Why build robot hands?

Rich Walker
Managing Director

Presentation for London Robotics Meetup Group

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ARRIVAL

Shadow Robot Company

THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2019

The Alconics

BEST INNOVATION IN AI HARDWARE 2019

A BIT ABOUT US

HOW WE STARTED

- 1997, Longest running robotics company in UK
- Experts in grasping & manipulation within robotics technology
- 40 staff spanning robotics hardware & software
- Global distribution and sales in research
- Global network of collaborators and partners

CLIENTS


NASA
HITACHI
Carnegie Mellon University
esa
European Space Agency
SIEMENS
ANA
UCL
gsk
GlaxoSmithKline
Massachusetts Institute of Technology
SynTouch
JAXA
OpenAI

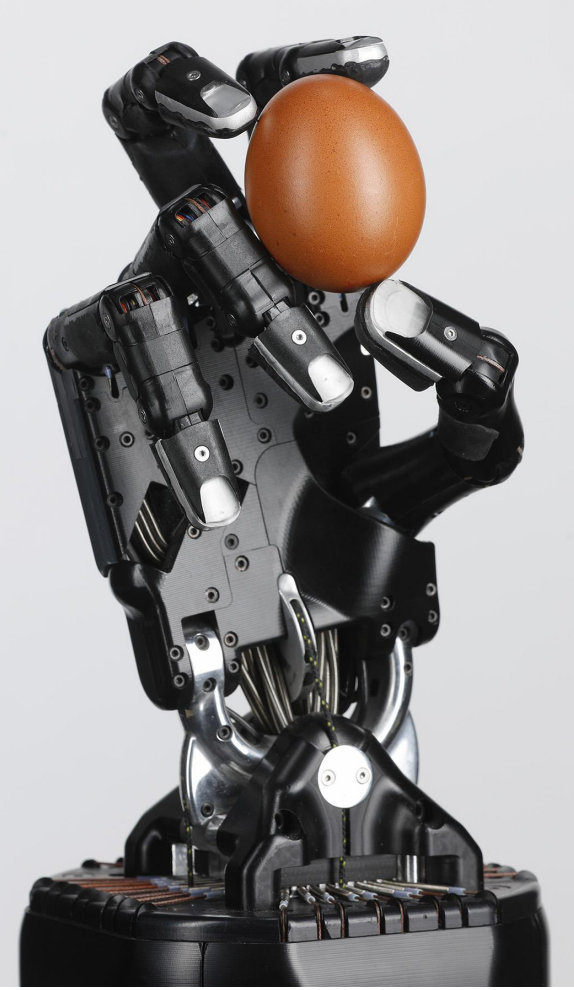
RESEARCH & DEVELOPMENT

- Many clients buy our robot hands for research and development purposes
- We also do a significant amount of internal and collaborative R&D as a company
- 7 Innovate UK projects
- 3 H2020 projects

MOVING ON FROM RESEARCH TO INDUSTRY APPLICATIONS

More and more industries are recognising how valuable our products can be and are using it to advance their sector

SHADOW DEXTEROUS HAND - FLAGSHIP PRODUCT

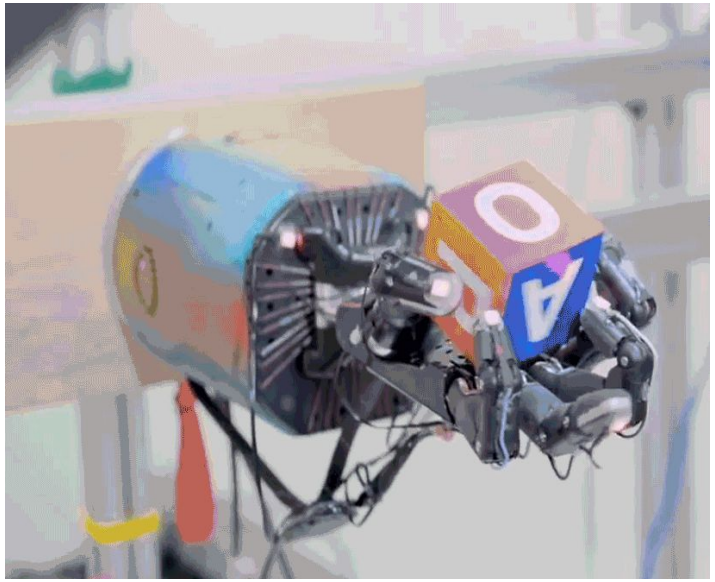


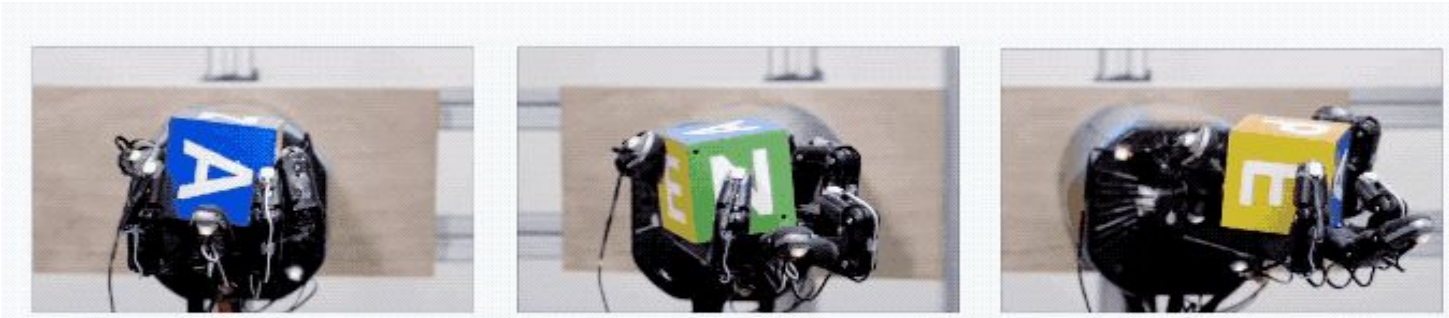
World’s most human-like robot hand

Advanced grasping and manipulation

Can be controlled remotely (teleoperation)

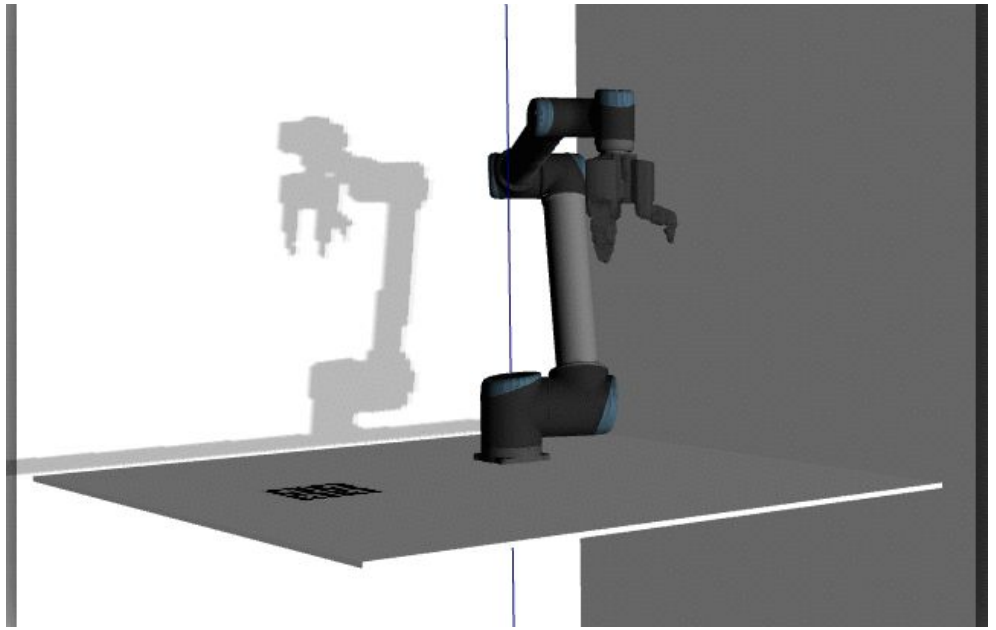
A key component in our TACTILE TELEROBOT





AUTONOMOUS GRASPING

- Easy to use, extensive grasping pipeline implemented
- Easy integration with any vision solution with a use of ROS transform frames
- Automatic grasp generation for symmetric objects
- Per object grasp definitions
- Tools for grasp creation



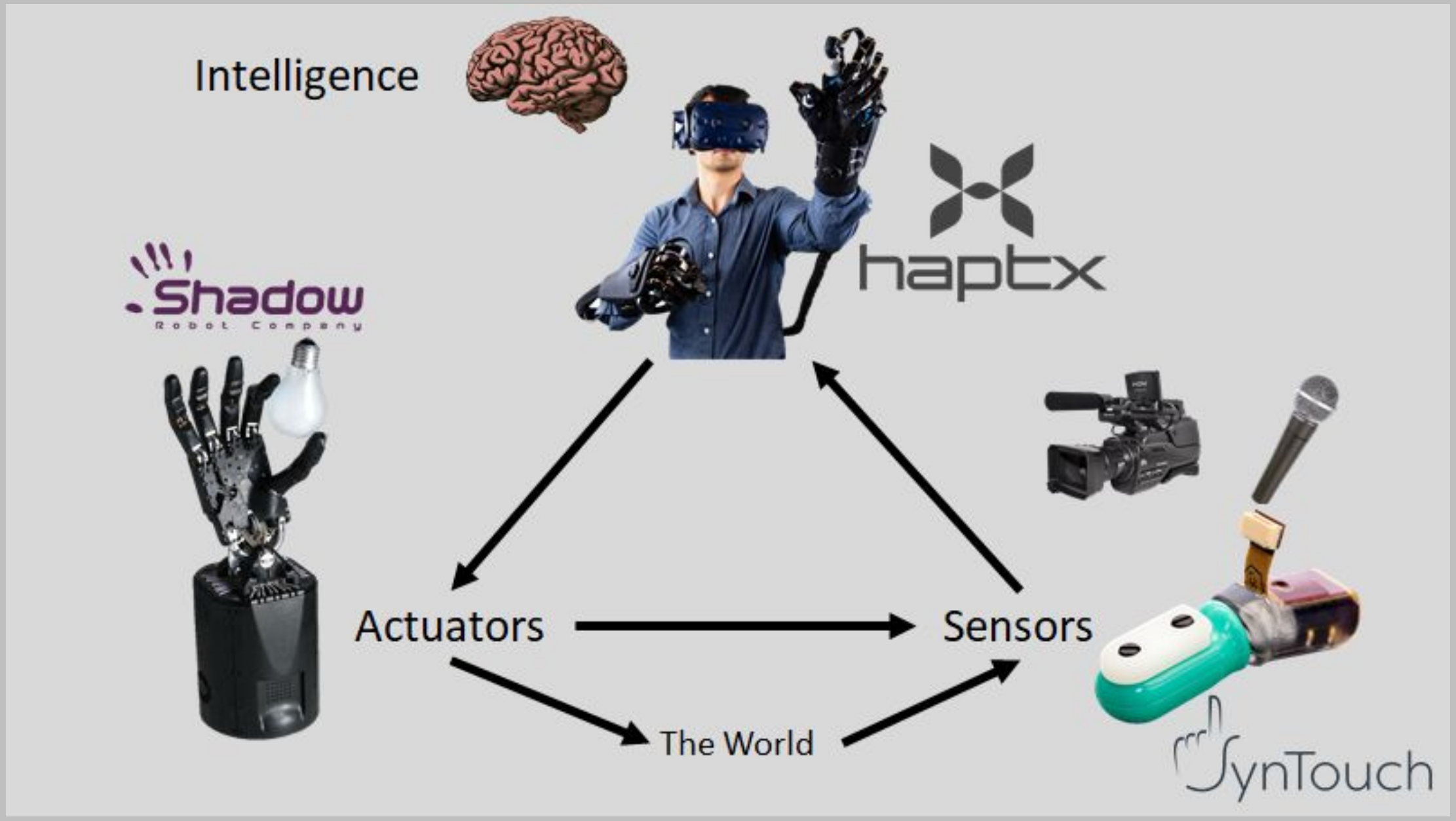
OUR NEW TACTILE TELEROBOT WITH TACTILE SENSING

TACTILE TELEROBOT - ROBOTS THAT CAN FEEL

SynTouch

haptx®

Shadow Robot Company


Intelligence
Shadow
Robot Company
haptx
Actuators
Sensors
The World
SynTouch

HOW IS THE DEXTEROUS HAND BUILT FOR TELEOP?

- 20 brushless DC motors
- 40 strain gauges
- 40 tendons
- 24 joints
- 24 position sensors
- 25 temperature sensors
- 5 pressure sensors or other fingertips
- 26 microcontrollers
- 2 CANbus interfaces
- 1 EtherCAT interface
- Custom-built in London or Madrid

WHAT INFORMATION CAN TACTILE SENSING PROVIDE?

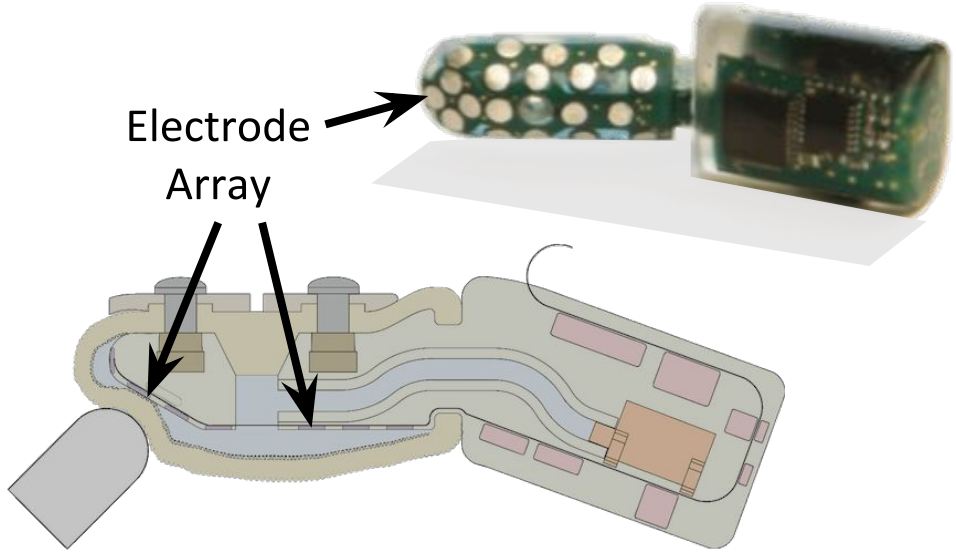
Force Sensing

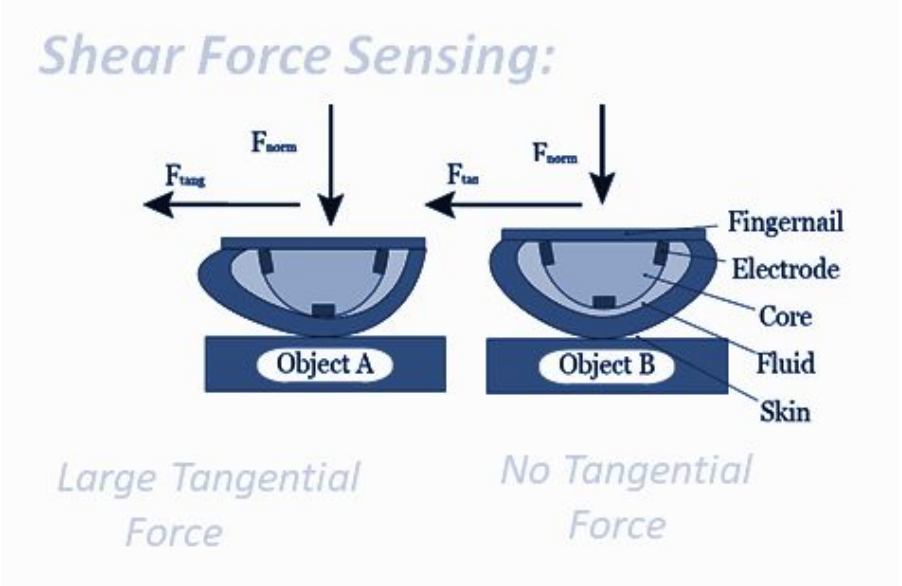
Forces deform skin and fluid

Impedance changes are sensed by electrodes

Raw data can be used to extract features:

- Normal Force
- Point of Contact
- Shear Force
- Radius of Curvature
- Compliance





Publications:

Wettels et al., Advanced Robotics, 2008

Wettels et al., IEEE BioRob, 2008

Wettels & Loeb, IEEE ROBIO, 2011

Su et al., Frontiers in Neurorobotics, 2012

ML and Analytical Solutions to Calculate 3-Axis Force, Torque and Point of Contact

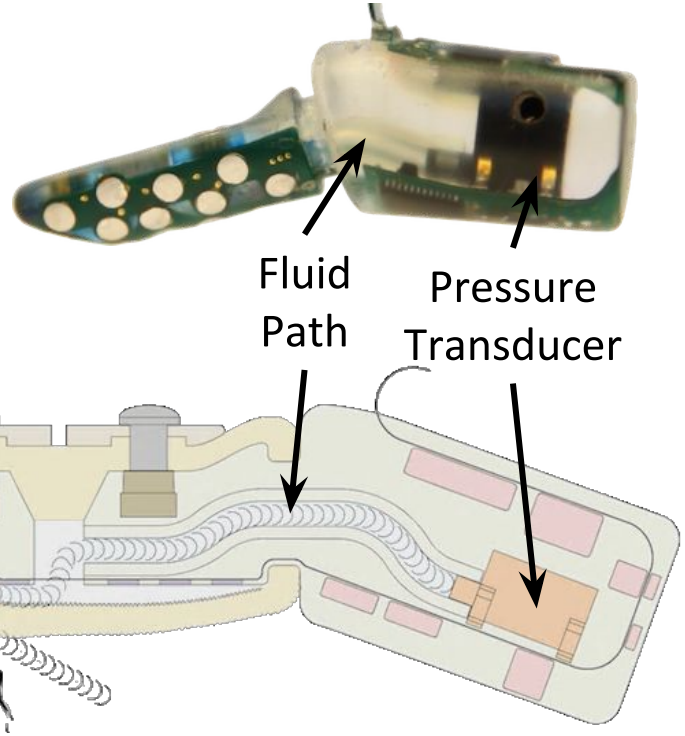
Vibration Sensing

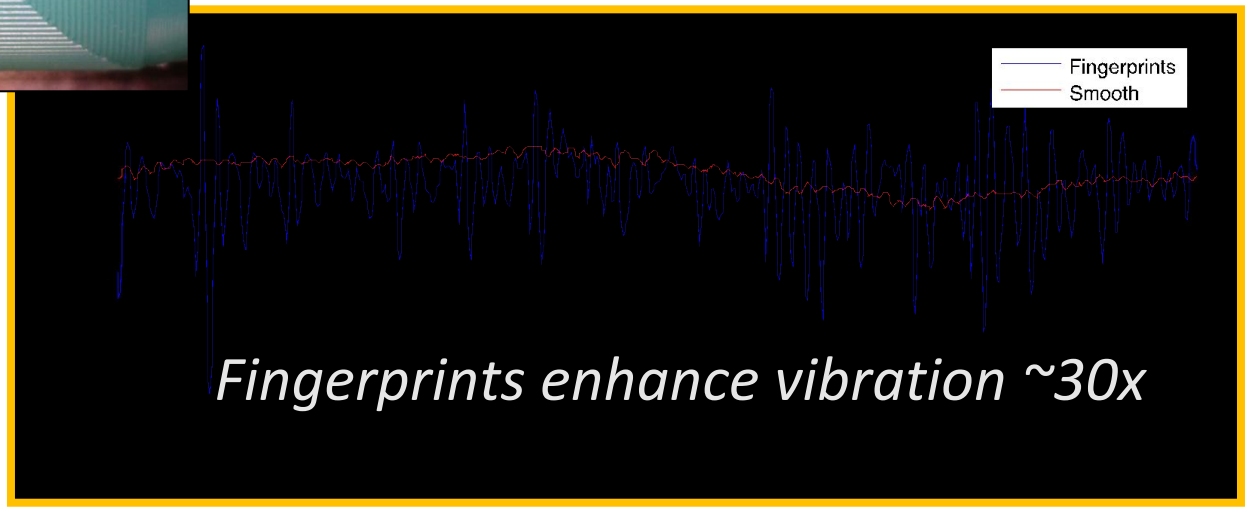
Sliding over textured objects results in vibrations

Vibrations travel efficiently through incompressible fluid

Vibrations sensed by transducer can be used to:

- Detect Slip
- Identify Texture Properties





Publications:

Fishel et al., BioRob, 2008

Fishel & Loeb, *DoD Physics of Biology*, 2009

Fishel & Loeb, BioRob, 2012

Fishel & Loeb, *Frontiers in Neurorobotics, 2012*

Temperature Sensing

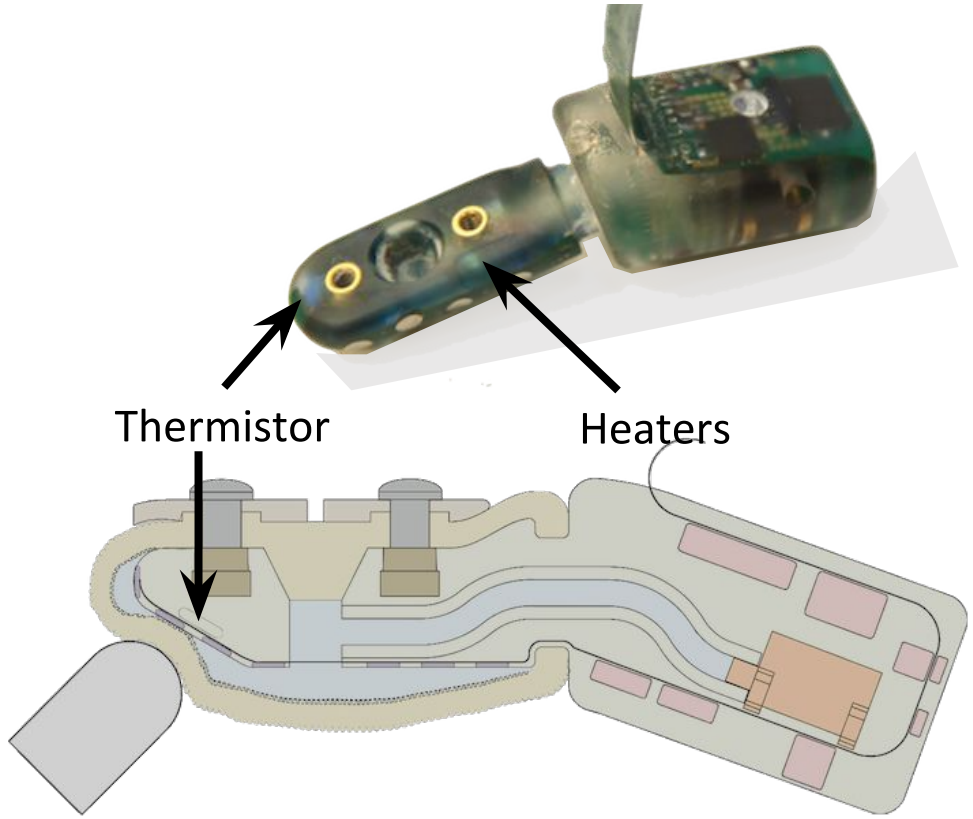
Finger is heated above room temperature

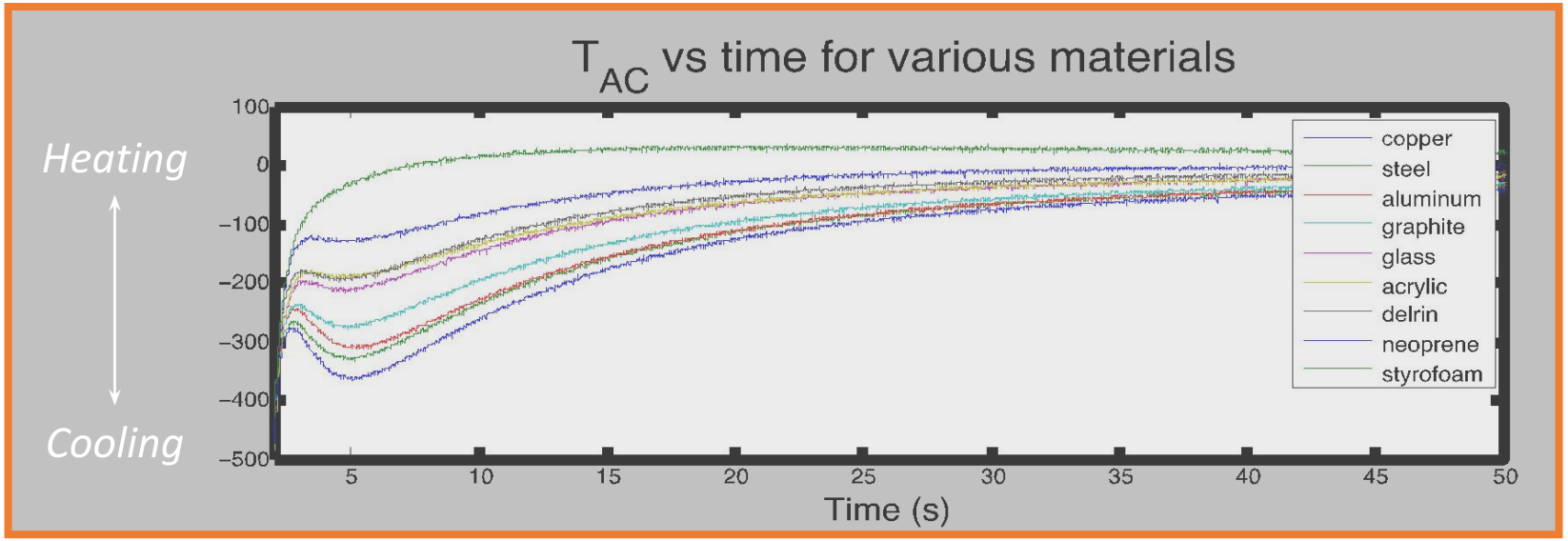
Contacted object draws heat

Temperature (and derivative) are measured

Data can be used to determine:

- Object temperature
- Material's thermal properties





Publications:

Lin et al., ROBIO, 2009

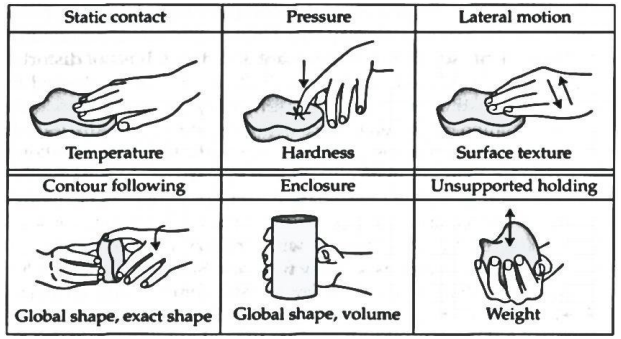
Xu et al., ICRA 2013

WHY IS TACTILE SENSING FOR TOUCH IMPORTANT IN ROBOTICS?


Touch
connects us
with the
world

ROBOTIC CAPABILITIES WITHOUT TOUCH

No tactile perception or discrimination of objects



Source: Jones, 2006

Vision is necessary to compensate

Aberystwyth University Jesse Sullivan

Not very dexterous or graceful →

PR2 – Destroys Can, RSS 2011

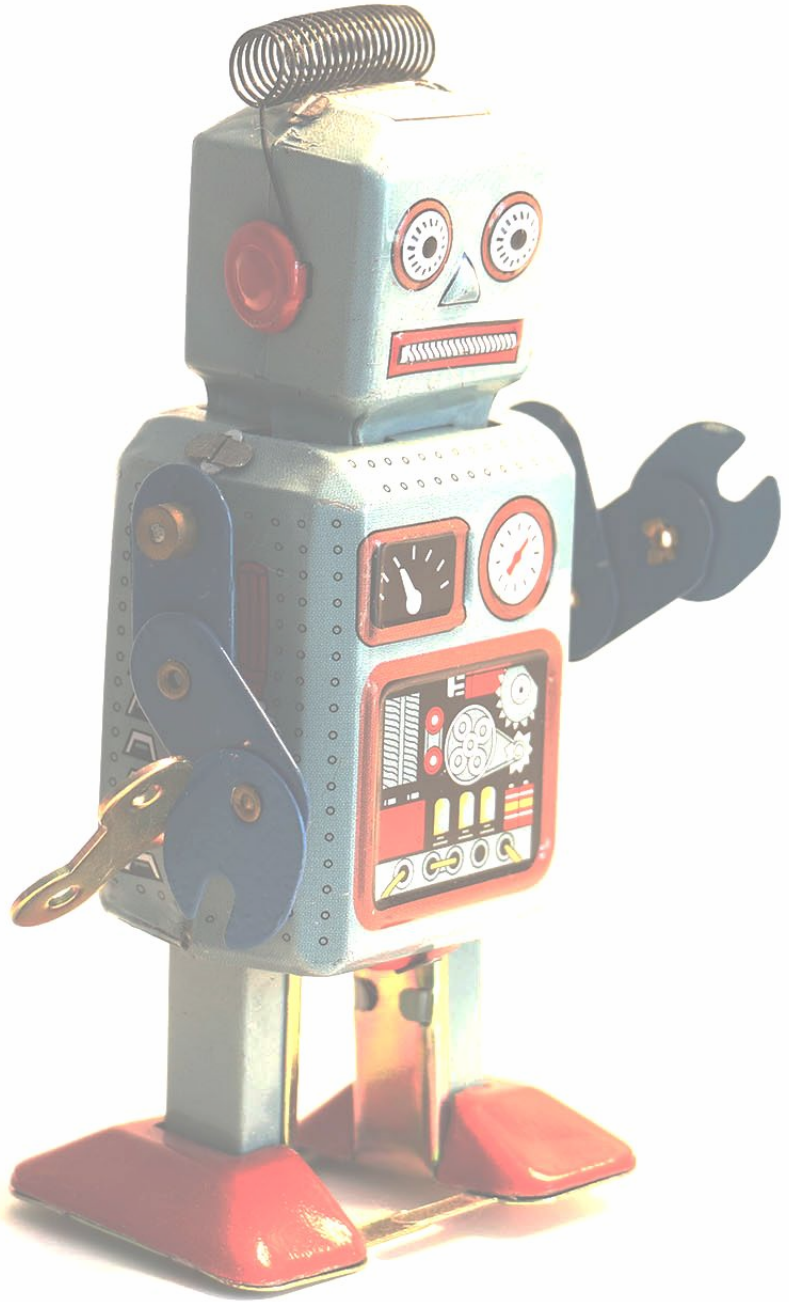
HOW CAN ROBOTS WITH TACTILE SENSING HELP IN INDUSTRY APPLICATIONS?

Dirty. Dangerous. Dull. Inaccessible.

Robots are being deployed for these tasks but lack intelligence, dexterity, and/or human touch!

SEND A HUMAN

NUCLEAR DECOMMISSIONING



APPLICATION FIELDS

Teleporting Skills

When an expert is needed (doctors, repair tech, etc.)

Dangerous or Inaccessible Environments

Nuclear, Space, Deep sea etc.

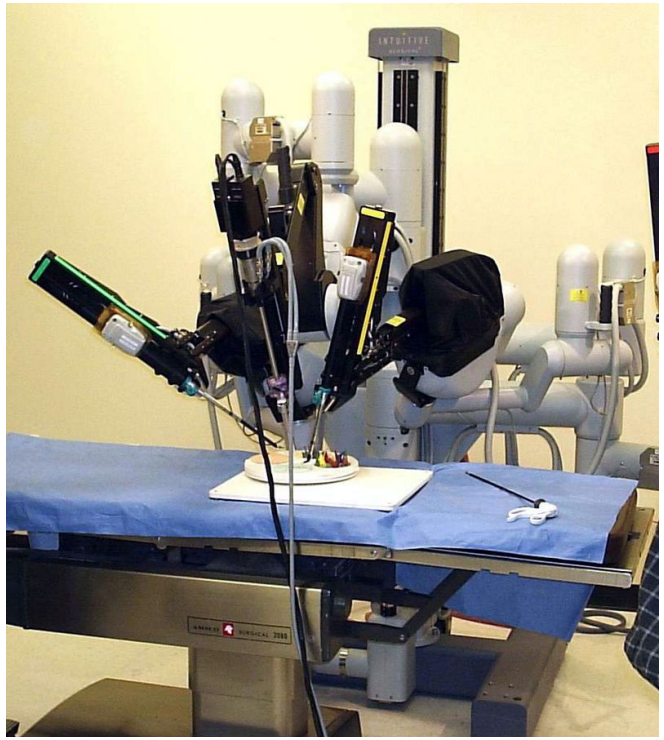
Machine Learning

Demonstration/ reinforcement learning of how to perform tasks

Semi-Autonomy & Efficiency

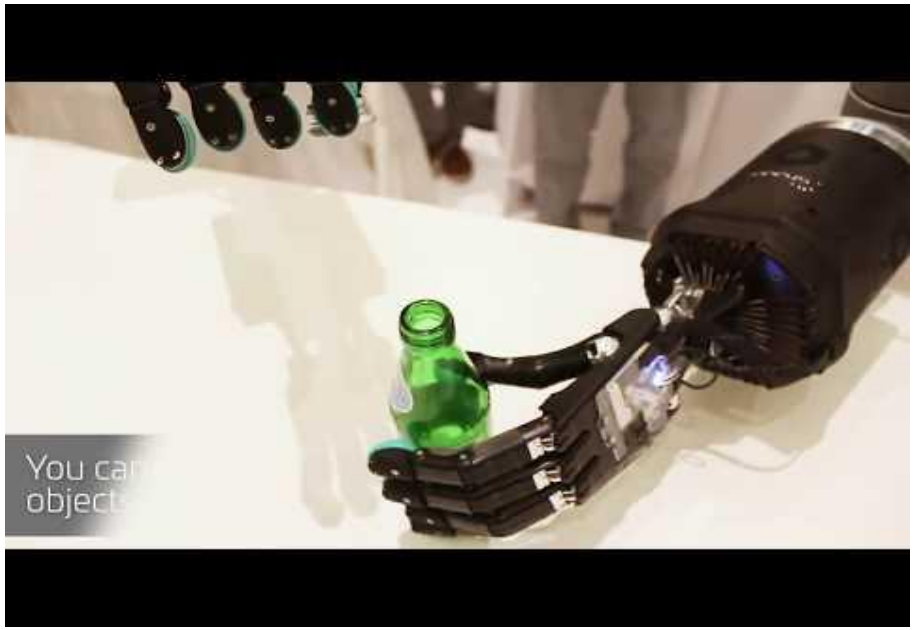
One person can control many robots

Telerobots Without Touch



Training + Preparation Time +
Careful and Slow = Expensive

Telerobots With Touch



Intuitive + Natural

Human intelligence and dexterity
infused with robotics

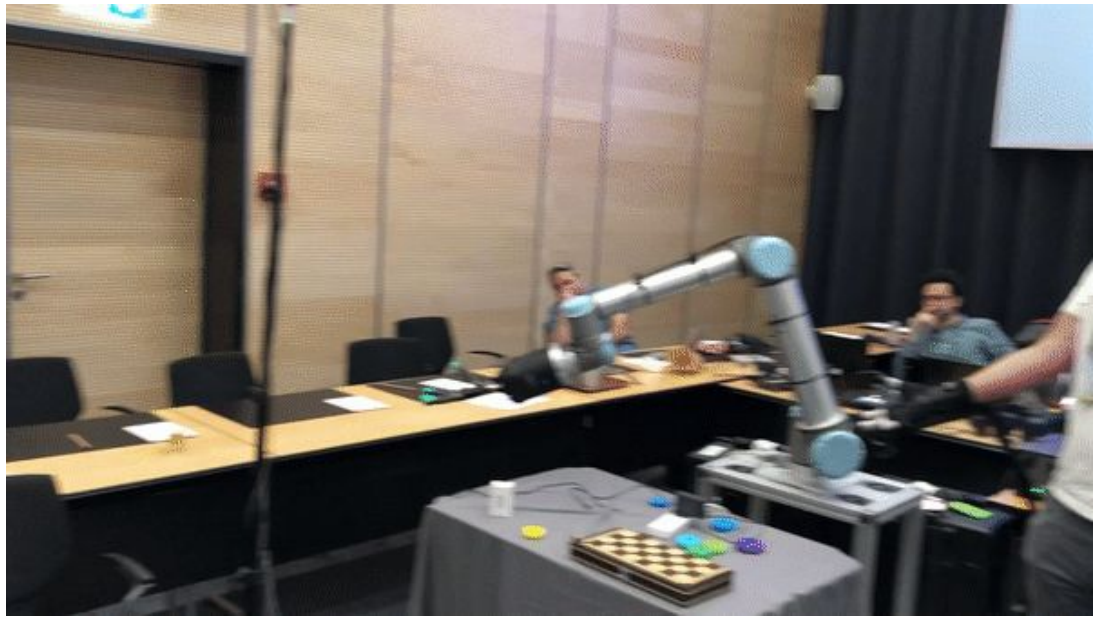
JEFF BEZOS, AMAZON'S CEO

"WEIRDLY NATURAL"

"THE TACTILE FEEDBACK IS AMAZING!"

IN CONCLUSION…

- Tactile Sensing for touch is critical for manipulation and perception
- Most tasks are still possible with vision alone BUT touch makes difficult tasks easy and intuitive
- High-fidelity teleoperation with touch can revolutionise dull, dirty or dangerous industries as well as be an excellent source of training data for AI and ML



FIELDS OF RESEARCH FOR TACTILE SENSORS

Haptic feedback (Robot -> Humans)

- Tactile Sensors
  - Compliant and accurate
  - Fingertip or skin covering the finger/palm
- Feedback to humans
  - Force feedback
  - Tactile feedback

Interpretation of tactile data (examples)

- To offer object pose estimation
- To offer object recognition based on its' features
- Object manipulation and grasp stability

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