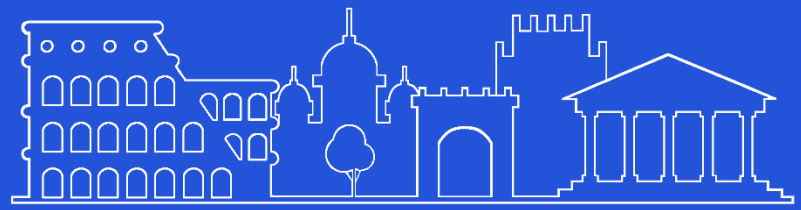
EUROVIS 2022

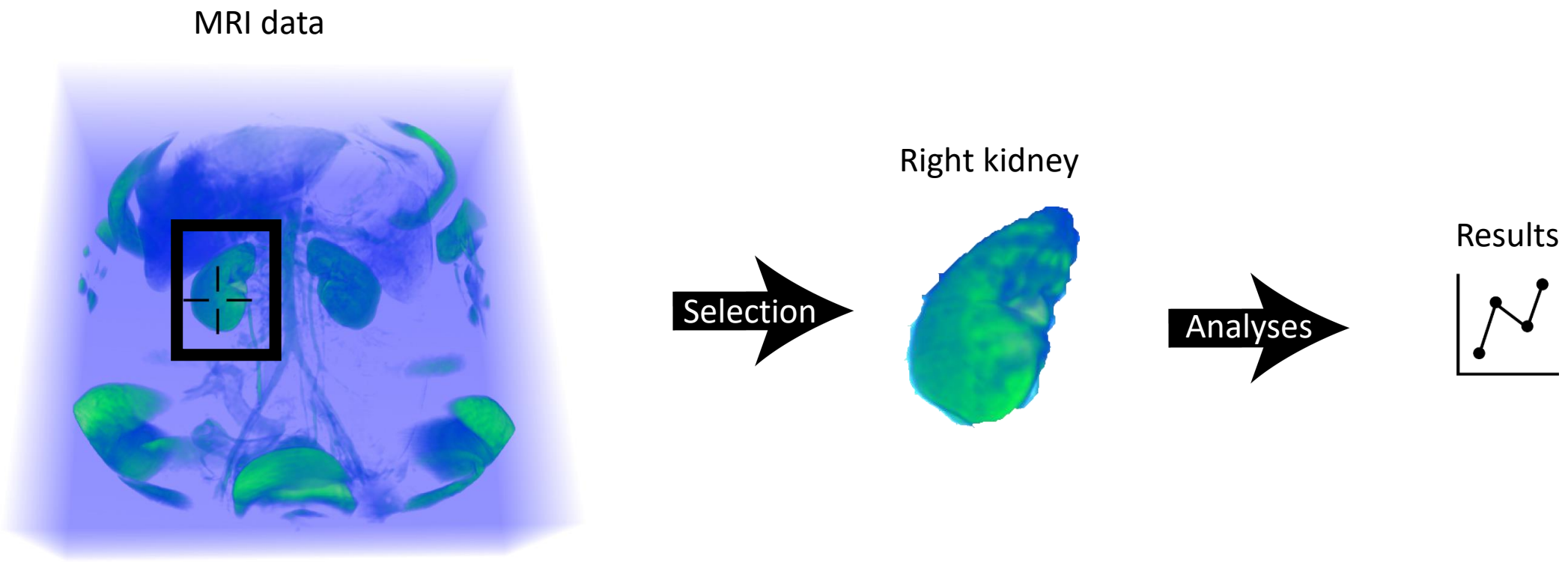
Hybrid Touch/Tangible Spatial Selection in Augmented Reality

Mickaël Sereno*, Stéphane Gosset, Lonni Besançon, Tobias Isenberg



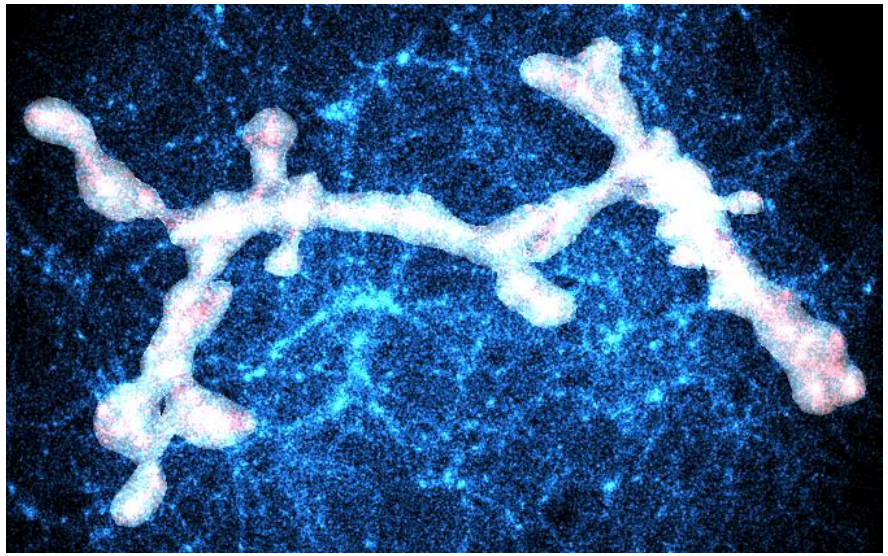
• 24th EG Conference on Visualization • Rome • 13-17 June 2022 •

Tasks: Select a subset of a 3D dataset
Analyse the right kidney

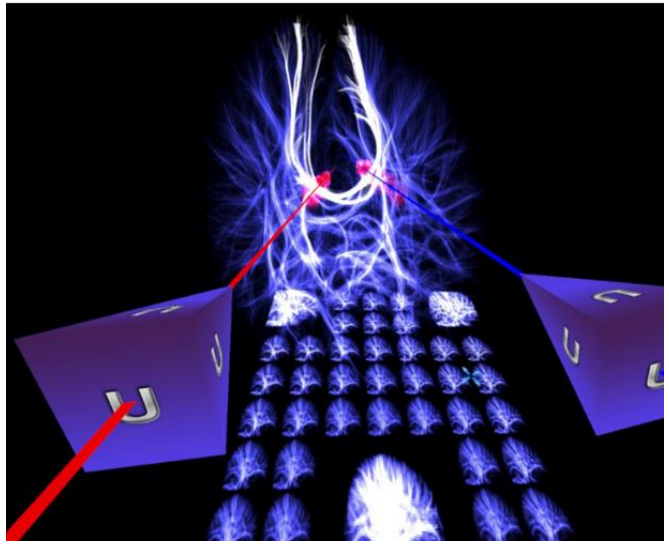


Benefits many types of data

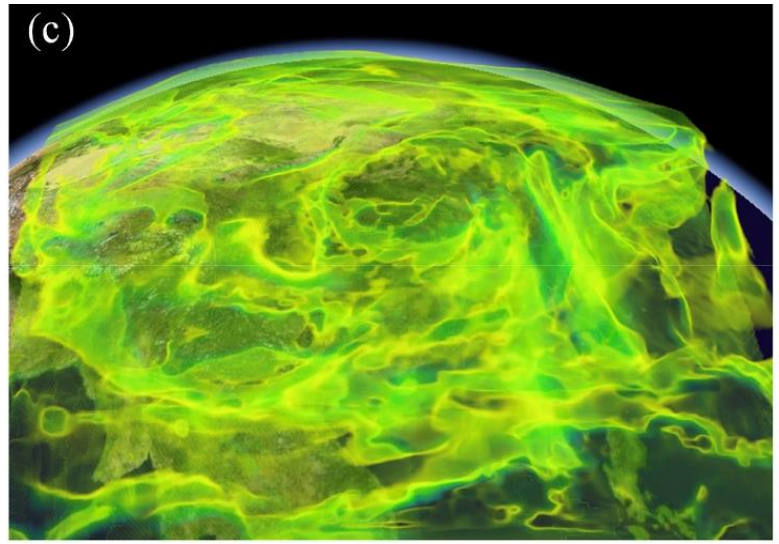
Cloud points (e.g., astronomy)



Trajectories (e.g., travels)

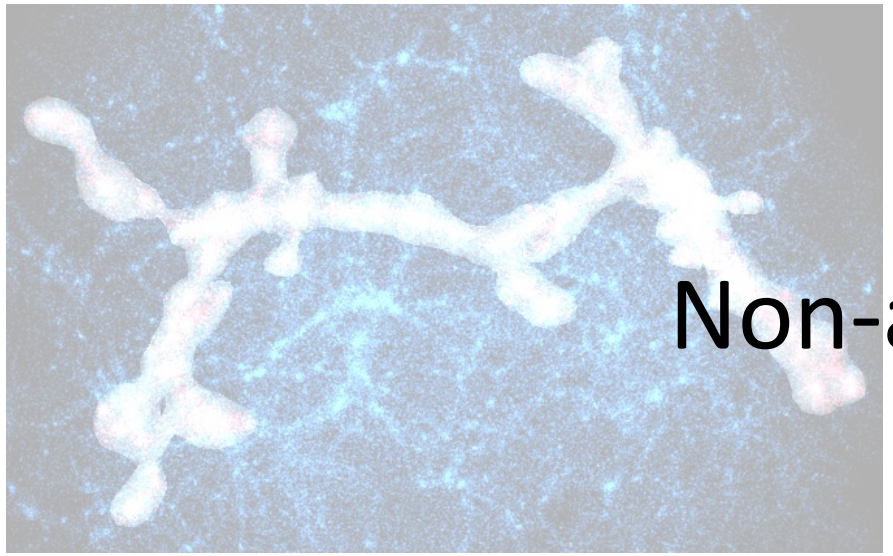


Scalar fields (e.g., weather)

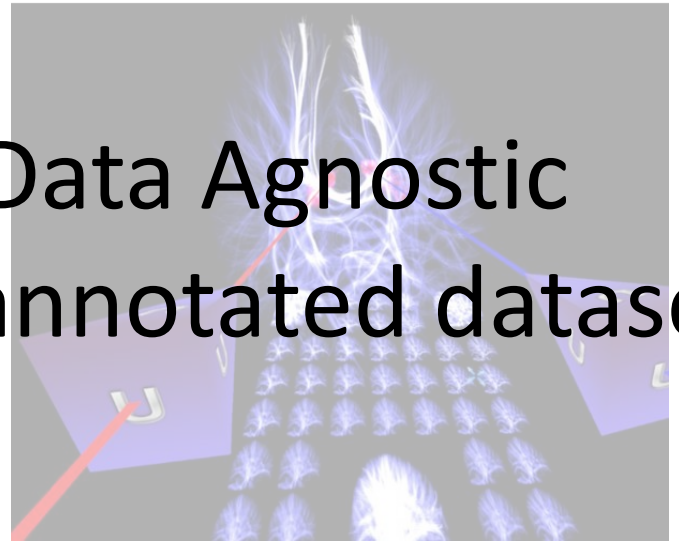


Benefits many types of data

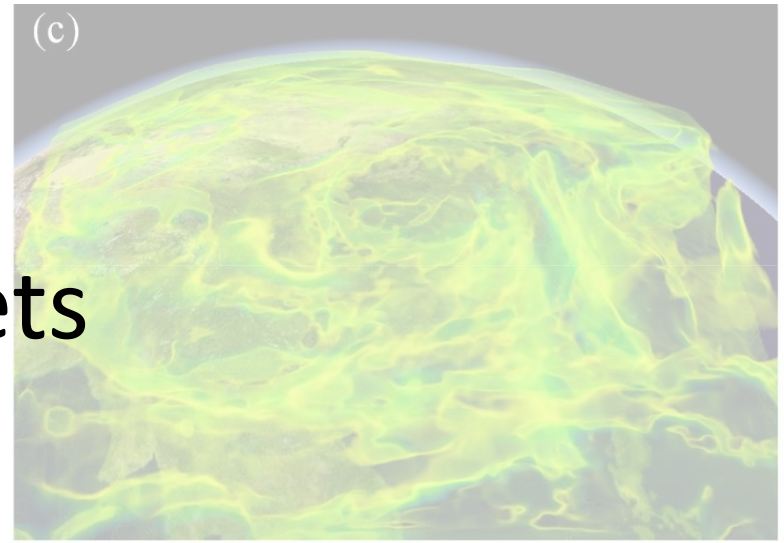
Cloud points (e.g., astronomy)



Trajectories (e.g., travels)



Scalar fields (e.g., weather)



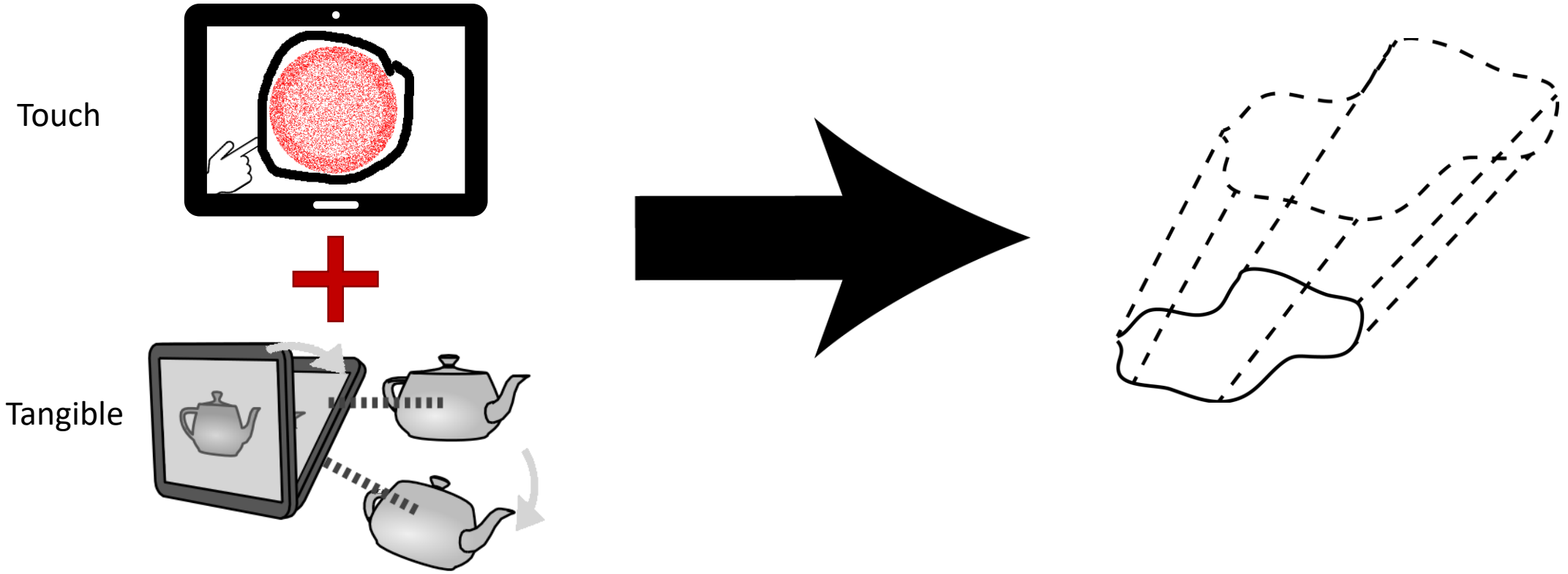
Data Agnostic

Non-annotated datasets

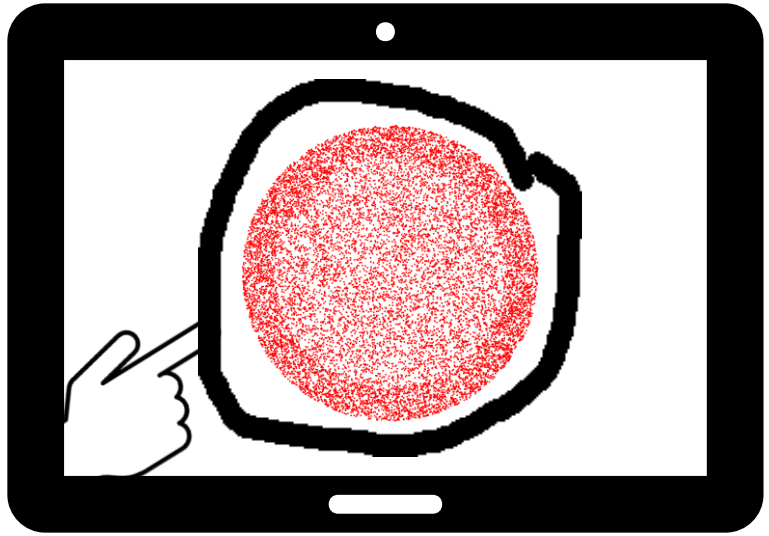
The Tangible Brush Project (EuroVis 2019)

L. Besançon, **Mickael Sereno**, M. Ammi, L. Yu, T. Isenberg, ‘‘**Hybrid Touch/Tangible Spatial 3D Data Selection’’**, 2019

Touch + Tangible → Brush the 3D space

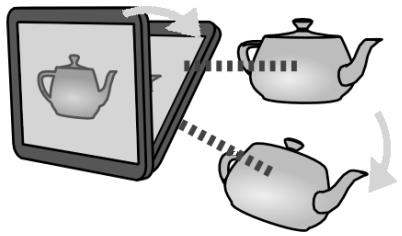


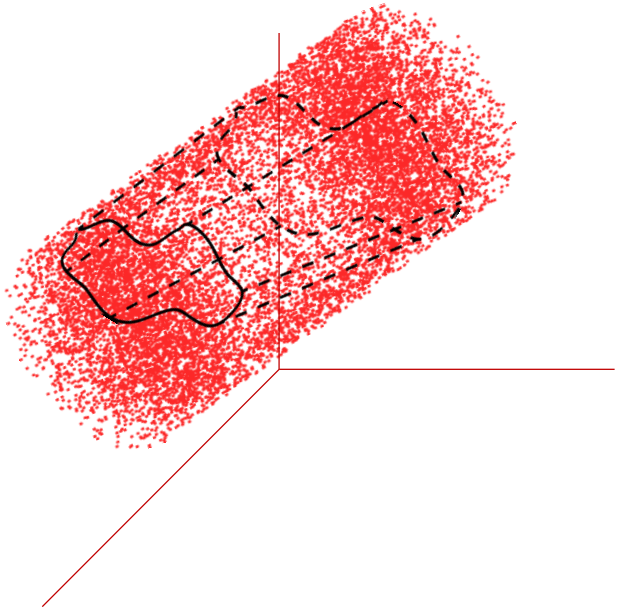
Brush the 3D Space: Main Steps



1. Draw the lasso (Determine size/shape)

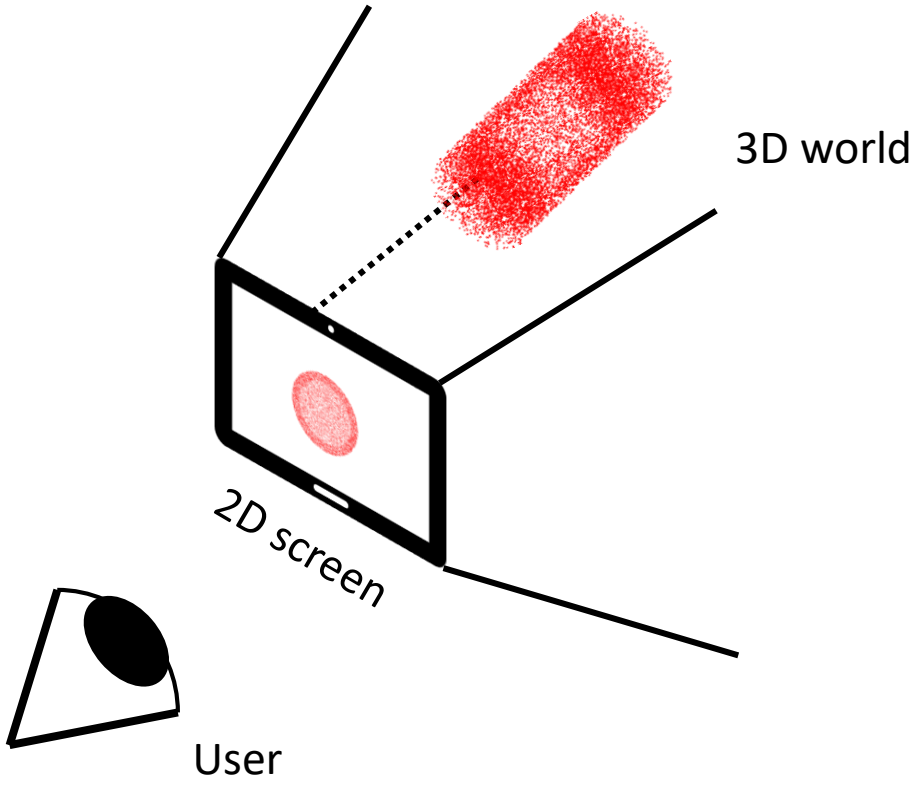
Brush the 3D Space: Main Steps



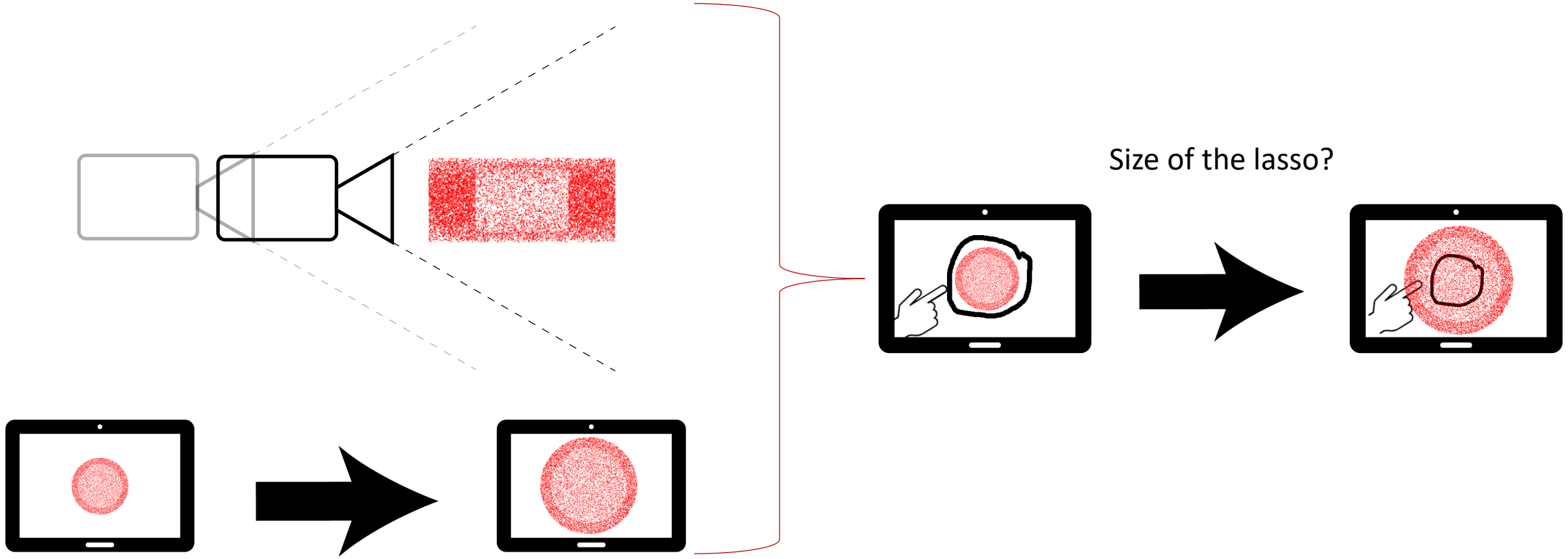


2. Move the tablet around (Determine path/start/end)

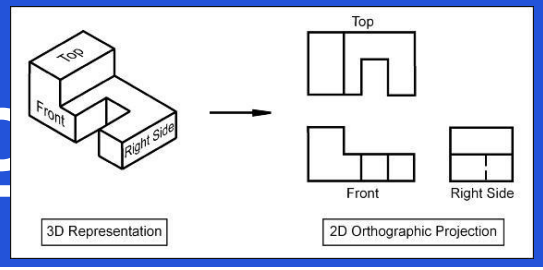
Tablet w.r.t 3D Space

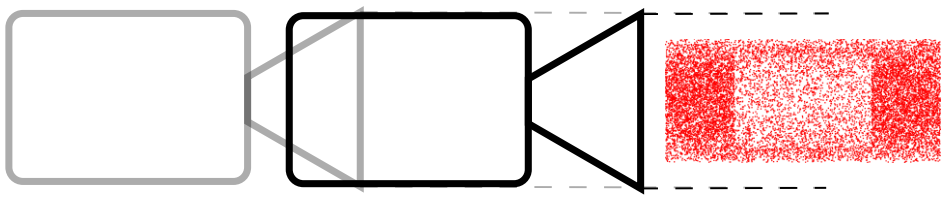


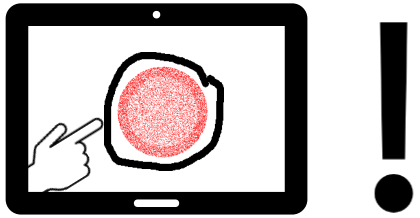
« 3D » perspective view

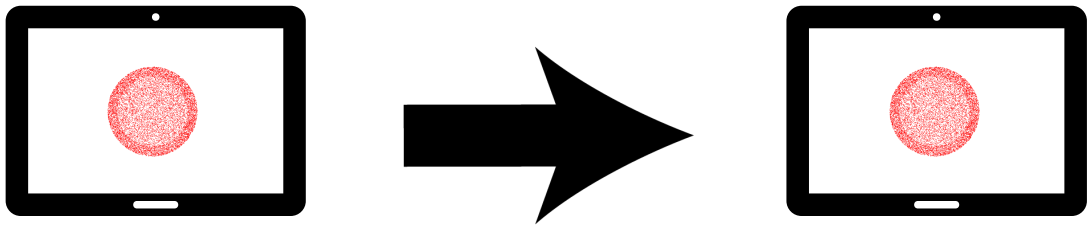


Orthographic





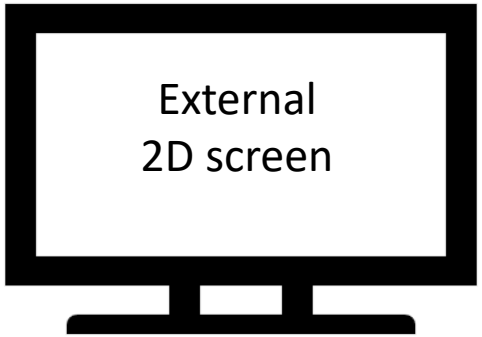




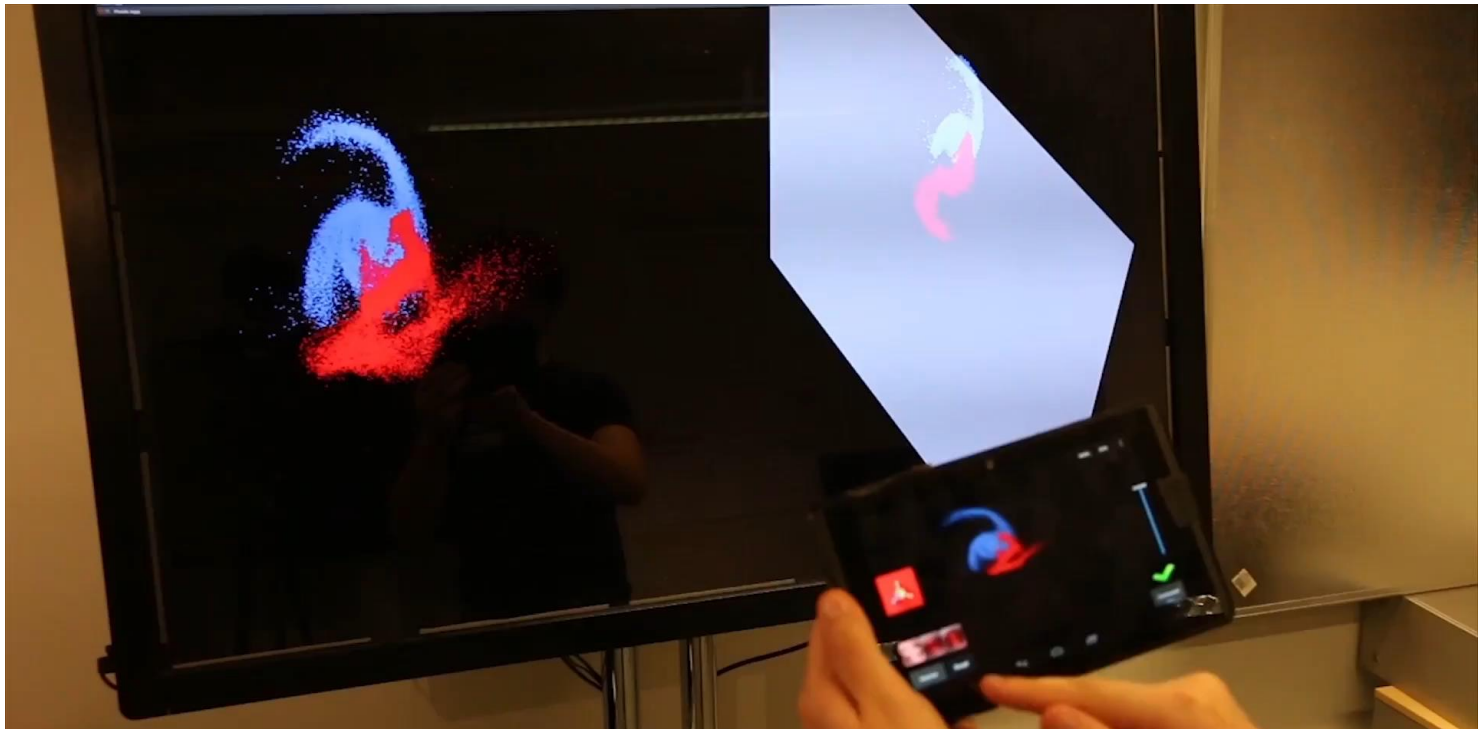
3D

Tangible Brush, Two Screens

Perspective

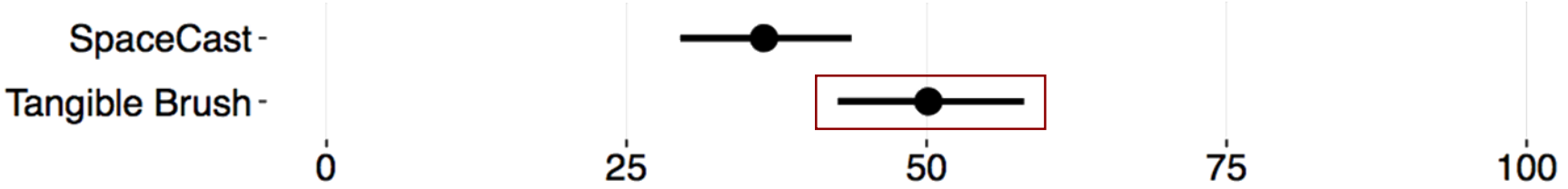


Orthographics



Tangible Brush
Accurate BUT Mentally Demanding

MCC score. **Tangible Brush more accurate**



Total Workload (TLX). **Tangible Brush more demanding**

Workload From 2D to 3D

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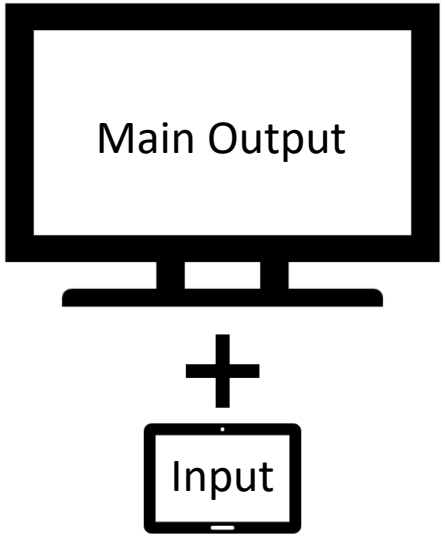
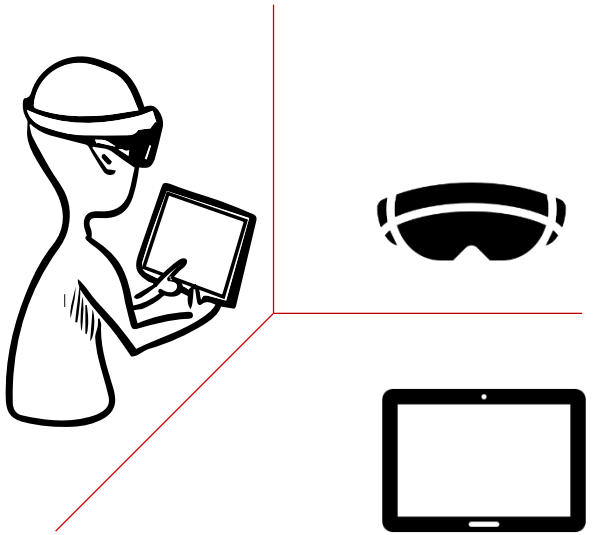
Original Approach



Decoupled

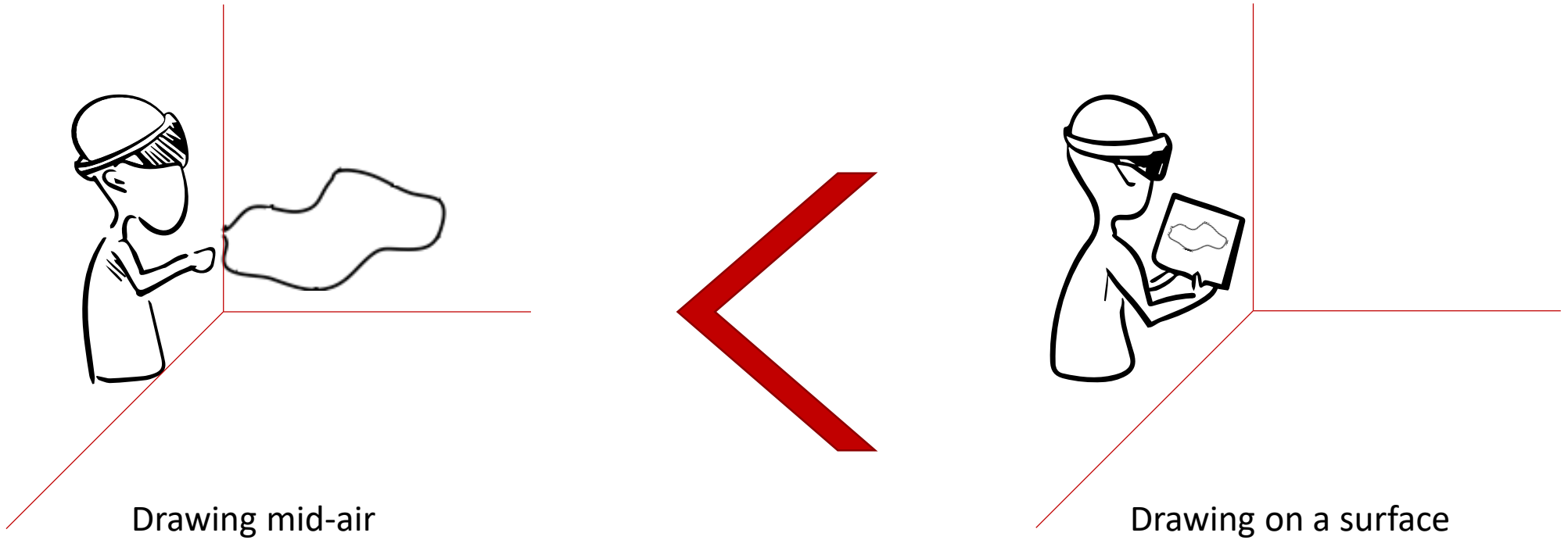
New Approach



Coupled

Is a tablet necessary?

Arora et al. (CHI, 2017) and Montano-Murillo et al. (VR, 2020)

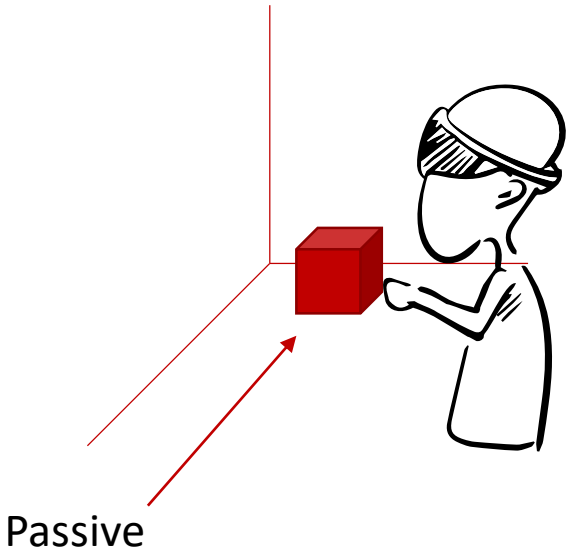


Drawing mid-air

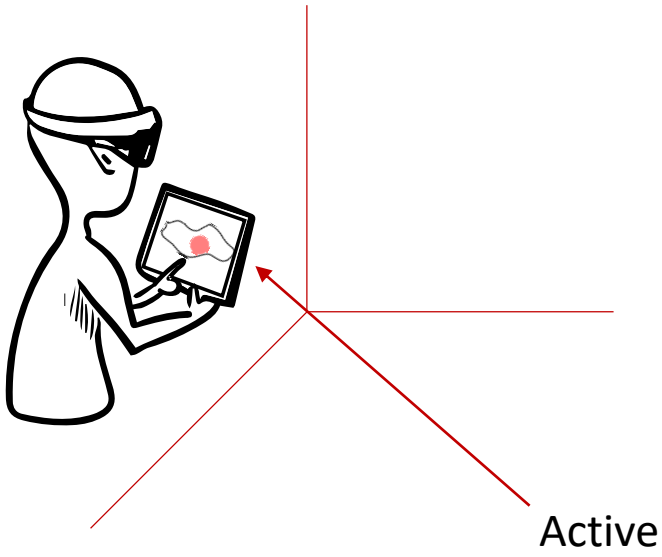
Drawing on a surface

Active Tangible Device

Usually

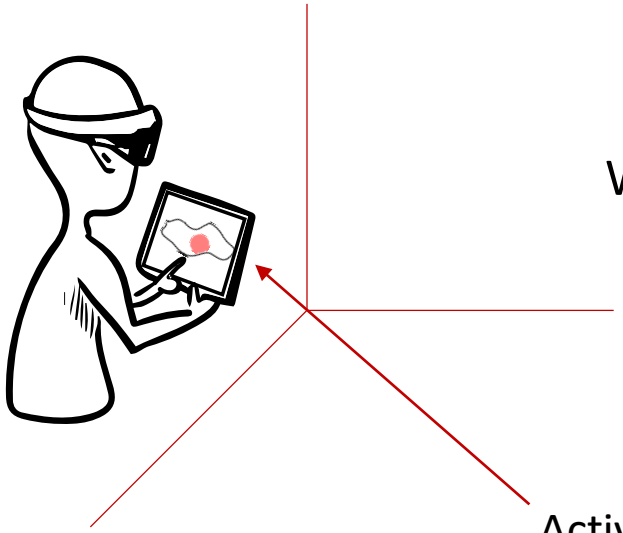


Now



Active Tangible Device

Now

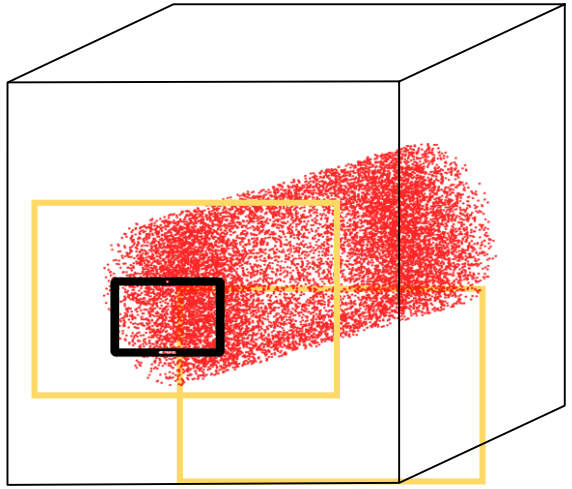


What are the implications of using an active tangible device where its 3D properties have meanings in the user's 3D space?

3D properties:

- Size
- Position
- Rotation

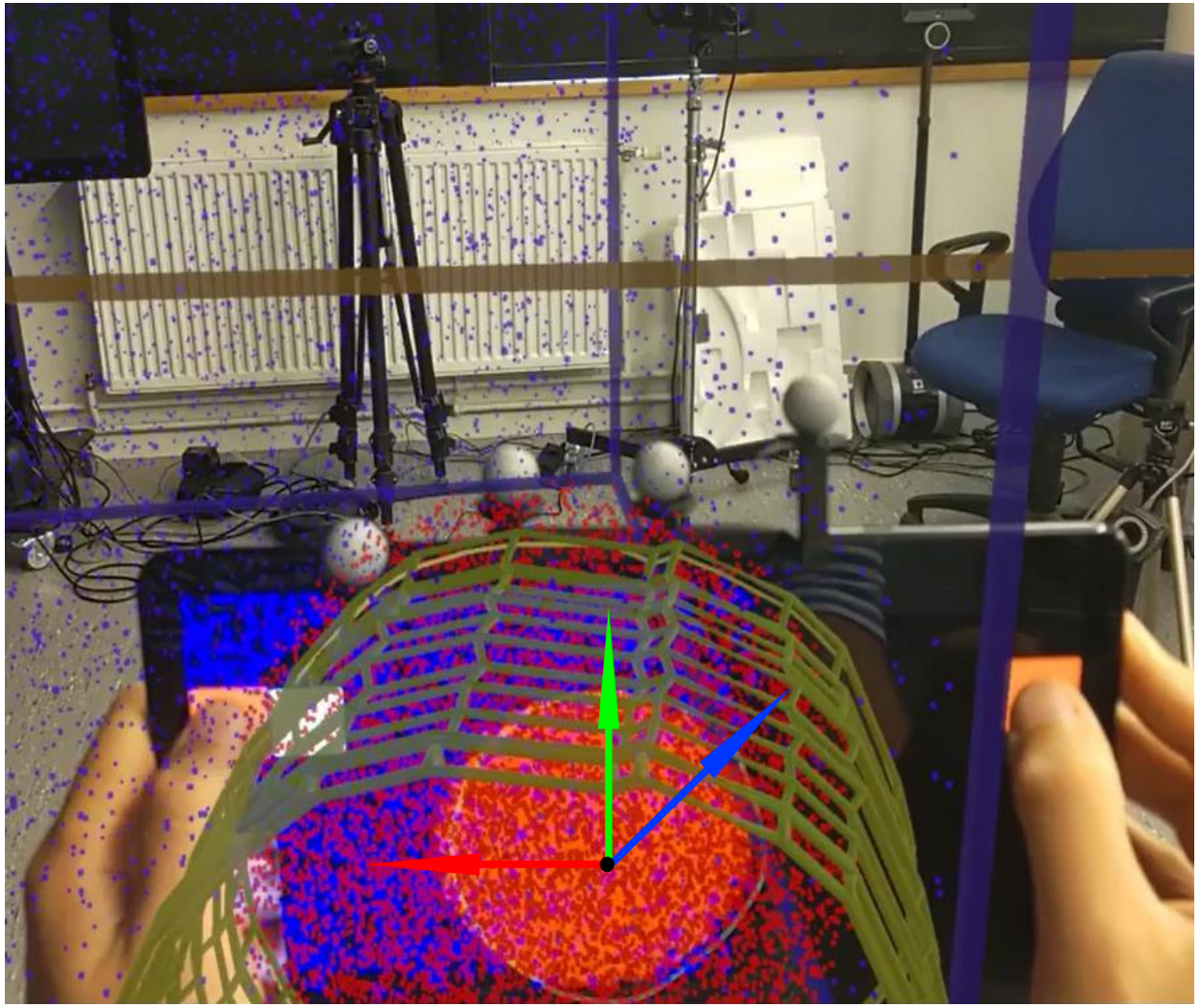
First issue: Scaling



Physical tablet: 10.5’’

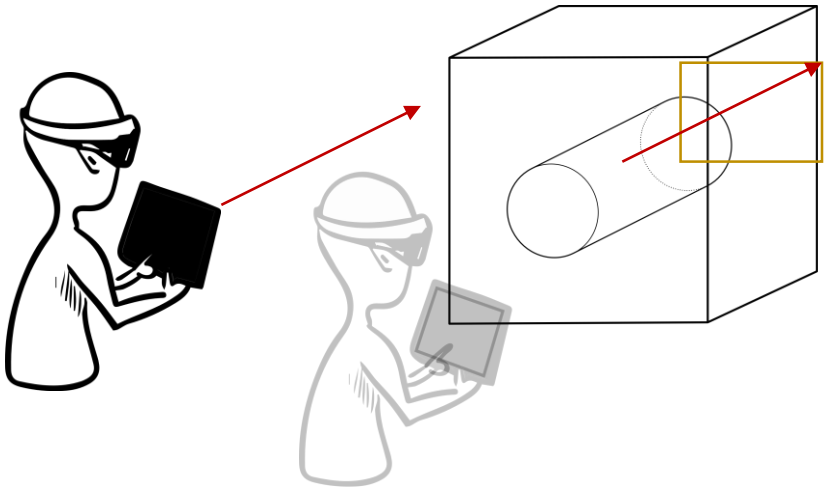
Virtual tablet: modular

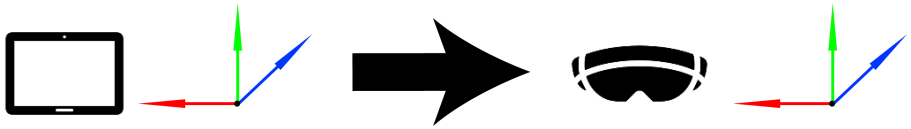
Position and Rotation
Mapping 1: Naïve Approach

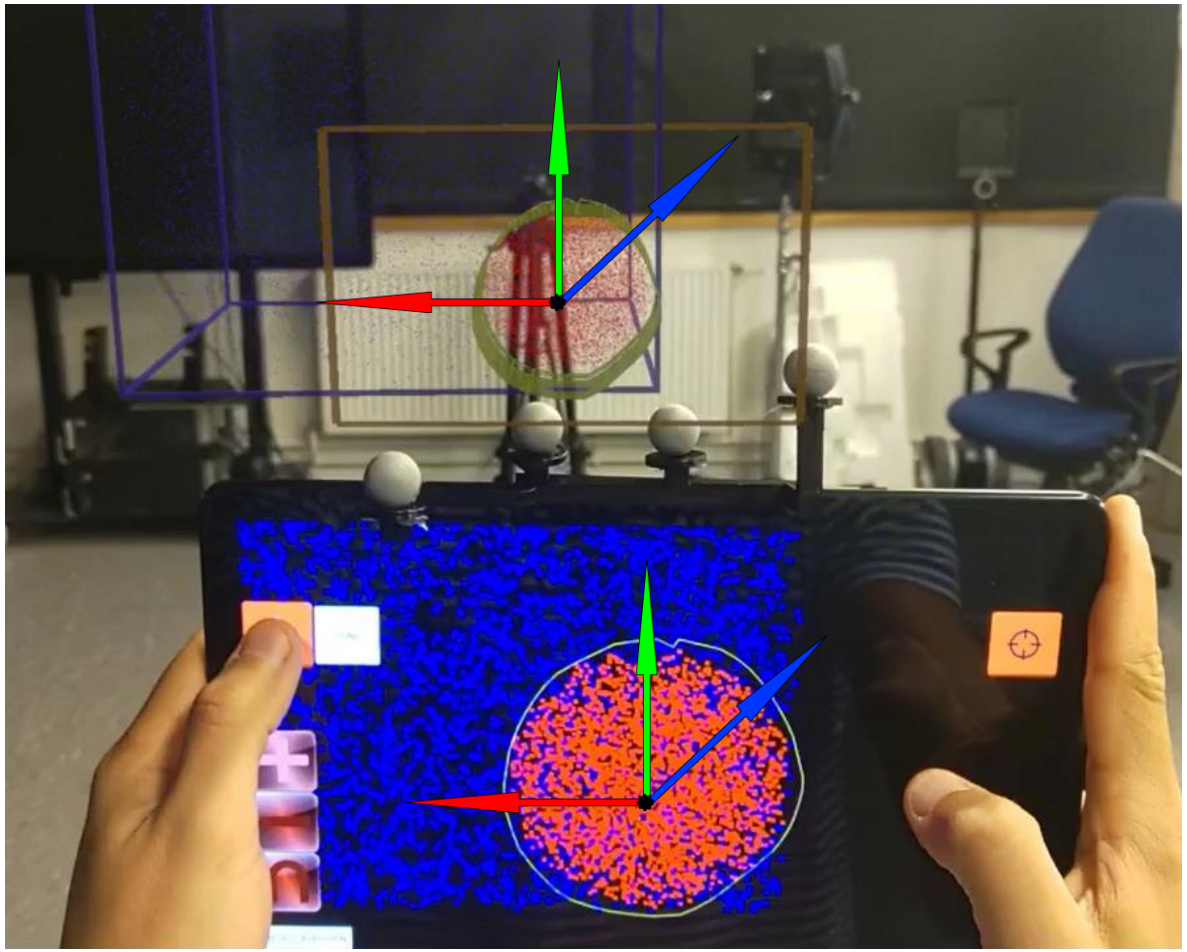


Position and Rotation Mapping 2: Relative-Aligned

Same orientation (w.r.t the 3D space)

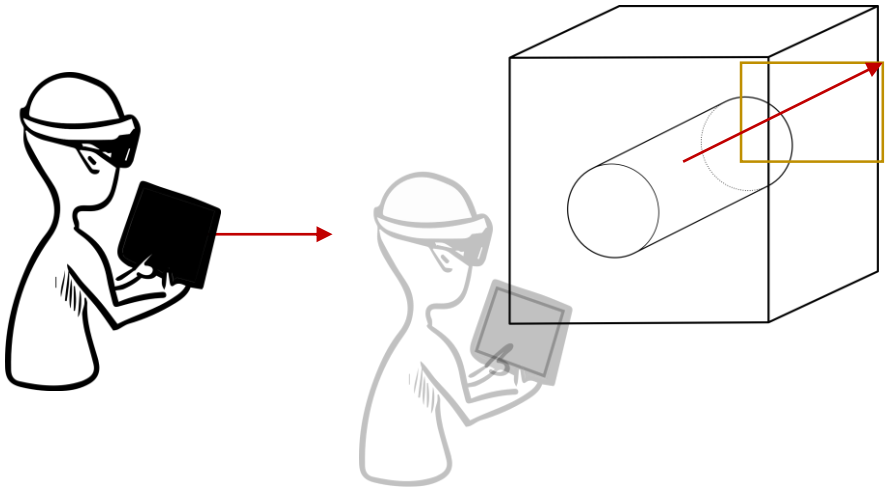


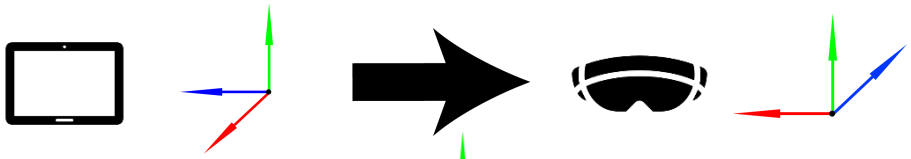


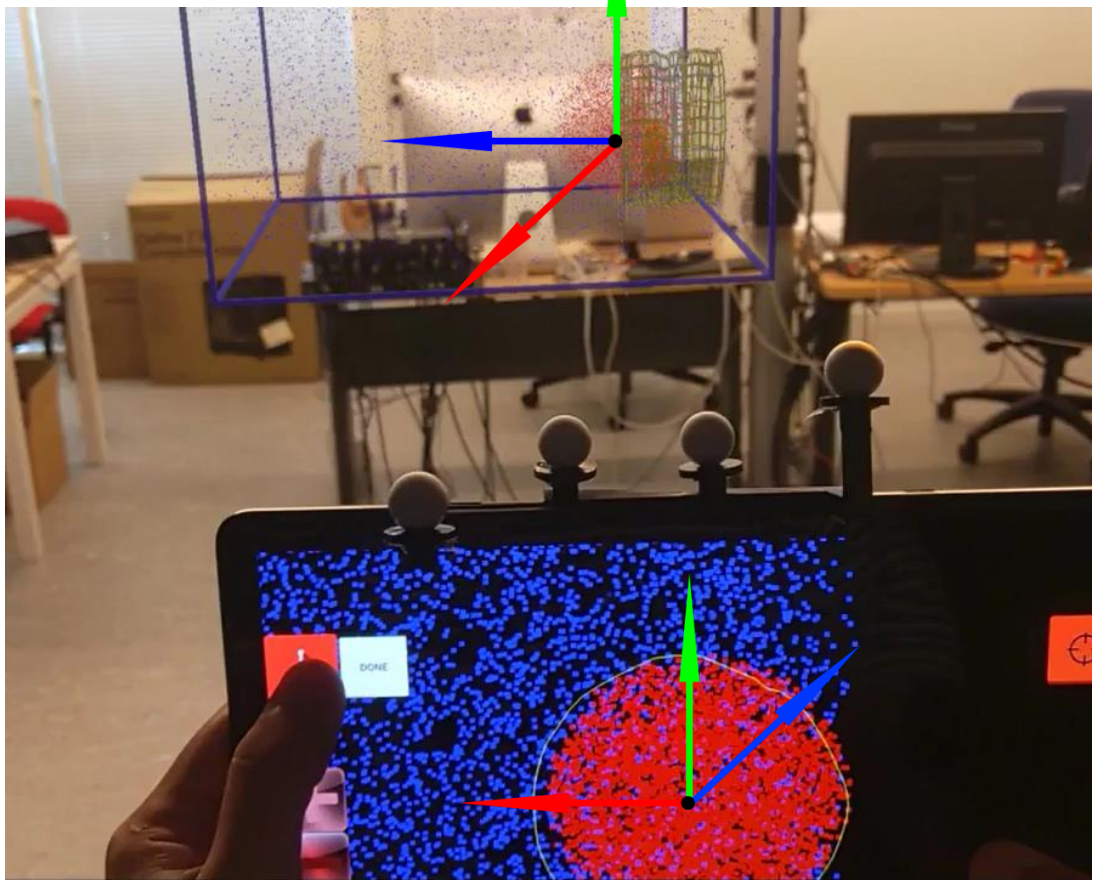


Position and Rotation Mapping 3: Relative-Full

Clutched Interaction
(same orientation w.r.t the tablet)

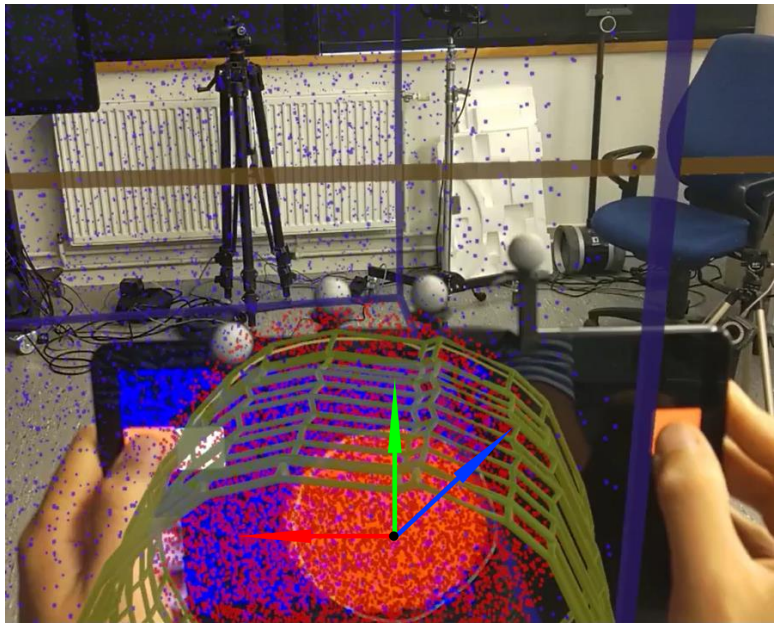




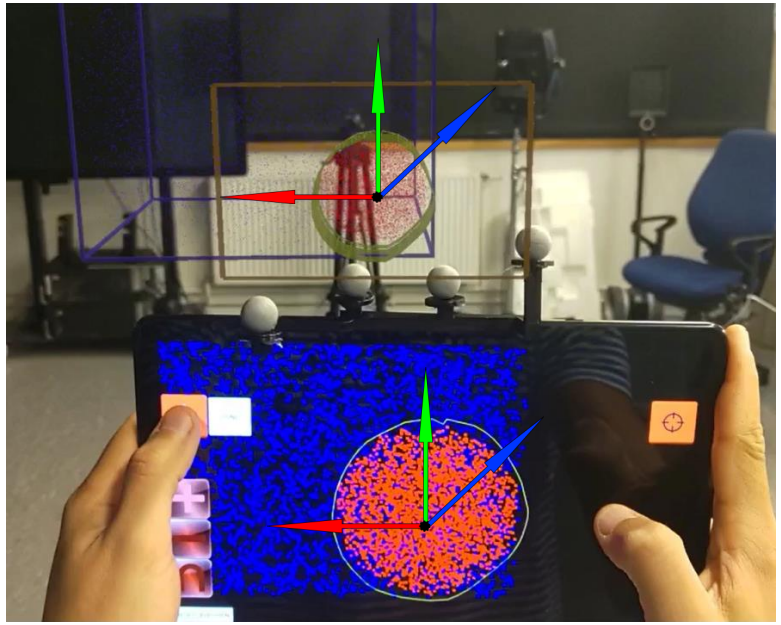


Position and Rotation Summary

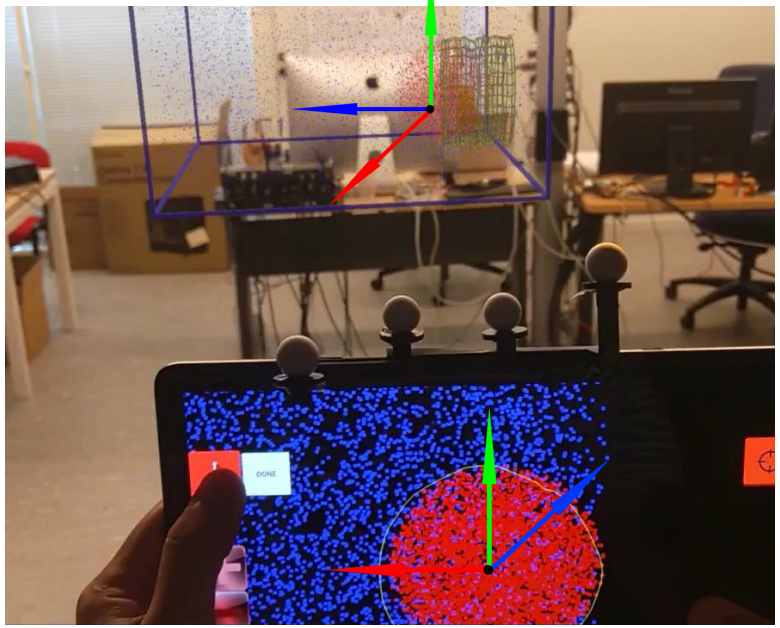
Naïve Approach



Relative-Aligned

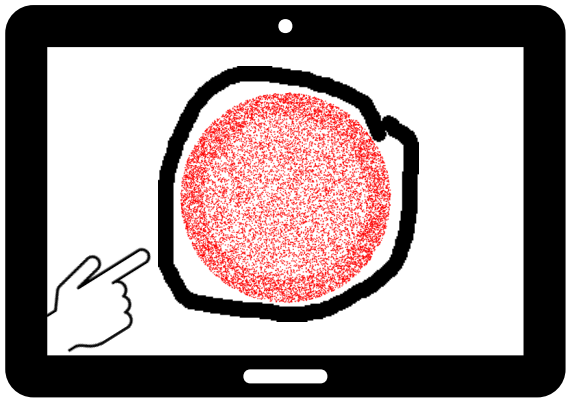


Relative-Full

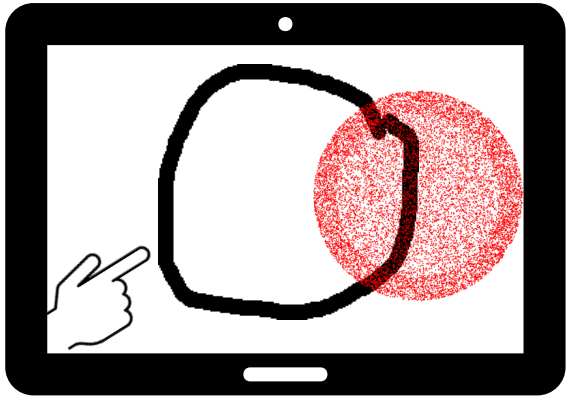


Relative Mappings

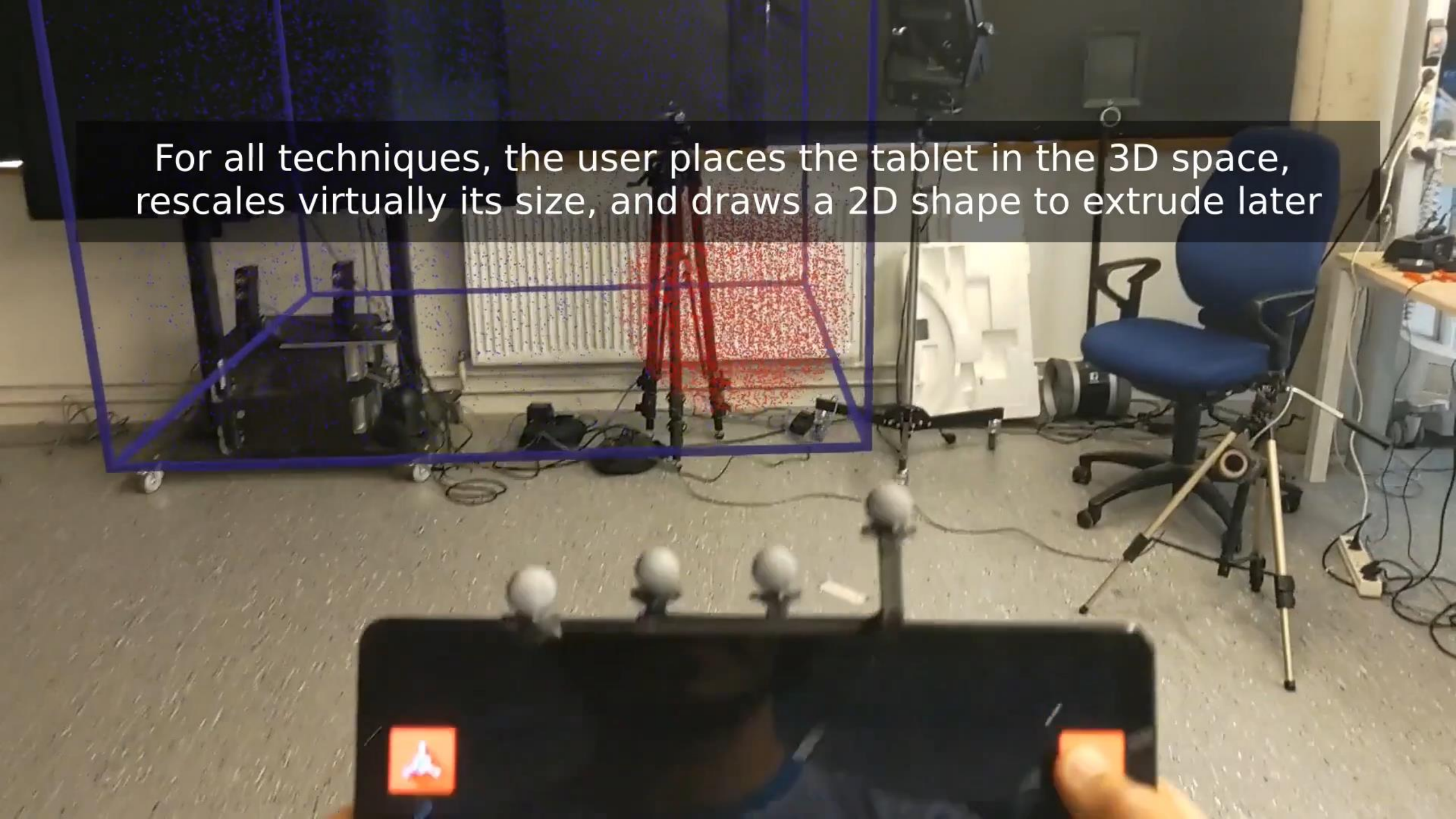
Constantly tracking the tablet?



Constantly tracking the tablet?

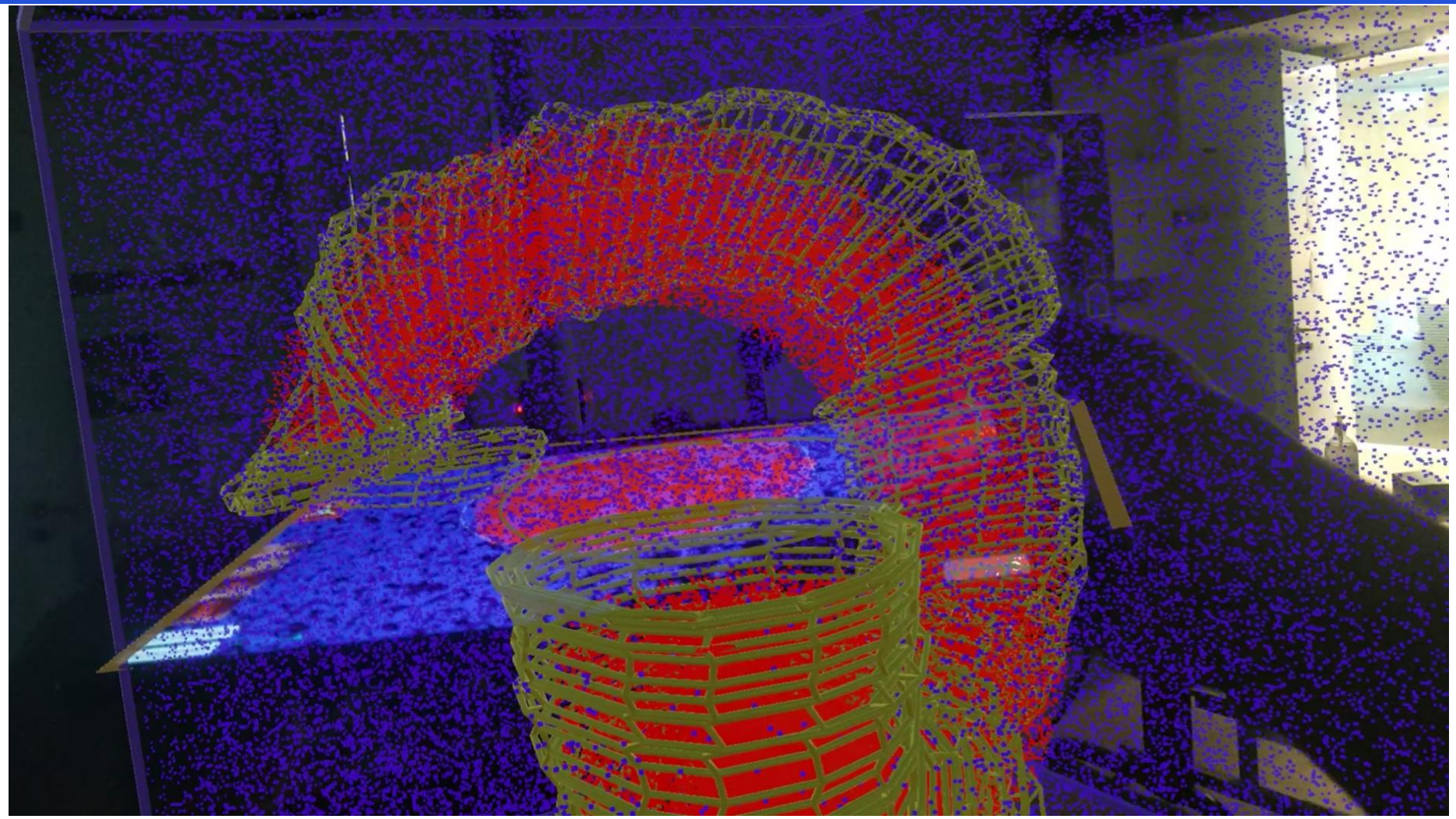


Freeze the view
to draw on a steady view

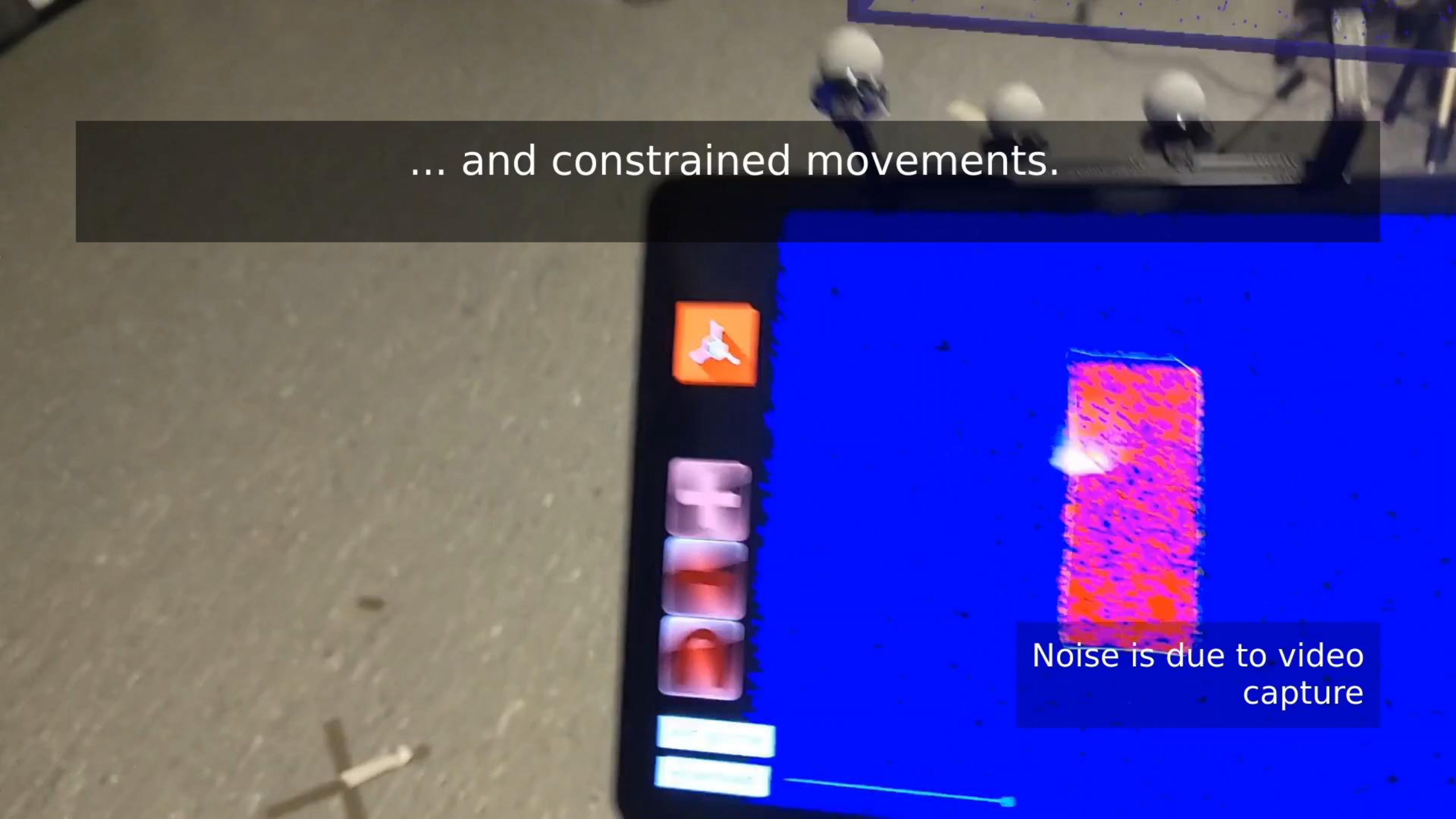

For all techniques, the user places the tablet in the 3D space,
rescales virtually its size, and draws a 2D shape to extrude later


Users can use unconstrained movements…
(Relative-Full – Clutched Interaction)

Example of Unconstrained Selection



... and constrained movements.

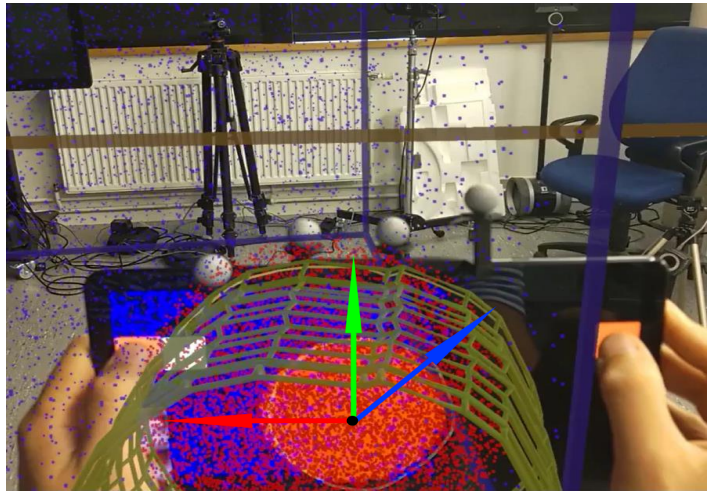


Noise is due to video capture

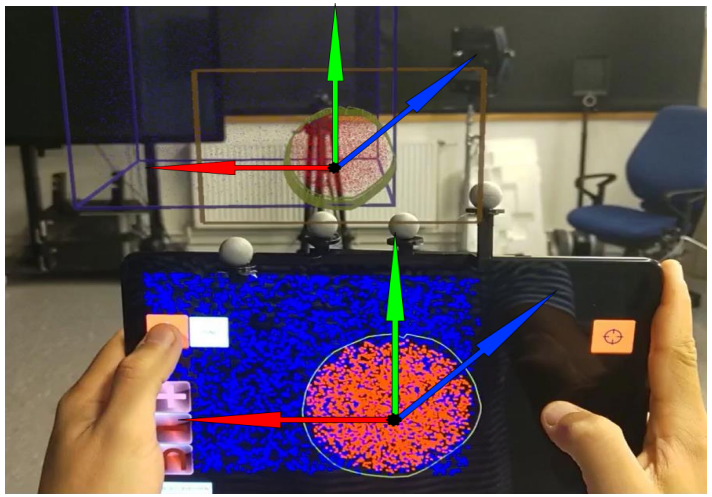
User Study

3 mappings

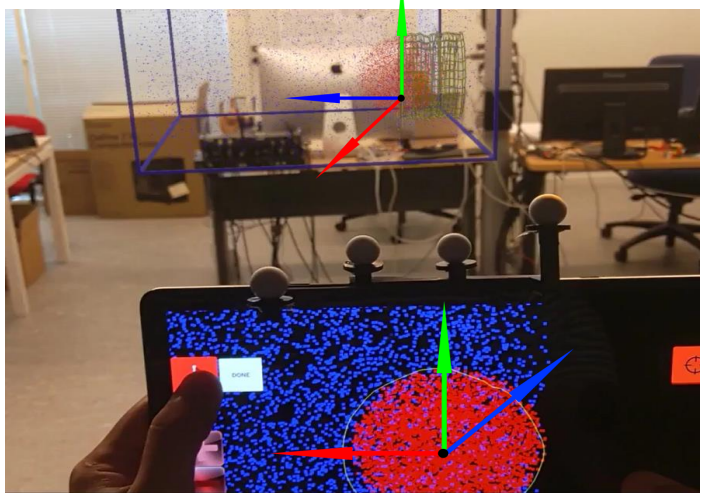
Naïve Approach



Relative-Aligned (position)

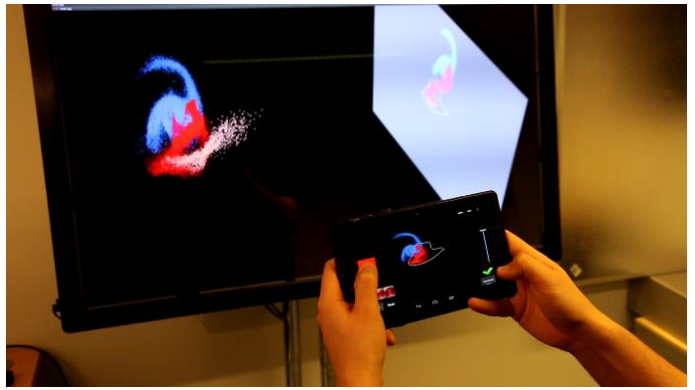


Relative-Full (position + rotation)



Relative Mappings

1 mapping



Two User Experiments
Within-Subject. Select Red, do not select Blue

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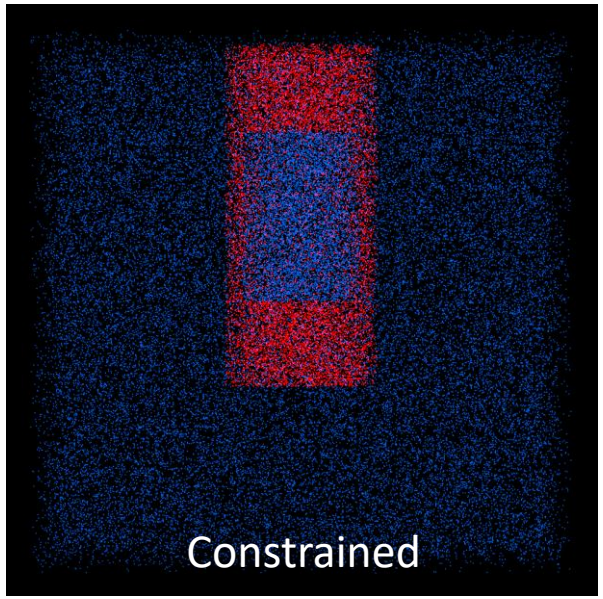
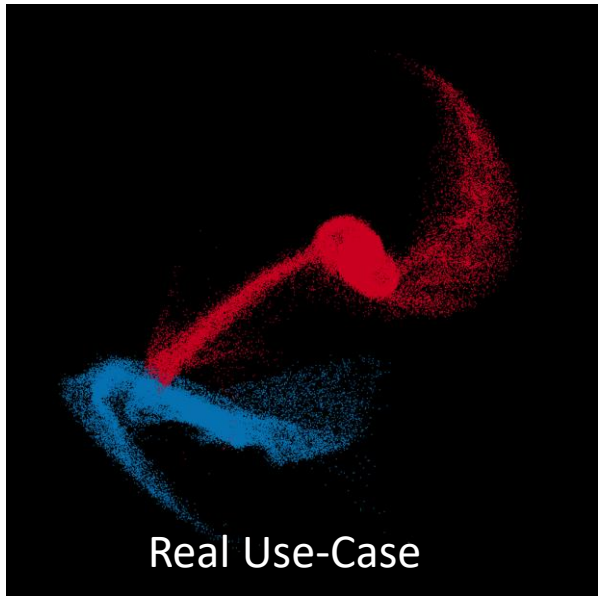
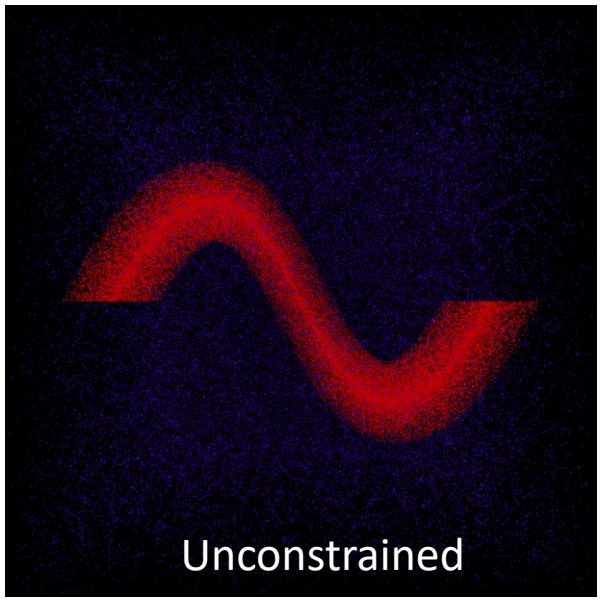
Two User Experiments

2X18

- AR alone
- “Best” AR vs. 2D



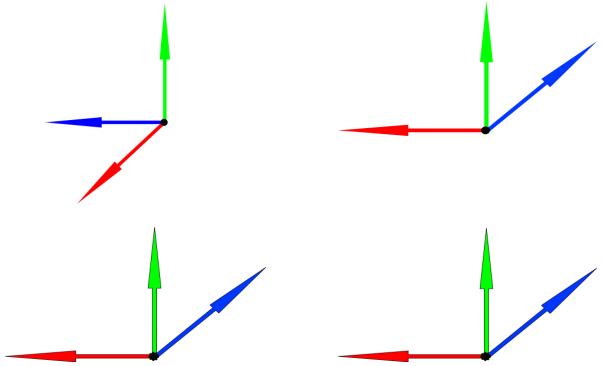




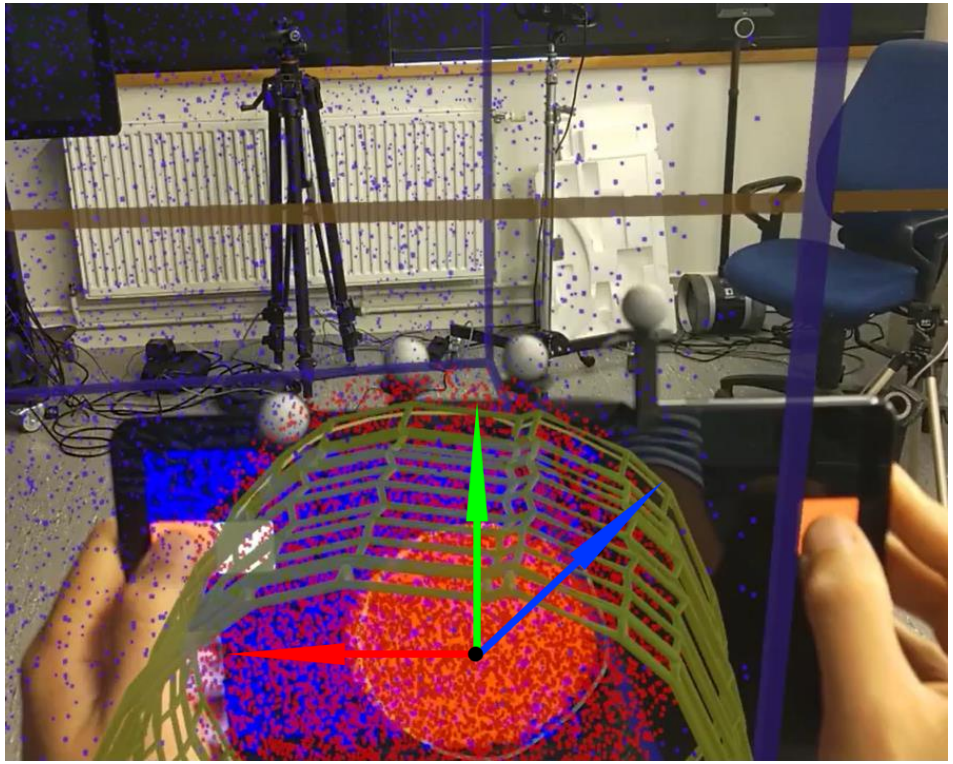
Experiment (AR)

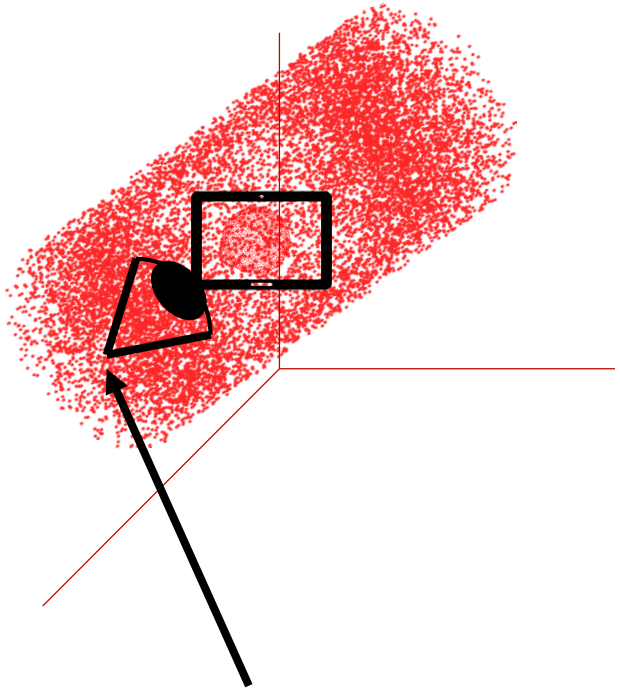
- **Relative-Full**: most accurate (But small size-effect)
- **Relative-Aligned**: required lowest effort
- **Relative-Aligned**: Preferred

  Naïve Approach: Least Preferred.
- Main Focus:



Issue with Direct Interaction
Naïve Approach

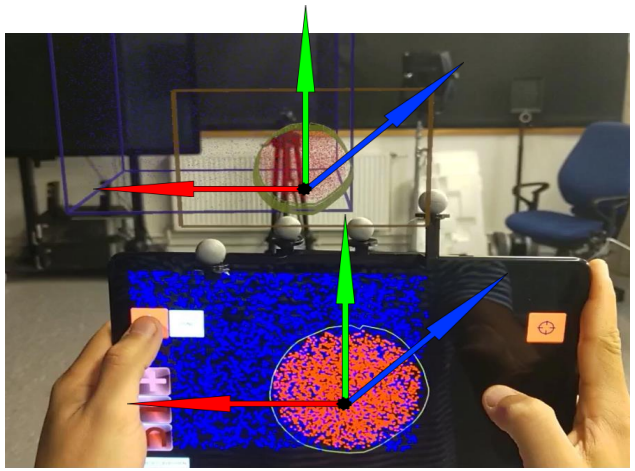




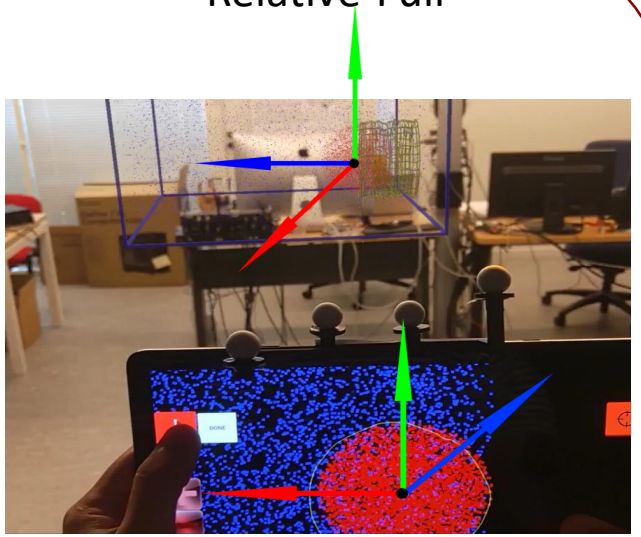
- Conflict between tablet and AR headset
- Lack of Scene-overview

AR - Overall

Relative-Aligned

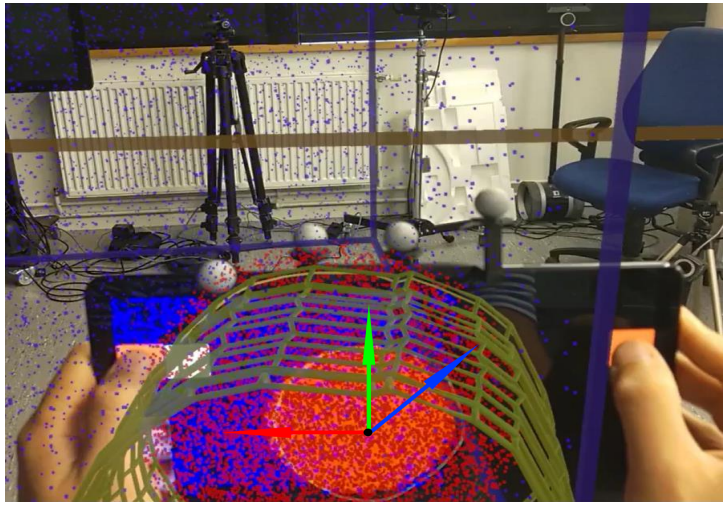


Relative-Full



Relative Mappings

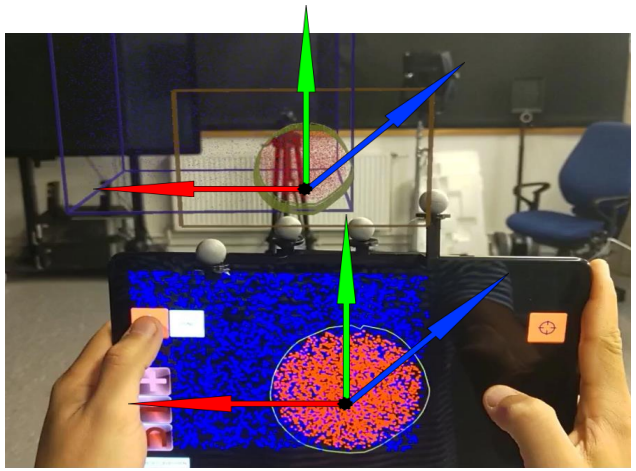
Naïve Approach



Experiment (AR vs. 2D)
Same protocol, different participants

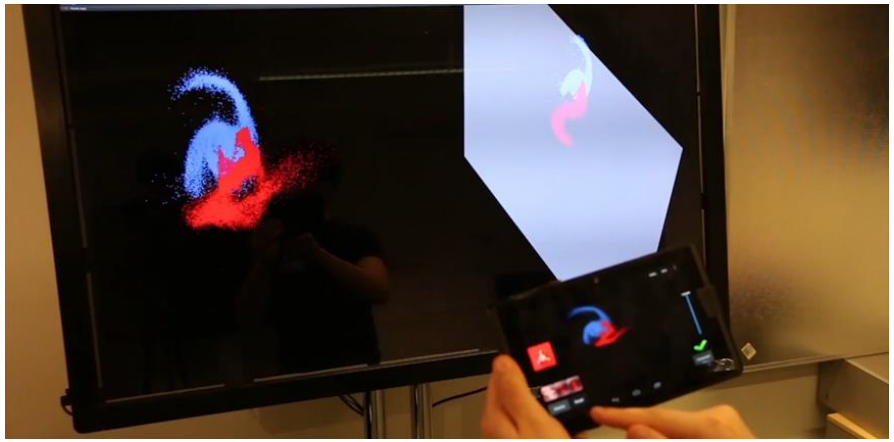
EUROVIS 2022

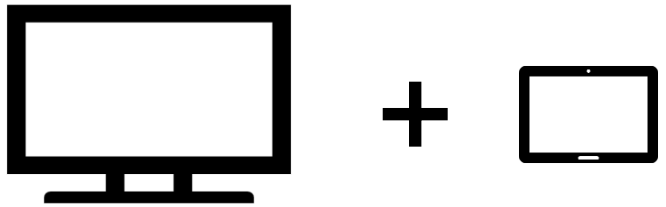
Relative-Aligned



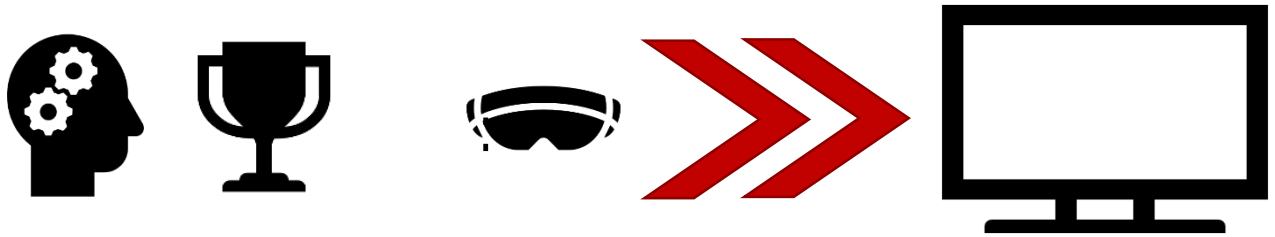
VS.

Original Setting

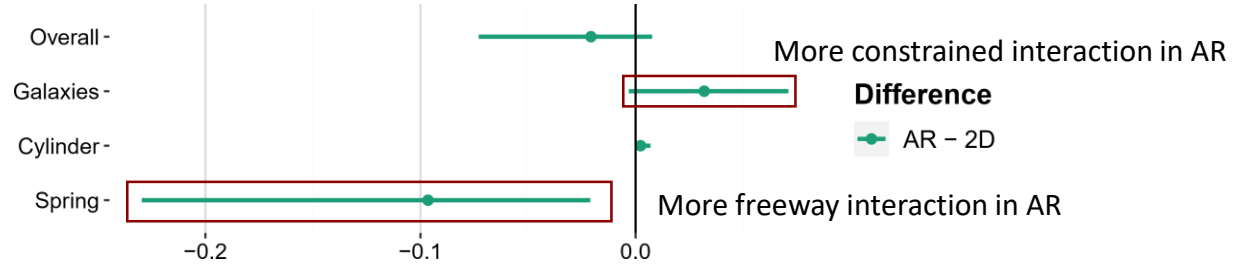




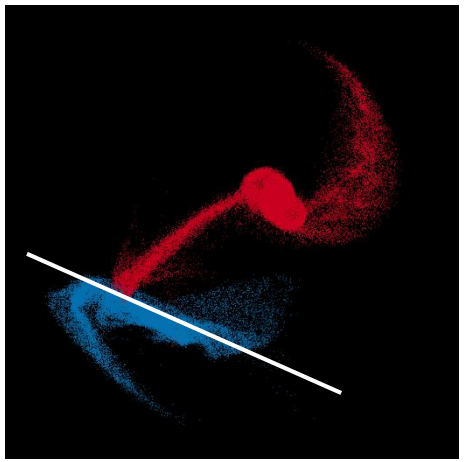
Experiment (AR vs. 2D)

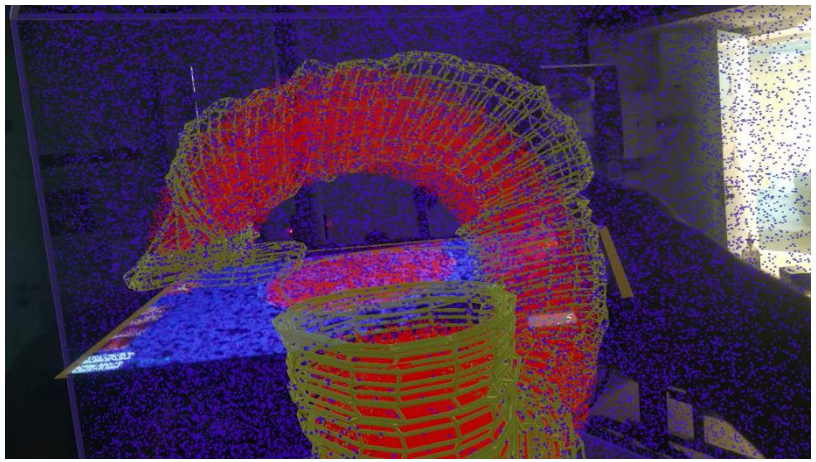
-  : Similar
- 

Experiment (AR vs. 2D)

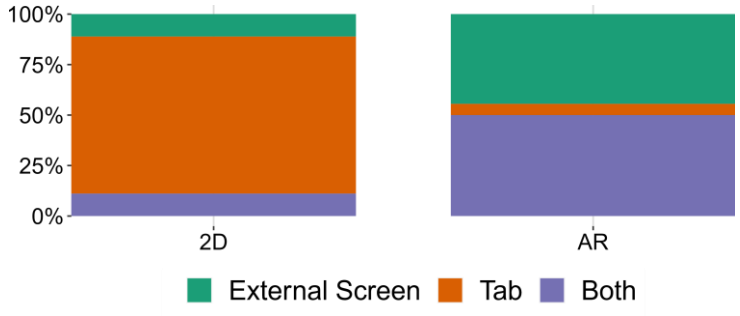


Constraint/Total operations.
Participants understood better the 3D visualizations in AR.

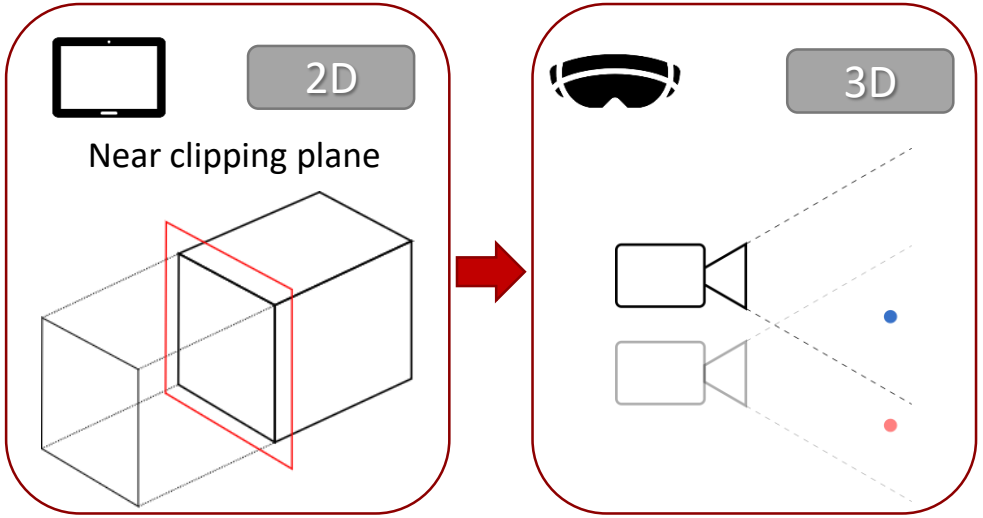




Experiment (AR vs. 2D)



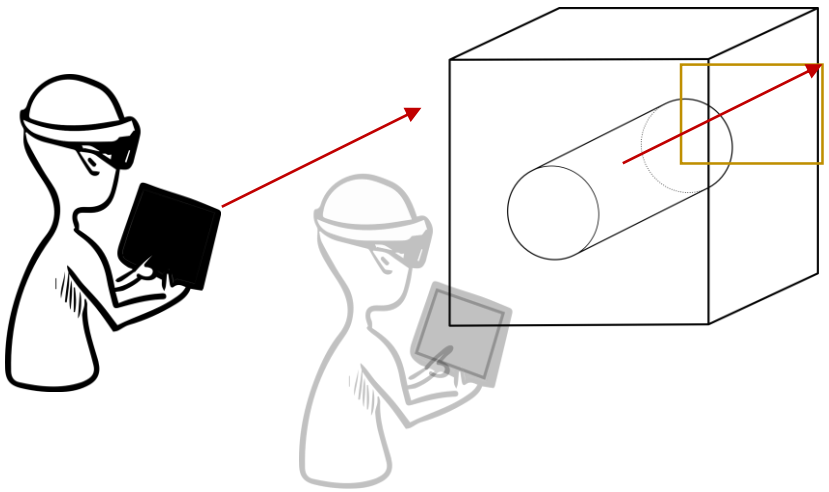
Participants' focus.
Switch from the Tablet to the AR view



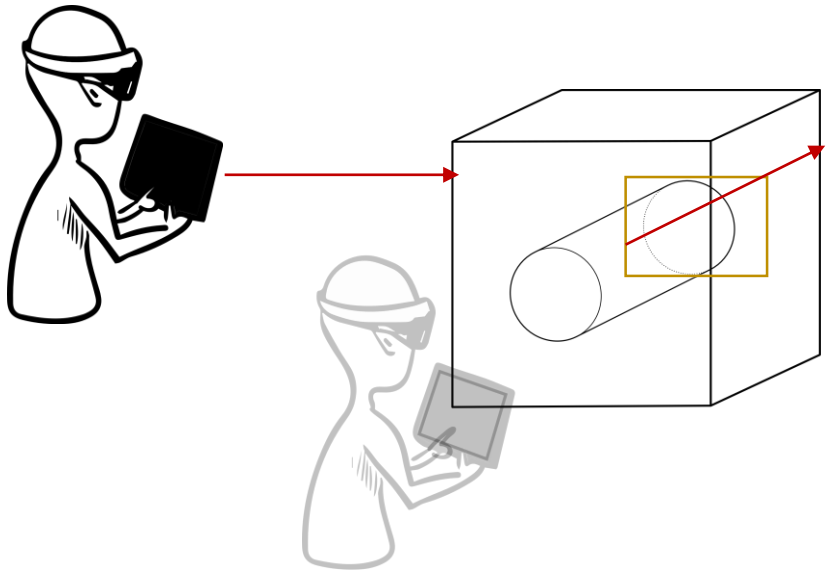
Insights about Users' strategies

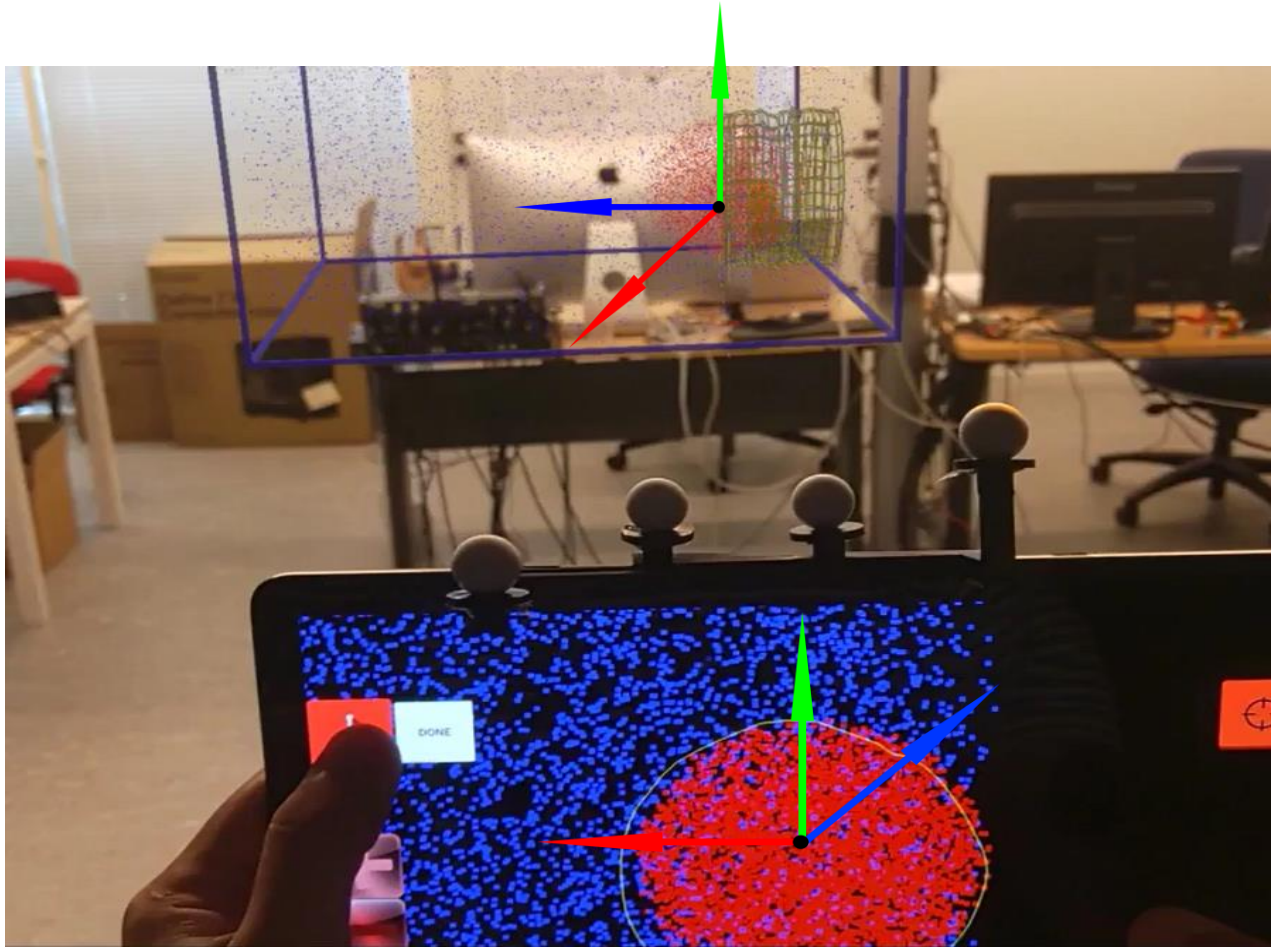
And future work…

Behaviors (Relative-Aligned)

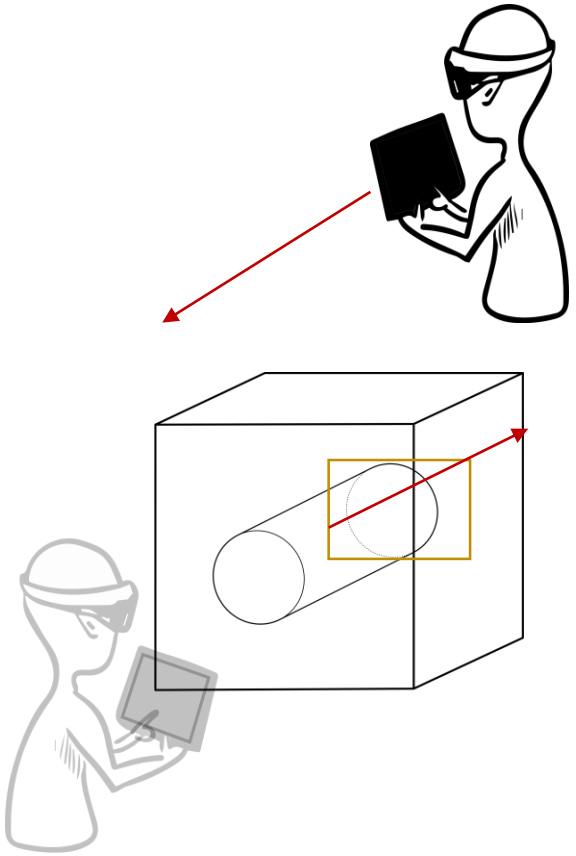


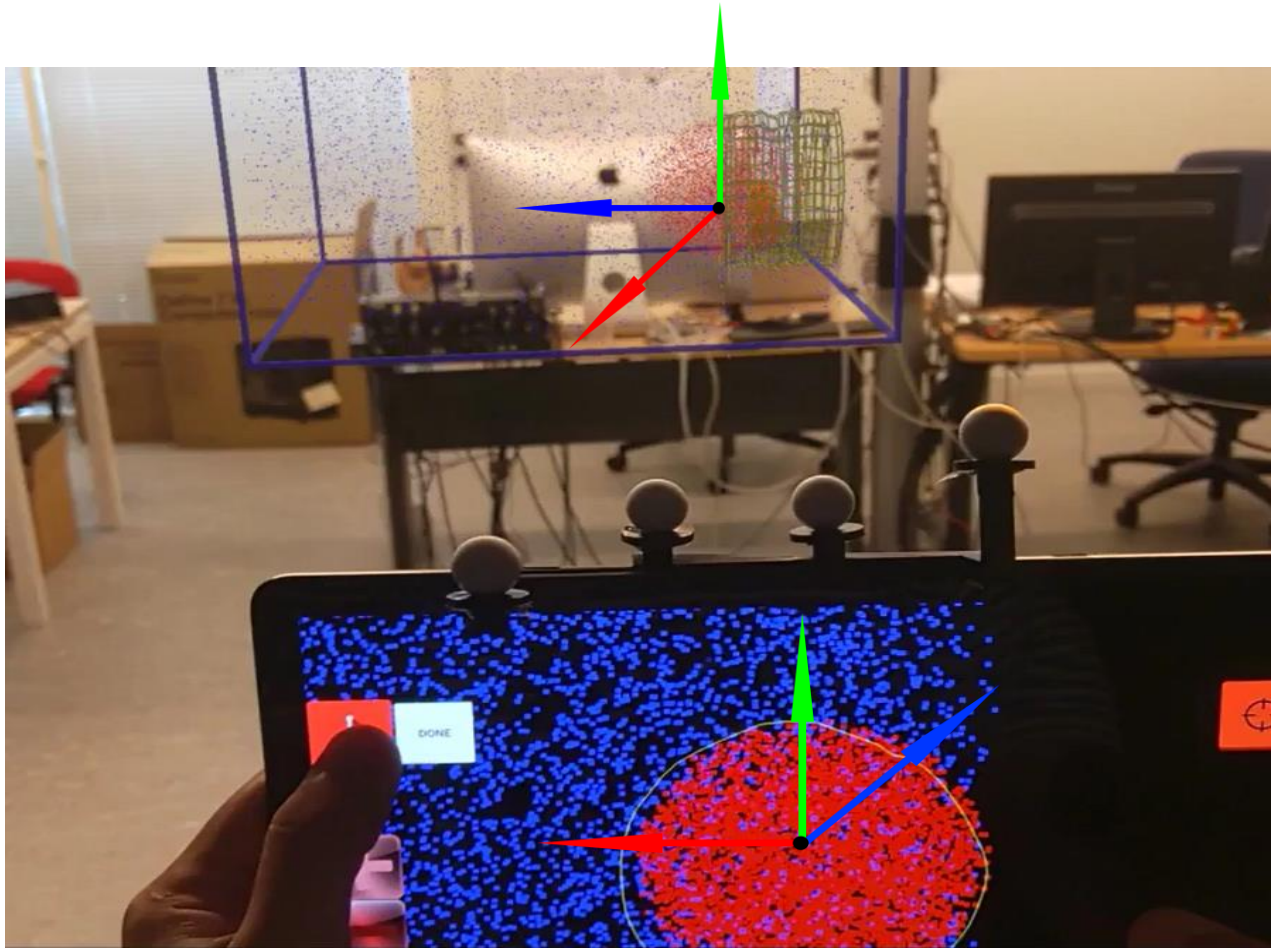
Behaviors (Relative-Full)



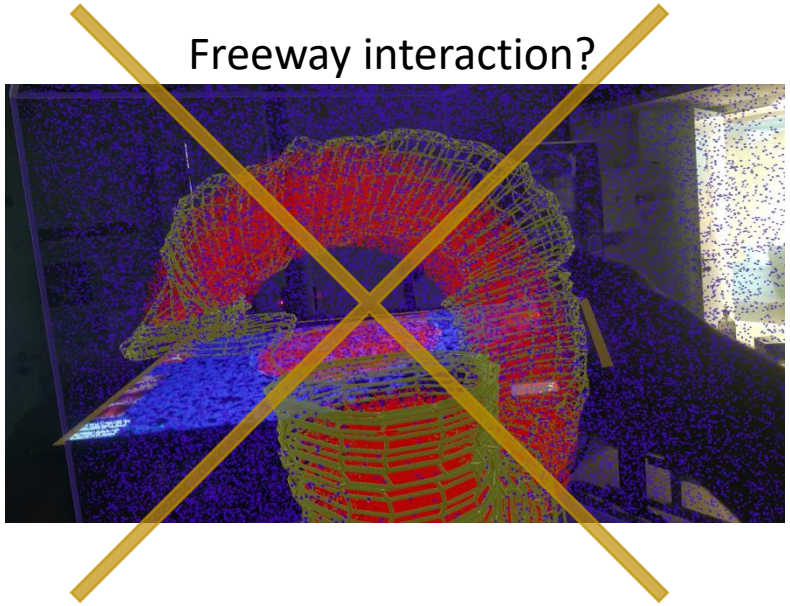


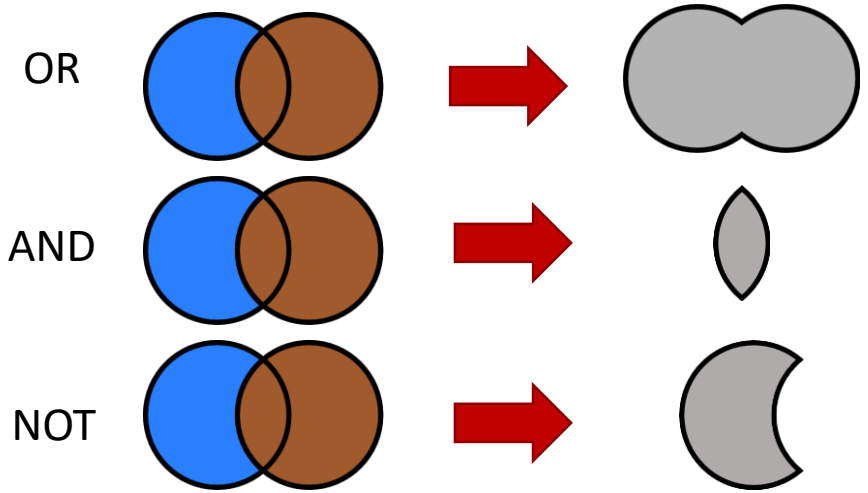
Behaviors (Relative-Full)





Mainly constrained operations



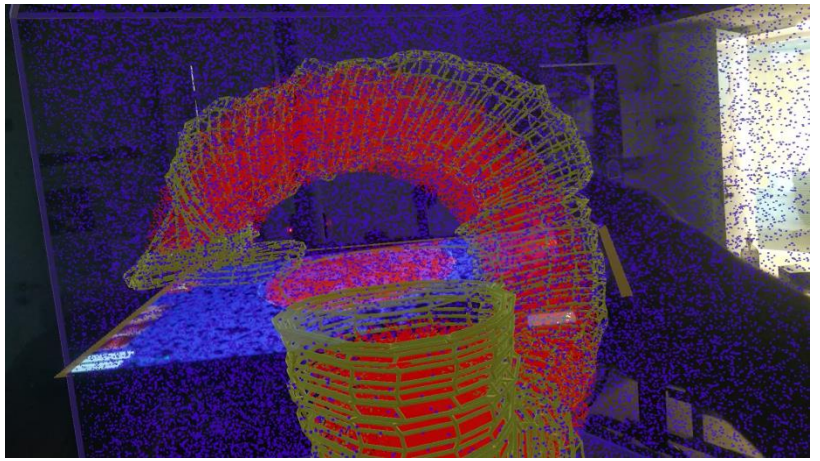


Participants mostly relied on 1-dimensional extrusions

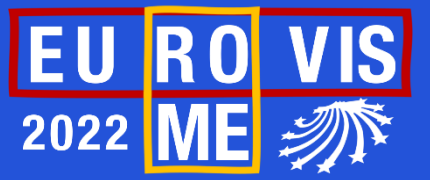
Future Work

- Test for different rotations (Relative-Full)
  - 45°
  - 90°
  - 180°

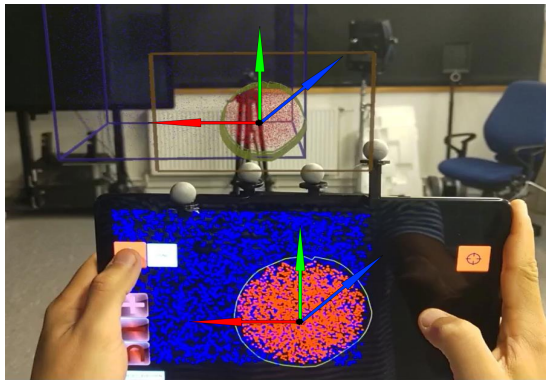
- Test the human’s ability to handle multiple degrees of freedom
  - By studying trained users?

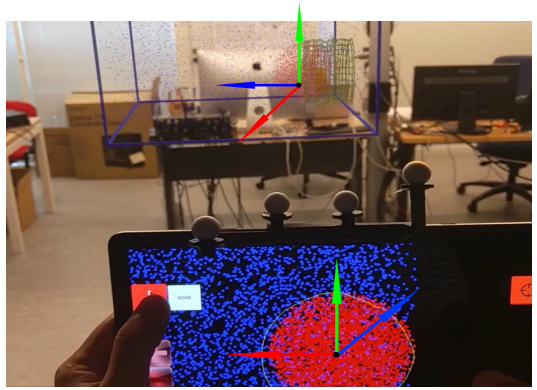


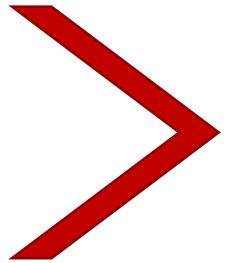
Summary

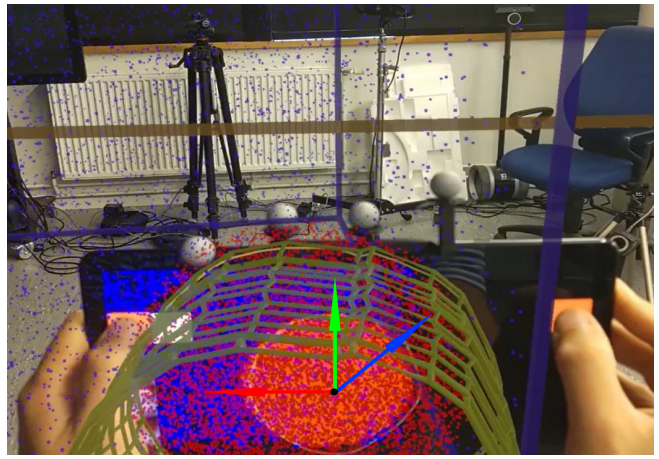


- Relative Mappings


Relative-Aligned


Relative-Full




Naïve Approach

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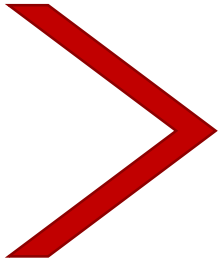

- Workload
- Preference