

- Definitions

- **Handheld AR/AV**

- **Pointing at physical targets**
- Pointing at virtual targets

- HMD-based AR/AV

- 3D pointing

Augmented Reality/Virtuality (AR/AV)



Handheld AR/AV

- Specificities:

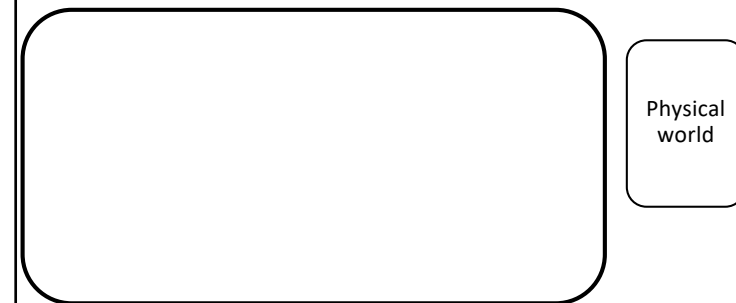
- Viewpoint is controlled by the device pose
- Direct Touch is the de facto standard input (1:1 mapping with the screen)

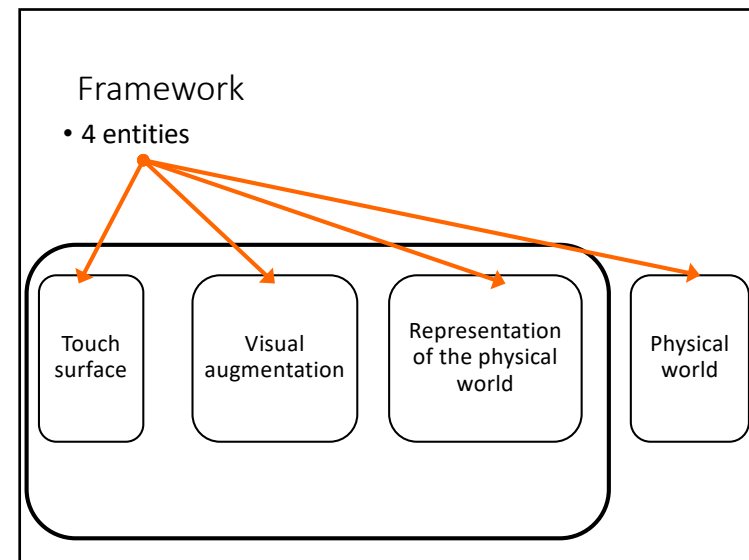
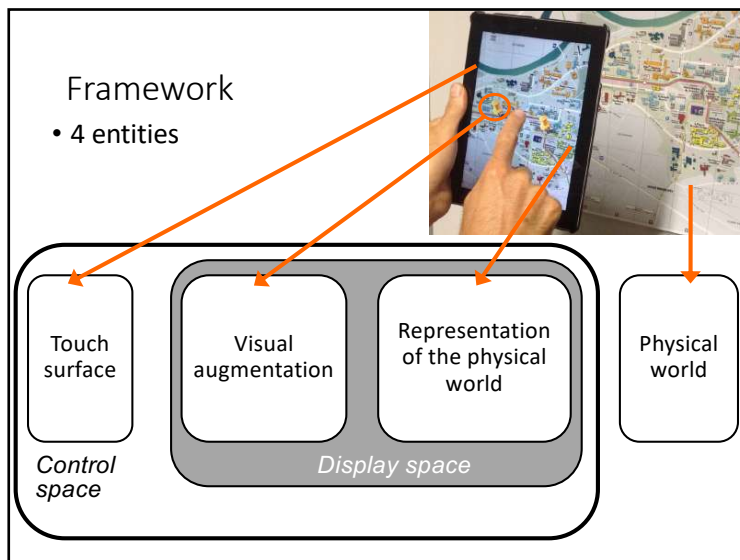
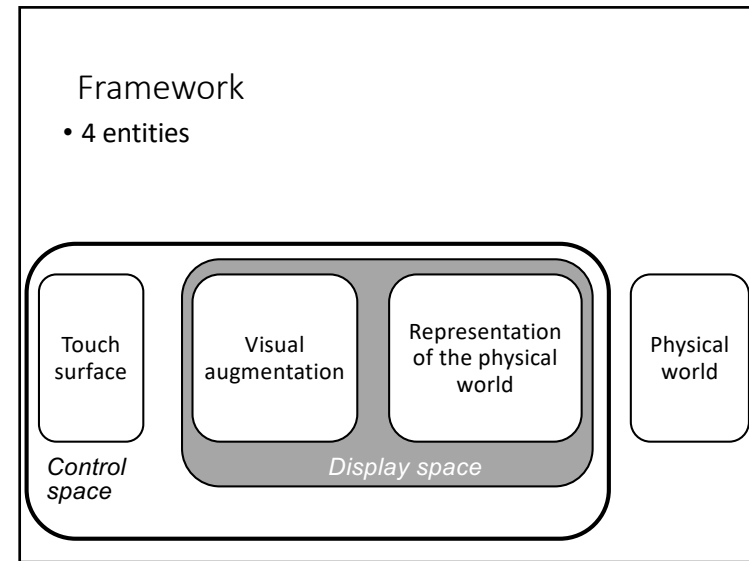
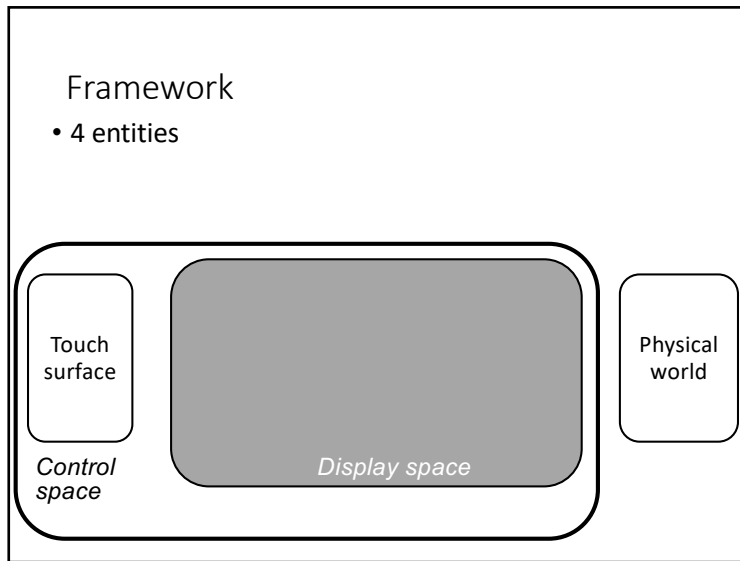
- Frame of reference for pointing?



Framework

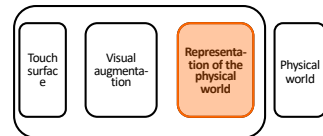
- 4 entities





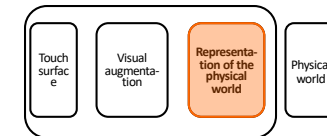
Representation of the Physical World

- 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

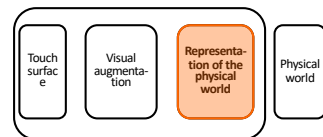
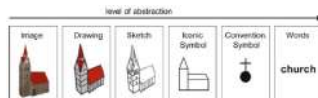


Representation of the Physical World

- Visual aspect:
 - Reproduction Fidelity axis

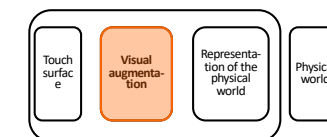


- Level of abstraction



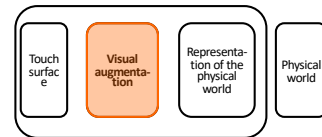
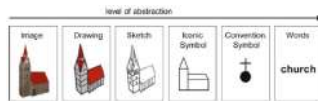
Visual Digital Augmentation

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



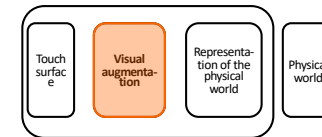
Visual Digital Augmentation

- Visual aspect:
 - Dimensionality 2D 3D
 - Level of abstraction

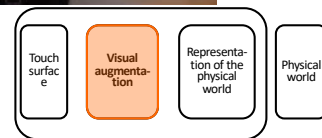


Visual Digital Augmentation

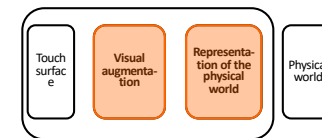
- Content:
 - Selection of content beyond de facto viewport visibility
 - Information filtering [Julier 00]



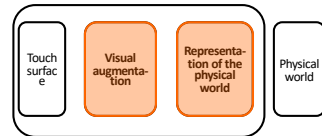
Visual Digital Augmentation



Distinction between Representation / Augmentation



Distinction between Representation / Augmentation

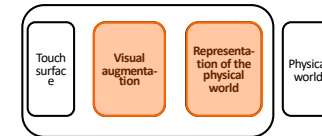


Distinction between Representation / Augmentation

- ClayVision



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

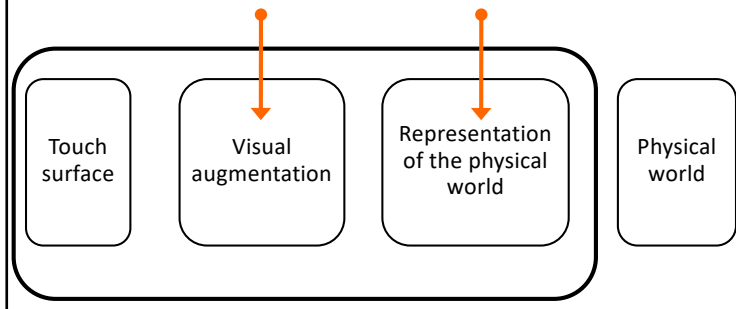


Framework

- 4 entities: design elements

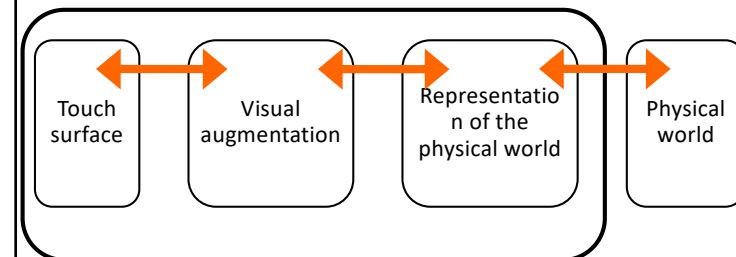
- **Visual aspect**
- **Selection of content**

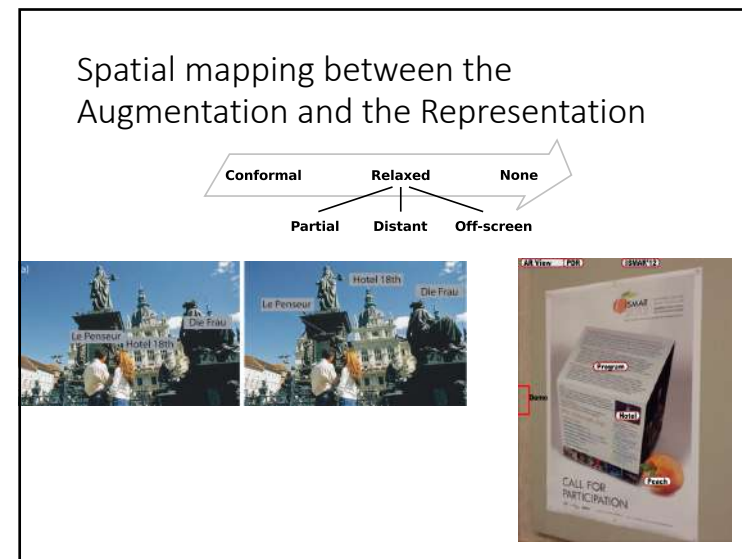
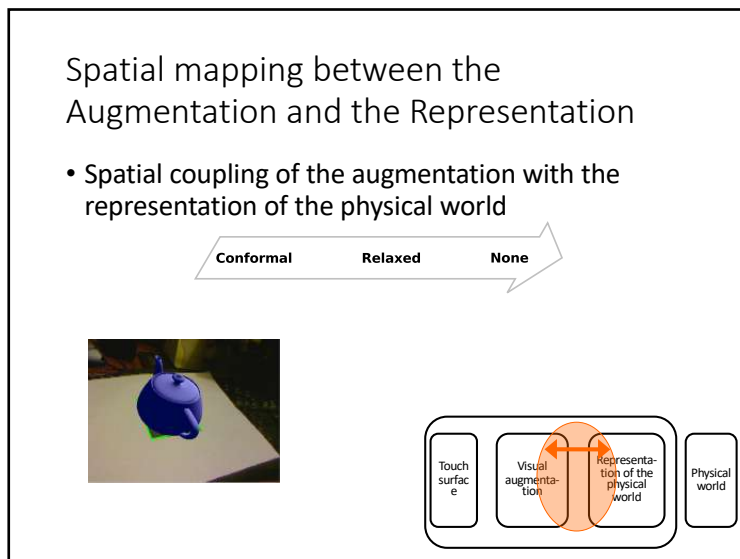
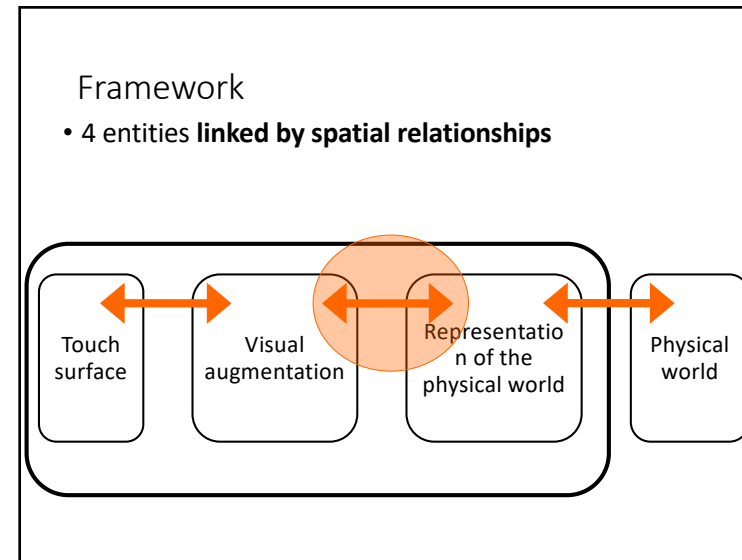
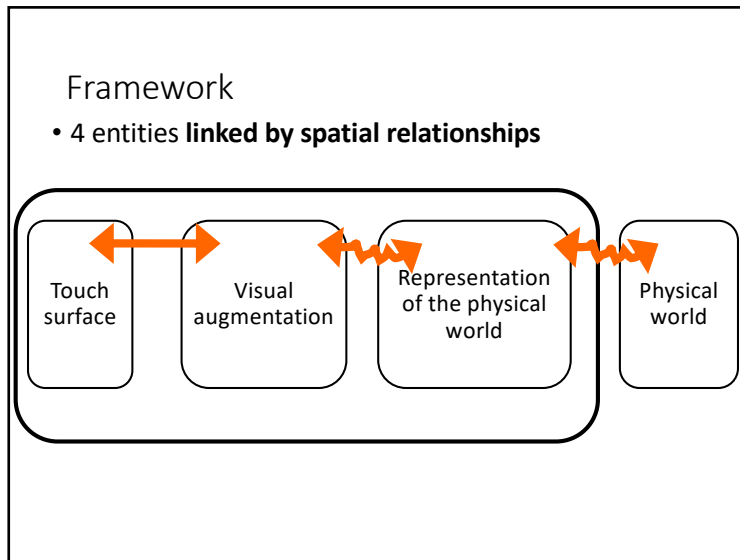
- **Visual aspect**
- **Selection of content (diminished reality)**



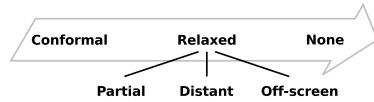
Framework

- 4 entities **linked by spatial relationships**

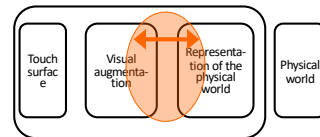




Spatial mapping between the Augmentation and the Representation

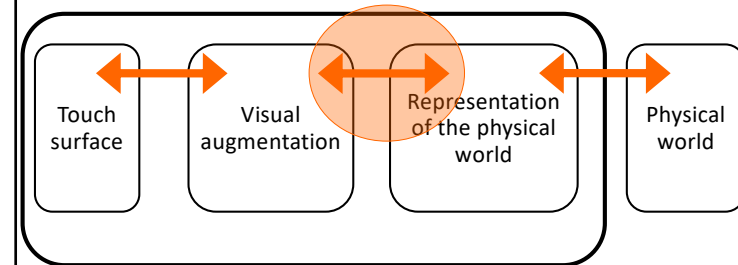


- Relaxing this coupling is useful to improve digital augmentation legibility



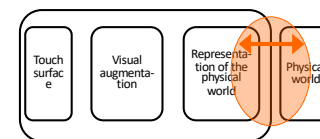
Framework

- 4 entities **linked by spatial relationships**

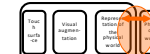


Spatial mapping between the physical world and its representation

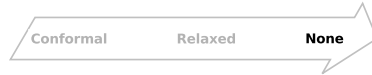
- Spatial coupling of the viewpoint with the handheld device pose



Spatial mapping between the physical world and its representation



Spatial mapping between the physical world and its representation

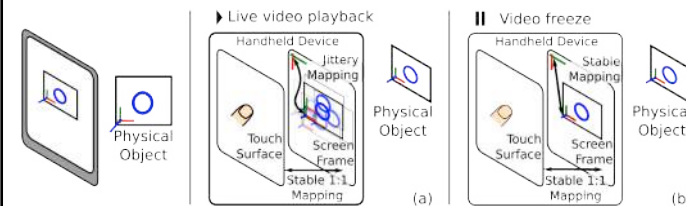


SnapAR [Sukan 12]



Spatial mapping between the physical world and its representation

- Spatial relationships temporality/partially broken for improving interaction
 - Video freeze



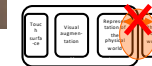
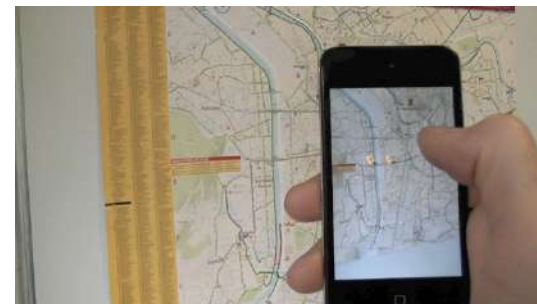
Spatial mapping between the physical world and its representation

- Adapt TapTap to AR

- Explicit and transient freeze rather than sustained
- 2 views: one with freeze, the other with live video



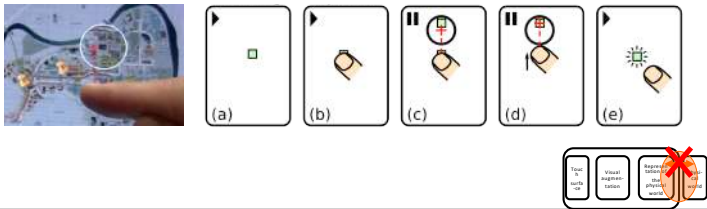
Spatial mapping between the physical world and its representation



Spatial mapping between the physical world and its representation

- Adapt Shift with freeze-frame

- Shift's callout and cursor overcome the 'fat finger' problem
- Freeze-frame avoids viewpoint instability
- On-demand precise quasi-mode

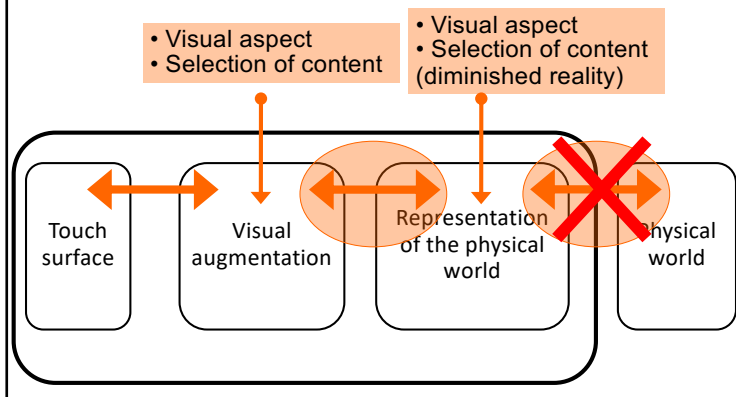


Spatial mapping between the physical world and its representation



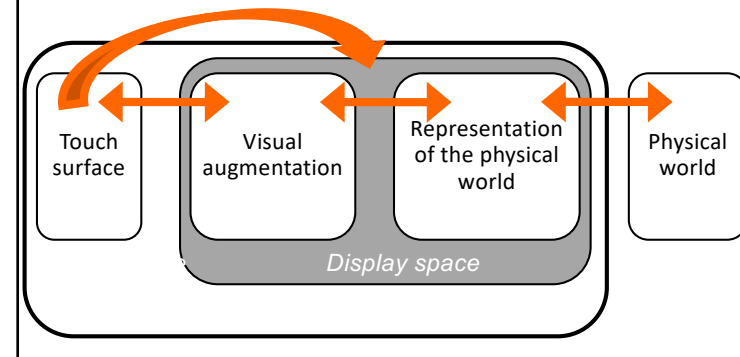
Framework

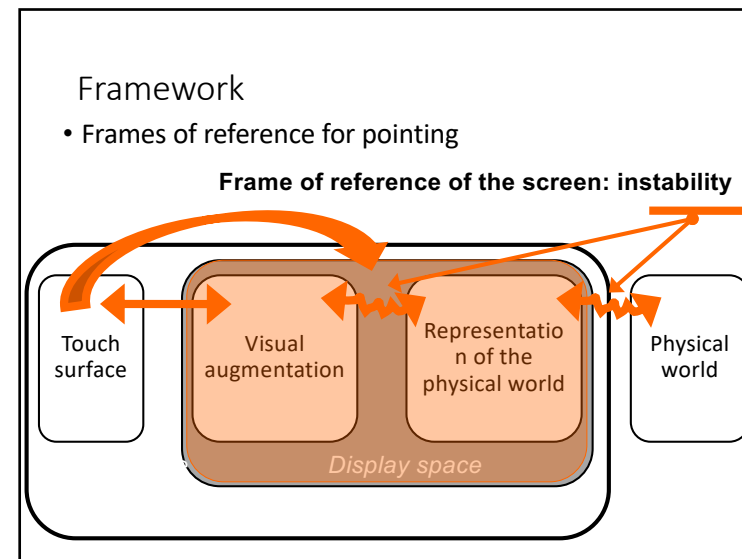
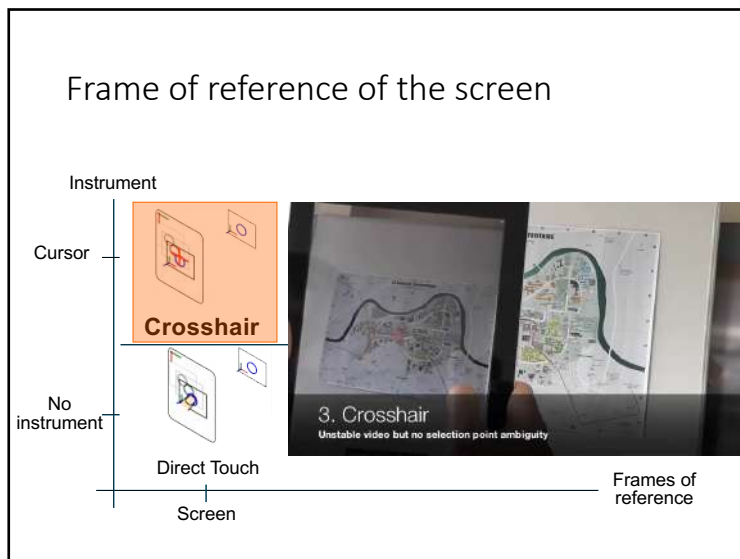
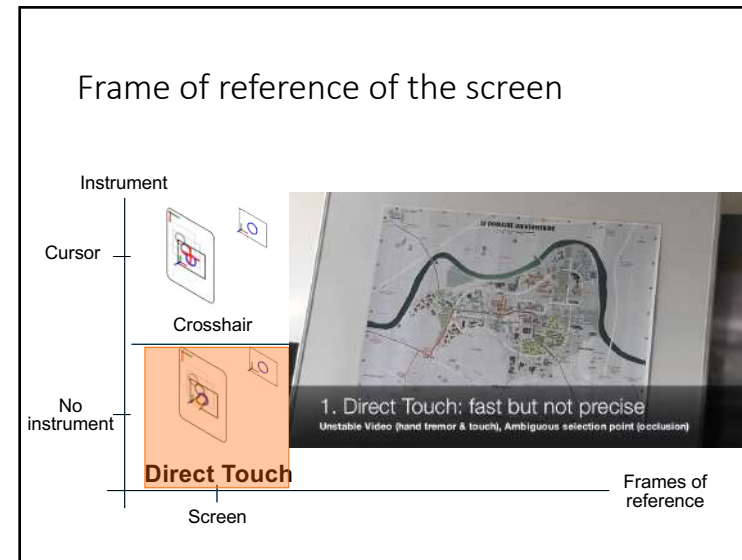
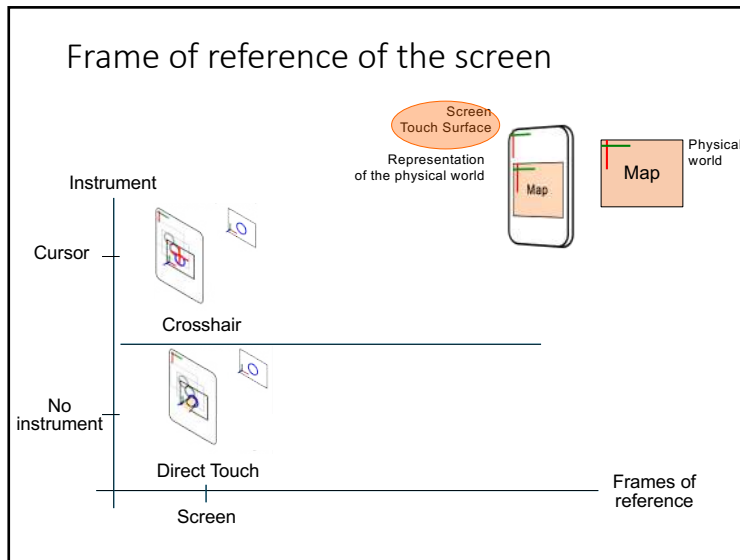
- 4 entities linked by spatial relationships

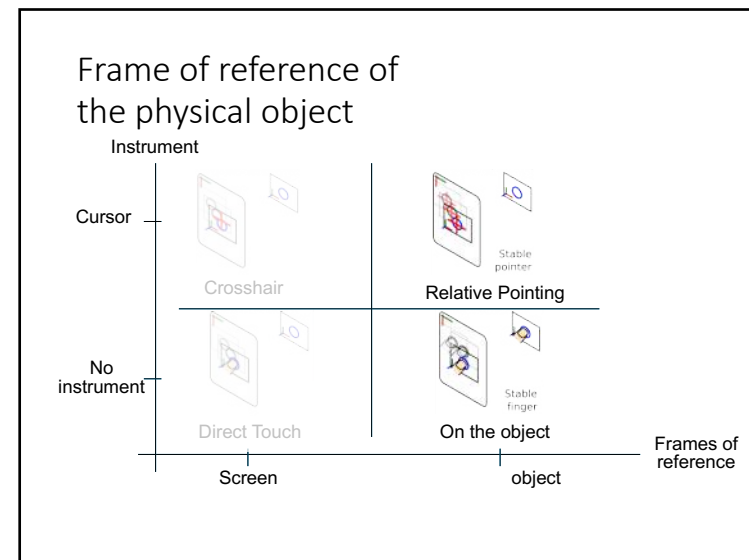
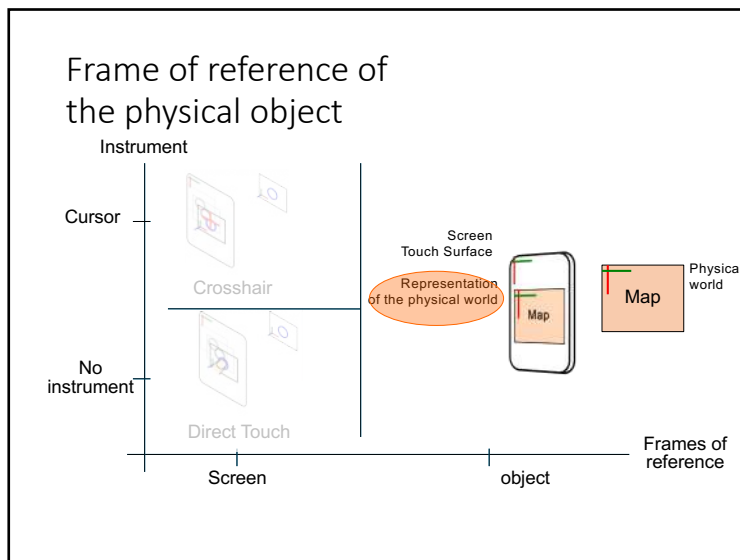
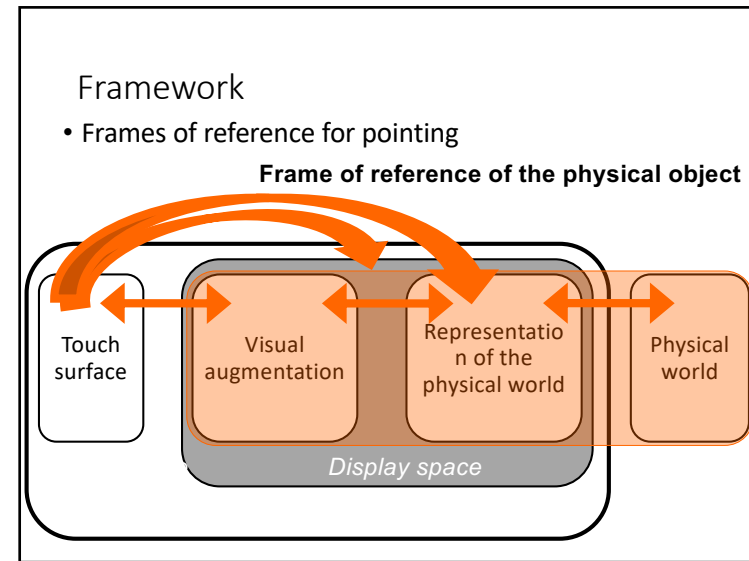
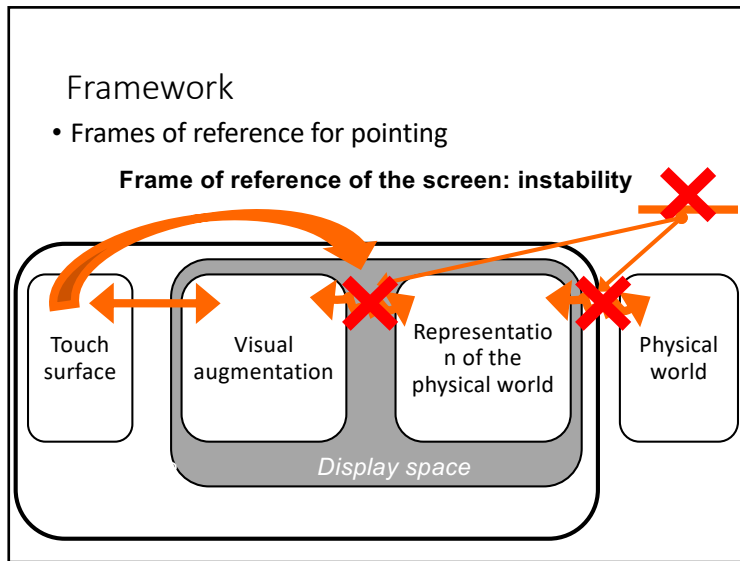


Framework

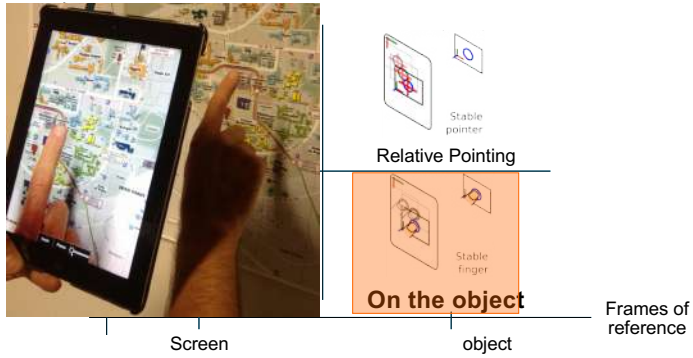
- Frames of reference for pointing



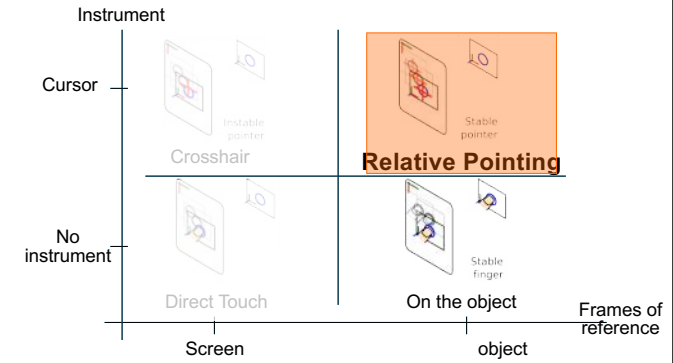




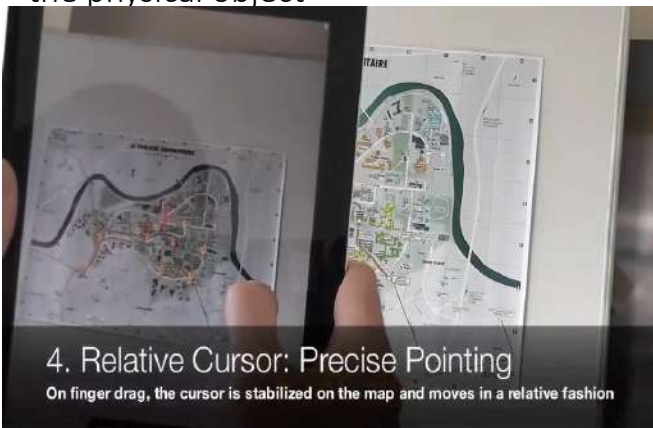
Frame of reference of the physical object



Frame of reference of the physical object

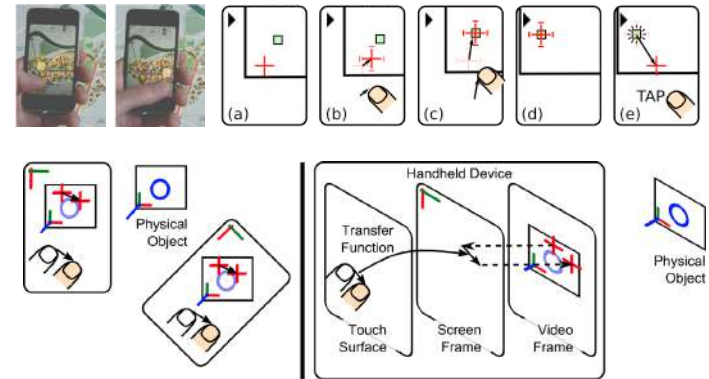


Frame of reference of the physical object



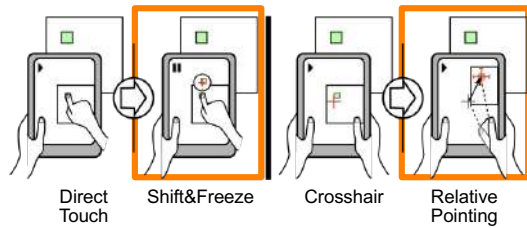
Frame of reference of the physical object

- Cursor stabilized in the physical object's frame



In-lab evaluations: Pointing

- User preference



In-lab evaluations: User preference

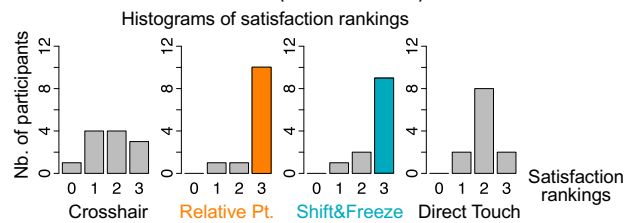
- 'Realistic' pointing task: Placing marks on a wall map
- 12 participants
- Handheld tablet



In-lab evaluations: User preference

- Results

- Shift&Freeze and Relative Pointing
 - Preferred over the baseline techniques
 - Precise mode used (73% of the time)



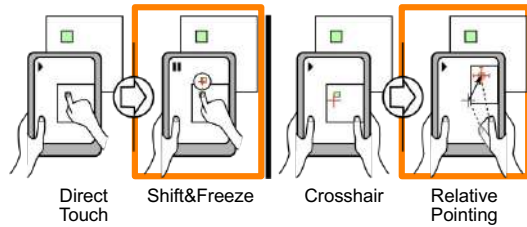
In-lab evaluations: User preference

- Results

- Shift&Freeze and Relative Pointing
 - Preferred over the baseline techniques
 - Precise mode used (73% of the time)
- Shift&Freeze
 - Participants used to Direct Touch
 - Freezing the frame during interaction: Not really disturbing in this context
- Tablet form factor: Unsafe hold

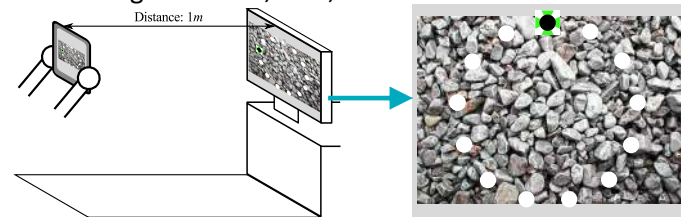
In-lab evaluations: Pointing

- User preference
- Comparing performance



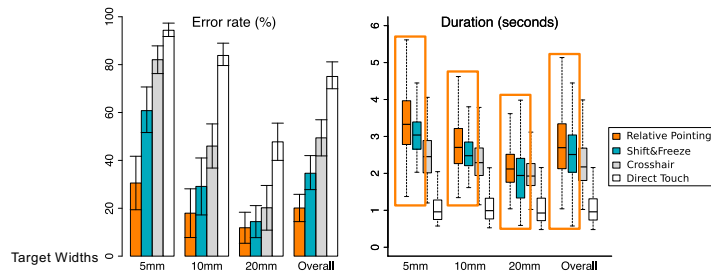
In-lab evaluations: Performance

- Abstract pointing task
- 12 participants
- Handheld tablet
- Small targets: 0.5cm, 1cm, 2cm



In-lab evaluations: Performance

- Results: Relative Pointing and Shift&Freeze
 - More precise than the baseline techniques
 - Relative Pointing less error prone
 - Comparable completion time



In-lab evaluations: Performance

- Results: Relative Pointing and Shift&Freeze
 - More precise than the baseline techniques
 - Relative Pointing less error prone
 - Comparable completion time
 - Precise modes used on purpose

Percentage of usage of the precise modes

| Techniques | Overall | W=0.5cm | W=1cm | W=2cm |
|--------------|---------|---------|-------|-------|
| Shift&Freeze | 83% | 91% | 91% | 66% |
| Relative Pt. | 78% | 99% | 83% | 52% |



Design framework

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

