

Design Framework for Handheld Augmented Reality

Spatial Relationships and Frames of Reference



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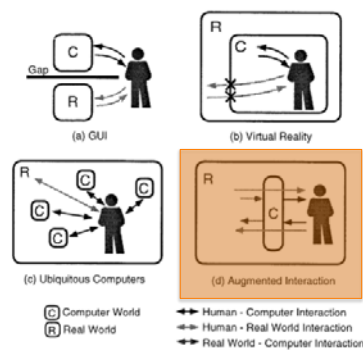


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AR: Definition

- [Azuma 97]
 - Combines real and virtual
 - Interactive in real time
 - Registered in 3D

[Rekimoto 95]



AR: Definition

- Specific to AR:
 - ‘Real’ AND ‘Virtual’
 - Spatiotemporal relationship between the physical world and digital content
- How to relax the **spatial constraint** while keeping physical/digital colocation?

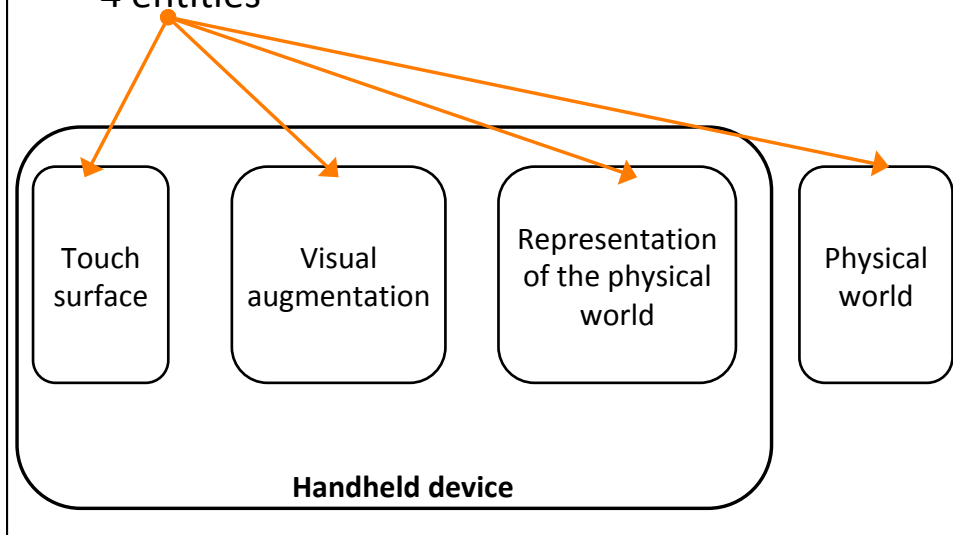
Handheld AR

- Handheld AR has some specificities:
 - Viewpoint is controlled by the device pose
 - Direct Touch is the de facto standard input (1:1 mapping with the screen)
- Frame of reference for pointing?



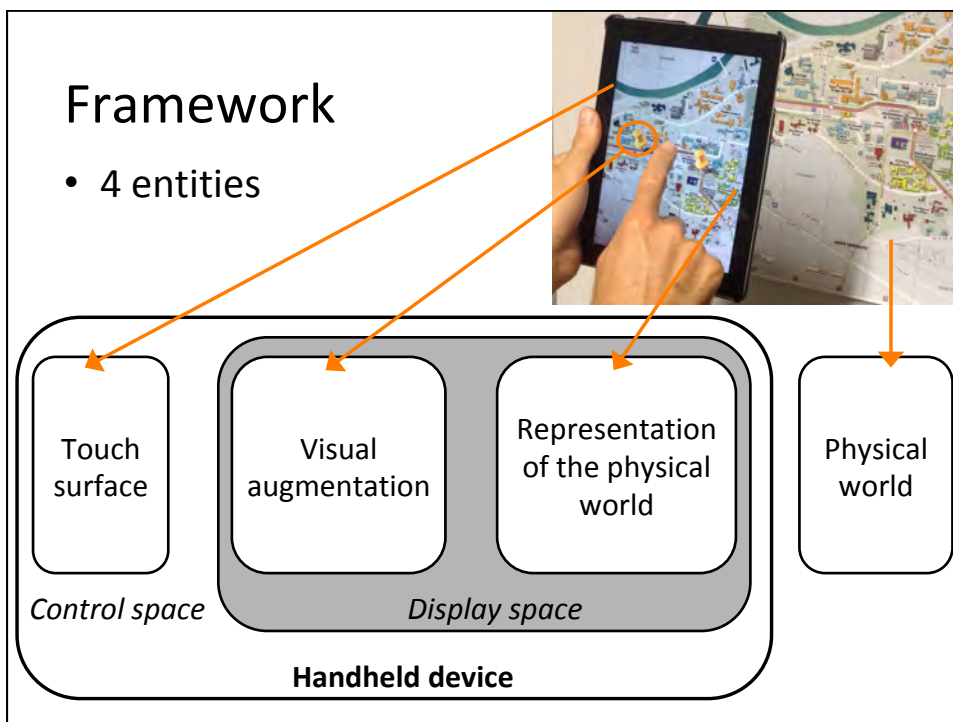
Framework

- 4 entities



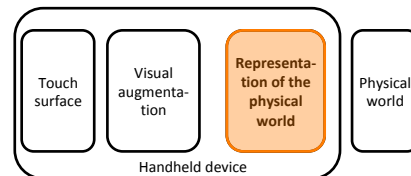
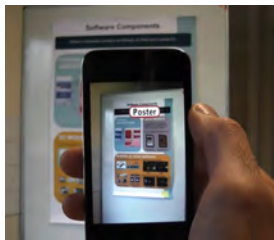
Framework

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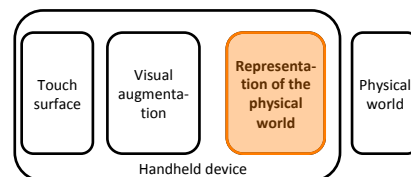
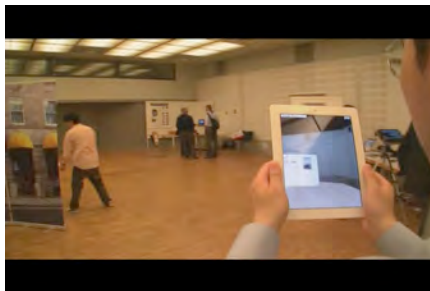
Representation of the Physical World

- On-screen content representing the physical surrounding
- It allows the user to map the viewpoint and digital augmentation in the physical world



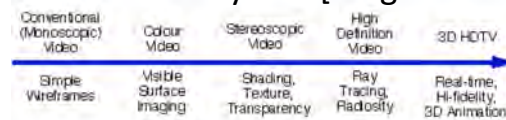
Representation of the Physical World

- Visual aspect:
 - Live video, snapshots
 - Non-photorealistic
 - Virtual Model

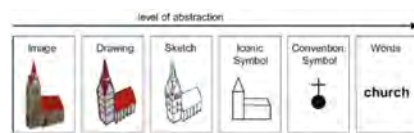


Representation of the Physical World

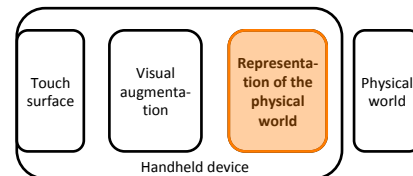
- Visual aspect:
 - Reproduction Fidelity axis [Milgram 1994]



- Level of abstraction [Normand 2012]

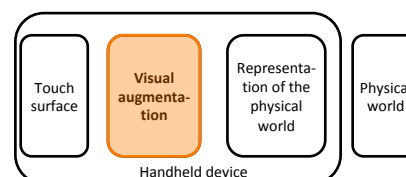


[Elias 08]



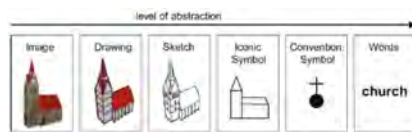
Visual Digital Augmentation

- On-screen content that is not the representation of the physical world
- Extra information and interaction

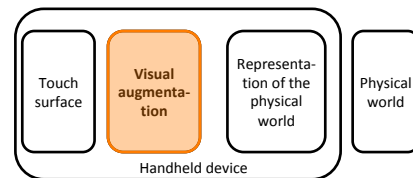


Visual Digital Augmentation

- Visual aspect:
 - Dimensionality 2D 3D [Tönnis 2011]
 - Level of abstraction [Normand 2012]



[Elias 08]

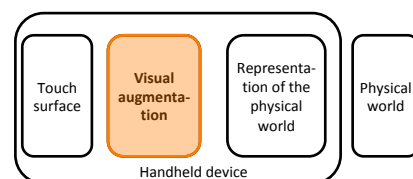


Visual Digital Augmentation

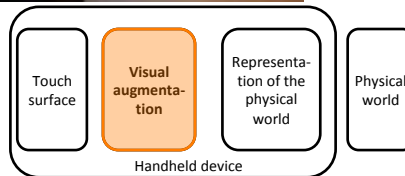
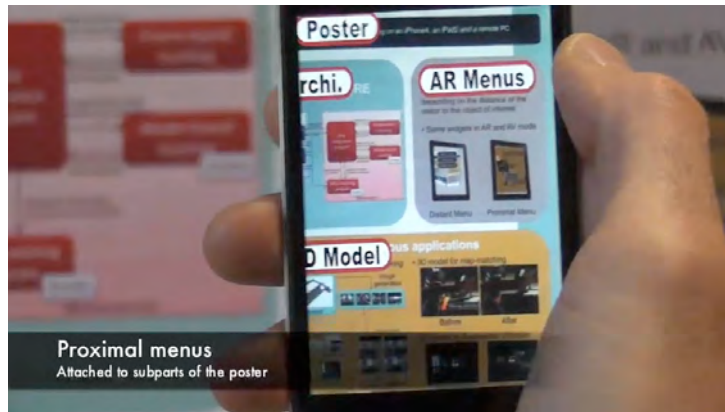
- Content:
 - Selection of content beyond de facto viewport visibility
 - Information filtering [Julier 00]



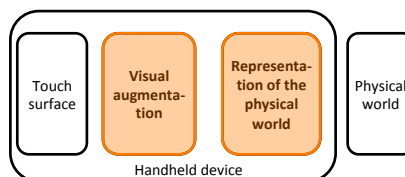
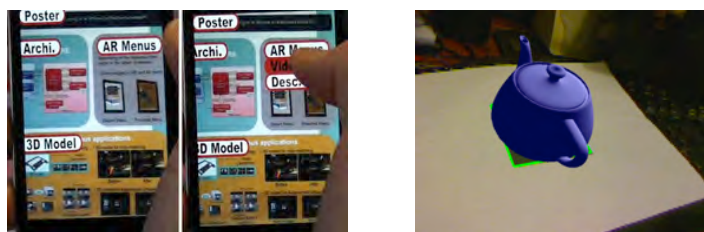
LOD Interface [DiVerdi 04]



Visual Digital Augmentation



Distinction between Representation / Augmentation

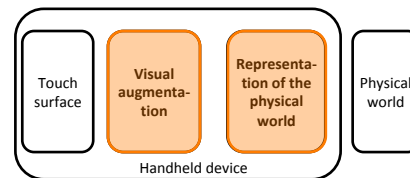


Distinction between Representation / Augmentation

- ClayVision [Takeushi 2012]



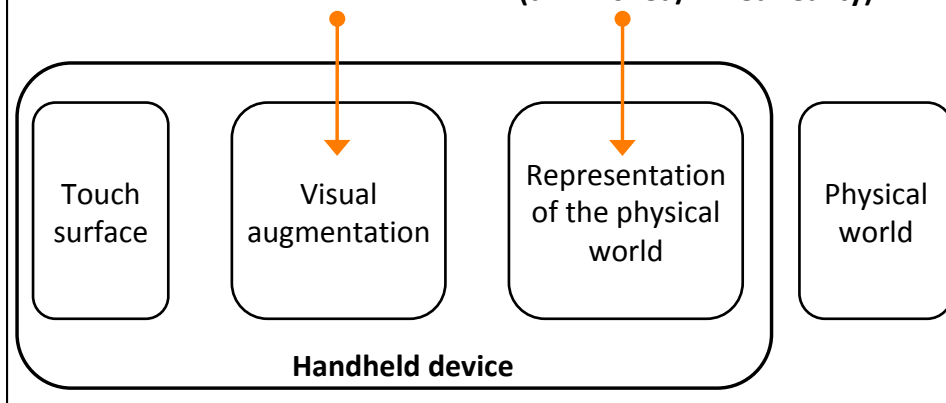
- Distinction on a per-characteristic rather than a per-object basis



Framework

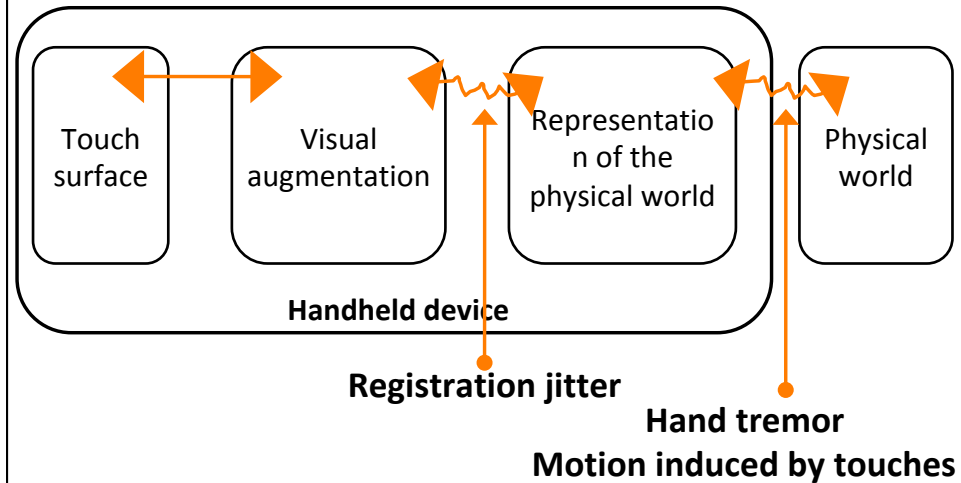
- 4 entities: design elements

- Visual aspect
- Selection of content
- Visual aspect
- Selection of content (diminished/mixed reality)



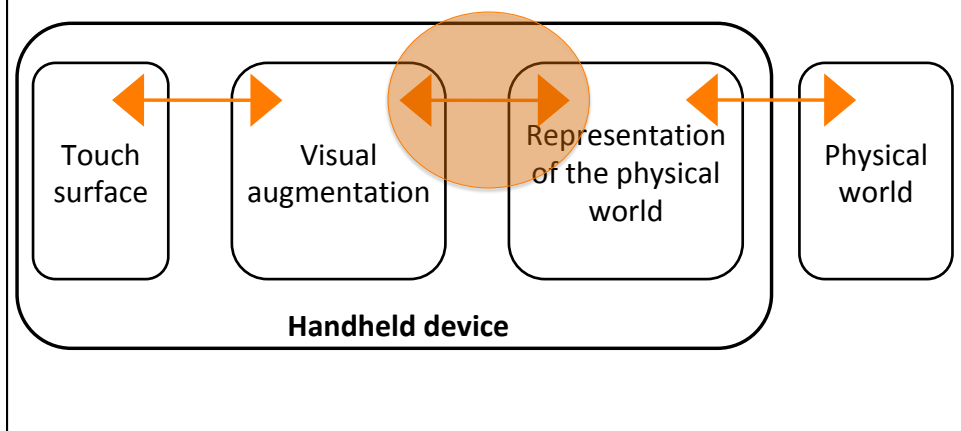
Framework

- 4 entities **linked by spatial relationships**



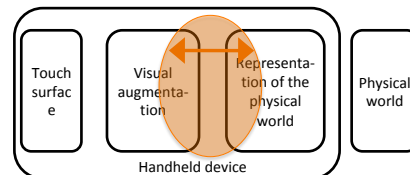
Framework

- 4 entities **linked by spatial relationships**

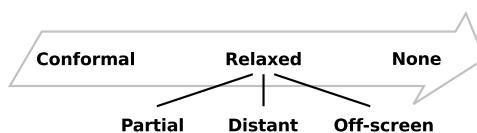


Spatial mapping between the Augmentation and the Representation

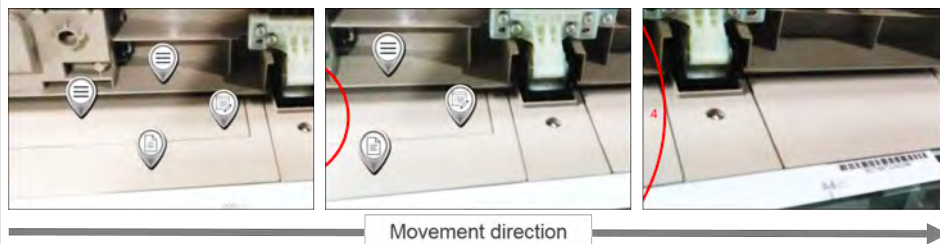
- Spatial coupling of the augmentation with the representation of the physical world



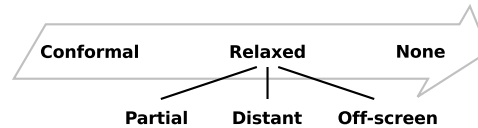
Spatial mapping between the Augmentation and the Representation



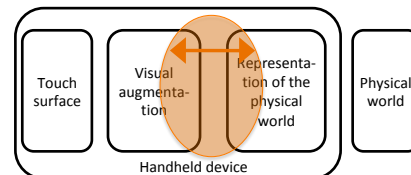
[Grasset 12]



Spatial mapping between the Augmentation and the Representation

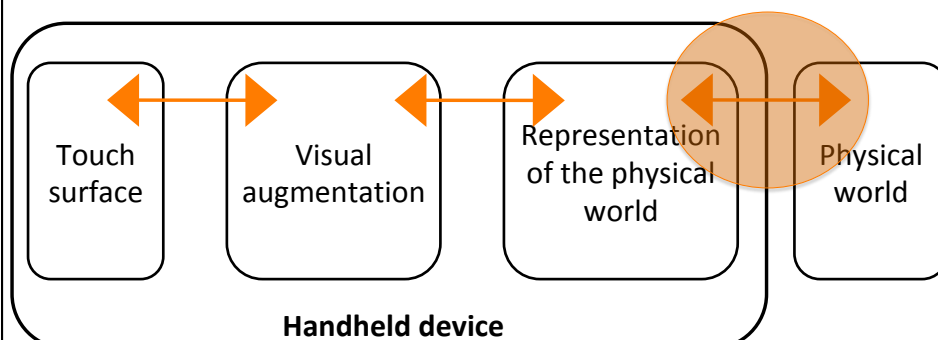


- Relaxing this coupling is useful to improve digital augmentation legibility



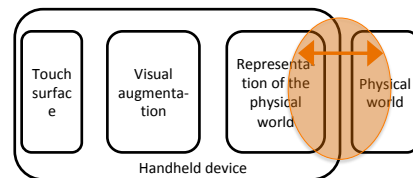
Framework

- 4 entities **linked by spatial relationships**

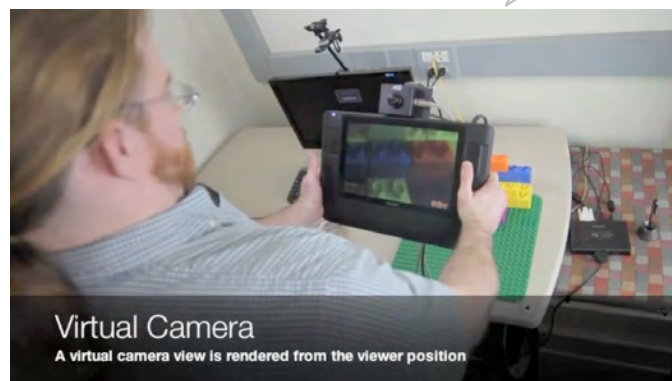


Spatial mapping between the physical world and its representation

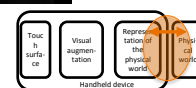
- Spatial coupling of the viewpoint with the handheld device pose



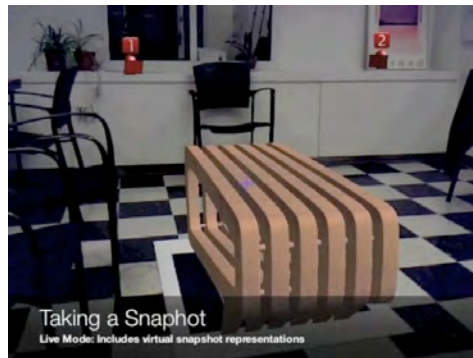
Spatial mapping between the physical world and its representation



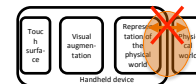
Virtual Transparency [Hill 11]



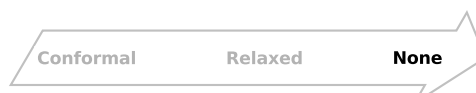
Spatial mapping between the physical world and its representation



SnapAR [Sukan 12]

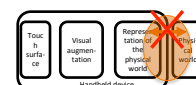
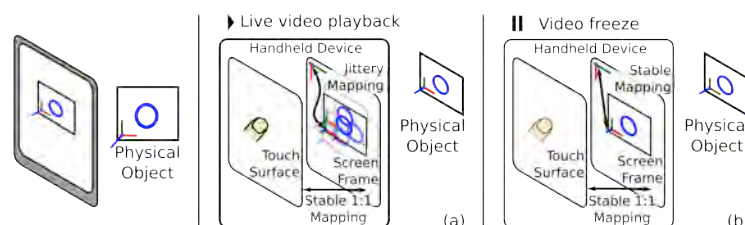


Spatial mapping between the physical world and its representation

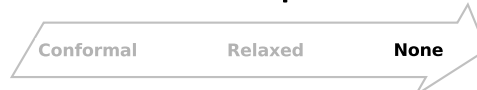


- Spatial relationships temporality/partially broken for improving interaction

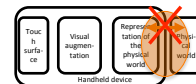
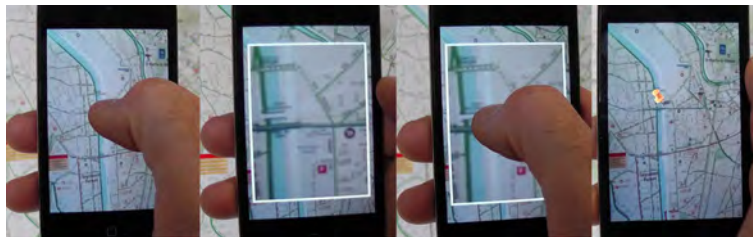
- Video freeze



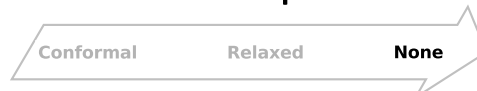
Spatial mapping between the physical world and its representation



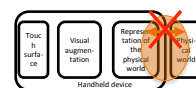
- Adapt TapTap [Roudaut 08] to AR
 - Explicit and transient freeze rather than sustained
 - 2 views: one with freeze, the other with live video



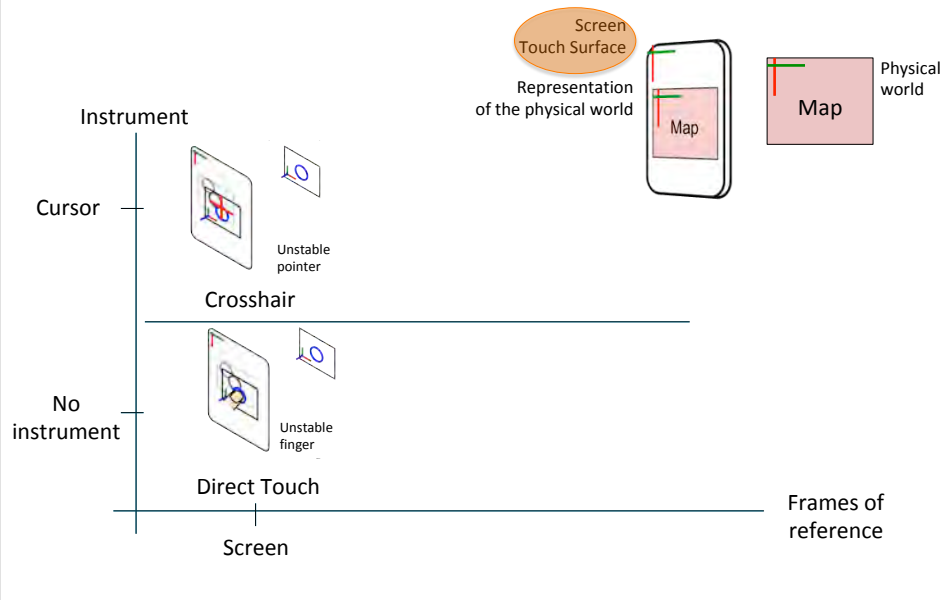
Spatial mapping between the physical world and its representation



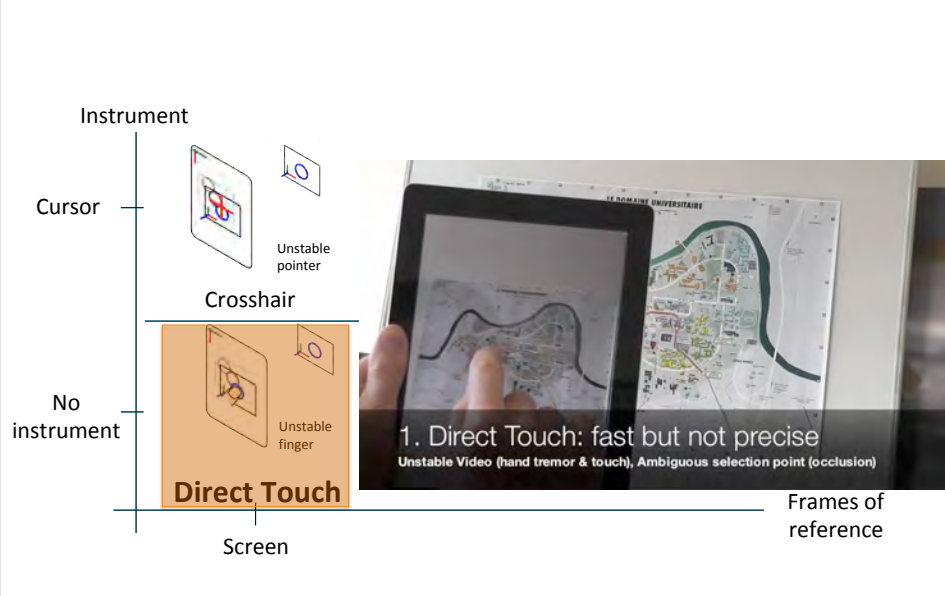
- Adapt Shift [Vogel 2007] with freeze-frame
 - Shift's callout and cursor overcome the 'fat finger' problem
 - Freeze-frame avoids viewpoint instability
 - On-demand precise quasi-mode



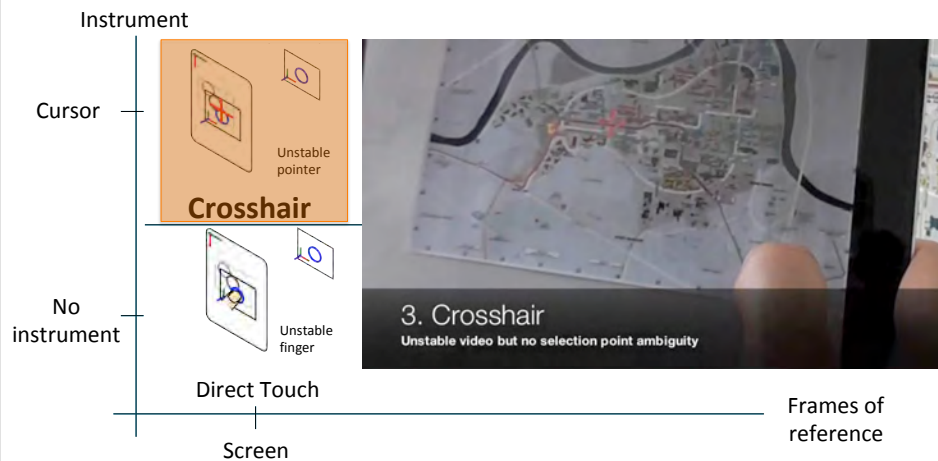
Frame of reference of the screen



Frame of reference of the screen

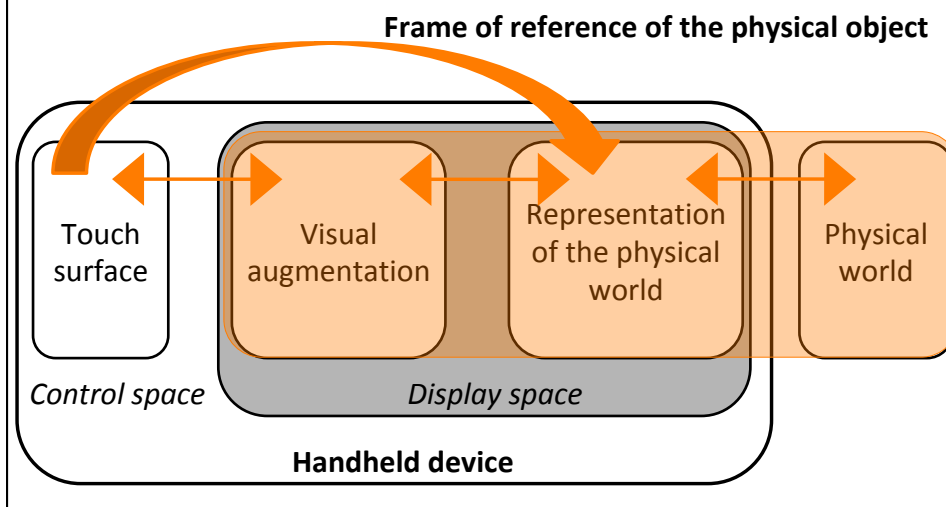


Frame of reference of the screen

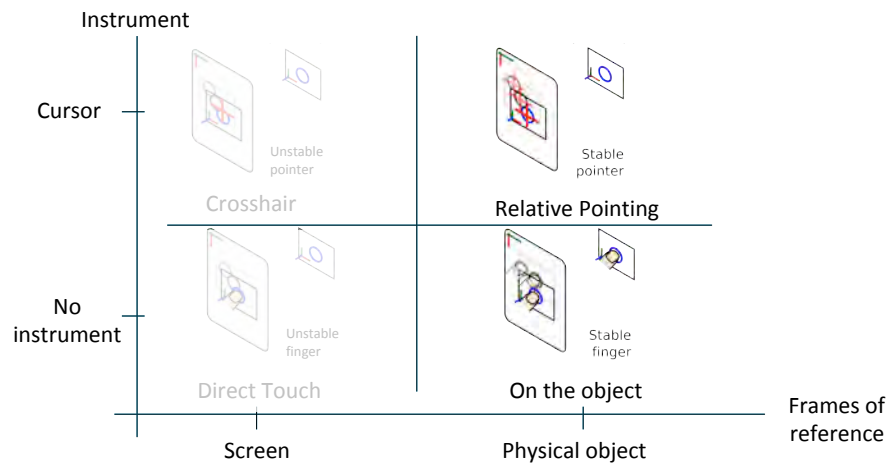


Framework

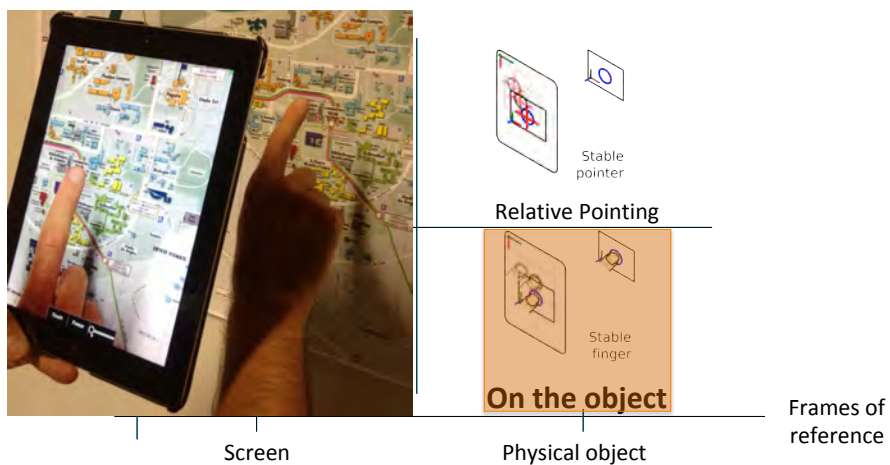
- Frames of reference for pointing



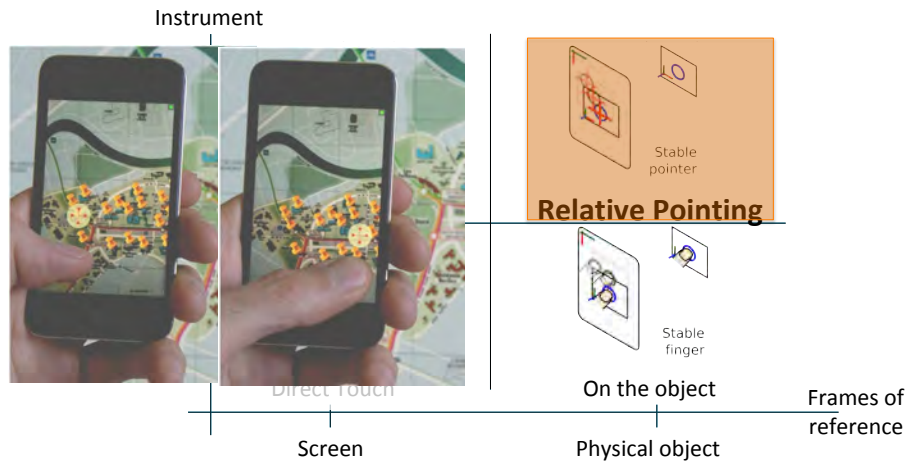
Frame of reference of the physical object



Frame of reference of the physical object

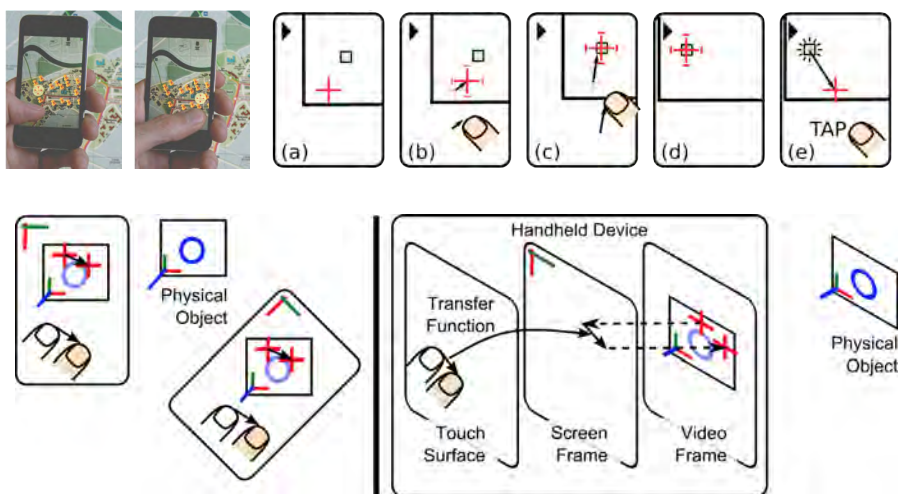


Frame of reference of the physical object



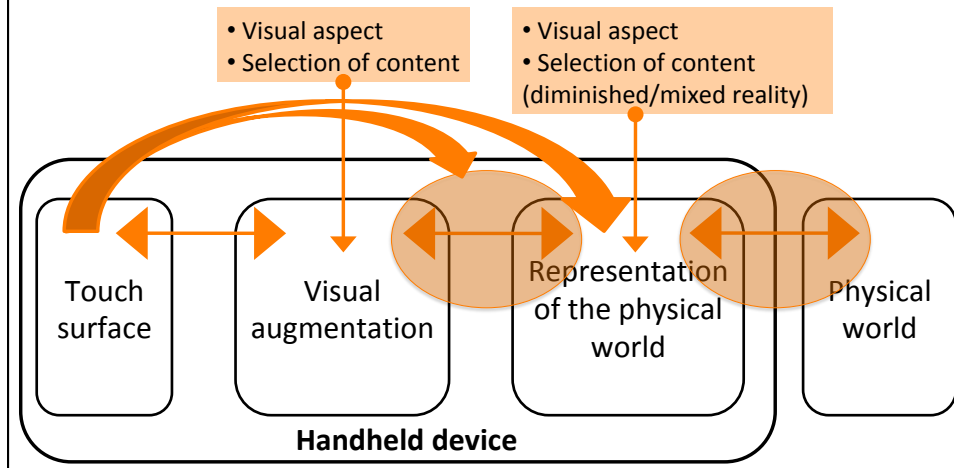
Frame of reference of the physical object

- Cursor stabilized in the physical object's frame



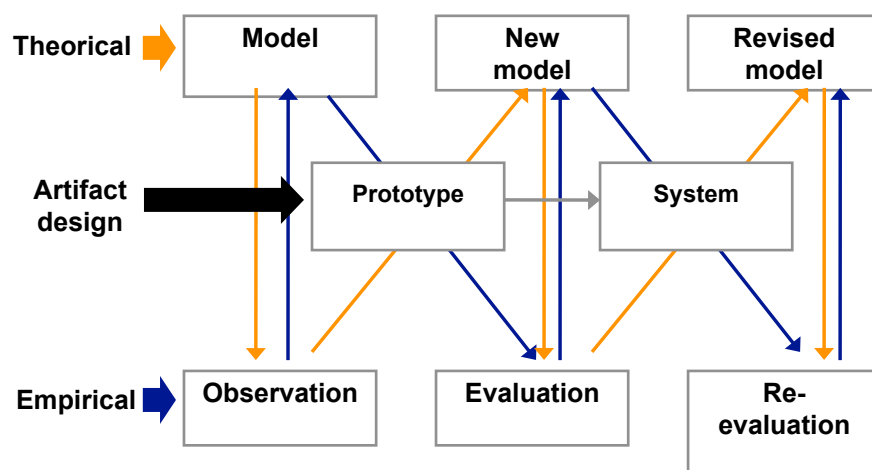
Conclusion: Design framework

- 4 entities linked by spatial relationships
- 2 frames of reference for pointing



Scientific approach:

deduction and induction



Thank you for your attention

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