« EMR-based human-in-the-loop of tactile devices »

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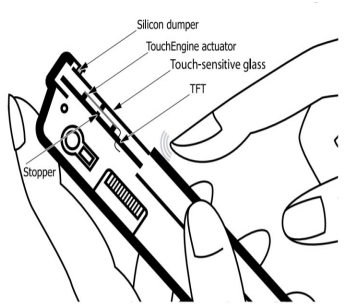
- Outline -

1. **The purpose of tactile feedback**
2. **Design and control of tactile feedback devices in L2EP/IRCICA**
3. **Human in the loop**
4. **Conclusions and look ahead**
5. **Biographies and references**

The purpose of tactile feedback

Haptic feedback: how to create physical feelings to a human user from a mechatronic device

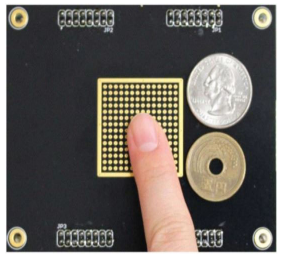
Example: the vibration of a mobile phone

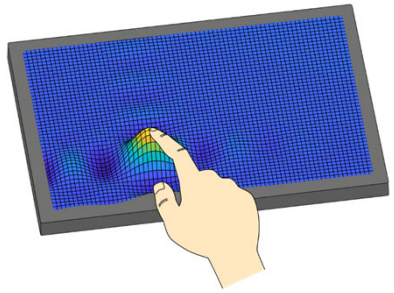


[Poupyrev_2003]

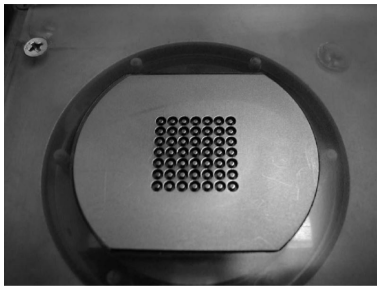
Tactile feedback: how to create physical feelings under the finger pulp

Electrode array [Kajimoto_2011]





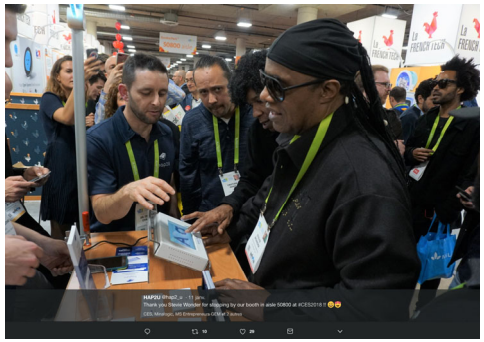
Time reversal control [Hudin_2014]



Tunable pin array [Shinogara_1998]

The purpose of tactile feedback

What for? -to help visually impaired people

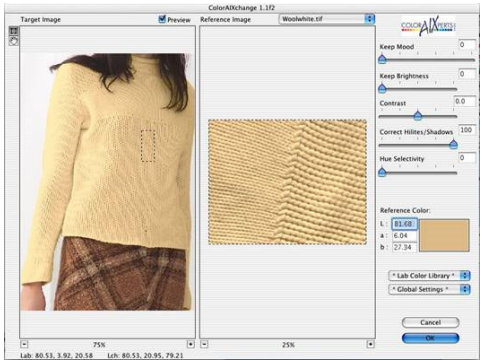


-to increase immersion in virtual environment

-to lower the cognitive charge (for drivers for example)

-for e-trade

-…….

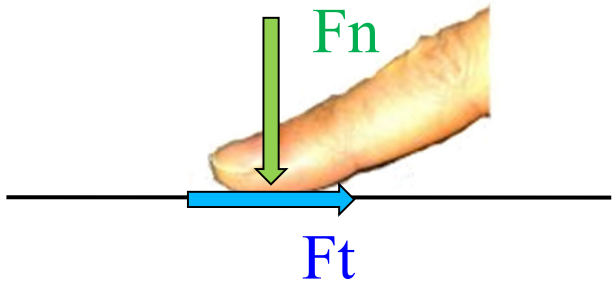


« 2. Design and control of tactile feedback devices in L2EP/IRCICA »

To tune the friction coefficient between a surface and the finger pulp

When sliding on a surface, the finger is subjective to a friction force:

$Ft=\mu*Fn$

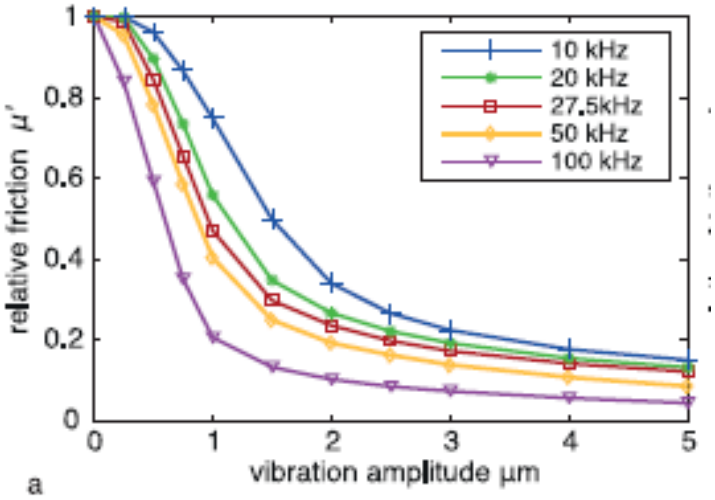


To tune the friction coefficient between a surface and the finger pulp

When sliding on a vibrating surface, the friction coefficient is reduced

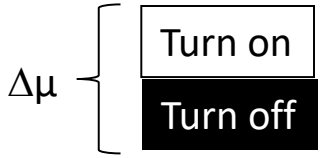
$$Ft=\mu(W)*Fn$$

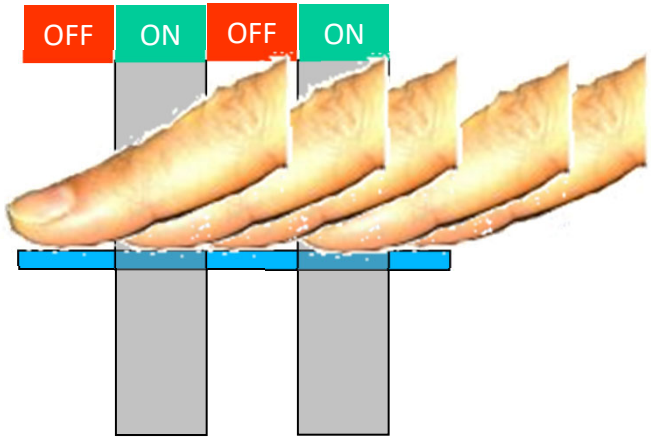
$$\mu'=\mu(W)/\mu_0$$



To tune the friction coefficient between a surface and the finger pulp

When tuning the vibration amplitude as a function of the finger position, we create textures

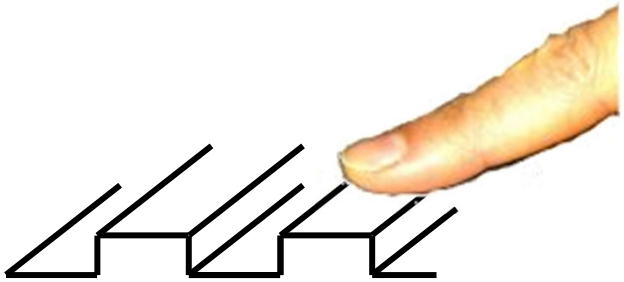




To tune the friction coefficient between a surface and the finger pulp

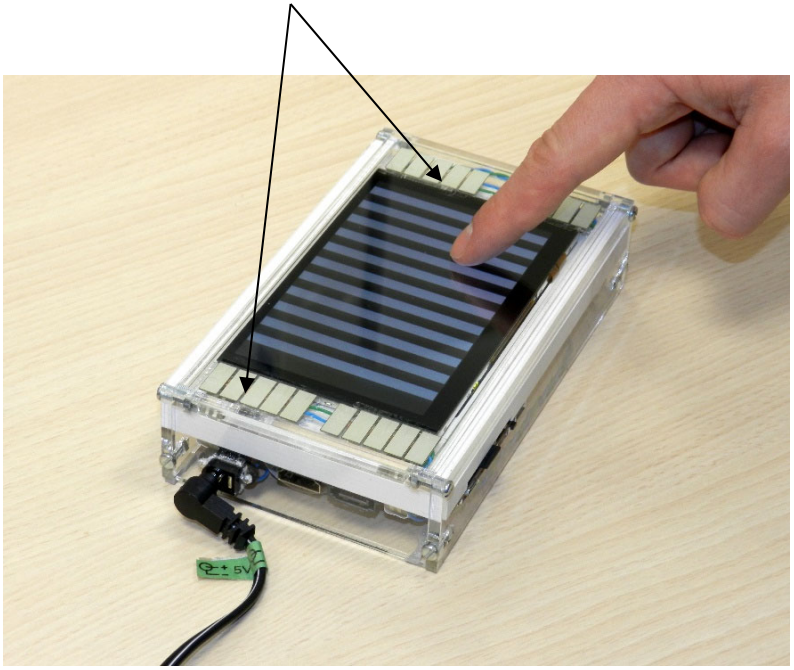
When tuning the vibration amplitude as a function of the finger position, we create textures

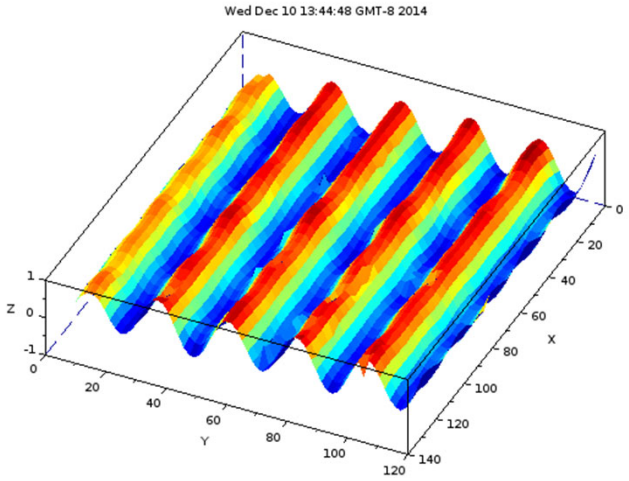
$\Delta\mu$ { Turn on / Turn off }



How to make the surface vibrate?

Thanks to piezo-electric actuators

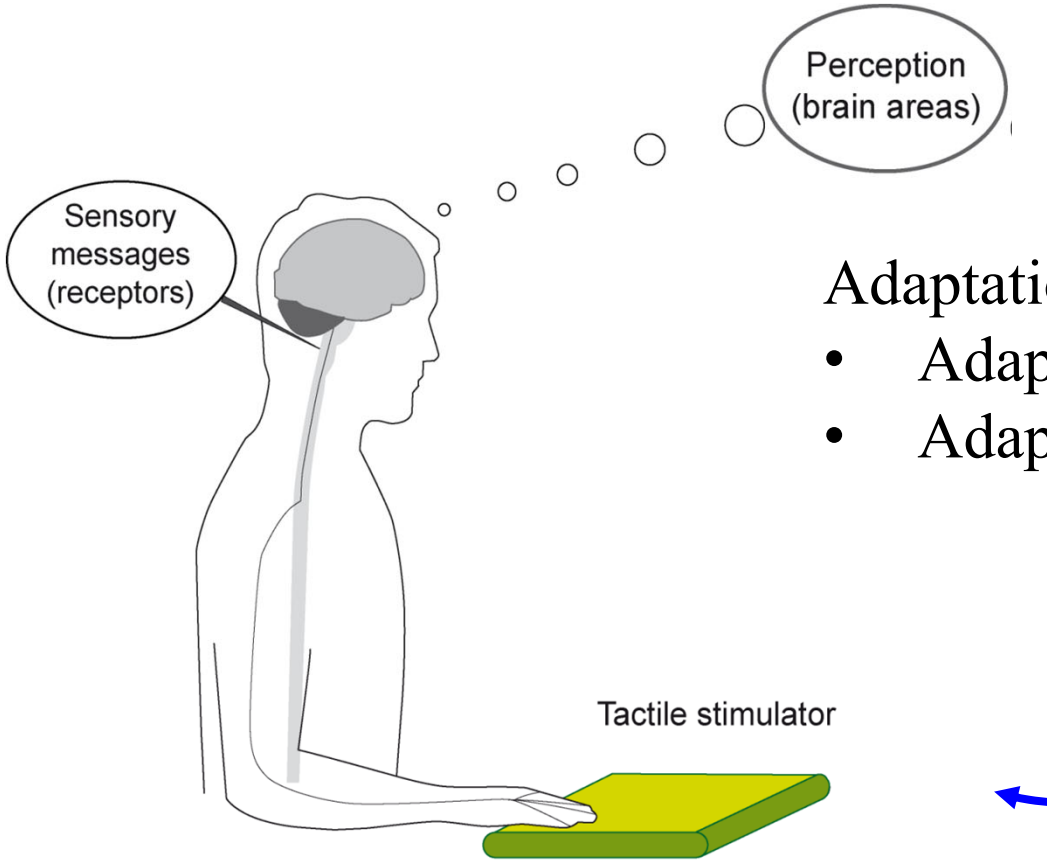




About 1 µm at 50kHz

« 3. Human in the loop »

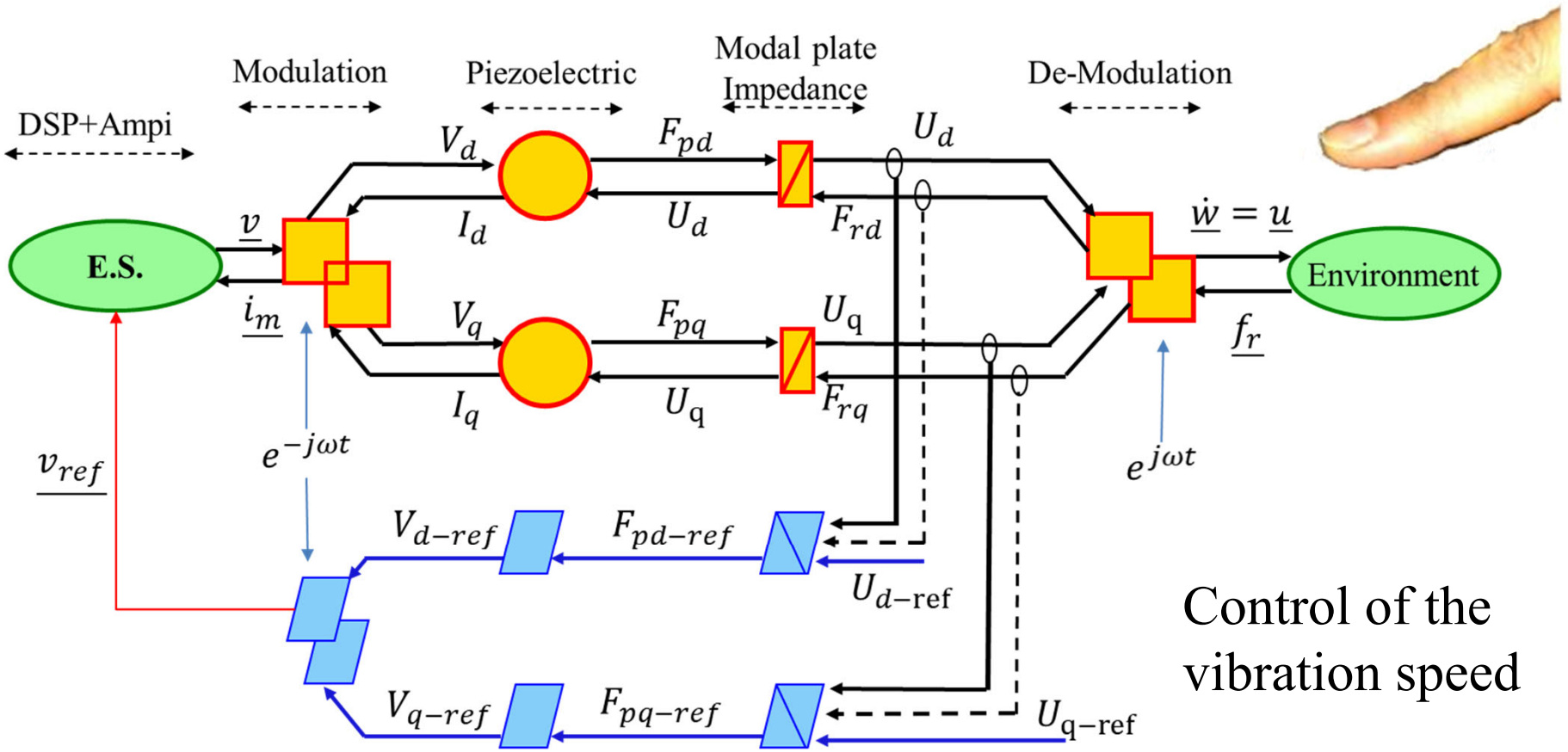
Human in the loop at a glance



Adaptation to each user

- Adapt the stimulator (design)
- Adapt the control strategy

Human in the loop using EMR
EMR and MCS of the stimulator (at the resonance frequency)

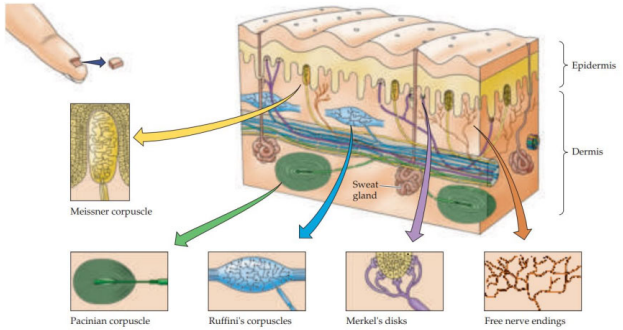


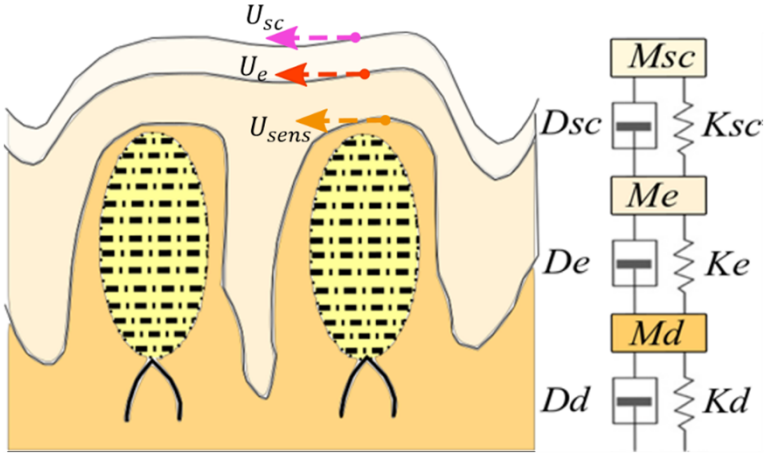
Control of the vibration speed

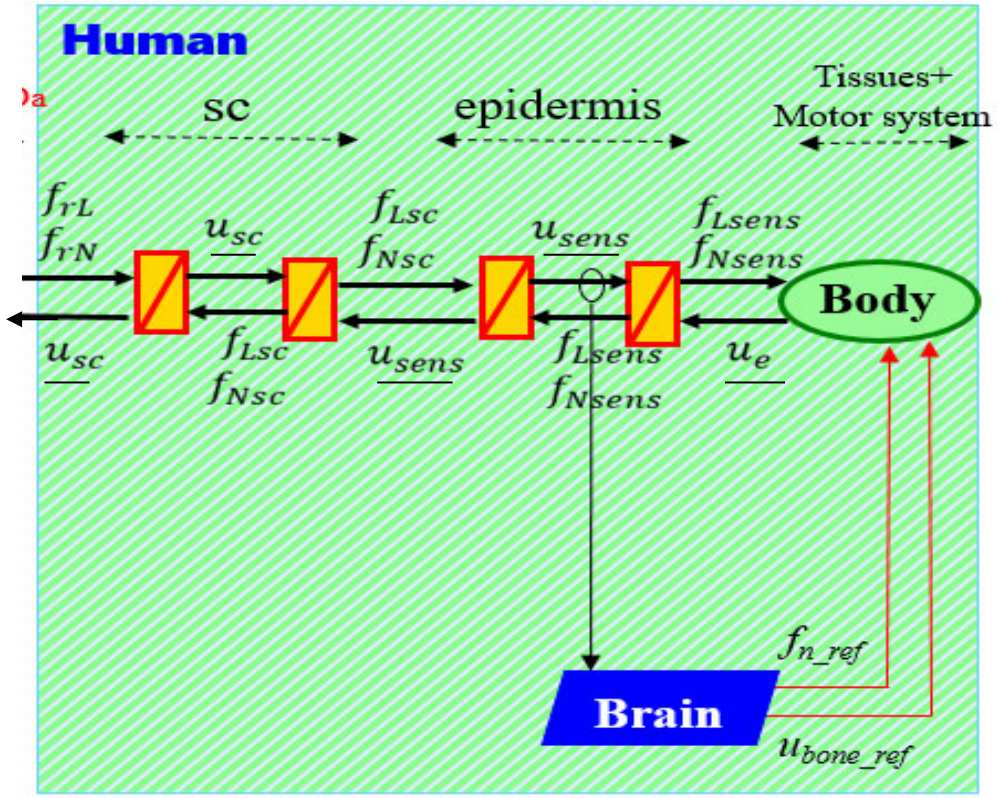
Human in the loop using EMR
EMR of the finger ?????

Human in the loop using EMR

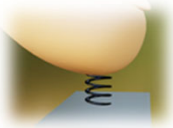
EMR of the finger ?????



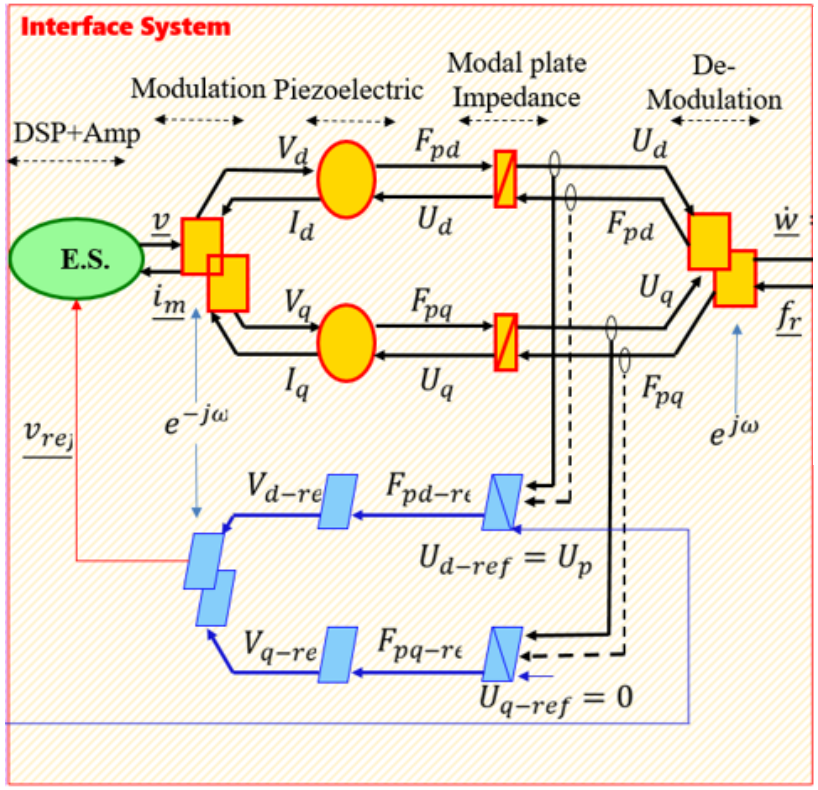


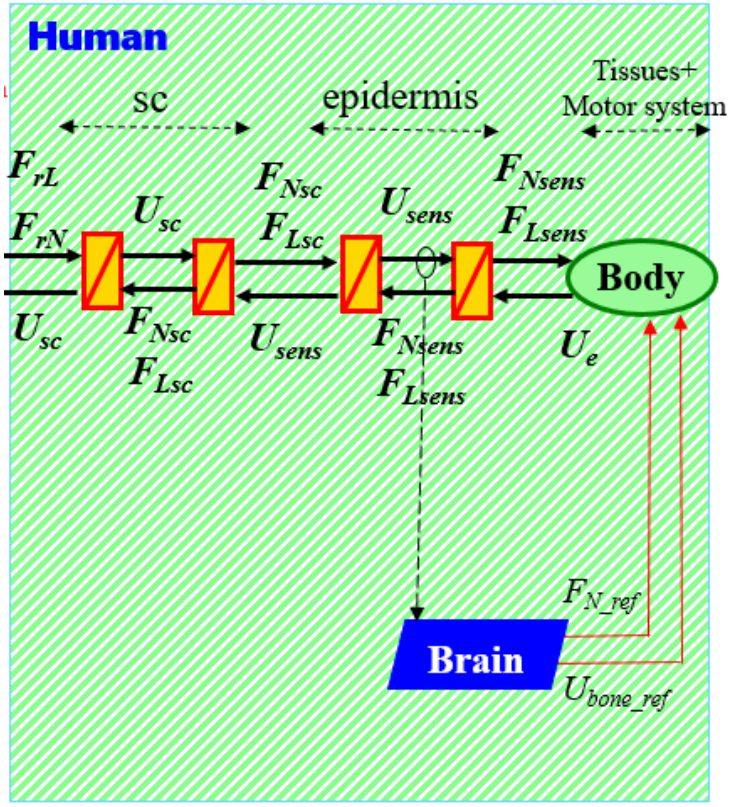


Human in the loop

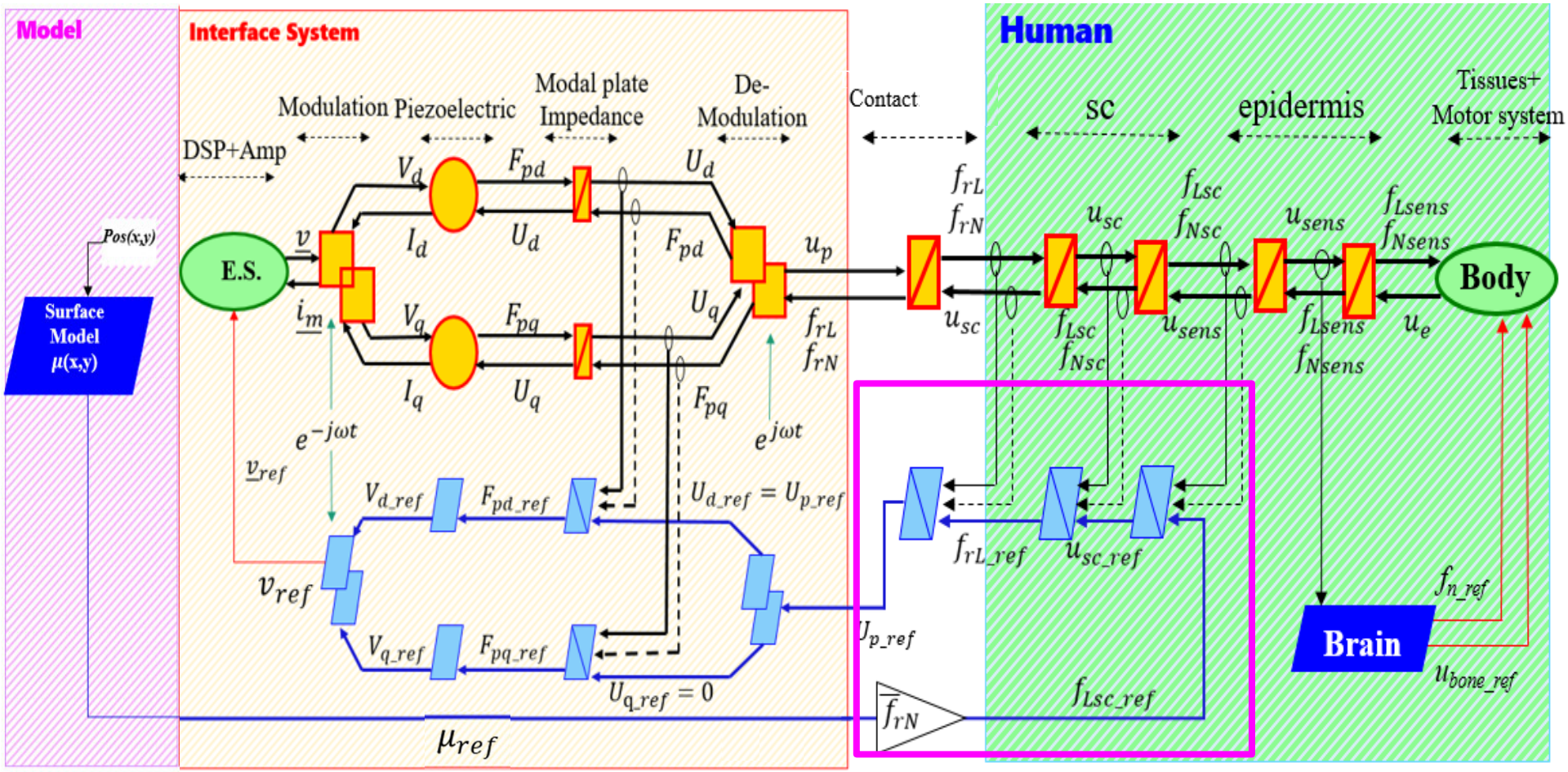


« third body »





Human in the loop



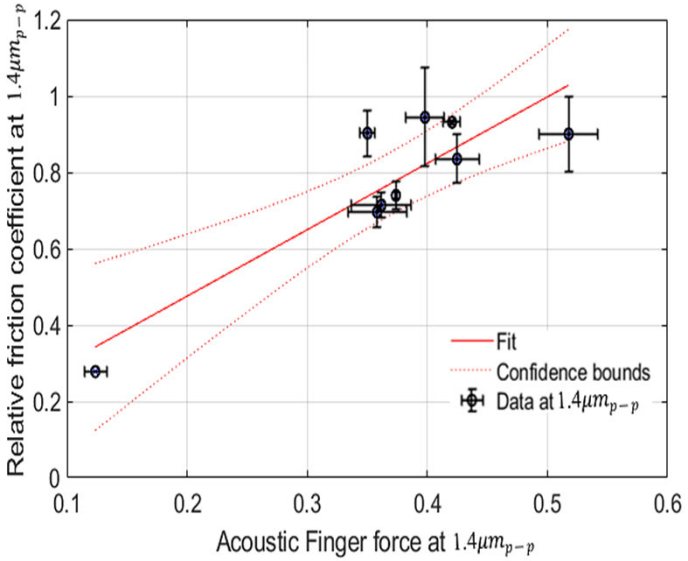
Human in the loop

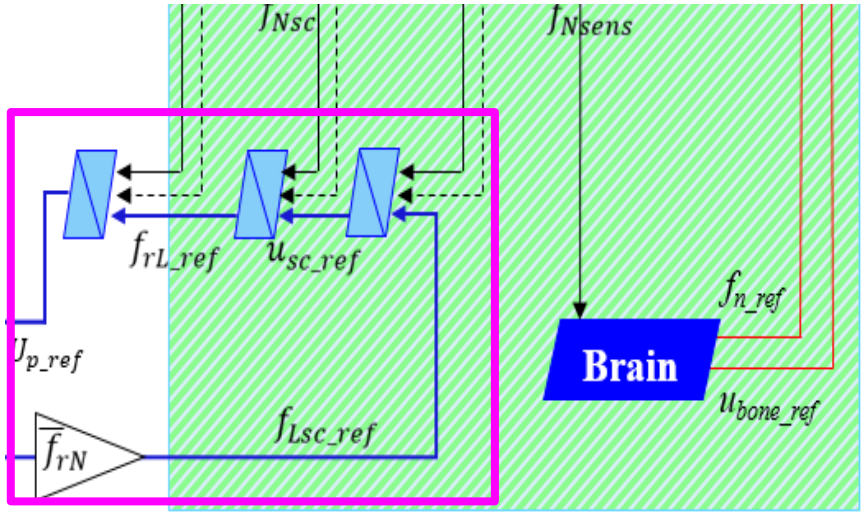
What is the added avlue of EMR in this case?

- Highlight the risk of control discrepancy
- Shows which relation should be found to perform the control

Current work: looking for a relationship between U_p and F_{Lsc}

- Statistical approach





« 5. Conclusions and Look-ahead »

Conclusions and Lookahead

1

In a very specific field of tactile feedback device:

- EMR is able to represent the human-device interaction
- MCS may be applied once the human model is defined
- EMR allows to guide researchers towards improvement of the control

2

For future works, we still have:

- To implement in real time the statistic relationship
- To provide a closed loop observer to cope with on line changes in the human skin
- To assess our approach on many users…..

«BIOGRAPHIES AND REFERENCES »

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From October 2018 she is research assistant at L2EP-IRCICA Laboratory working on her PhD Thesis. Her domains of re-search deal with the modeling and control of piezoelectric actua-tors for positioning and force feedback applications, and Hu-man-in-the-Loop analysis for ultrasonic surface tactile display design.

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