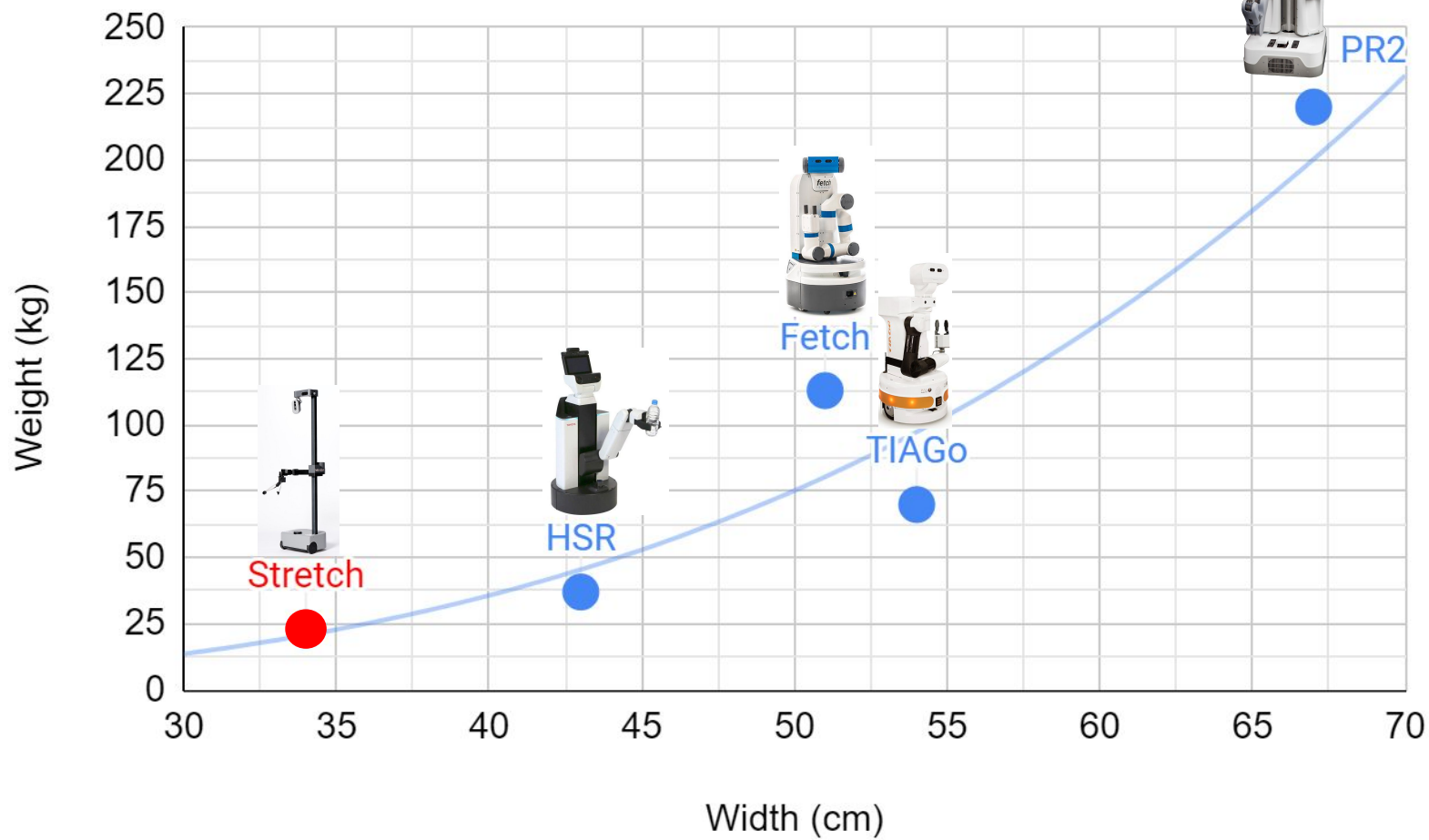


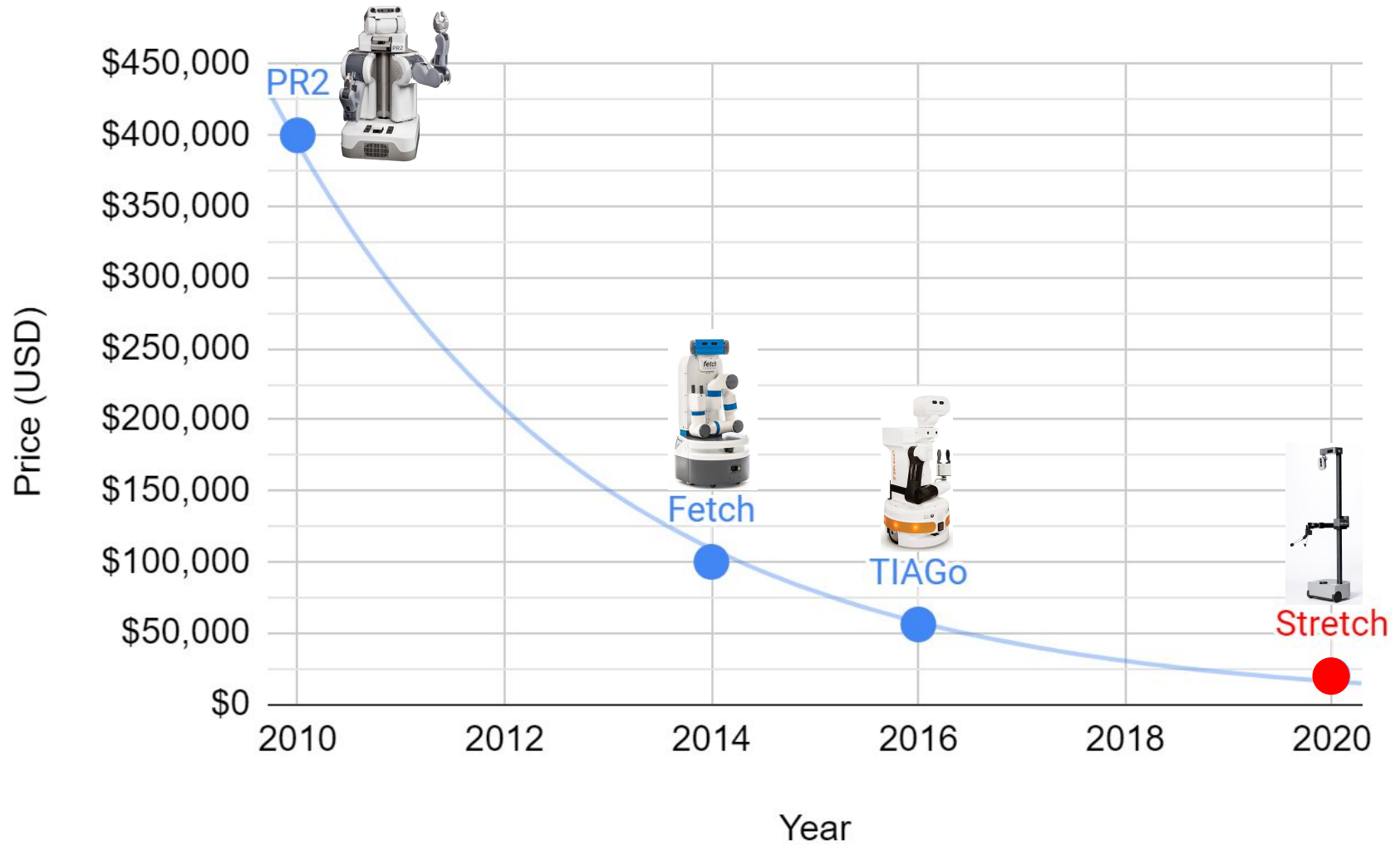
- 67 cm wide (~2.2 ft)
- 227 kg (~500 lb)
- \$400,000

Smaller, Lighter, More Affordable



- 34 cm wide (~1.1 ft)
- 23 kg (~51 lb)
- \$20,000



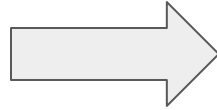


The Core Design Problem

Smaller

Lighter Weight

Lower Cost



Smaller Workspace

Lower Applied Forces

Fewer Degrees of Freedom



Georgia Tech's 1st Prototype
March 2017



Hello Robot's Product - A Robot for Research
July 2020



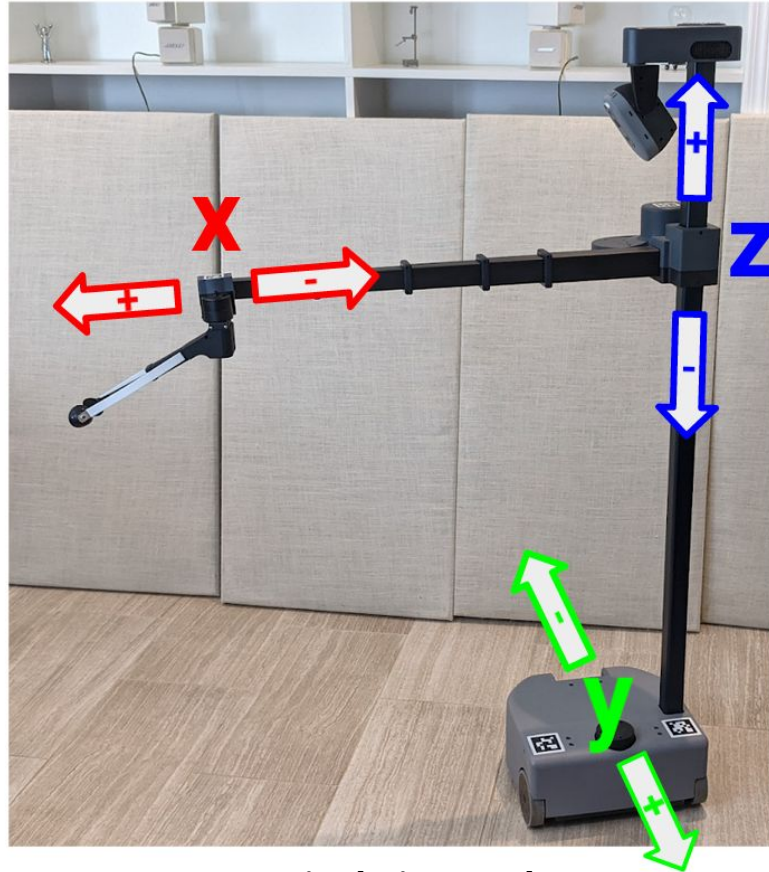
2016	2017		2018	2019	2020
------	------	--	------	------	------

Cartesian Manipulator



Manipulation Mode

Cartesian Manipulator



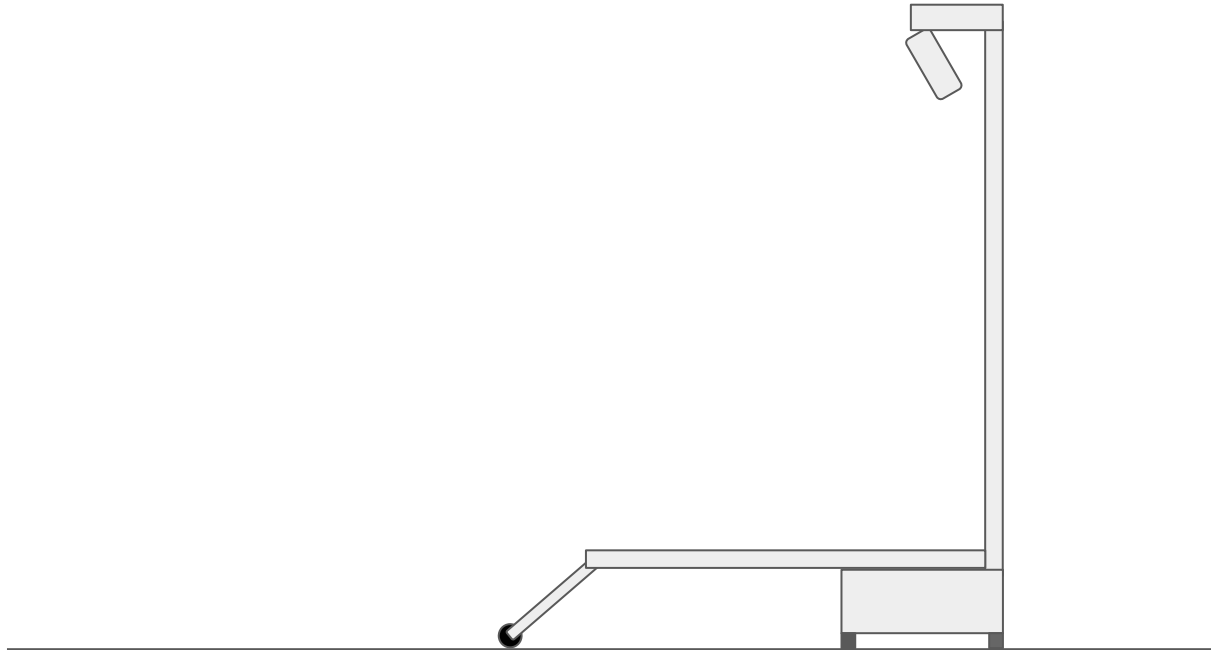
Manipulation Mode

Arm & Tool Stow in the Footprint



Navigation Mode
(*Differential Drive Mobile Robot*)

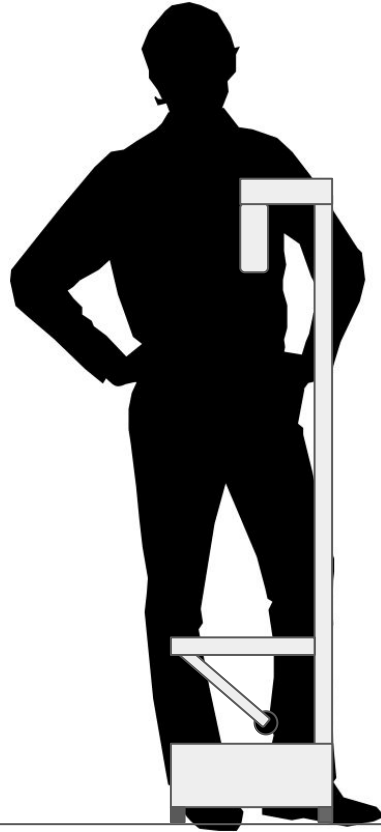
Reaches the Floor



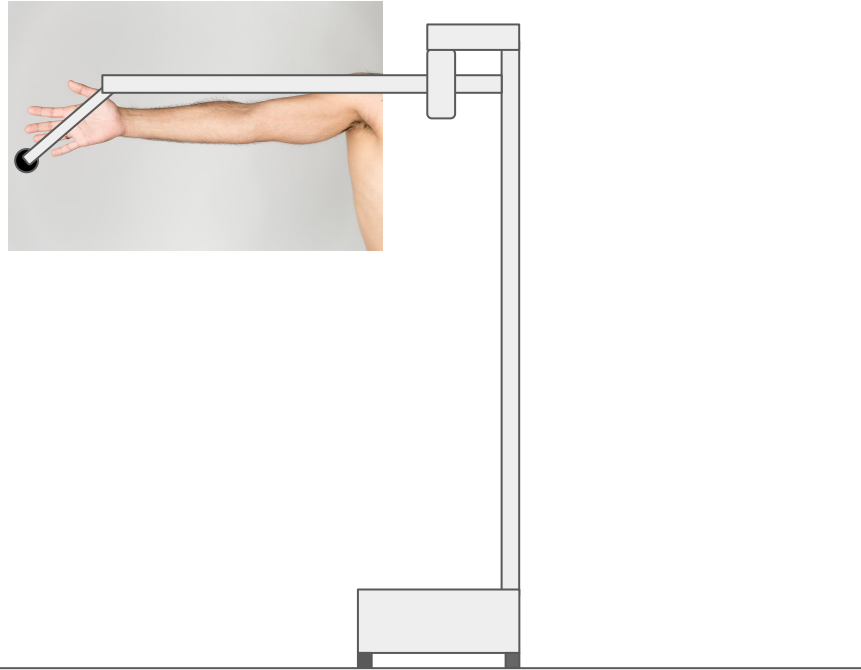
Reaches 36" Countertops



< 50th Percentile Hip Width



50th Percentile Arm Length



23 kg (51 lb)

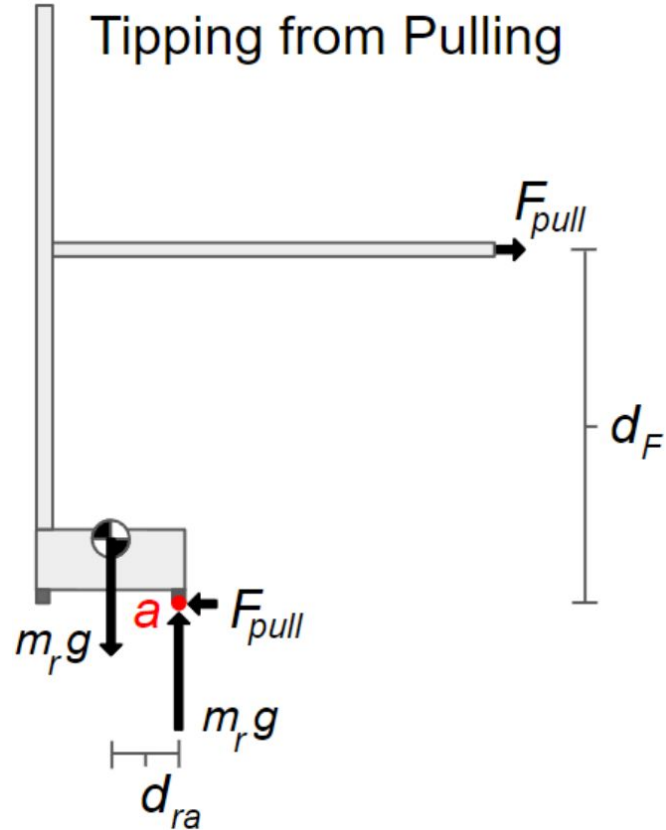




Image from <https://sites.gatech.edu/robotic-caregivers/> .



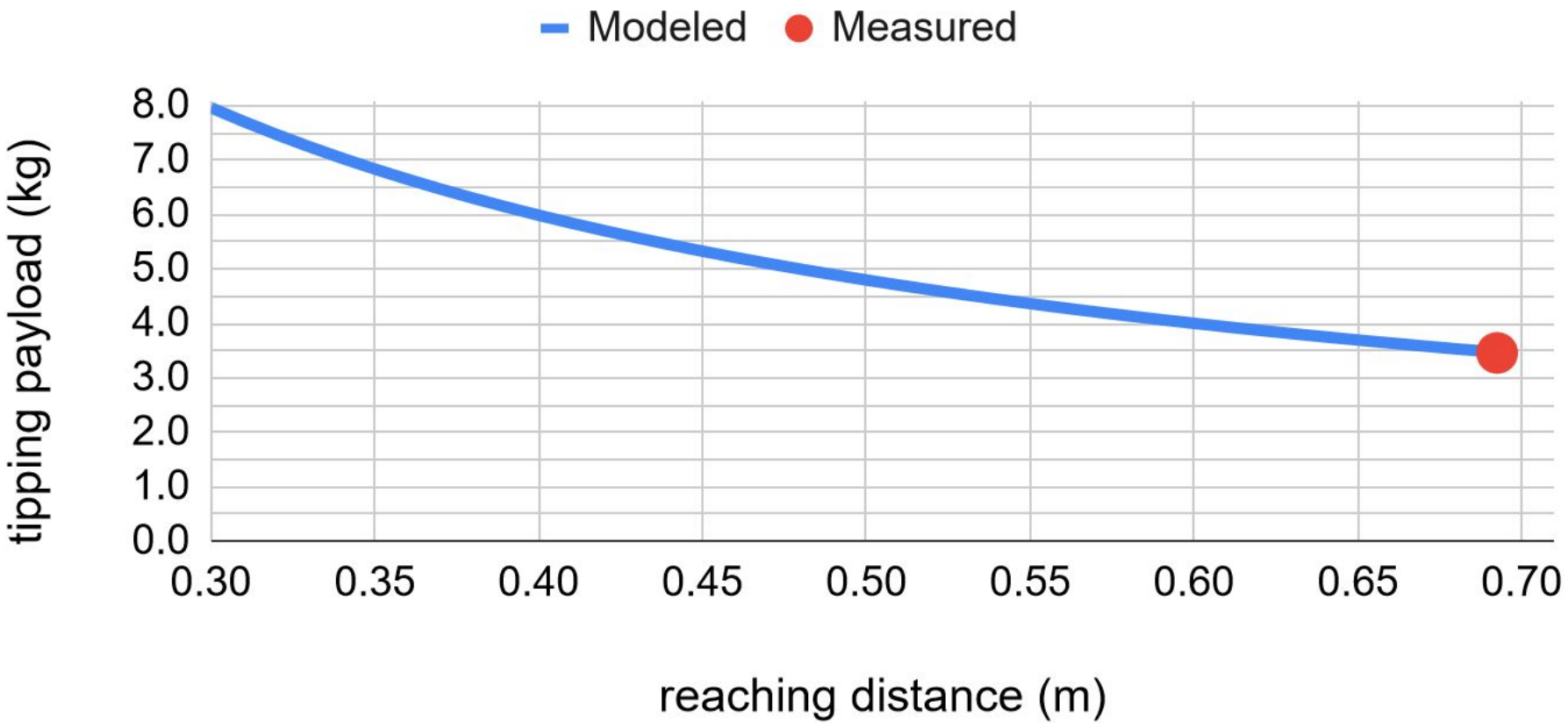
Models of Static Stability



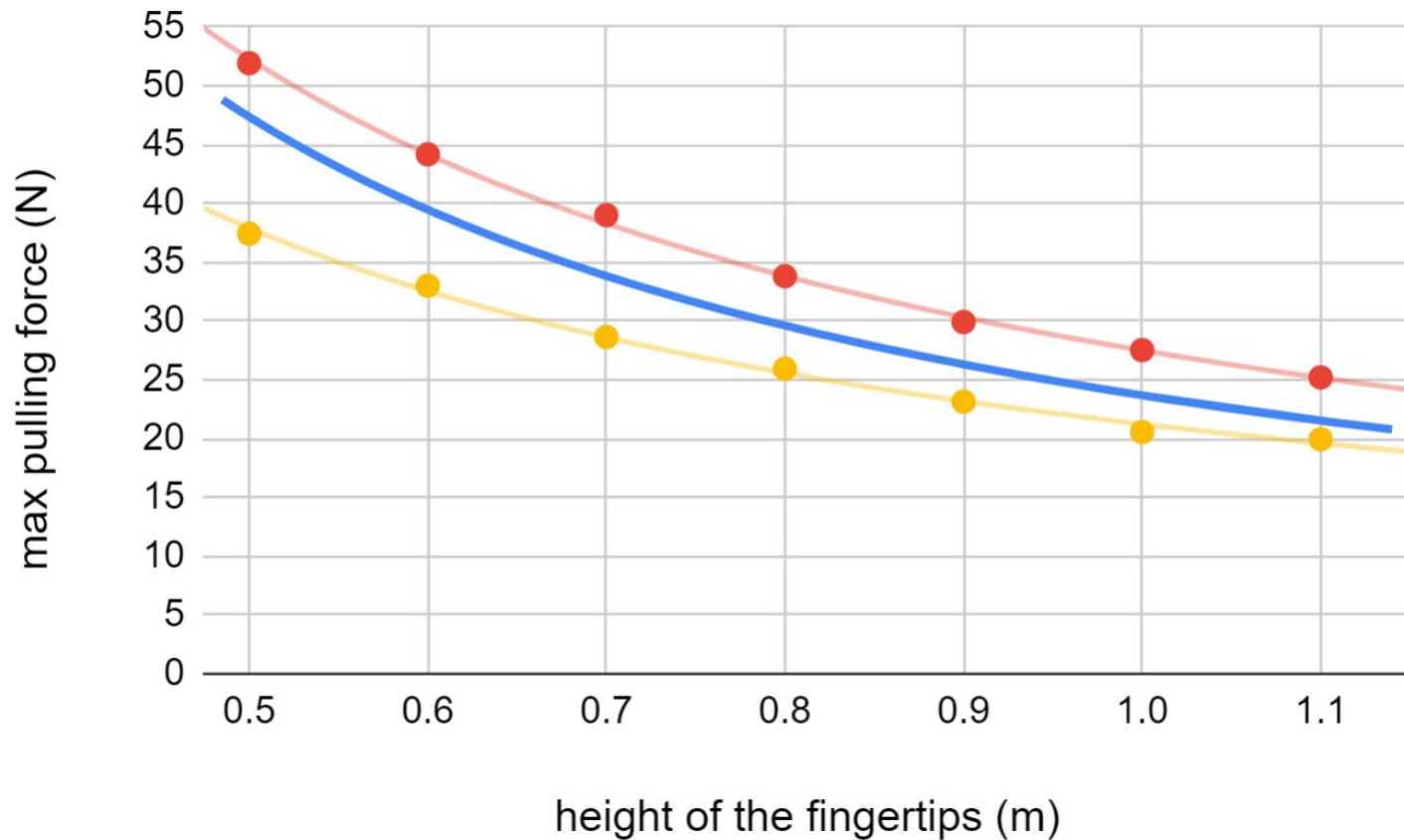
Simple Closed-Form Expressions

$$m_{\text{payload}} = m_r \frac{c}{t + \frac{2ld_p}{w}}$$

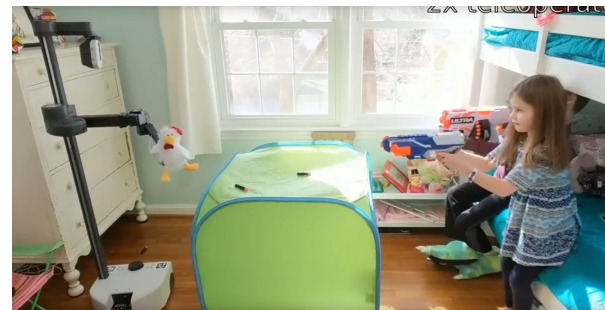
$$F_{\text{pull/push}} = m_r g \frac{cw}{2hl}$$



— model predictions ● arm fully retracted ● arm fully extended

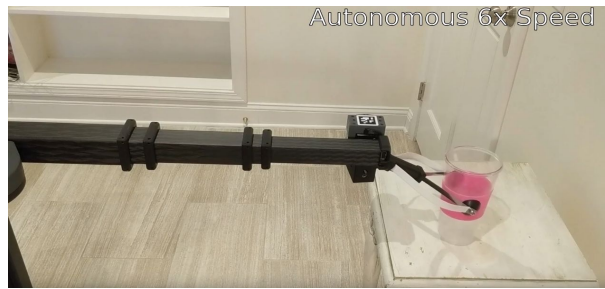
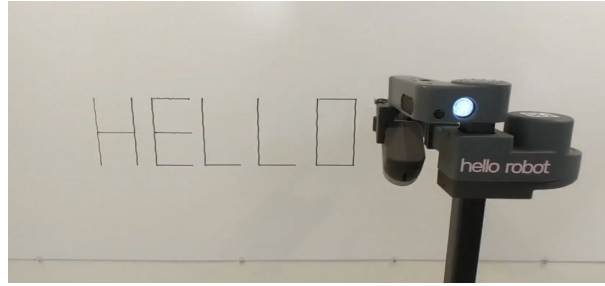


Teleoperated Home Examples



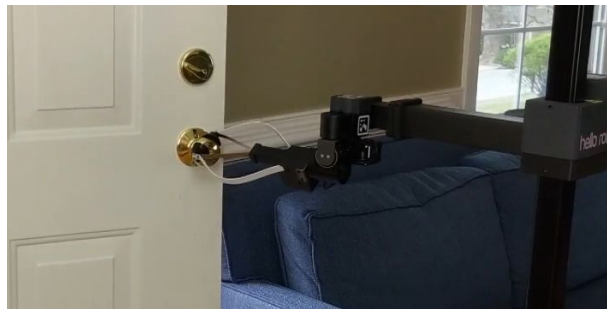
<https://www.youtube.com/c/HelloRobot/videos>
<https://github.com/hello-robot>

Autonomous Home Examples



<https://forum.hello-robot.com/t/autonomy-video-details>

Teleoperated Examples with the Dexterous Wrist



<https://www.youtube.com/c/HelloRobot/videos>
<https://github.com/hello-robot>

Stretch is being used by a growing community of researchers.



Figure from www.hello-robot.com.