

Touch, interaction, and presence in telerobotics

- some challenges from
the field

RICH WALKER

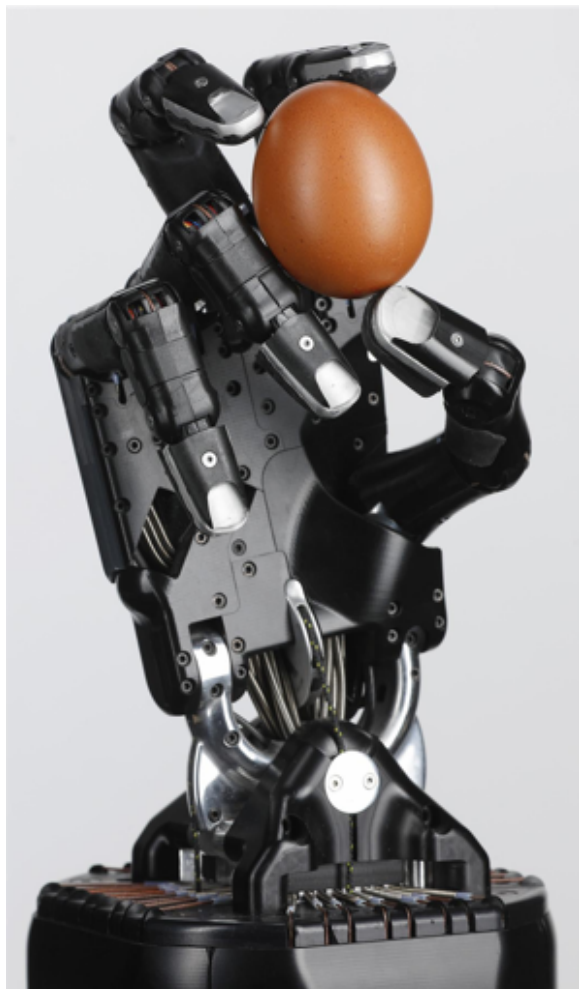
MANAGING DIRECTOR

08/07/2020





HOW WE STARTED



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



CLIENTS





OUR NEW TACTILE TELEROBOT WITH TACTILE SENSING



TACTILE TELEROBOT – ROBOTS THAT CAN FEEL





MATT SIMON SCIENCE 03.01.18 09:00 AM

HOW I BECAME A ROBOT IN LONDON—FROM 5,000 MILES AWAY

WIRED



HAPTIX

I AM BUT a babe, exploring the world for the first time.

Wearing a computerized glove, I reach forward in pursuit of a little toy basketball. A robotic arm and hand do the same, mimicking my every move. Slowly I grasp the object, lift it, swing my arm over, and let go, dropping the ball—*plonk!*—into a plastic cup.

I am very, very proud of myself. Applause erupts from the computer in front of me. But this is no American applause here in San Francisco, this is *British* applause. The robotic

We successfully trialled **haptic feedback** across the Atlantic, from **California** to **London** covered exclusively by **WIRED!**

Intelligence



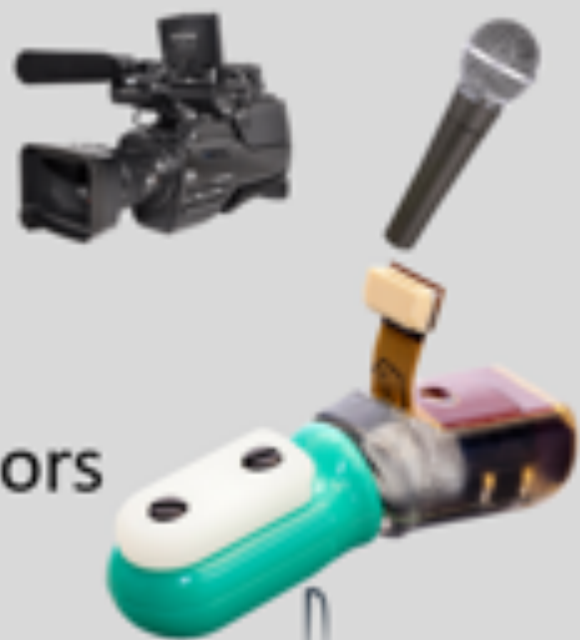
haptix



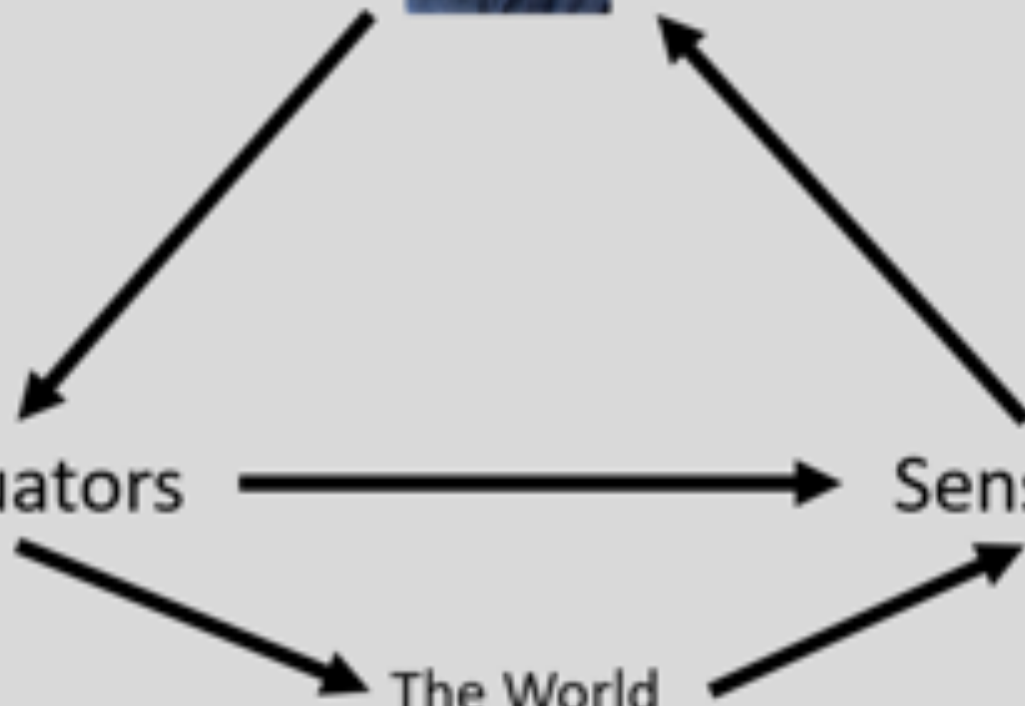
Actuators

Sensors

The World



SynTouch





Quantum leap in ease of use.
We're **shifting** the **art of the possible** in telerobotics!



60 s <https://youtu.be/HZkudU01kqA>



2 m 35 s <https://youtu.be/3rZYn62OId8>



WHAT INFORMATION CAN TACTILE
SENSING PROVIDE?

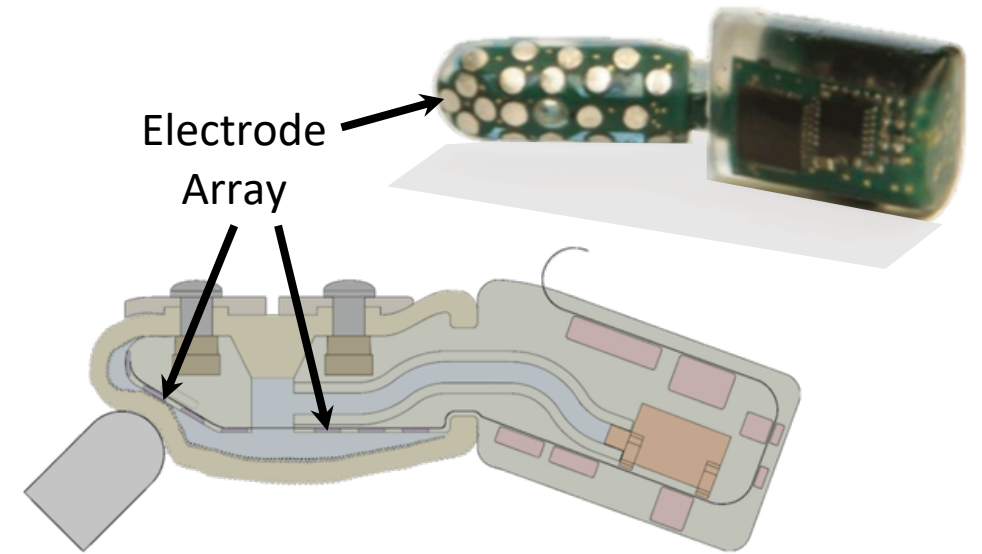
Force Sensing

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:

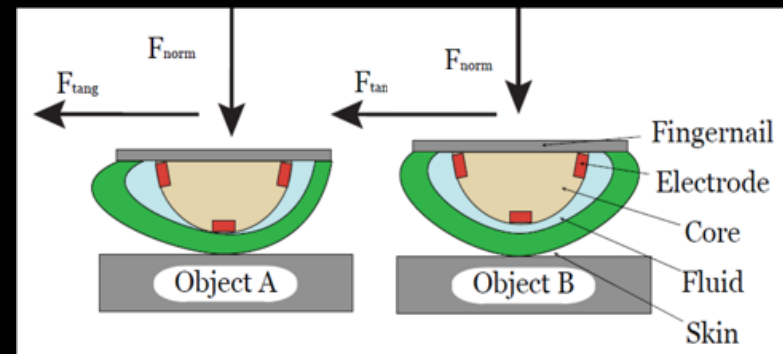
Wettels et al., Advanced Robotics, 2008

Wettels et al., IEEE BioRob, 2008

Wettels & Loeb, IEEE ROBIO, 2011

Su et al., Frontiers in Neurorobotics, 2012

Shear Force Sensing:



*Large Tangential
Force*

*No Tangential
Force*

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

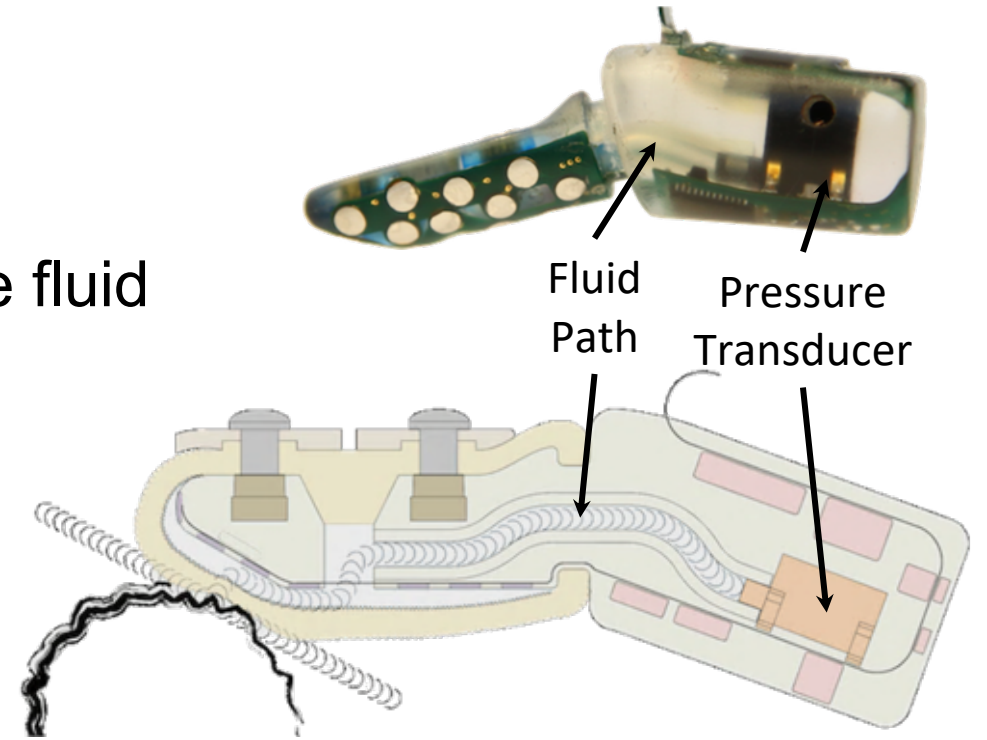
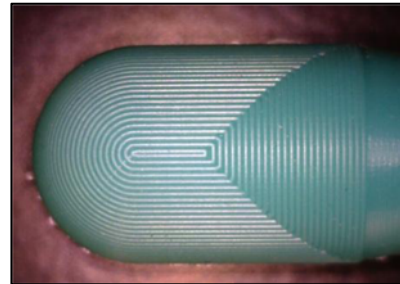
Vibration Sensing

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



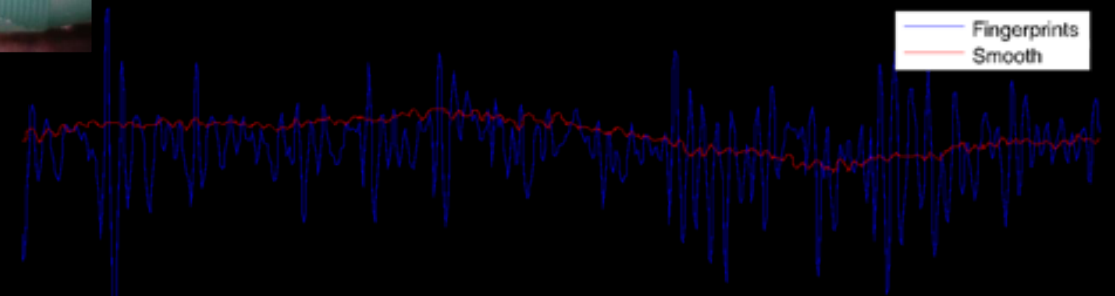
Publications:

Fishel et al., BioRob, 2008

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

Fishel & Loeb, BioRob, 2012

Fishel & Loeb, *Frontiers in Neurorobotics*, 2012



Fingerprints enhance vibration ~30x

Temperature Sensing

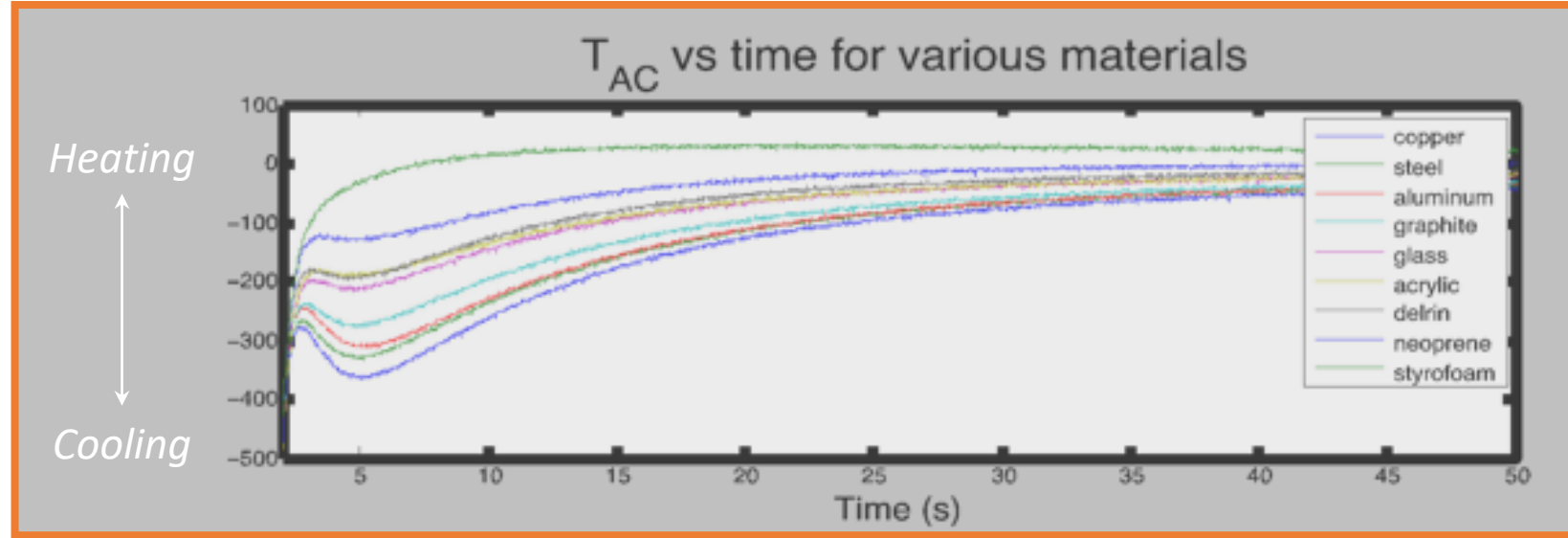
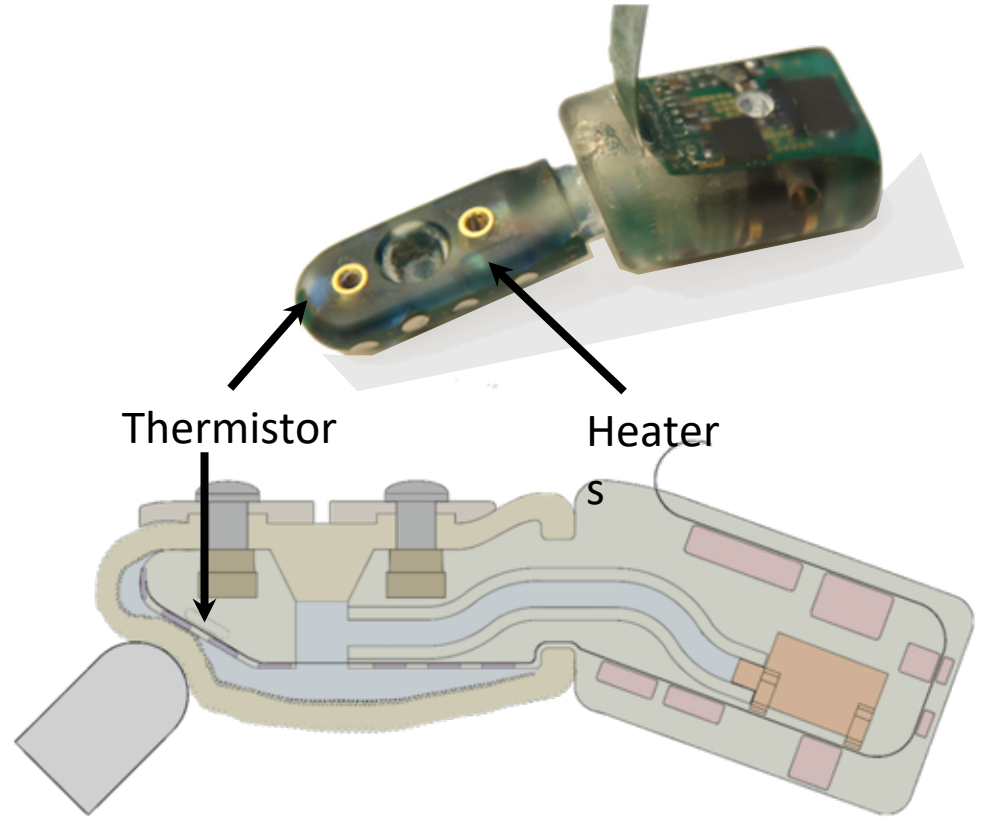
Finger is heated above room temperature

Contacted object draws heat

Temperature (and derivative) are measured

Data can be used to determine:

- Object temperature
- Material's thermal properties

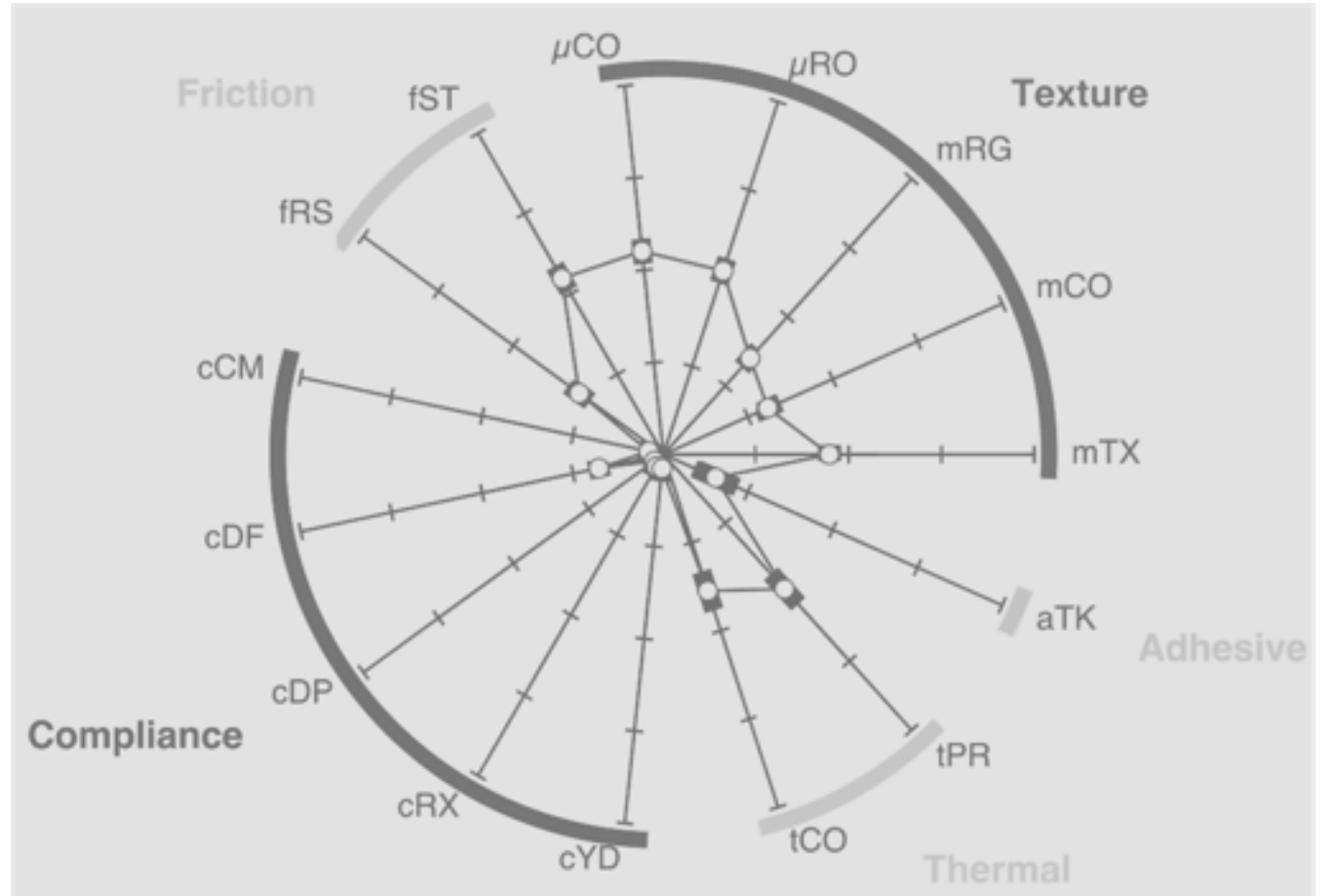


Publications:

Lin et al., ROBIO, 2009

Xu et al., ICRA 2013

OVERALL, IT CAN
QUANTIFY TOUCH
BETTER THAN
HUMANS





WHY IS TOUCH FEEDBACK IMPORTANT IN ROBOTICS?



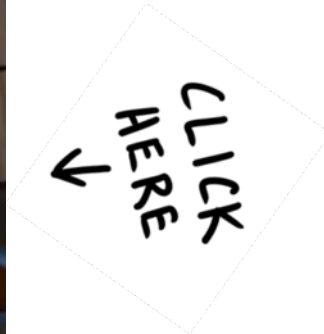
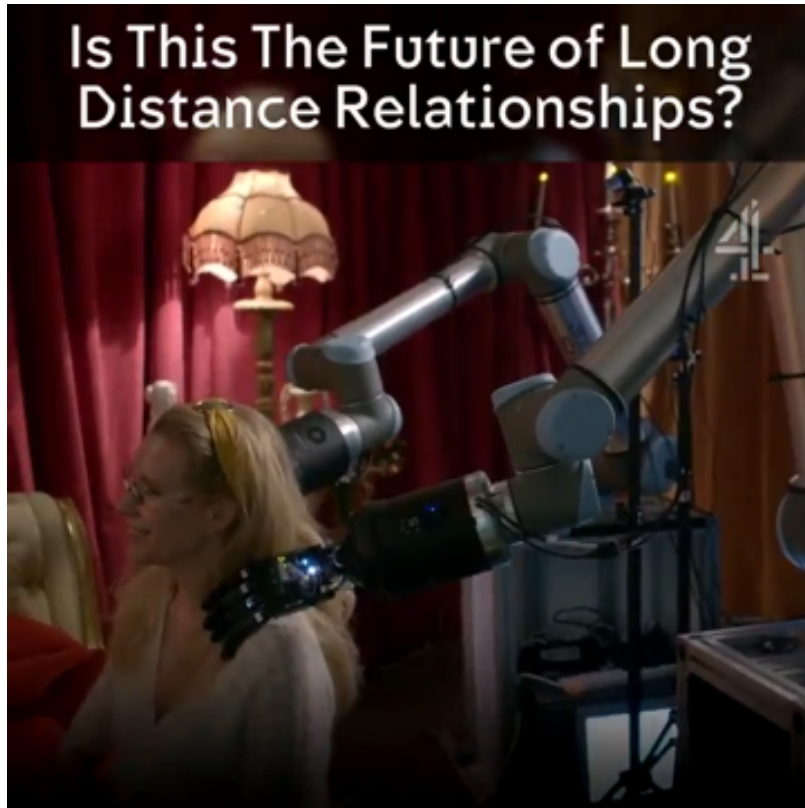
Touch
connects us
with the
world



Channel 4
@Channel4

When you put the love in glove @RonJichardson

#KevinsRoughGuideToTheFuture with @VodafoneUK
continues tonight at 9pm



“People think that technology is pushing people further apart and actually, this [the Tactile Telerobot], is bringing us together”

– Jon Richardson, British Comedian





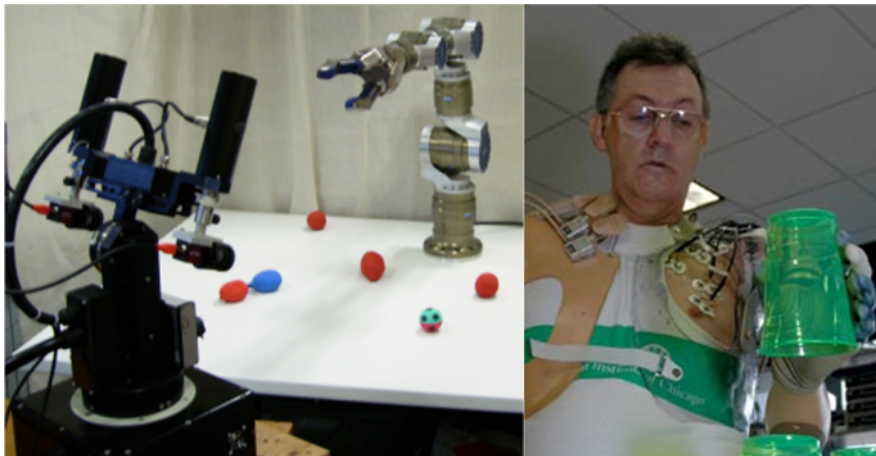
ROBOTIC CAPABILITIES WITHOUT TOUCH

No tactile perception or discrimination of objects

Static contact	Pressure	Lateral motion
 Temperature	 Hardness	 Surface texture
Contour following	Enclosure	Unsupported holding
 Global shape, exact shape	 Global shape, volume	 Weight

Source: Jones, 2006

Vision is necessary to compensate



Aberystwyth University

Jesse Sullivan

Not very dexterous or graceful →



PR2 – Destroys Can, RSS 2011



TOUCH, VISION AND DEXTERITY

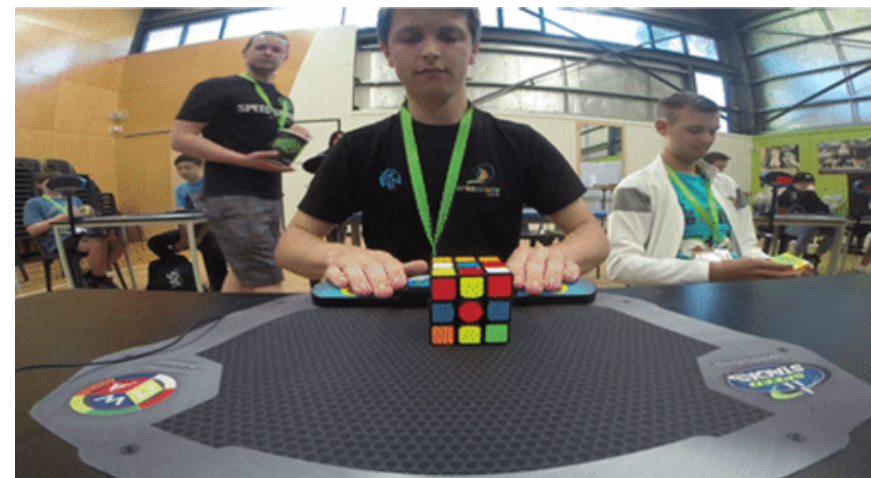
In Fully-Defined Environments:

Robots w/ precision, speed, and optimal planning will always outperform humans.

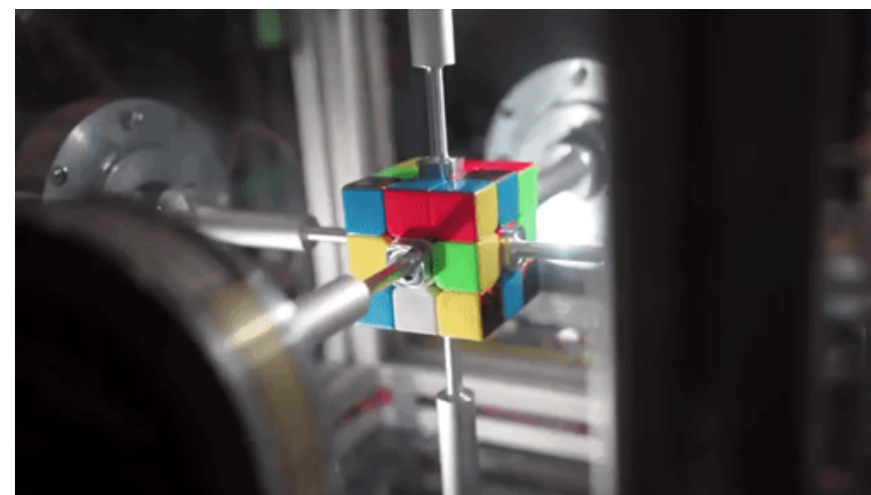
In the Real World (unstructured/unknown):

Vision is very useful for **planning**, but touch is necessary for **dexterity** in manipulation.

Dexterity: The ability to respond intelligently to the unexpected

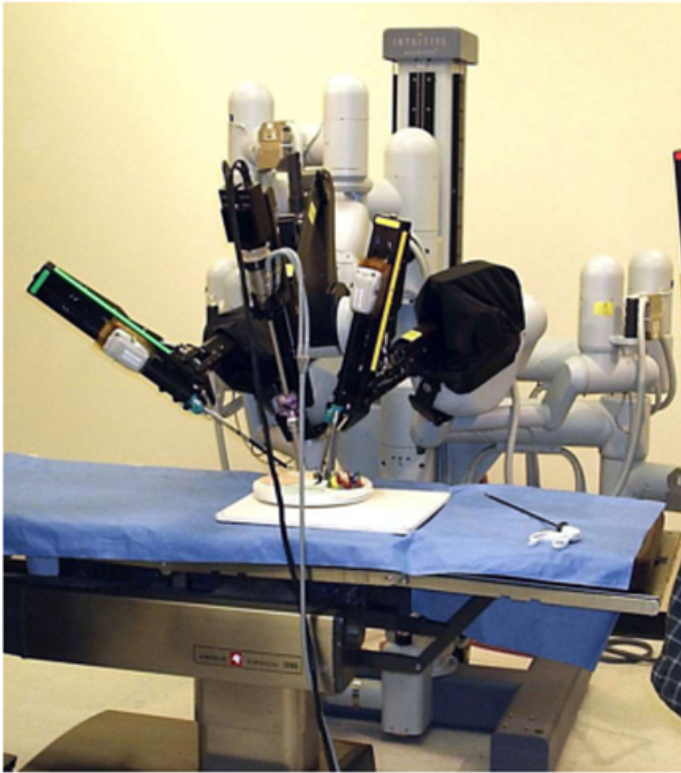


HUMAN: 4.22 SECS



ROBOT: 0.38 SECS

Telerobots Without Touch



Training + Preparation Time + Careful and Slow = Expensive

Telerobots With Touch



Intuitive + Natural

Human intelligence and dexterity infused with robotics

“WEIRDLY NATURAL. THE TACTILE FEEDBACK IS AMAZING!” Jeff Bezos, Founder & CEO of Amazon



HOW CAN ROBOTS WITH TACTILE SENSING HELP IN INDUSTRY APPLICATIONS?

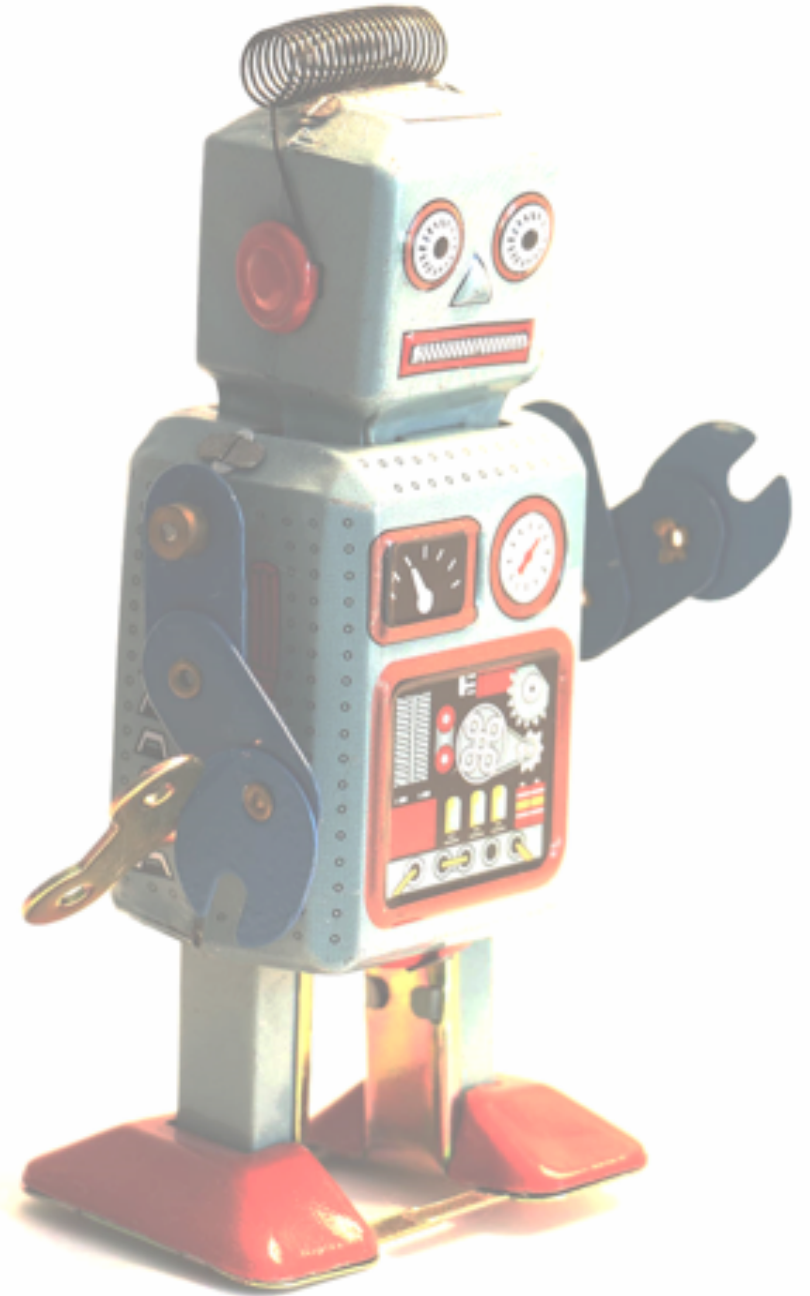
Dirty. Dangerous.
Dull. Inaccessible.

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

SEND A HUMAN



NUCLEAR
DECOMMISSIONING





THE PREMISE: YOUR HANDS. ANYWHERE

Dangerous or Inaccessible Environments

Nuclear, Oil & Gas, Pharma, Deep Sea, Defence, Space etc.

Teleporting Skills

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

Machine Learning

Demonstration/
reinforcement learning
of how to perform tasks

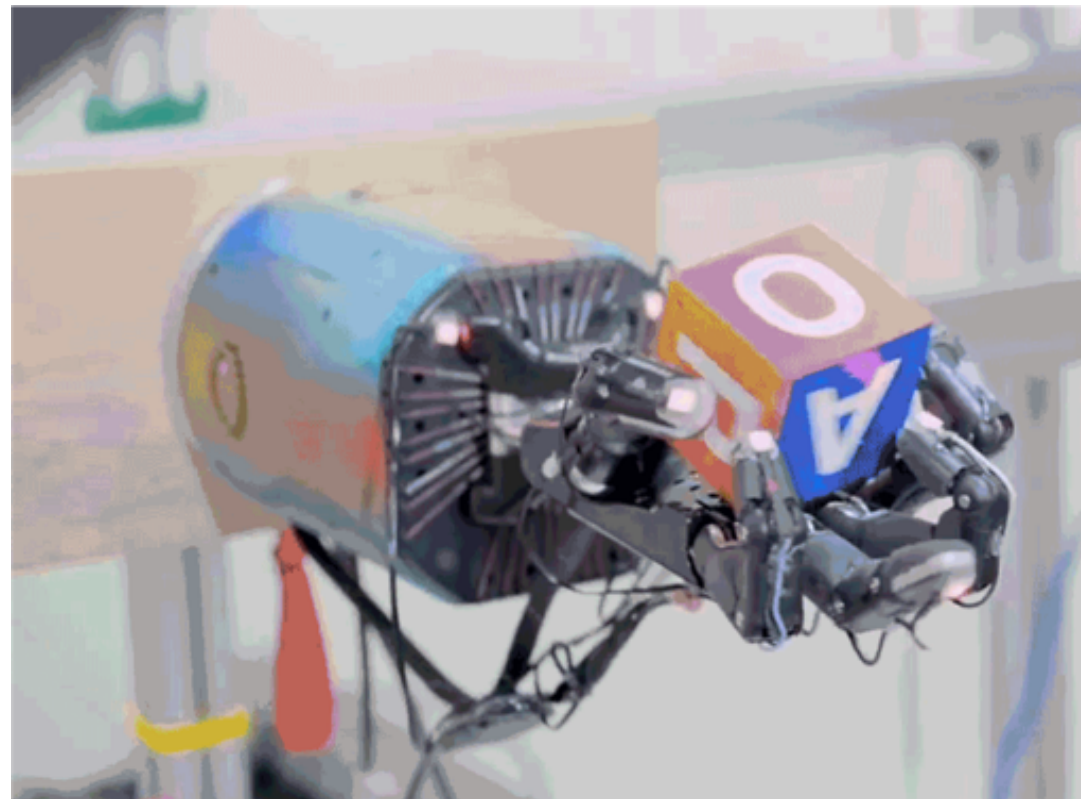
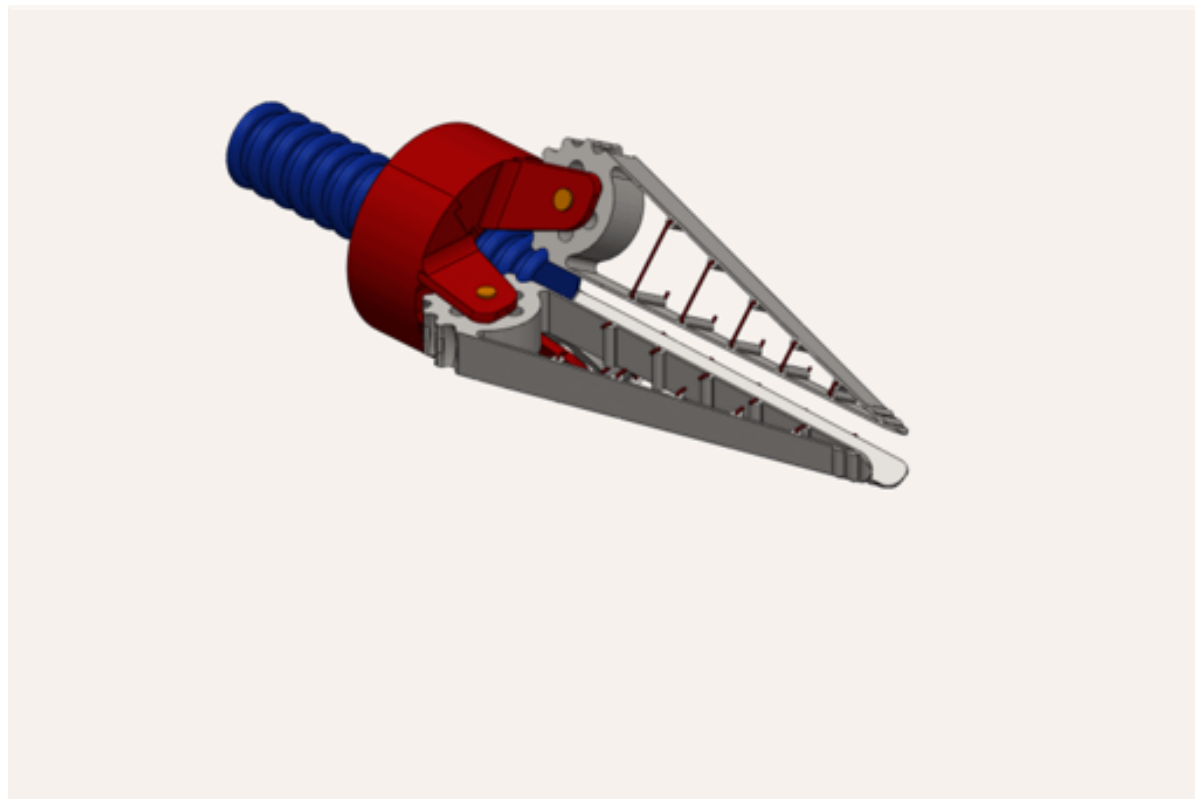
Semi-Autonomy & Efficiency

One person can
control many robots



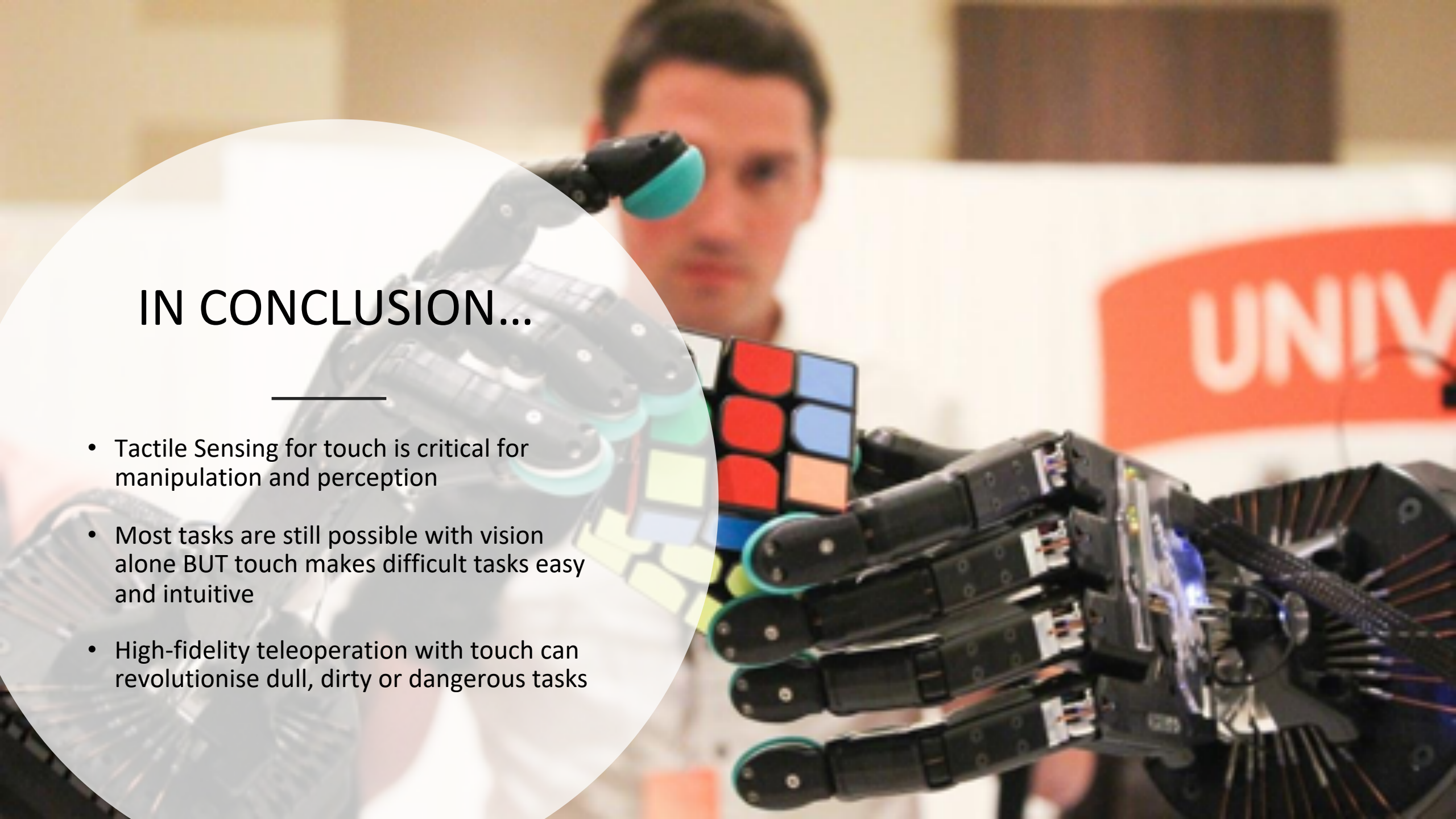


GRIPPERS AREN'T ENOUGH – MOVING TELEROBOTS FORWARDS



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 tasks



GET YOUR HANDS ON IT!

Visit:
WWW.TACTILETELEROBOT.COM





WWW.SHADOWROBOT.COM

+44(0)207 7002487

CONTACT@SHADOWROBOT.CO
M

LONDON (HQ) | MADRID |
BRISTOL | BUDAPEST | SAN
SEBASTIÁN | BOGOTÁ | KRAKÓW

