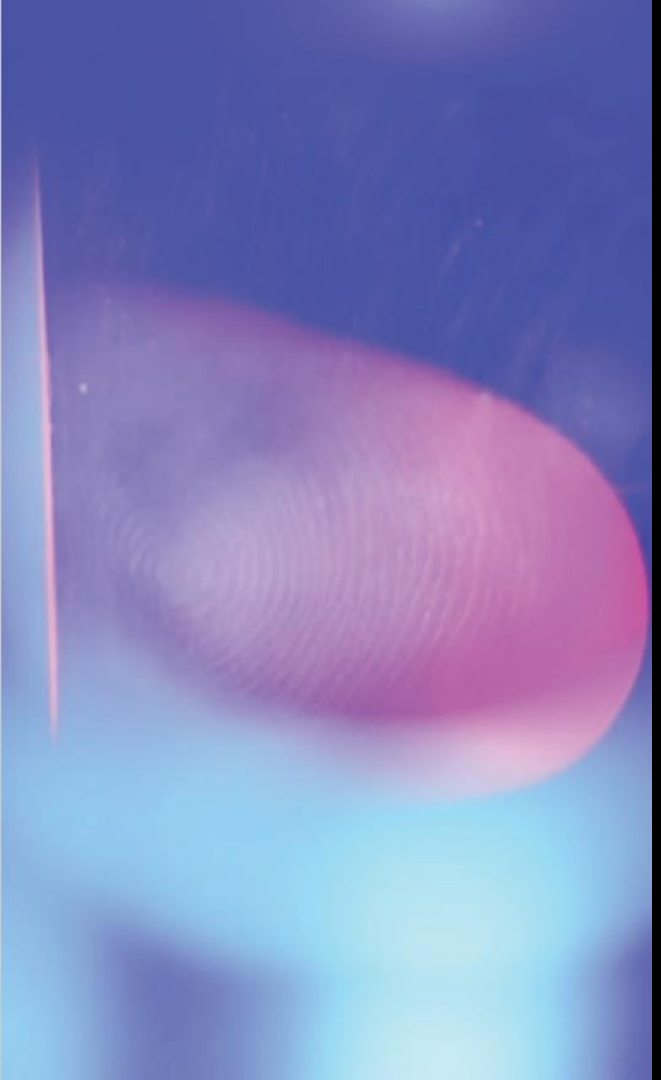

How frictional properties of a surface influence skin deformation on initial contact

Laurence Willemet and Michaël Wiertlewski

CNRS / Aix-Marseille Université, France
TU Delft, The Netherlands

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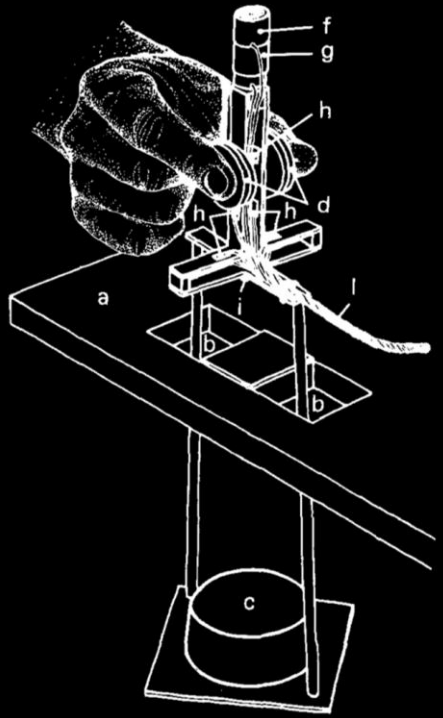
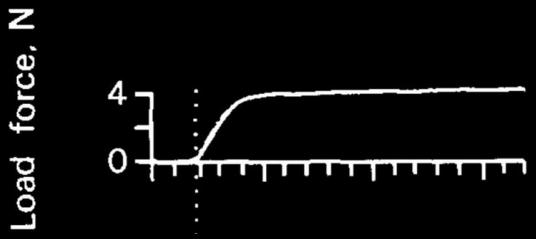
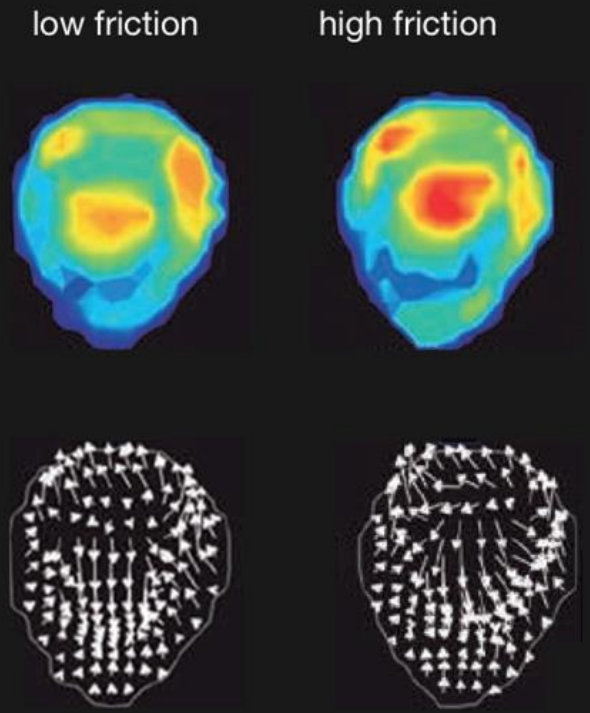
Introduction - Friction influences grip





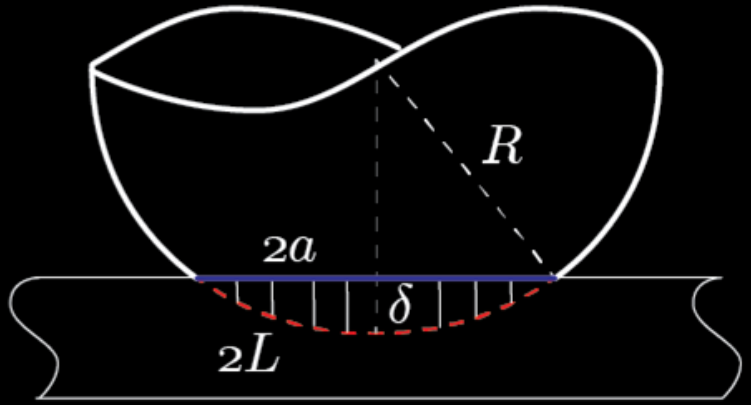
Johansson & Westling 1984

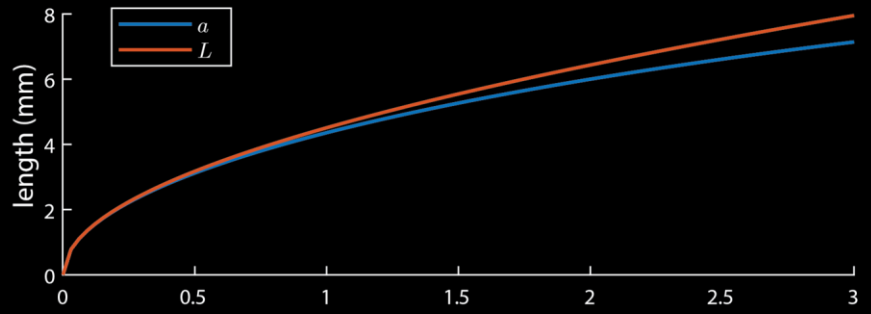
Introduction - Traction field



Johansson & Flanagan 2009

Hypothesis





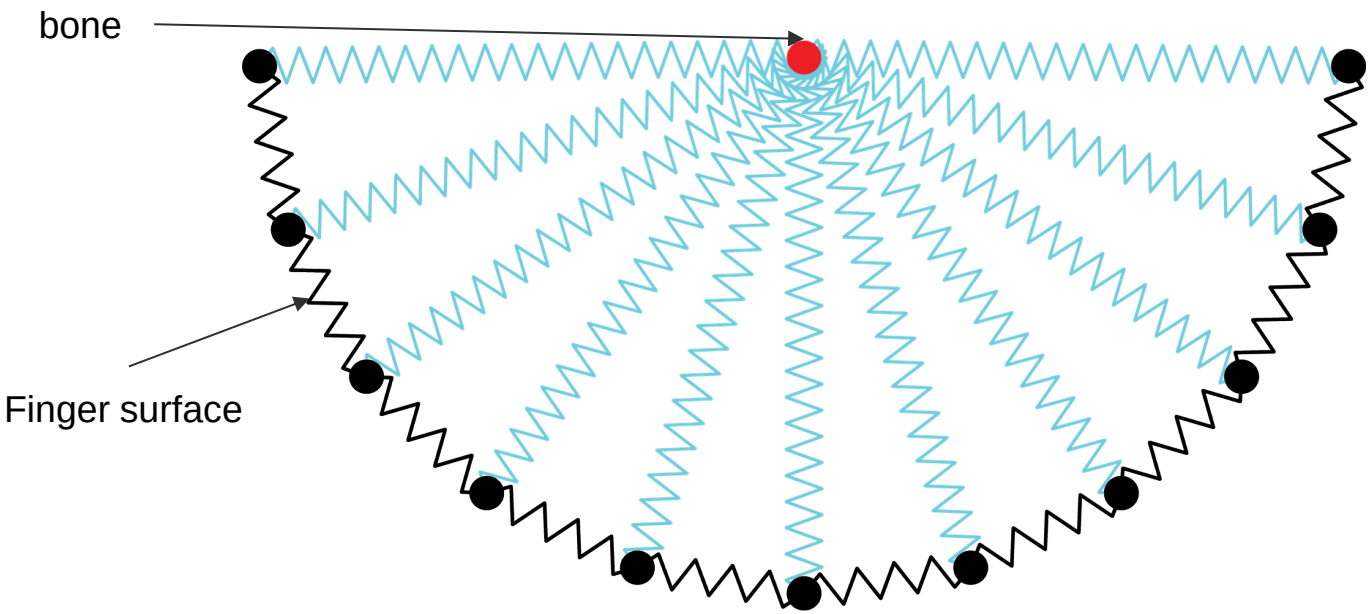
$$L = R \arccos\left(\frac{R-\delta}{R}\right)$$

$$a^2 = \left(R^2 - (R-\delta)^2\right)$$

Research problem

How does the **lateral traction field** develops from a **normal compression** on a high- or low-**friction** surface ?

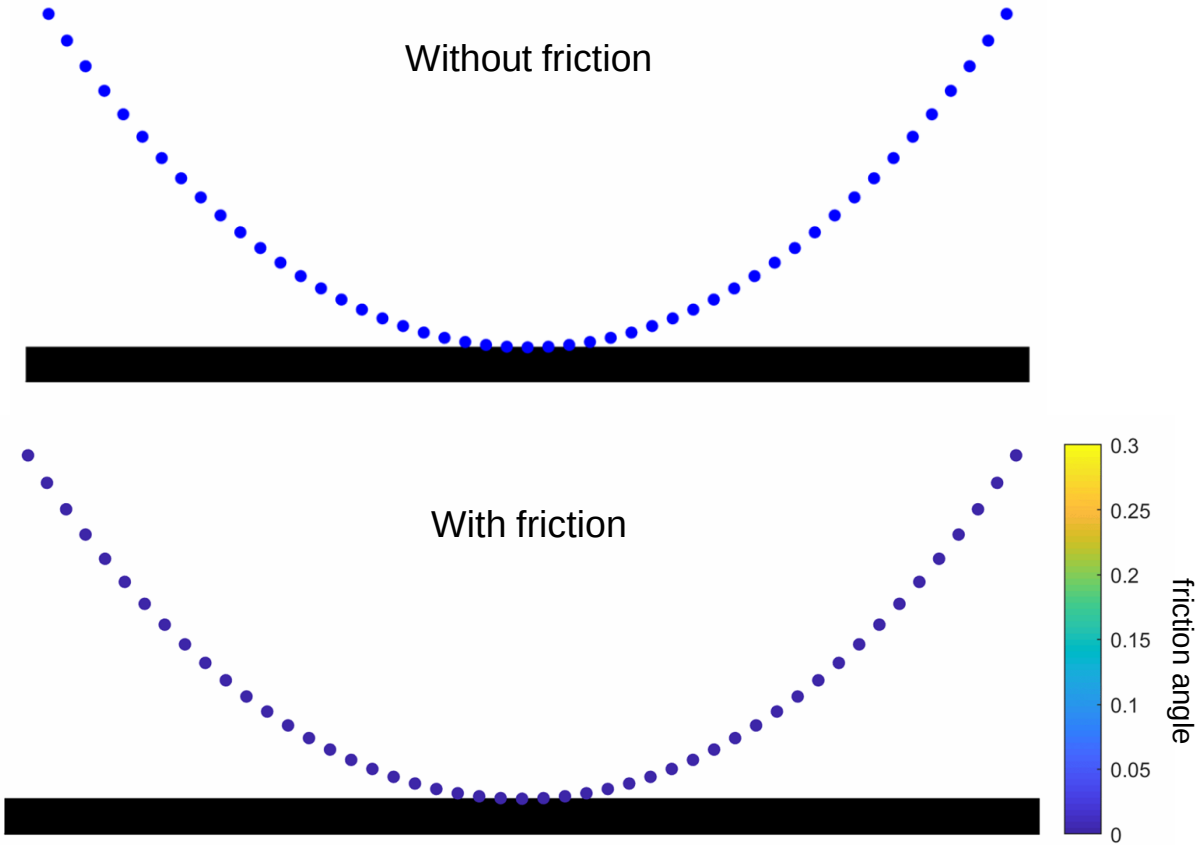
Model of the finger surface - FDTD



$$B\begin{bmatrix}\dot{U}_n\\ \dot{U}_t\end{bmatrix}+K\begin{bmatrix}U_n\\ U_t\end{bmatrix}+\begin{bmatrix}F_n\\ F_t\end{bmatrix}_{ext}=0$$

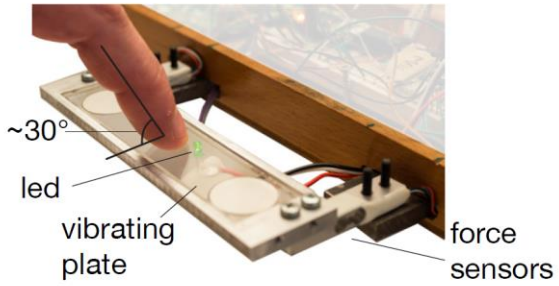
- Normal force: Contact by penalty method
- Tangential force: Friction using Dahl model

Model predictions - Stress profile

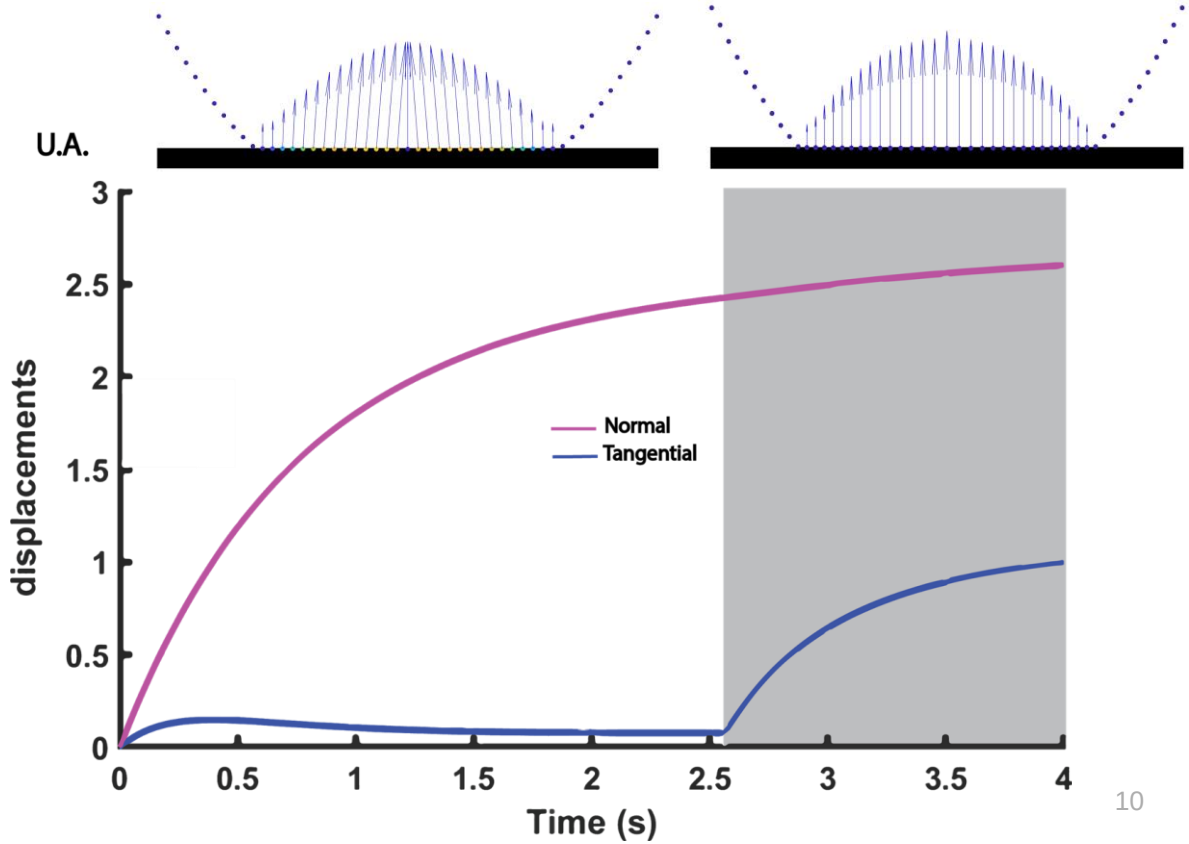


- Consistent with Hertzian contact
- Friction has an effect on elements spacing

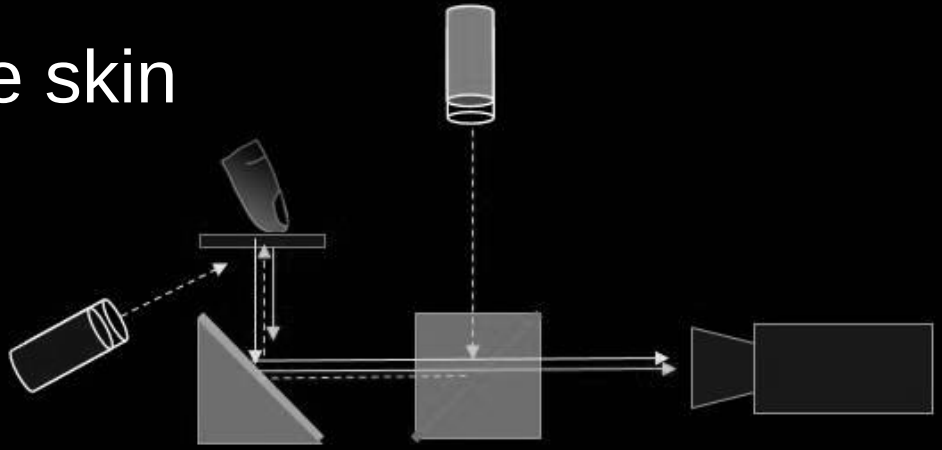
Model predictions - Ultrasonic click

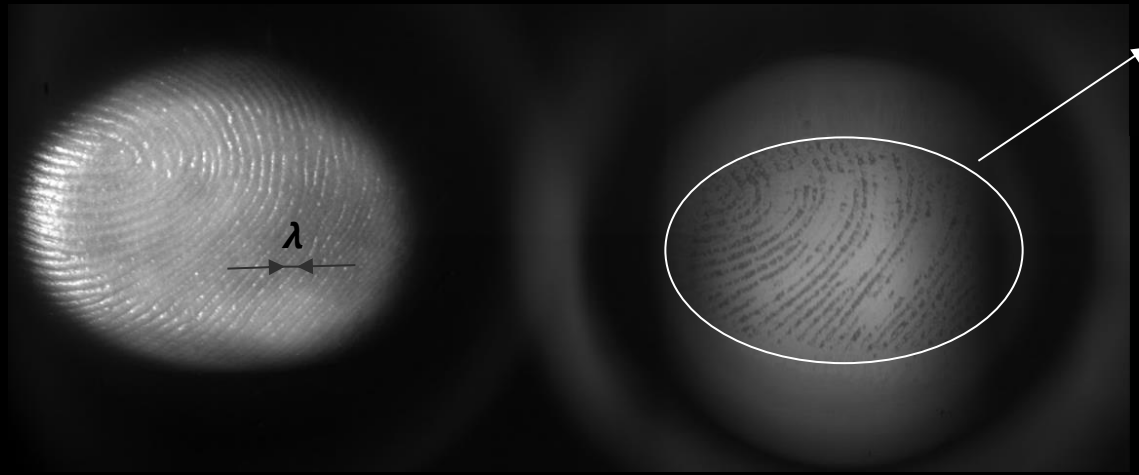


Monnoyer et al. 2016



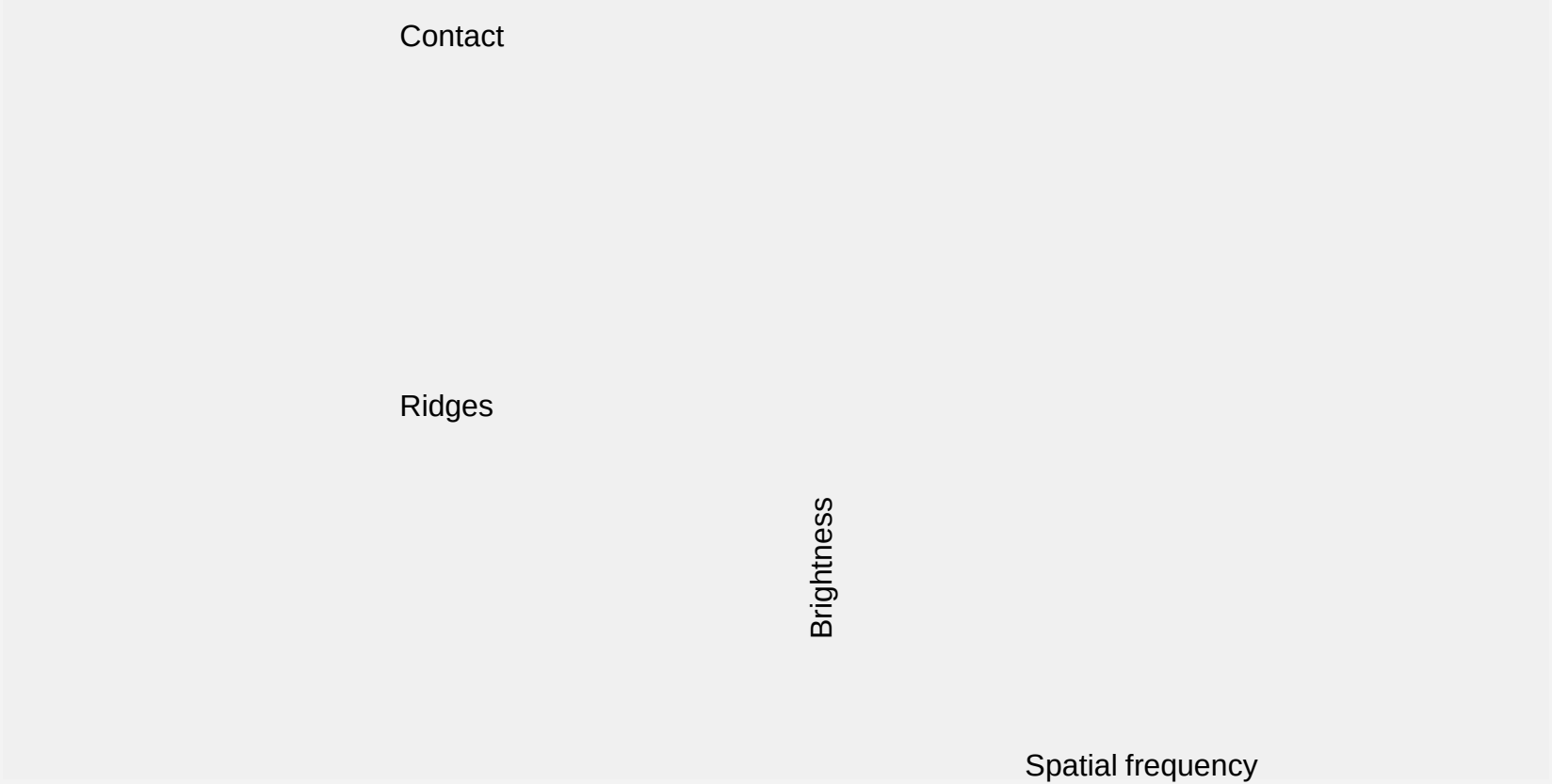
Imaging of the skin



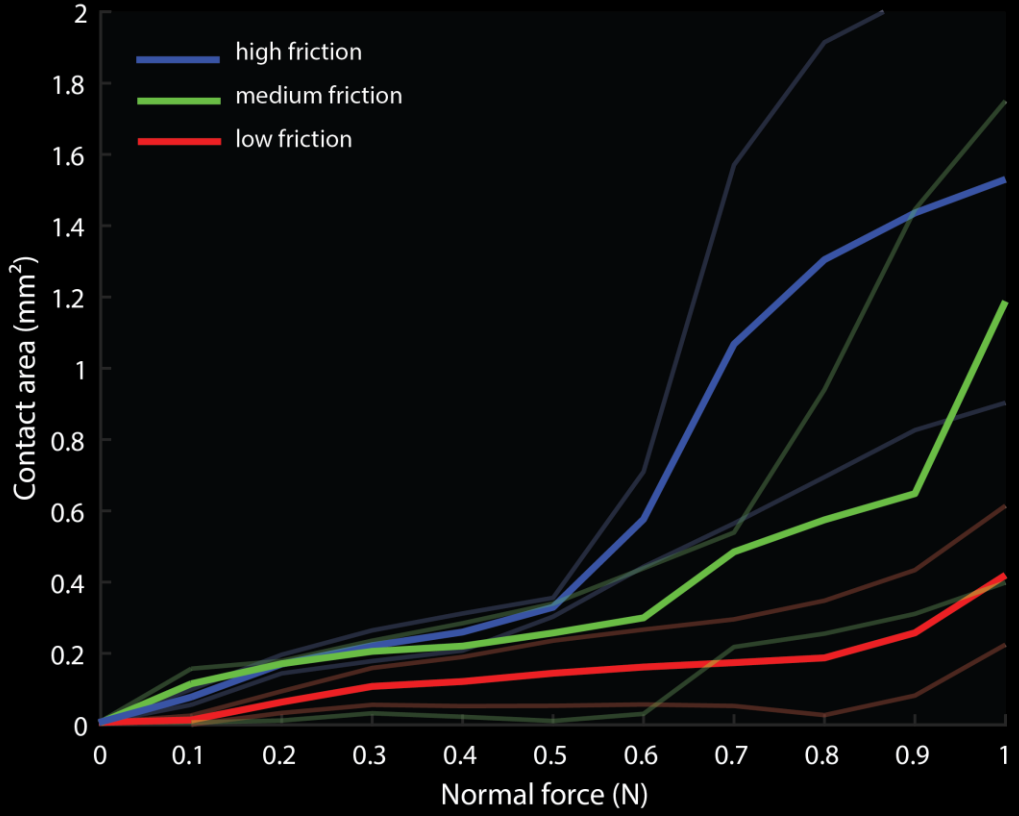


$$Ac = \frac{\sum pixel(I)}{resolution}$$

Imaging of the skin - with friction



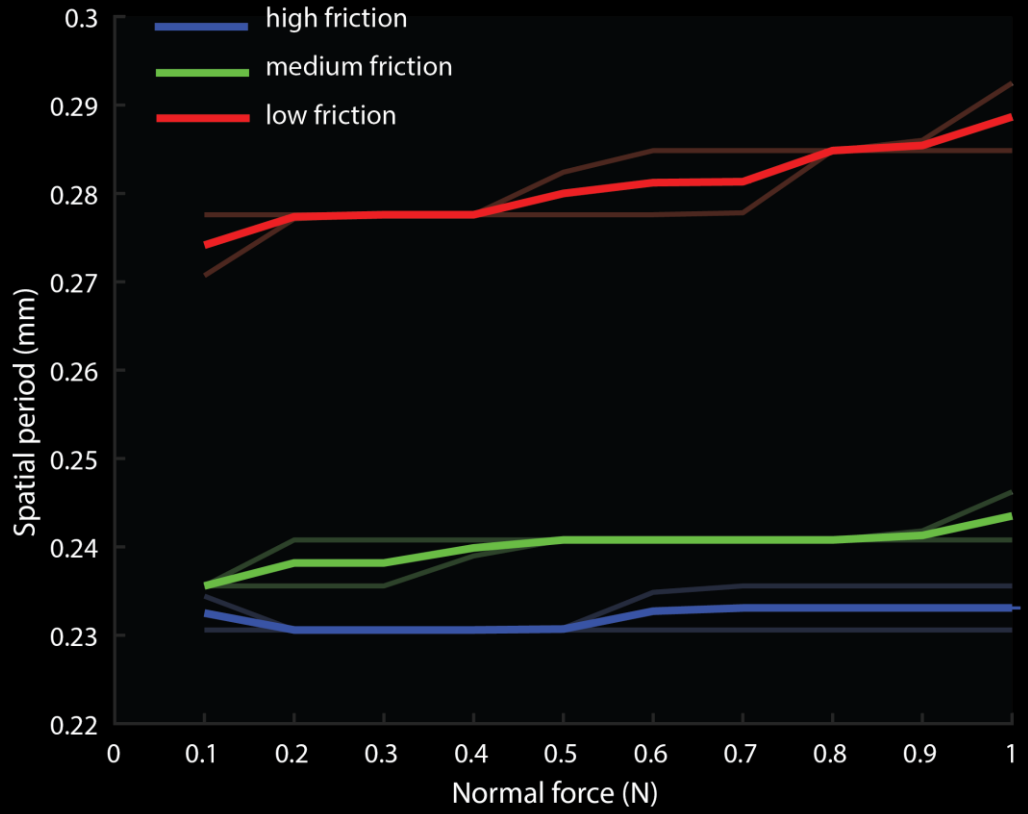
Imaging of the skin - Results



The area of contact increases with the normal force in the 3 conditions.

The higher the friction, the higher contact area for a given normal force.

Imaging of the skin - Results



The higher the friction, the more the skin is compressed

Lateral strain reaches 20%.

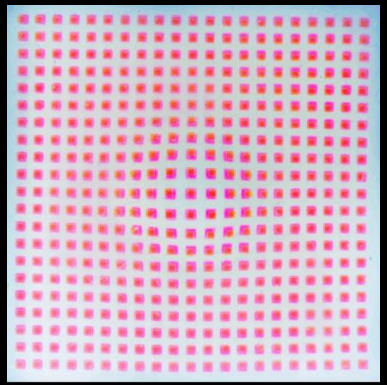
Conclusion & Discussion

- Force is not a necessary cue for sensing friction

- The brain likely uses cues from the radial stretch distribution (see Prof. Birznieks' talk)

- Applications in surface haptics and in robotics

- Currently exploring the link with psychophysics



Lin et al., 2018

Acknowledgements

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cnrs

TU Delft Delft University of Technology

Thank you for your attention !

WIP 1 P.29

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