

hello robot™

Introduction to Stretch

Charlie Kemp, Ph.D.
Co-founder & CTO

www.hello-robot.com



Learn More at Tomorrow's Talk

Hello Robot: Democratizing Mobile Manipulation with ROS

Applications

12:20 - 12:40 CDT

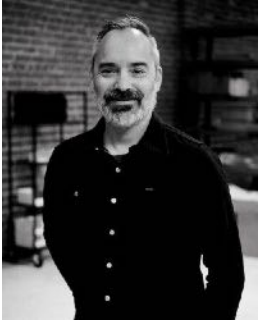
Binit Shah, Aaron Edsinger, Charlie Kemp

Hello Robot presents the Stretch RE1, a compact, lightweight, and capable mobile manipulator for indoor human environments. This talk will cover the story of Stretch, the growing community and ecosystem around the platform, and the role of ROS with an emphasis on ROS 2. We will provide examples of ways universities, startups, and large companies are using Stretch, including research on assistance for people with disabilities. Notably, Hello Robot's code for Stretch is primarily in Python and all of it is open source on GitHub, including the firmware, so attendees will be able to see the code for themselves.

Relevant URL

hello robot™

Founding Team



Aaron Edsinger, Founder & CEO

- Founder Meka Robotics and Redwood Robotics
- Former Director of Robotics, Google
- PhD MIT CSAIL
- Built Meka and Redwood Robotics and sold to Google
- World expert on design for robot manipulation



Charlie Kemp, Founder & CTO

- Associate Professor, Georgia Tech
- Founder & Director of the Healthcare Robotics Lab
- PhD MIT CSAIL
- World expert on assistive mobile manipulation

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.

The Stretch RE1



**“Beautifully
Simple, Clever
Robot Design”**

**- IEEE
Spectrum**

Hardware & Software Platform

- \$19,950 for a **complete robot**
 - gripper
 - sensors
 - onboard computer
- Compact, lightweight, contact sensitive, calibrated
- Open source software
 - From firmware up
 - Python & ROS

Successful Launch in July 2020

IEEE SPECTRUM Topics Reports Blogs Multimedia

Automaton Robotics Home Robots

14 Jul 2020 | 4:01 GMT

Ex-Googler's Startup Comes Out of Stealth With Beautifully Simple, Clever Robot Design

Hello Robot's Stretch wants to reinvent how mobile manipulators perform tasks in home environments

By Evan Ackerman and Eric Guizzo




Photo: Hello Robot

Hello Robot, founded by former Google robotics director Aaron Edsinger and Georgia Tech professor Charlie Kemp, is introducing Stretch, a mobile manipulator that weighs only 23 kg and costs less than \$20,000.

SVR Silicon Valley Robotics supporting the innovation and commerce



Hello Robot wins Innovation Award in SVR 'Good Robot' Industry Awards

Posted on [December 14, 2020](#) by [Andra Keay](#)



BBC Sign in Home News Sport Reel Wo

NEWS

Home Prince Philip Coronavirus Video World US & Canada UK Business

Tech



01:30

Research robot helps with housework and other news



Cornell University



umbrella research



The Design of Stretch

[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.

Two Modes of Operation



Manipulation Mode
(Cartesian Manipulator)



Navigation Mode
(Differential Drive Mobile Robot)



**Arm & Tool Stow
into the Footprint**

Two Modes of Operation



Manipulation Mode
(Cartesian Manipulator)



Navigation Mode
(Differential Drive Mobile Robot)



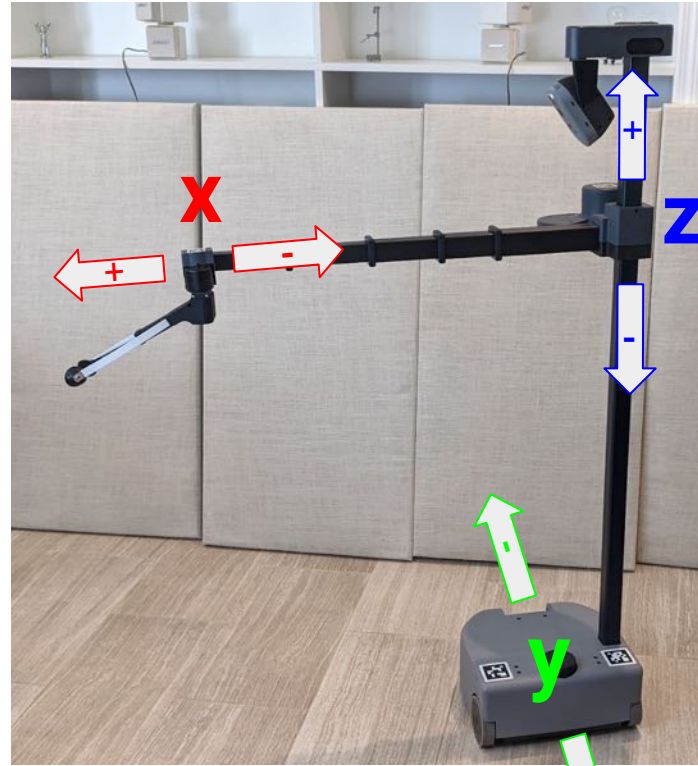
**Arm & Tool Stow
into the Footprint**

Manipulation Depends on the Mobile Base



Manipulation Mode
(Cartesian Manipulator)

Manipulation Depends on the Mobile Base

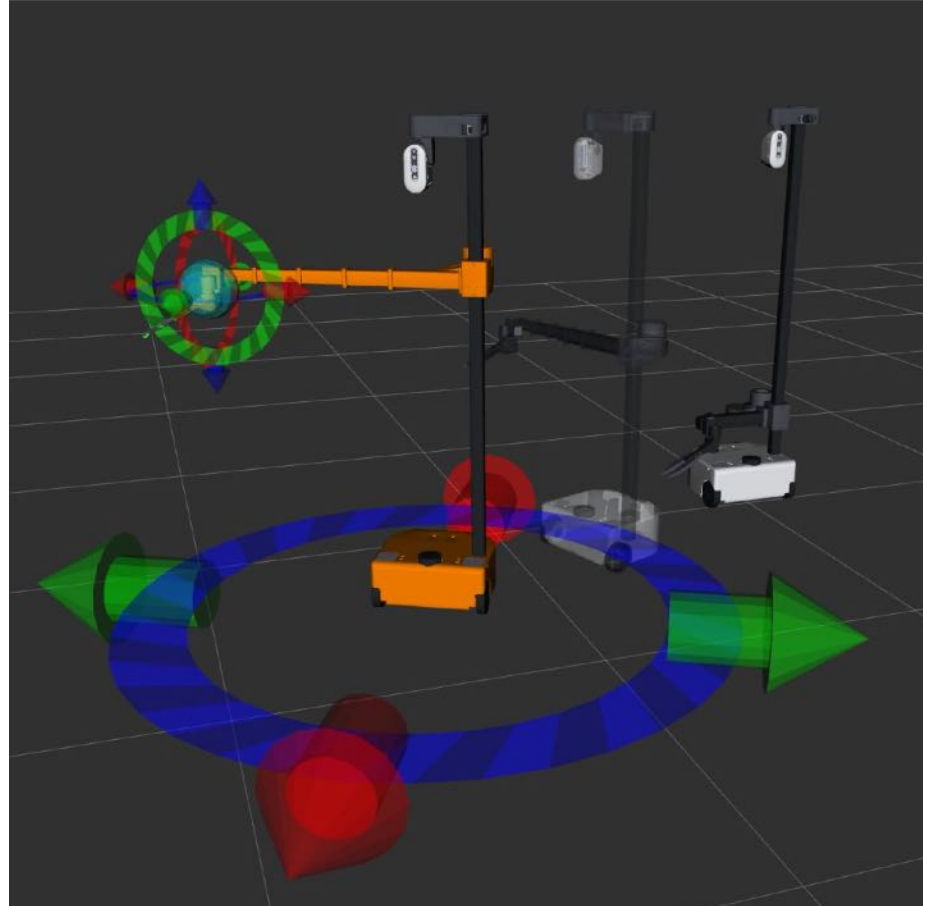


Manipulation Mode
(*Cartesian Manipulator*)

 **MoveIt2**



PICKNIK



Small, Lightweight, Affordable & Capable

- Core Degrees of Freedom
 - 4 DOF: minimal proximal actuation for Cartesian end-of-arm motion and base mobility
 - + 1 DOF wrist for stowing tools & planar dexterity
 - + 2 DOF optional wrist accessory for additional dexterity
- Dimensions matched to human environments
 - The human form deconstructed and reassembled (*robotic cubism*)

[La Femme au Violon - Pablo Picasso. 1911](#)



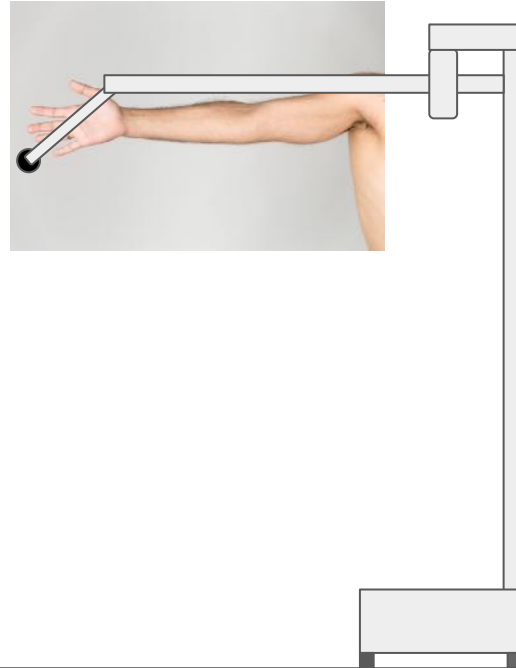
“In Cubist artwork, objects are analyzed, broken up and reassembled in an abstracted form”

- <https://en.wikipedia.org/wiki/Cubism>

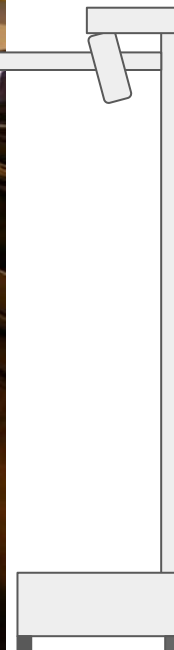
< 50th Percentile Hip Width



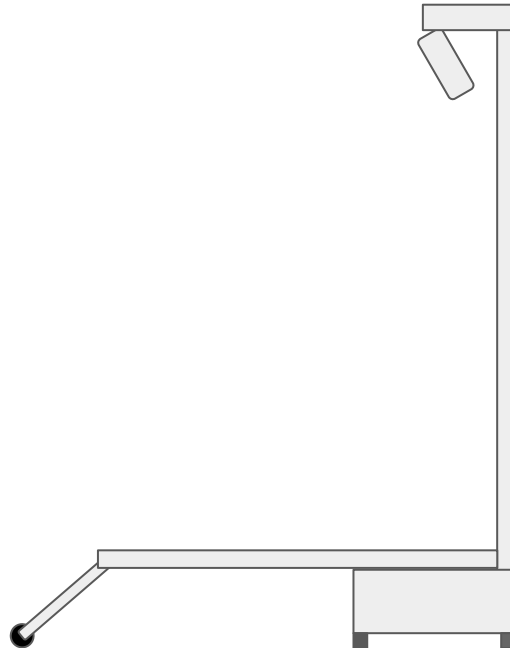
50th Percentile Arm Length



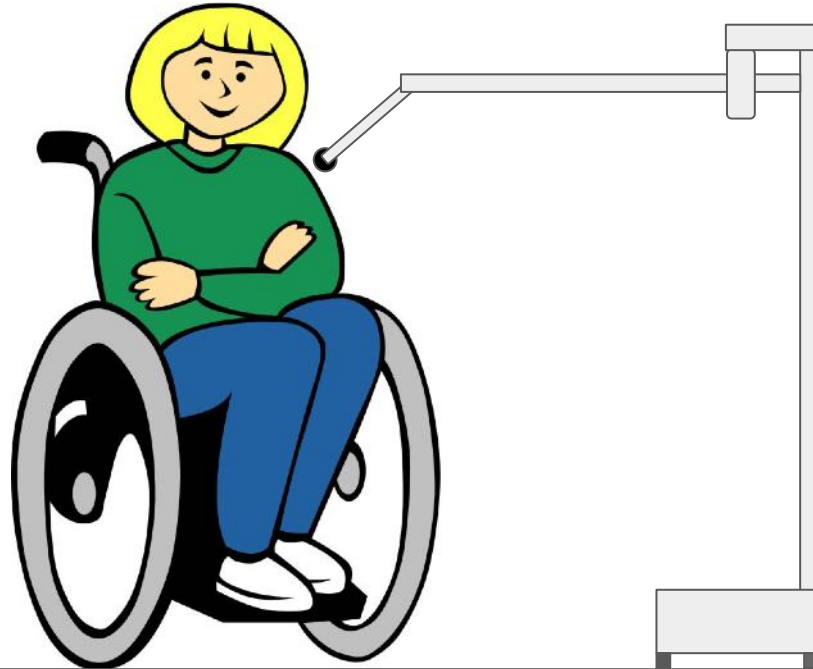
Reaches 36" Countertops



Reaches the Floor



95th Percentile Shoulder Height for Wheelchair Users



23 kg (51 lb)









A Capable Robot

<https://www.youtube.com/c/HelloRobot/videos>

Teleoperated Home Examples



<https://www.youtube.com/c/HelloRobot/videos>

Teleoperated Workplace Examples



Shelf Picking



Inspection with a Camera

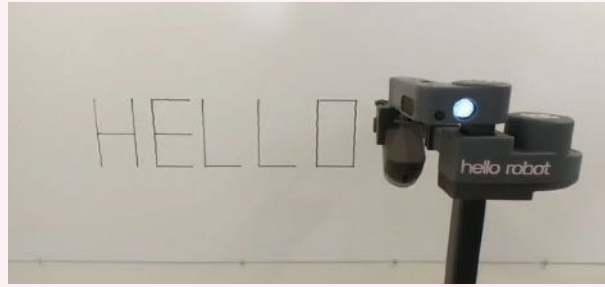
<https://www.youtube.com/c/HelloRobot/videos>

Teleoperated Examples with the Dexterous Wrist



<https://www.youtube.com/c/HelloRobot/videos>

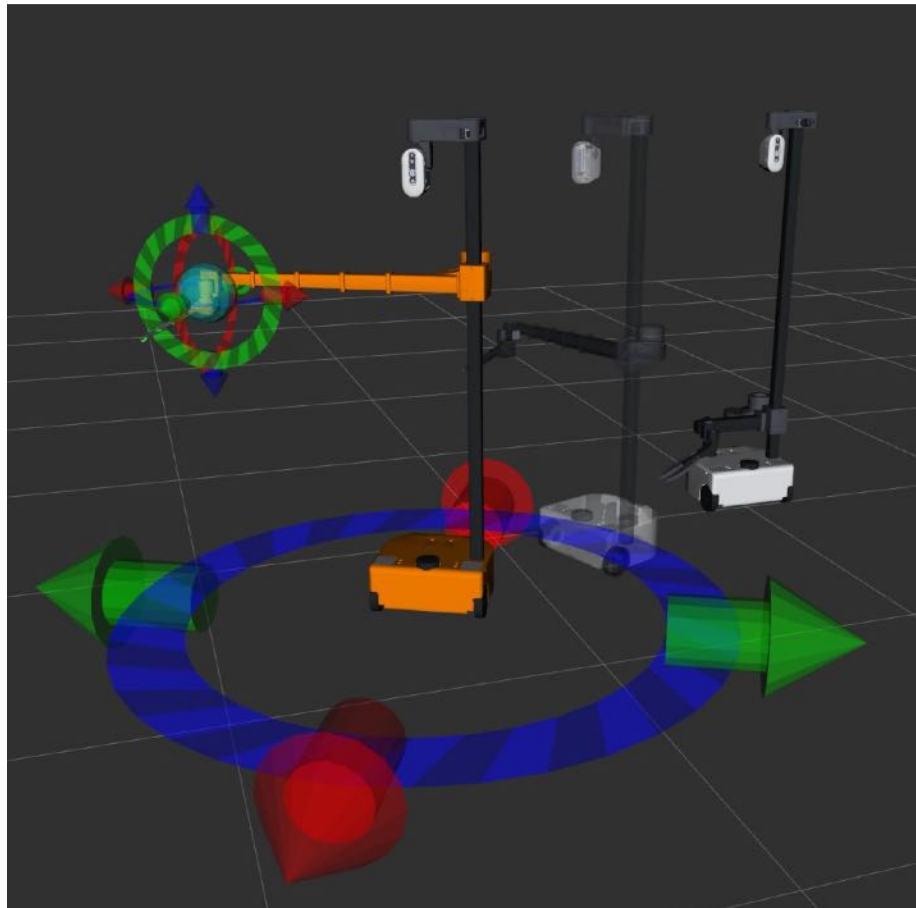
Autonomous Examples



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

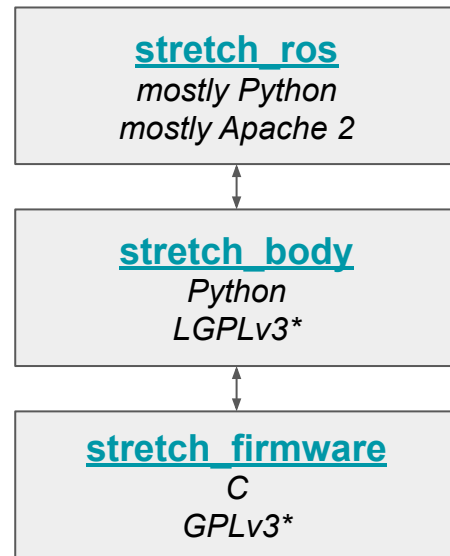
MoveIt2

- great community
- de facto standard
- wide range of capabilities
- road to ROS 2



stretch_ros & stretch_ros2

- https://github.com/hello-robot/stretch_ros
 - Melodic & Noetic
 - calibration, simulation, demonstrations
- https://github.com/hello-robot/stretch_ros2
 - Galactic
 - MoveIt 2
 - working in simulation
 - real robot *in progress*
 - *Full ROS 2 support in progress*



**dual licensing available*

Live Demo of MoveIt 2 with the Stretch RE1!



Binit Shah
Lead Software Engineer

