

**Computer Science > Robotics***[Submitted on 22 Sep 2021]*

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

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

Mobile manipulators for indoor human environments can serve as versatile devices that perform a variety of tasks, yet adoption of this technology has been limited. Reducing size, weight, and cost could facilitate adoption, but risks restricting capabilities. We present a novel design that reduces size, weight, and cost, while still performing a variety of tasks. The core design consists of a two-wheeled differential-drive mobile base, a lift, and a telescoping arm configured to achieve Cartesian motion at the end of the arm. Design extensions include a 1 degree-of-freedom (DOF) wrist to stow a tool, a 2-DOF dexterous wrist to pitch and roll a tool, and a compliant gripper. We justify our design with mathematical models of static stability that relate the robot's size and weight to its workspace, payload, and applied forces. We also provide empirical support by teleoperating and autonomously controlling a commercial robot based on our design (the Stretch RE1 from Hello Robot Inc.) to perform tasks in real homes.

Comments: 6 pages plus references, 7 figures

Subjects: **Robotics (cs.RO)**Cite as: [arXiv:2109.10892](#) [cs.RO](or [arXiv:2109.10892v1](#) [cs.RO] for this version)**Submission history**From: Henry M. Clever [[view email](#)]

[v1] Wed, 22 Sep 2021 17:56:51 UTC (11,297 KB)

**Download:**

- PDF
- [Other formats](#)



Current browse context:

cs.RO

< [prev](#) | [next](#) >[new](#) | [recent](#) | [2109](#)

Change to browse by:

[cs](#)**References & Citations**

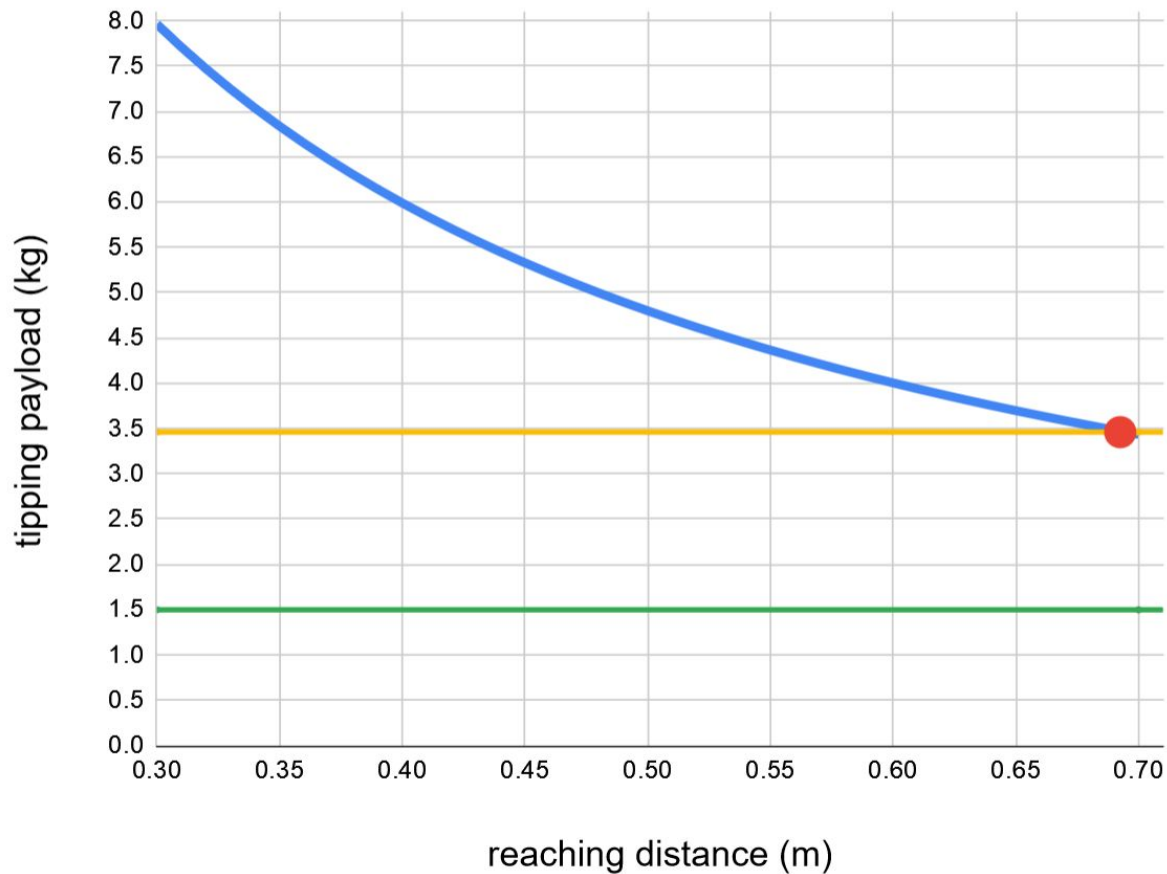
- [NASA ADS](#)
- [Google Scholar](#)
- [Semantic Scholar](#)

**Export Bibtext Citation****Bookmark**

[The Design of Stretch: A Compact, Lightweight Mobile Manipulator for Indoor Human Environments](#), Charles C. Kemp, Aaron Edsinger, Henry M. Clever and Blaine Matulevich, arXiv, 2021.

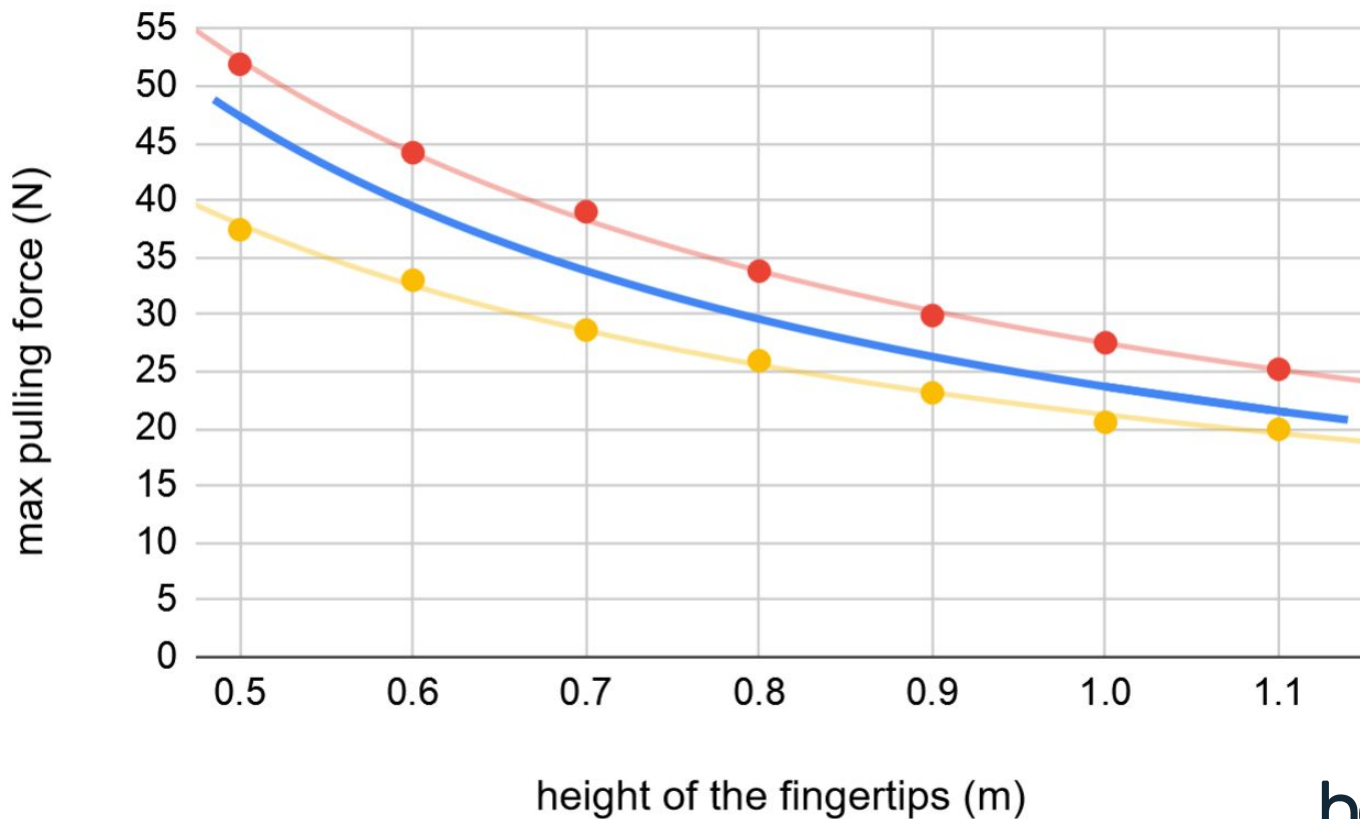
# Maximum Payload with Gripper

— Modeled   ● Measured   — No Safety Margin   — Specification (no gripper)

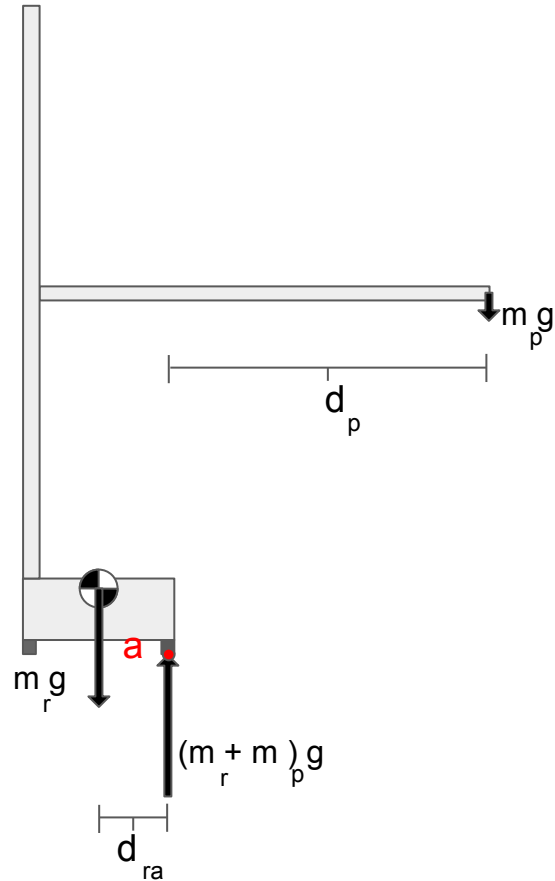


# Circles Represent Averages of Measurements

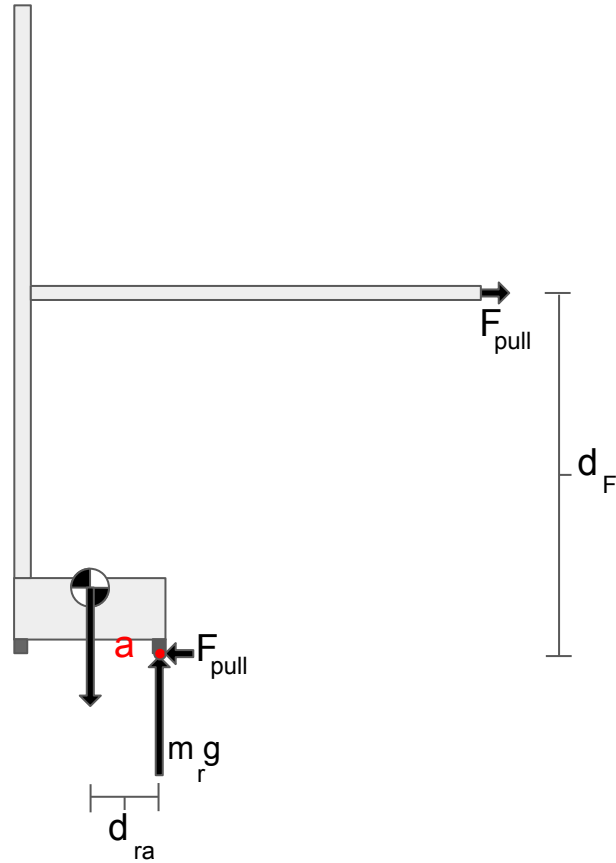
— model predictions   ● arm fully retracted   ● arm fully extended



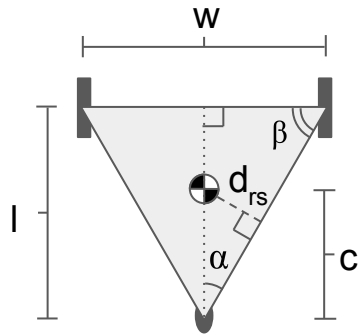
# Tipping from Payload



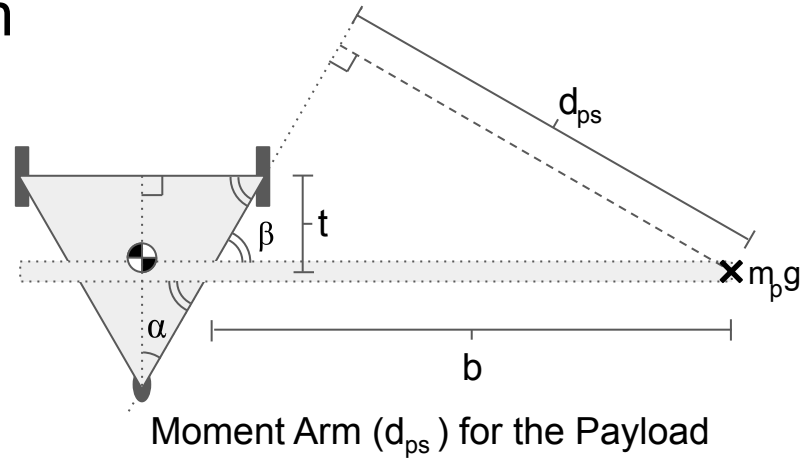
# Tipping from Pulling



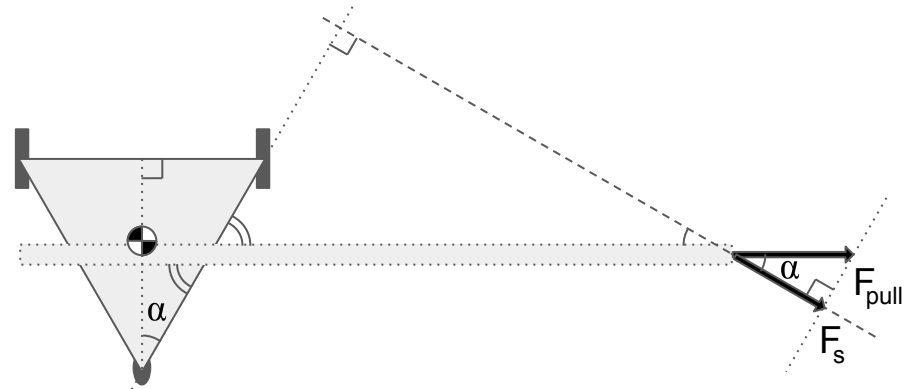
# Triangular Support Polygon



Moment Arm ( $d_{rs}$ ) for the Robot's Center of Mass



Moment Arm ( $d_{ps}$ ) for the Payload



Tipping Component ( $F_s$ ) of the Pulling Force