

# Touch, interaction, and presence in telerobotics

- some challenges from  
the field

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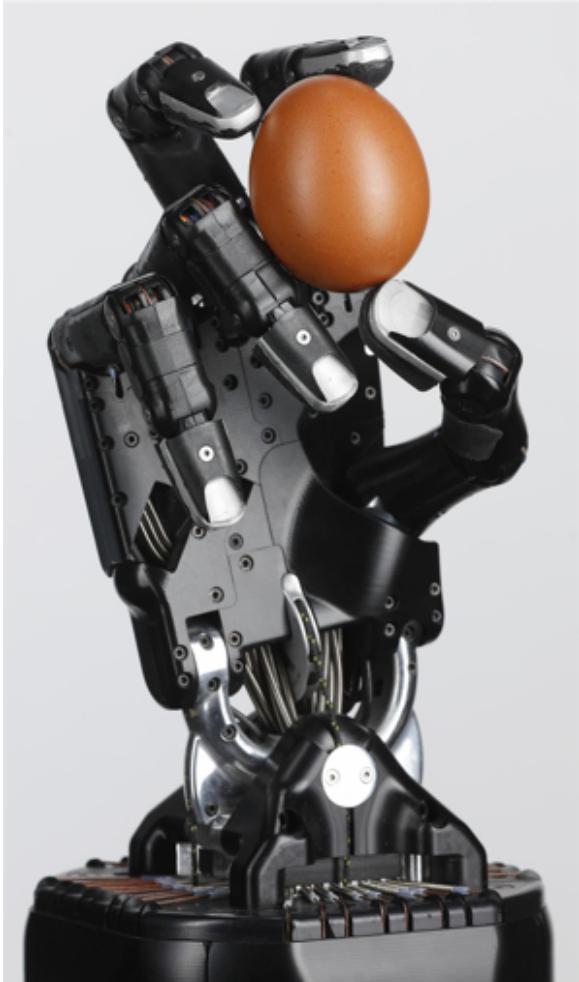
RICH WALKER

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 08:00 AM

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

**WIRED**

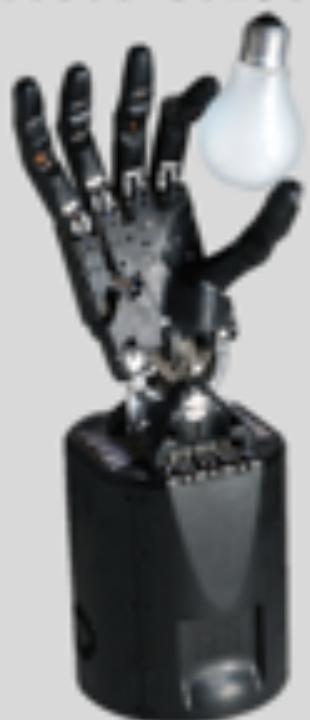
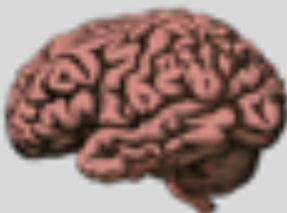
HAPTX

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—*ploink!*—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



Actuators

Sensors

The World



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

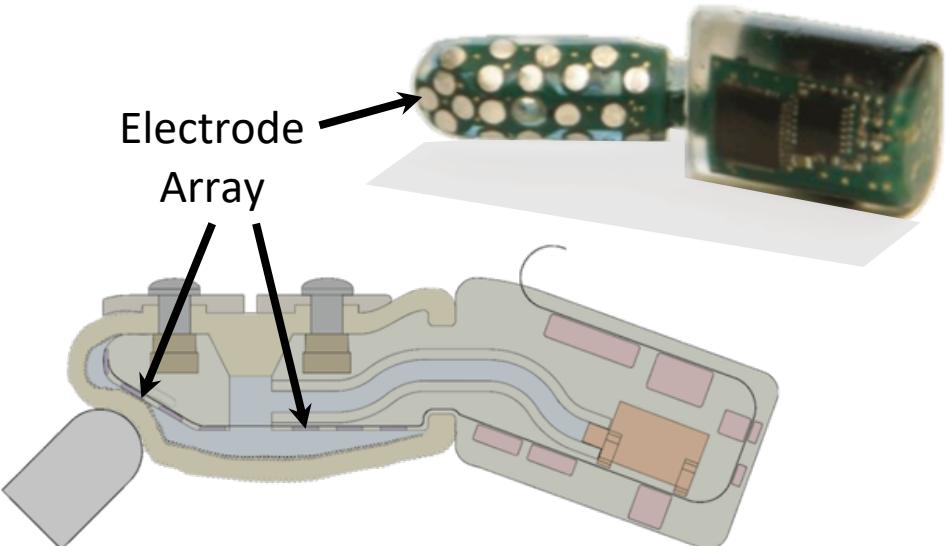
## Publications:

Wettels et al., Advanced Robotics, 2008

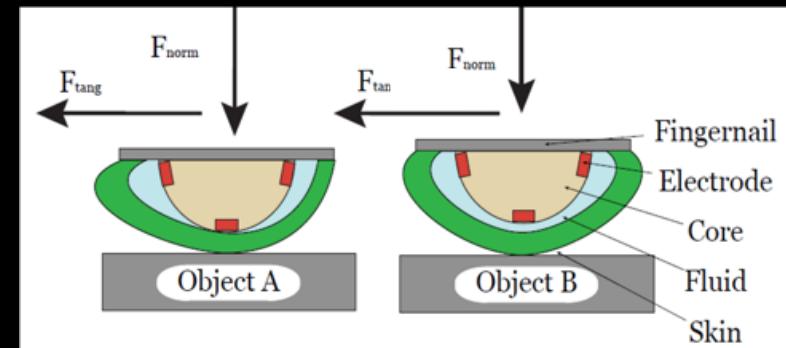
Wettels et al., IEEE BioRob, 2008

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**

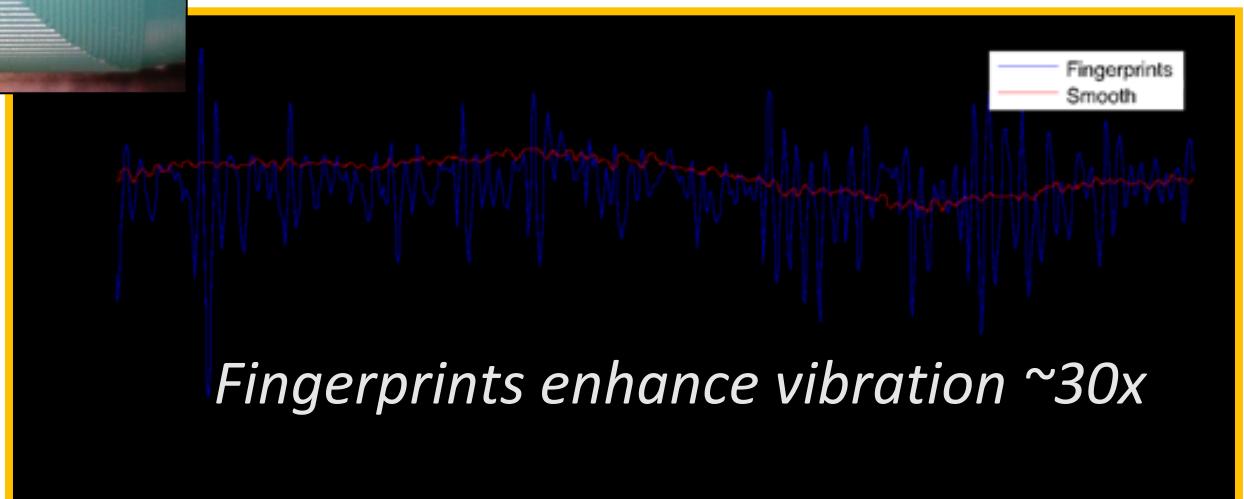
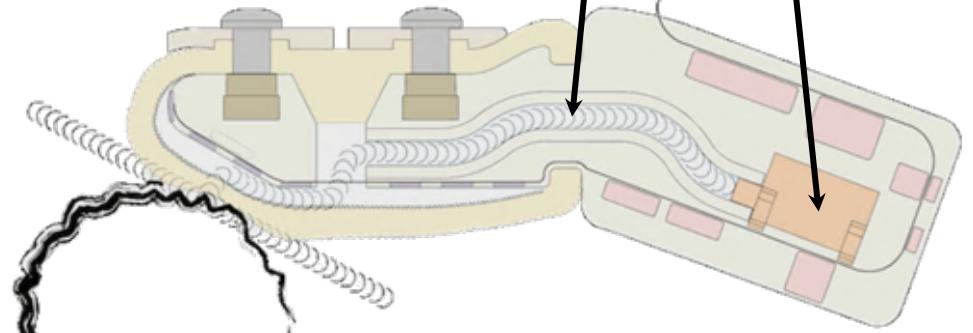
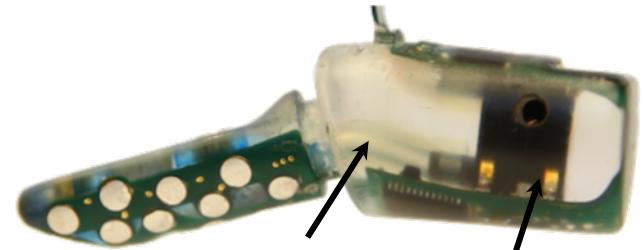
# Vibration Sensing

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

# Temperature Sensing

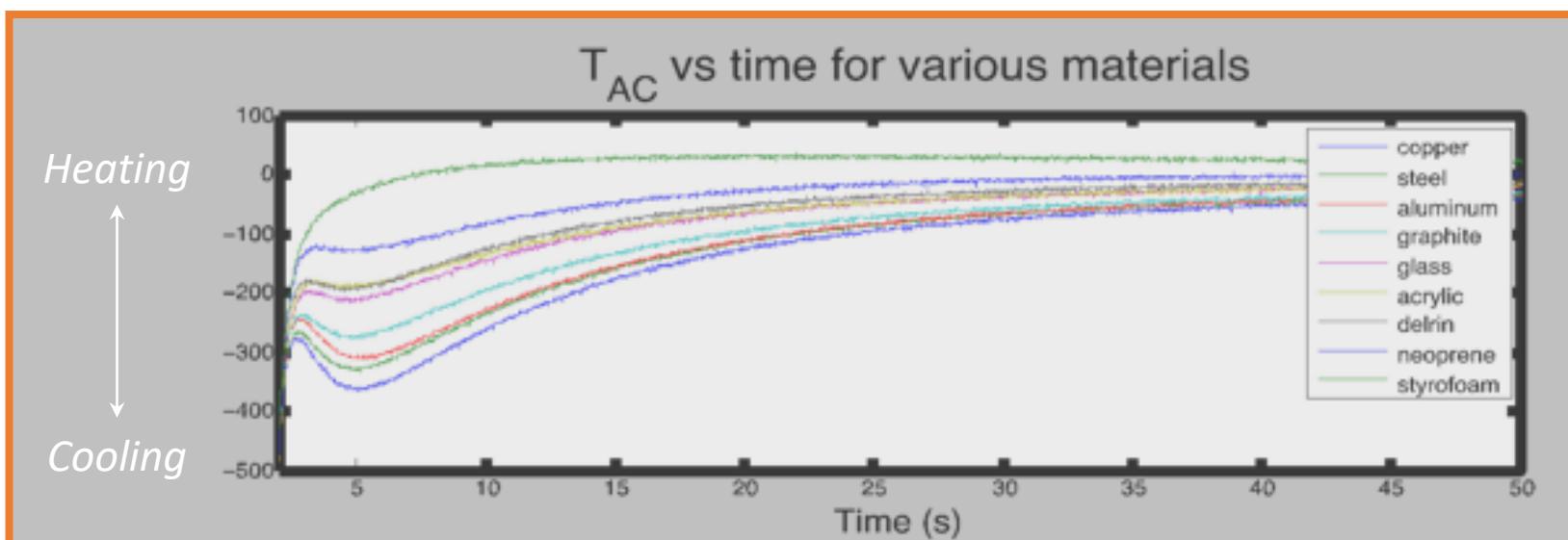
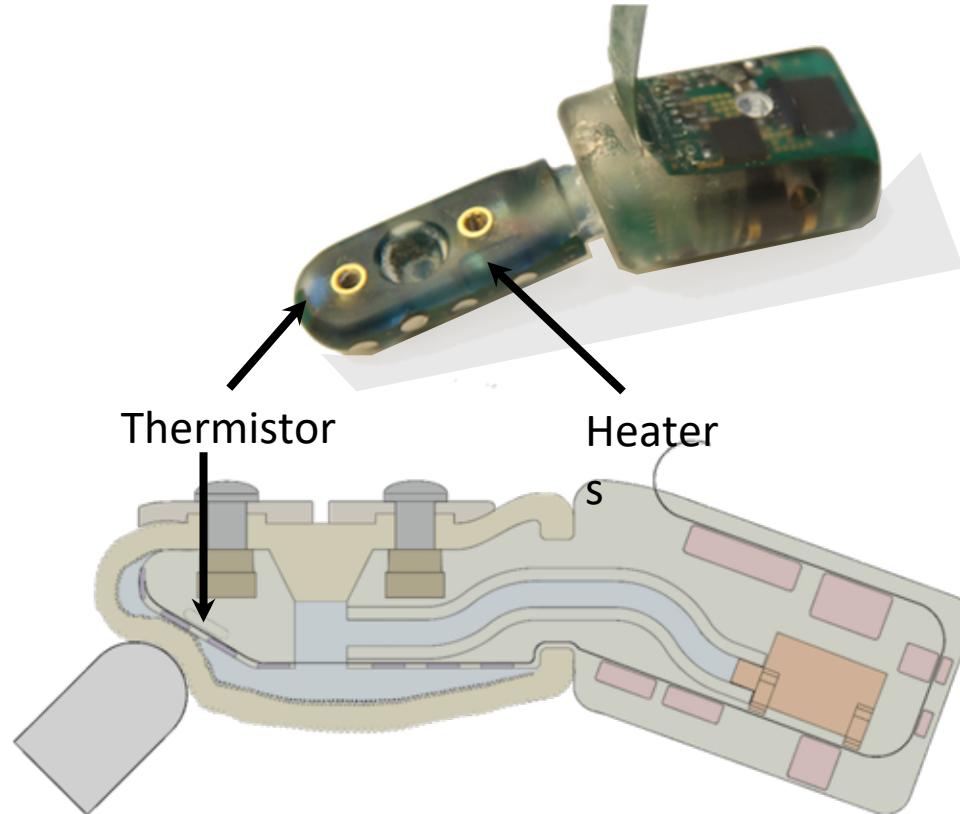
Finger is heated above room temperature

Contacted object draws heat

Temperature (and derivative) are measured

Data can be used to determine:

- Object temperature
- Material's thermal properties

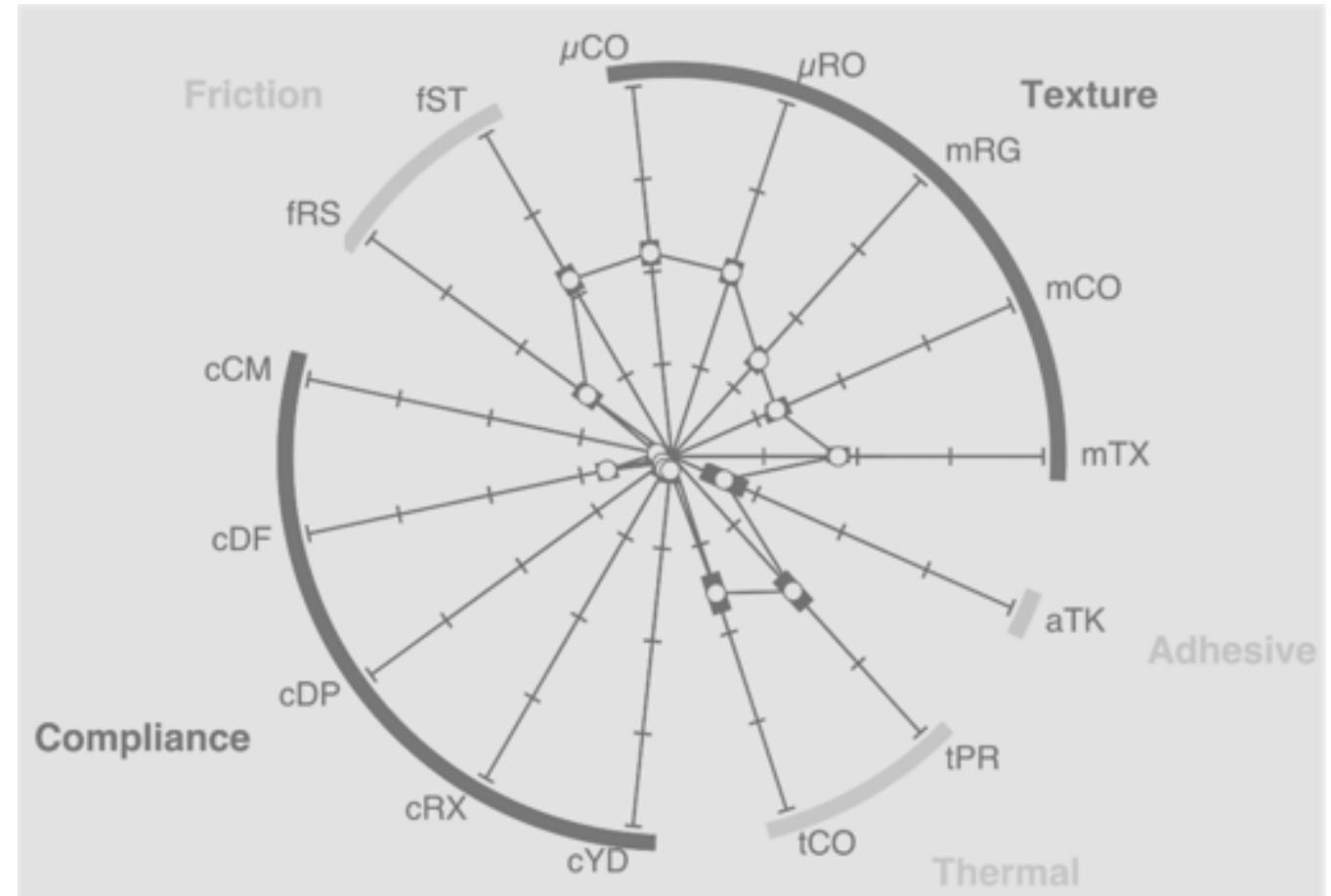


## Publications:

Lin et al., ROBIO, 2009

Xu et al., ICRA 2013

OVERALL, IT CAN  
QUANTIFY TOUCH  
BETTER THAN  
HUMANS





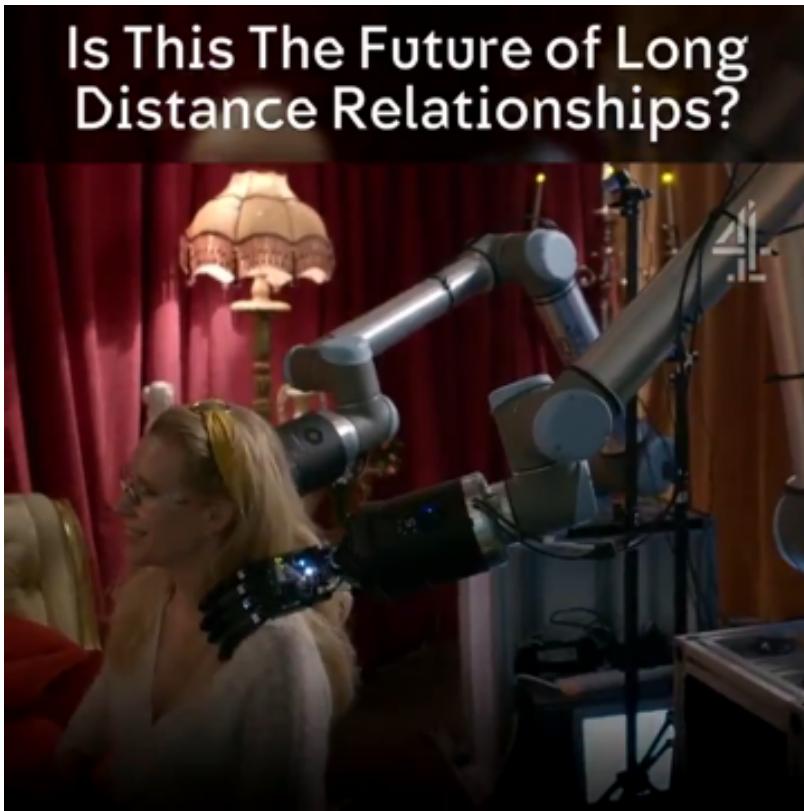
# WHY IS TOUCH FEEDBACK IMPORTANT IN ROBOTICS?

A close-up photograph of two hands clasped together. One hand is dark-skinned and the other is light-skinned, symbolizing diversity and connection. The hands are positioned in the lower half of the frame, with the text 'Touch connects us with the world' placed to the right.

Touch  
connects us  
with the  
world

When you put the love in glove [@RonJichardson](#)

#KevinsRoughGuideToTheFuture with [@VodafoneUK](#)  
continues tonight at 9pm



←  
CLICK  
HERE

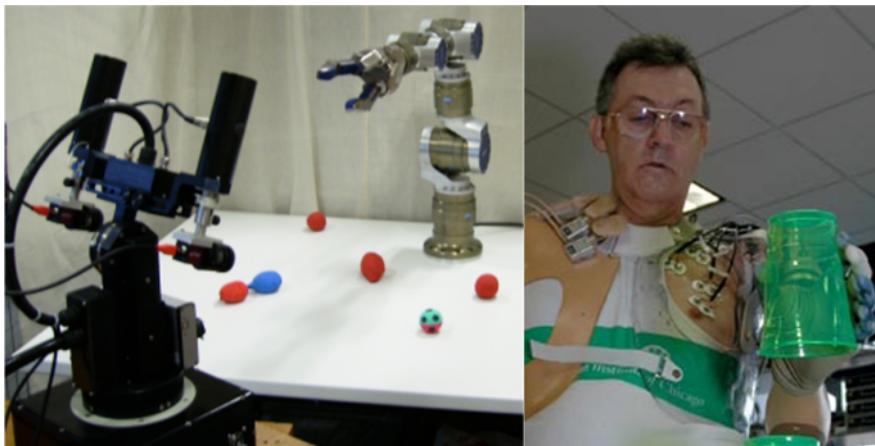
“People think that technology is pushing people further apart and actually, this [the Tactile Telerobot], is bringing us together”

– [Jon Richardson](#), British Comedian



# ROBOTIC CAPABILITIES WITHOUT TOUCH

No tactile perception or discrimination of objects



Vision is necessary to compensate

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

Not very  
dexterous or →  
graceful

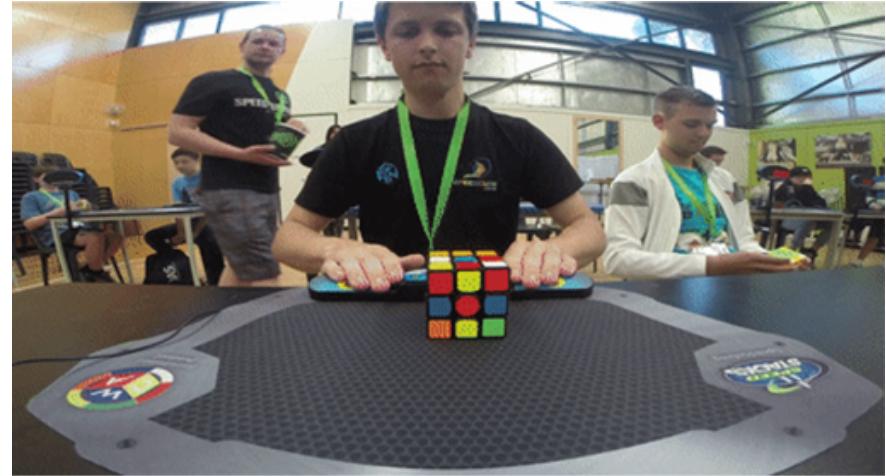


PR2 – Destroys  
Can, RSS 2011

# TOUCH, VISION AND DEXTERITY

## In Fully-Defined Environments:

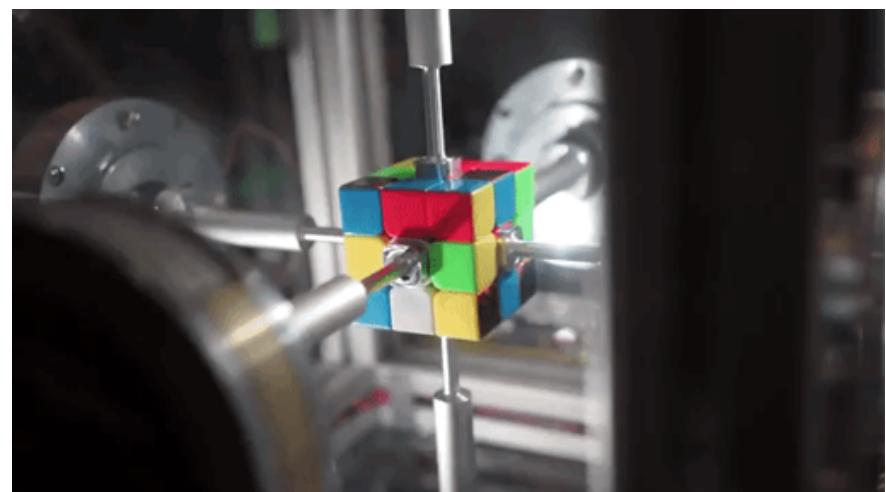
Robots w/ precision, speed, and optimal planning will always outperform humans.



## In the Real World (unstructured/unknown):

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

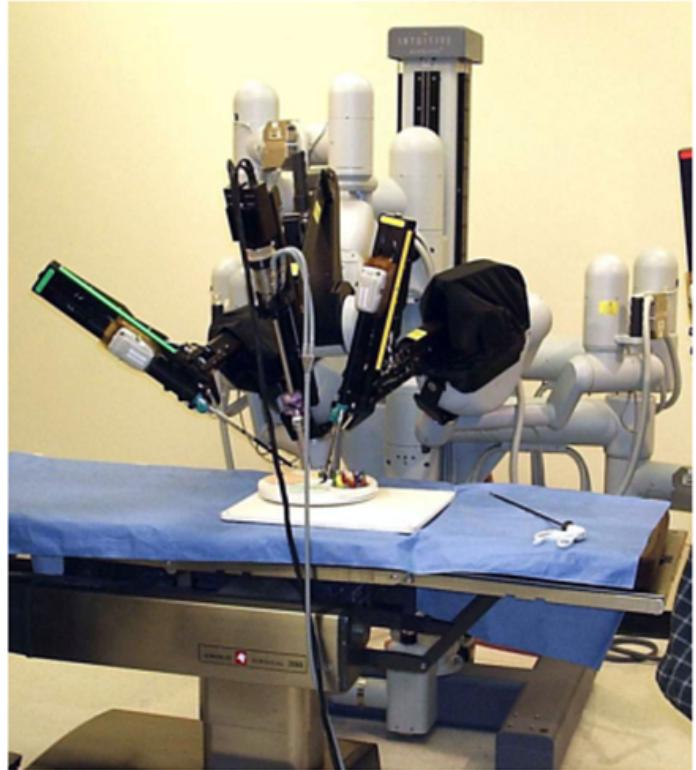
Dexterity: The ability to respond intelligently to the unexpected



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

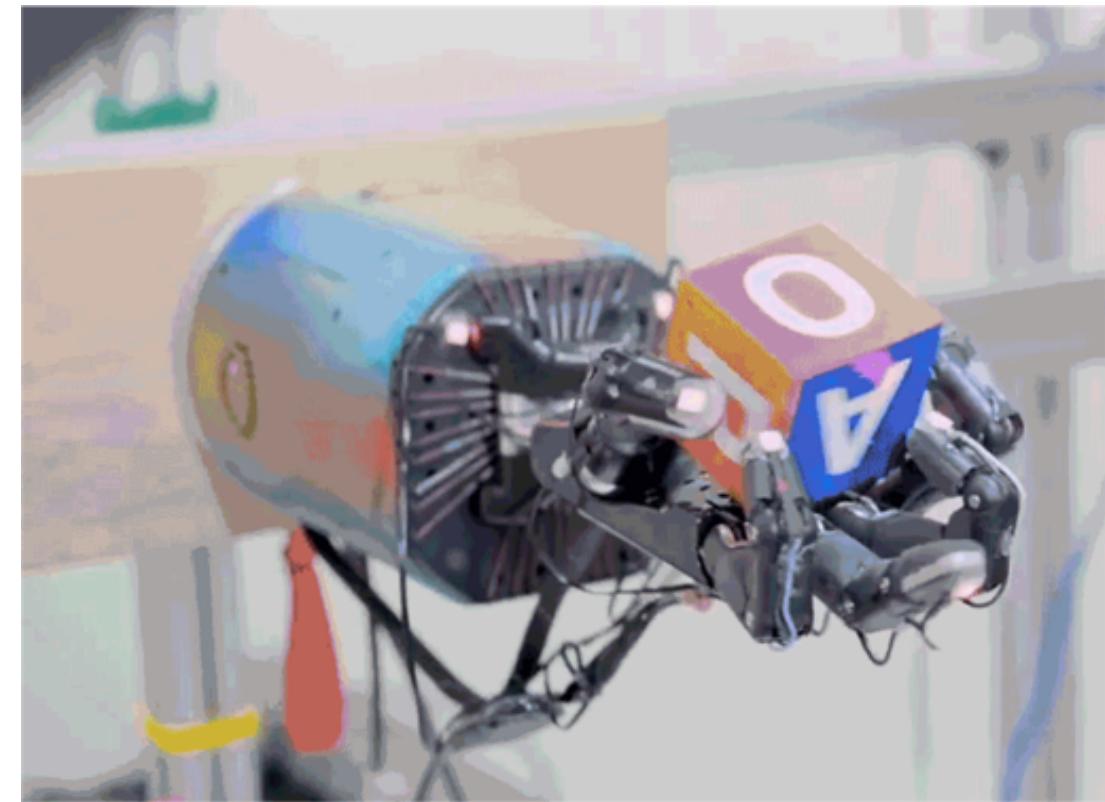
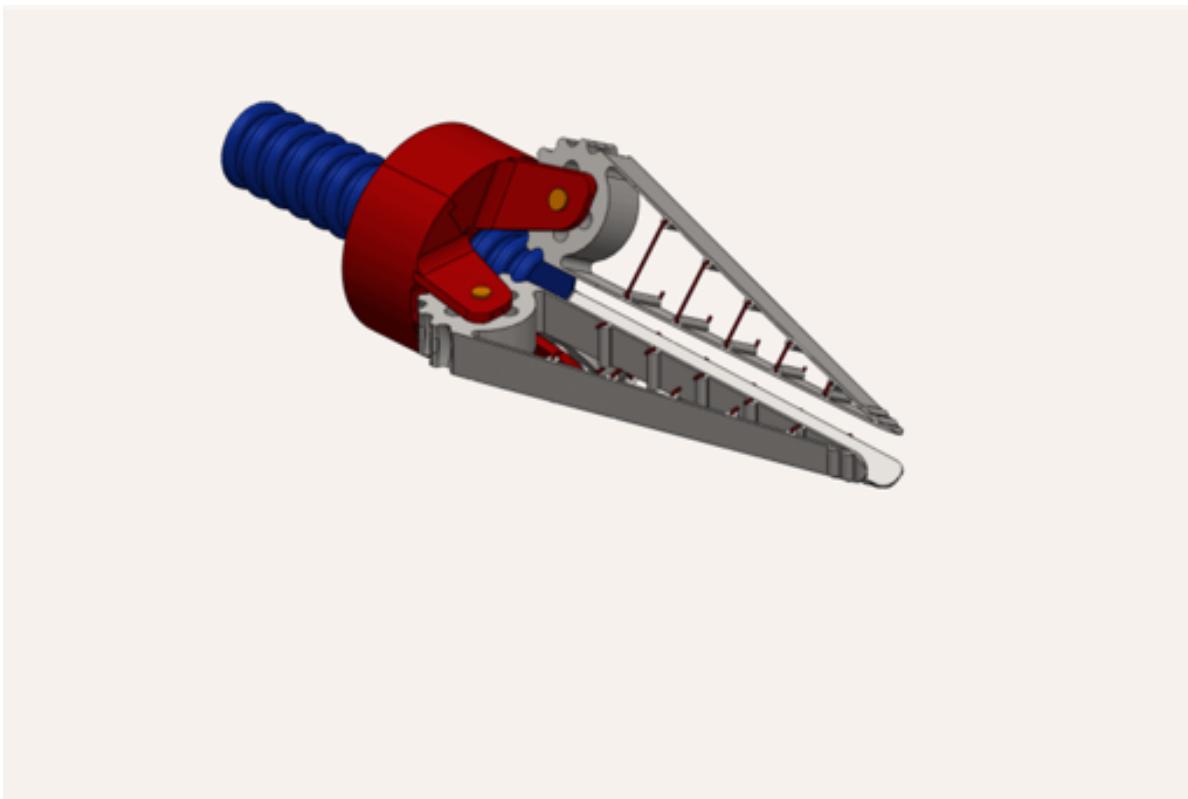
Demonstration/reinforcement learning of how to perform tasks

## Semi-Autonomy & Efficiency

One person can control many robots



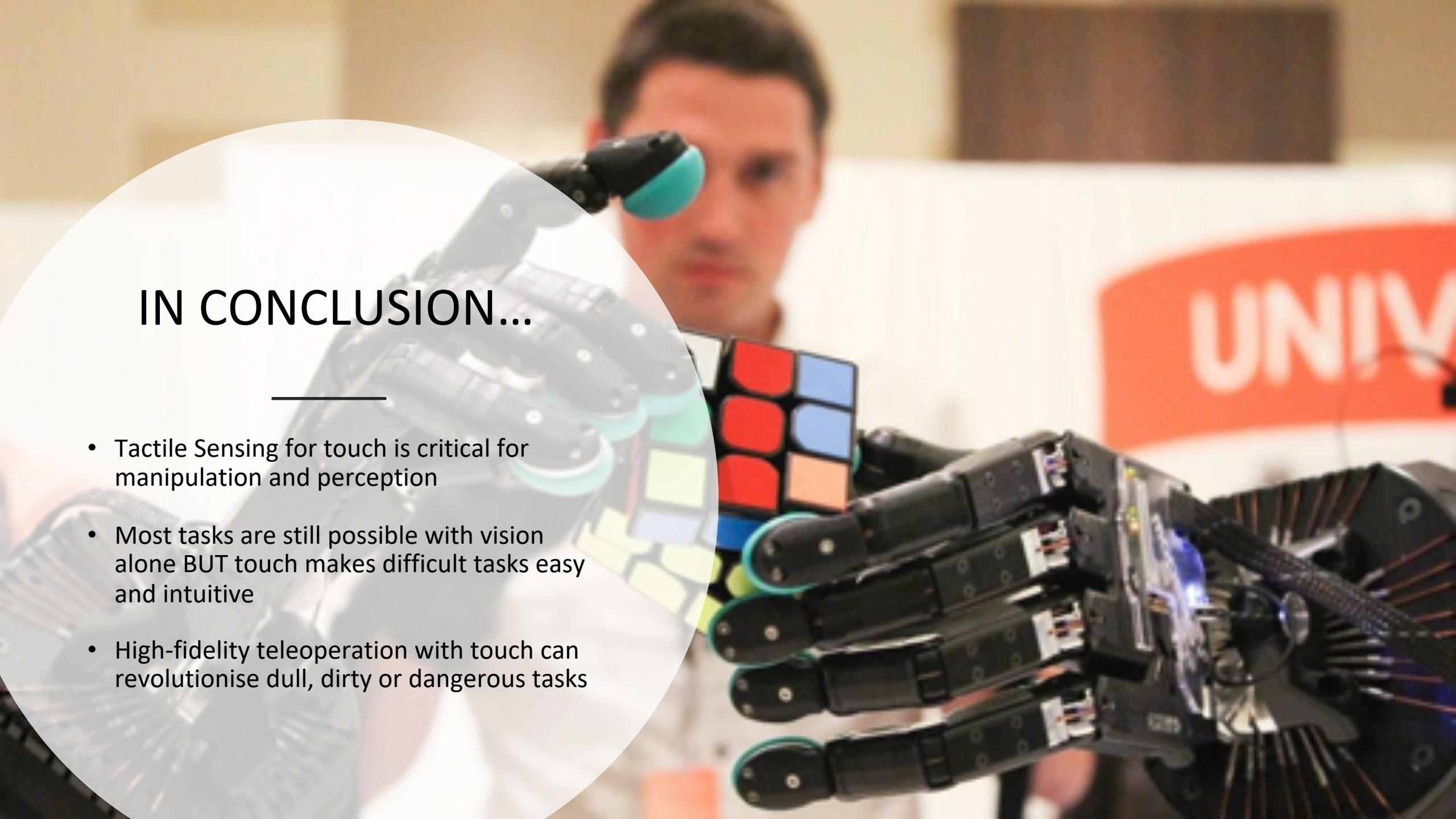
# GRIPPERS AREN'T ENOUGH – MOVING TELEROBOTS FORWARDS



## IN CONCLUSION...

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- 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](http://WWW.TACTILETELEROBOT.COM)





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