Modular Human-Computer Interfaces: interaction techniques and development

PROJET FINANCÉ PAR L'ANR
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Modular human-computer interfaces: a type of shape-changing interfaces

Shape-Changing Interfaces: A new way to interact with computers

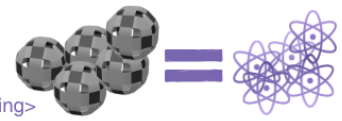
Current Status: Limited changes = Limited behaviors

Using **dynamic changes in** a device's **physical shape to interact** with computers for input and output.

Programmable Matter*: A new type of modular interface

Next step: Dynamic changes and responsive behaviors

- A modular robot composed of **many mm-scale, stand-alone, spherical, and detachable robots that can rearrange themselves** in 3D space, allowing for as many shapes as Play-Doh.
- 1 mm-scale robot is like 1 atom of "classical" matter.



<warning> Not operational now </warning>

How can we investigate interactions and properties to help development without tangible prototypes?

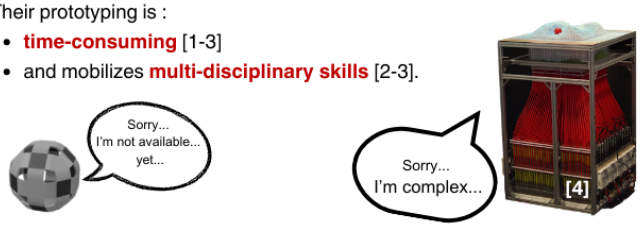
Prototyping: The challenge of shape-changing interfaces

Too complex to load

Shape-changing interfaces are complex interfaces in terms of development and prototyping.

Their prototyping is :

- **time-consuming** [1-3]
- and mobilizes **multi-disciplinary skills** [2-3].



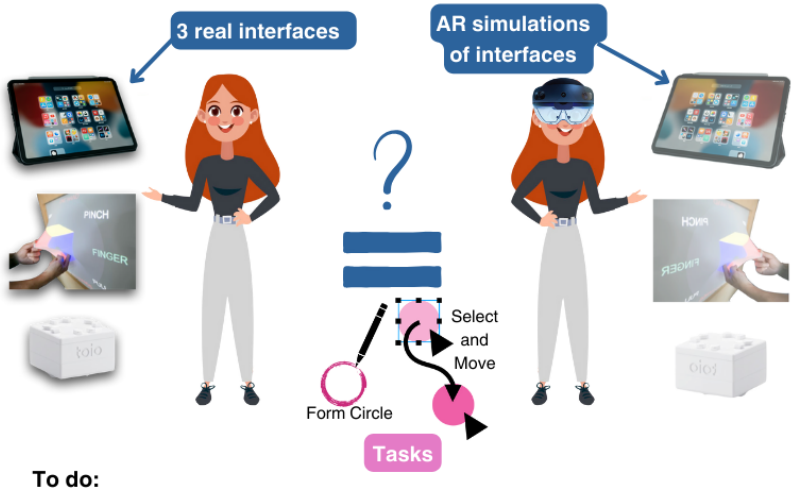
Augmented Reality (AR): A new way to prototype interfaces?

Jobert et al. is coming

- **Validate a new method** to evaluate interactions.
- Study real interfaces and their modelizations in AR with Hololens 2 (Microsoft) to compare participants' interactions.

Hypotheses:

- Regardless of the interface, the number of similar interactions between AR and real conditions is superior to the number of dissimilar interactions.
- The more the interface resembles an interface known to participants, the more similar the interactions performed by participants will be between the AR presentation and the real interface.



To do:

- [x] Running experiment:
  - 18 participants for 36 sessions
  - 12 tasks extracted from the literature
  - 432 interactions made (12 tasks x 3 interfaces x 36 sessions)
- [x] ≈30 hours of recorded video
- [x] Extraction of 1 criterion matrix to analyze videos
- [ ] Cotation of 432 interactions
- [ ] Analysis of results

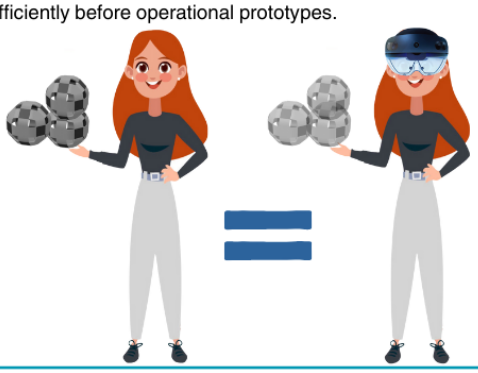
Anticipate needs and start the development by integrating them early

Make first user studies in AR

Implementing interactions of the future

- Anticipate users' needs to **interact with** the **specificities** of the interface.
- Use time efficiently before operational prototypes.

Then



References:
* https://www.programmable-matter.com
**https://www.sony.com/en/SonyInfo/design/stories/toio/
[1] Alexander, J. et al. 2018. Grand challenges in shape-changing interface research. CHI 2018.
[2] Ghosal, R. et al. 2019. Rapid prototyping of pneumatically actuated inflatable structures. UIST 2019
[3] Khan, A. et al. 2019. Soft inkjet circuits: rapid multi-material fabrication of soft circuits using a commodity inkjet printer. UIST 2019.
[4] Follmer, S. et al. 2023. inFORM: dynamic physical affordances and constraints through shape and object actuation. UIST 2013.

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