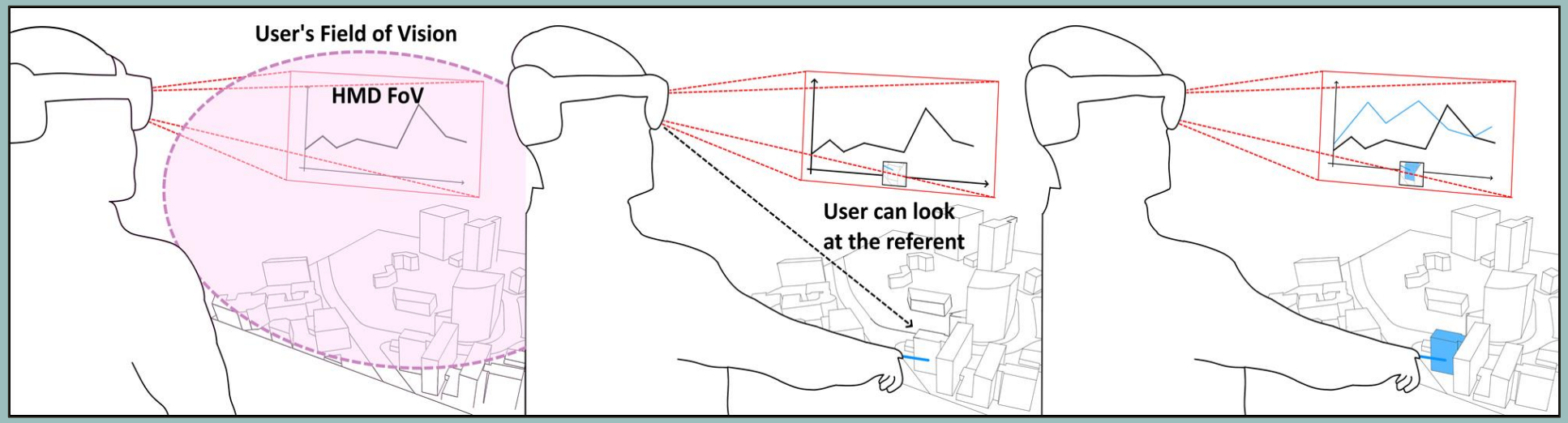
INTERACT 2025




# POINTING AT PHYSICAL TARGETS AROUND THE FIELD OF VIEW OF OPTICAL SEE-THROUGH HEAD-MOUNTED DISPLAYS



Clément Truillet, Marcos Serrano and Emmanuel Dubois

*University of Toulouse, IRIT, France, {Firstname.Lastname@irit.fr}*

# INTRODUCTION

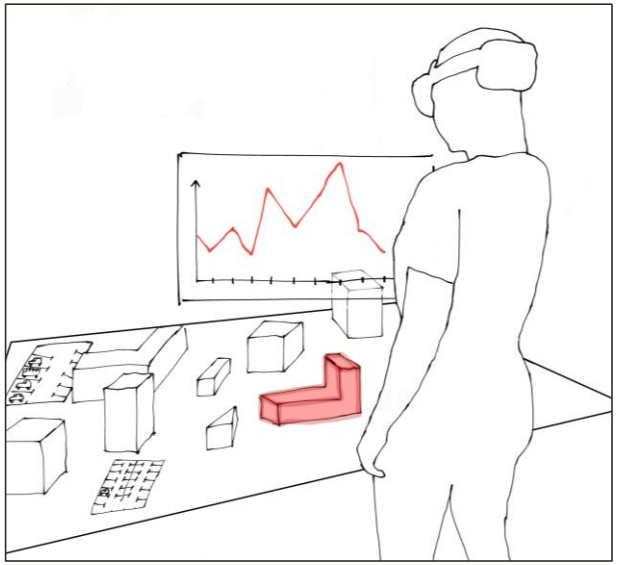
- **Situated Visualisation**
  - Allows users to visualize the **data** in the local context of a **physical object** that generates or is related to that data

- The physical object is known as the **physical referent**

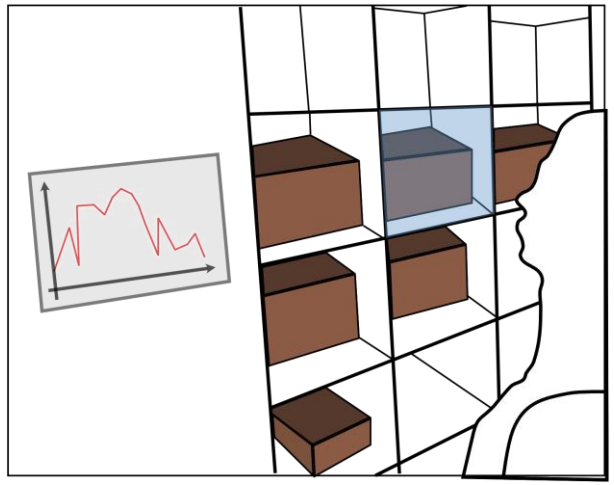
- Users can access **data near their referent** to benefit from the **immediate physical surroundings** to help make sense of the data

- As a result, these tasks require users to interact with **both physical and digital** objects distributed around them

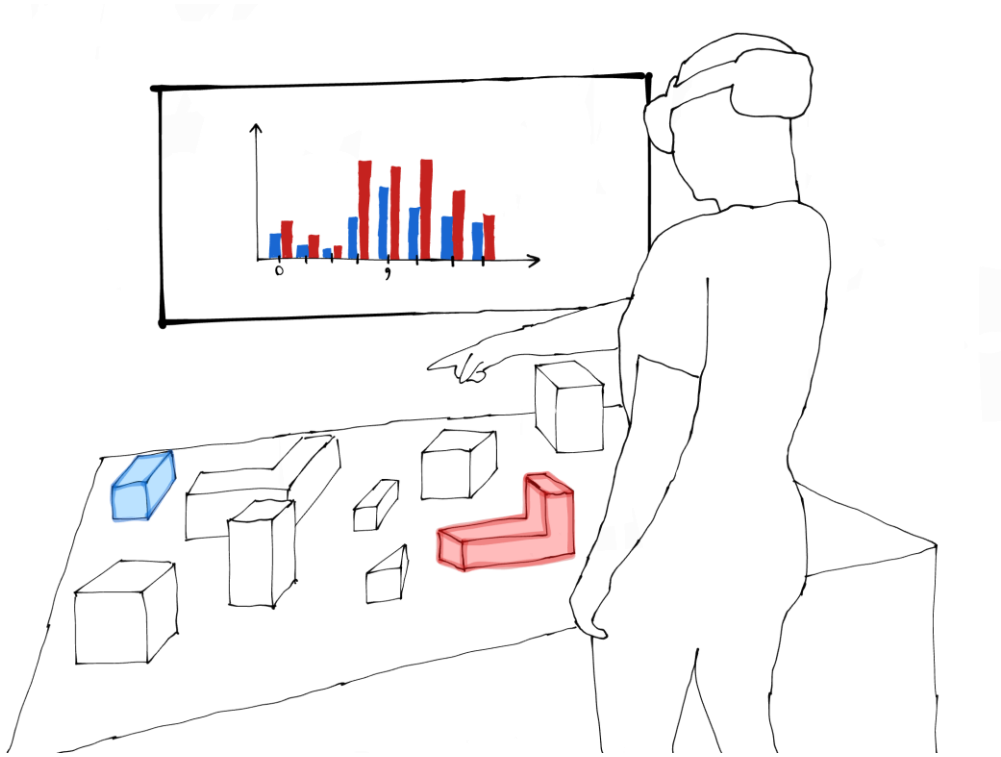
**Energy Monitoring**



**Warehouse Management**



# AUGMENTED REALITY



Augmented Reality headsets

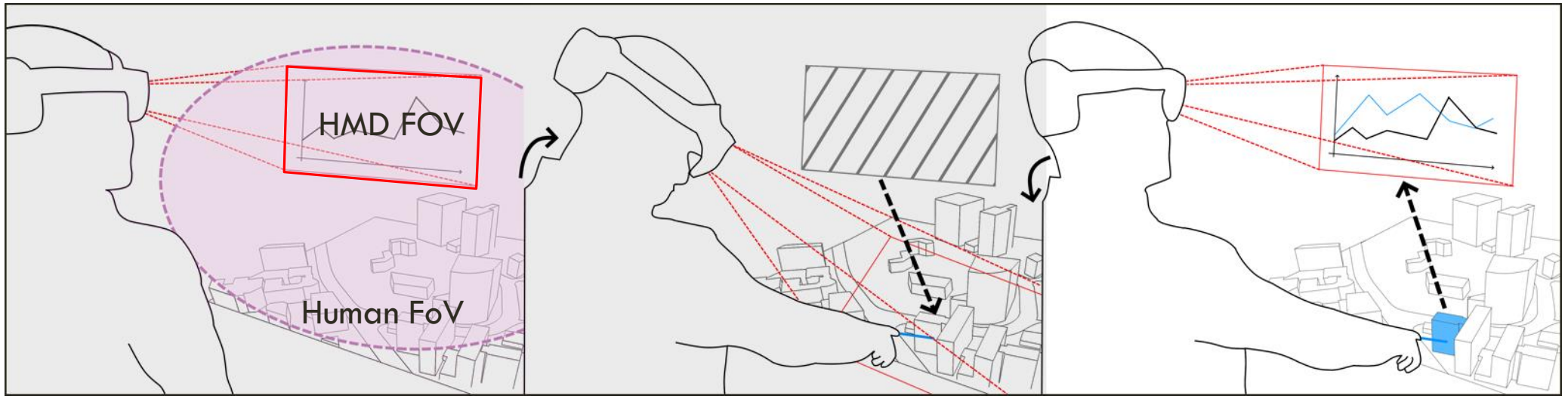
- Unlimited displays areas
- Multiples points of view
- Data spatial exploration

Optical See-Through HMD : as close as possible of reality

- Interaction anchored on the referent

But given the limited HMD FoV, the physical referents may be spread around the HMD FoV

# CONTEXT

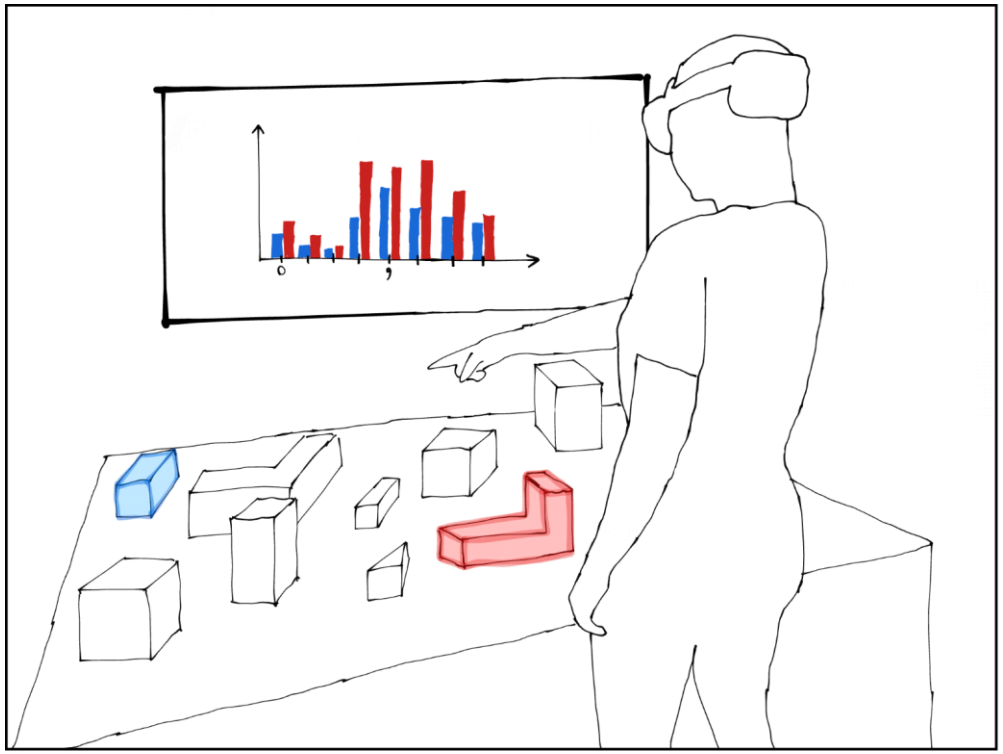



- Users need to **move their head** to place the referent in the HMD FoV
- Leads to an **uncomfortable neck** position
- **Divert the user's attention** from the data visualization
- **Hinder** interaction

# USAGE SCENARIOS

**Augmented Physical Model for data analysis**

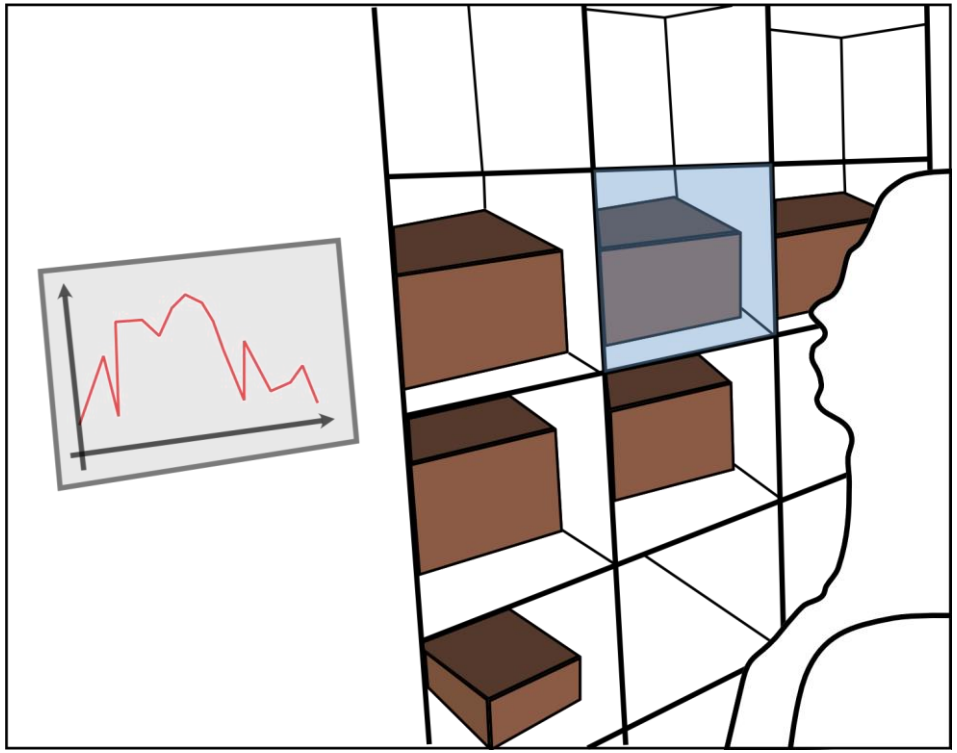
- Urban planners brainstorm about the urban management of a campus
- Alice, an urban planner, wears her AR HMD to **study the flow of students entering and leaving an university building**
- Alice can **filter the data** by selecting nearby physical objects such as metro or bus stations **even if they are around the HMD FoV**



# USAGE SCENARIOS

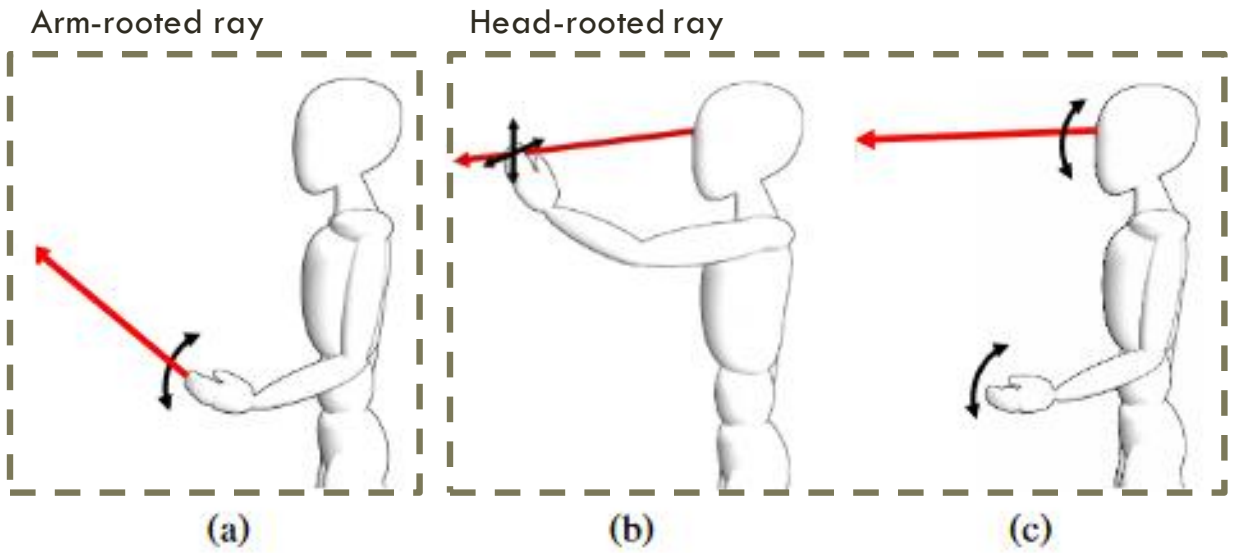
**Logistic management**

- Daniel, a logistics operator responsible for stock management in a warehouse, uses an AR HMD to monitor stock levels.
- Designating a place on a shelf allows him to examine the full stock history of the product **without having to move his head up and down frequently.**
- By selecting the product, he gets a detailed overview of its stock history



# RELATED WORK – ORIGIN OF THE RAY

- **Numerous** pointing solutions in AR
- Preference on **raycasting** for pointing tasks
- **Head-Rooted rays** allowing users to better anticipate the point of impact




[Argelaguet and Andujar, 2009]

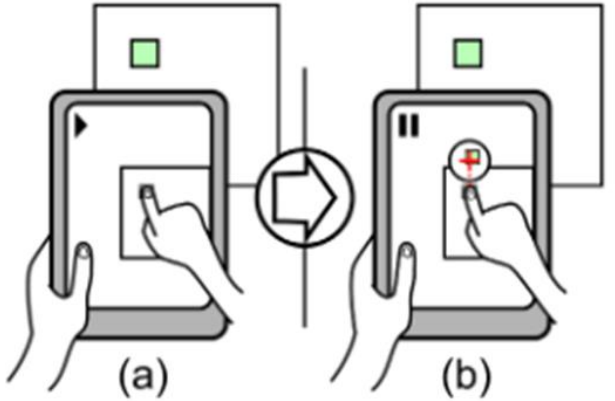
# RELATED WORK – LIMITED HMD FIELD OF VIEW

## Locating objects out of AR devices' FoV


SidebARs [Siu and Herskovic, 2013]

- Guidance techniques
- Users are constrained to move their head
- We know where the objects are
  - **Outside** the HMD FoV and
  - **Inside** the Human FoV

## Overview+Details interfaces




Shift&Freeze [Vincent et al. 2013]

- Two-step approaches
- Combine **direct** and **indirect** view for pointing
- Enable sequential exploration of the overview **without compromising performances**

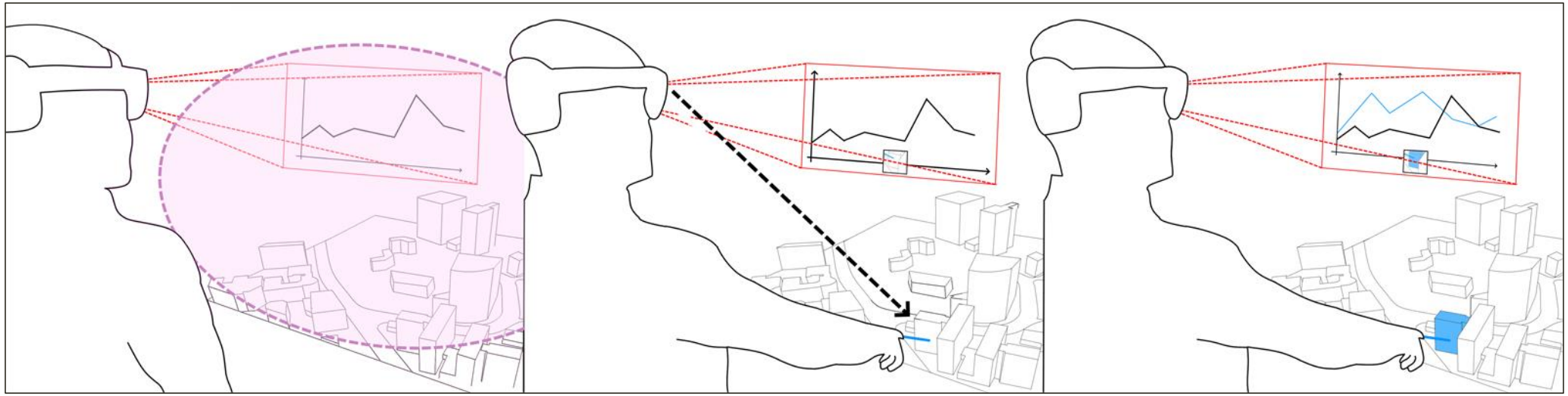
# OUR WORK

Pointing in AR at **physical objects** located **around the HMD FoV** without **head movements**

- Allow users to select physical referents spread around them to access the related data in context while avoiding cumbersome head movements

- How to point at physical targets around the HMD FoV while the user visualizes data in front of him within the FoV

# OUR APPROACH



Keep a **permanent eye** on the data

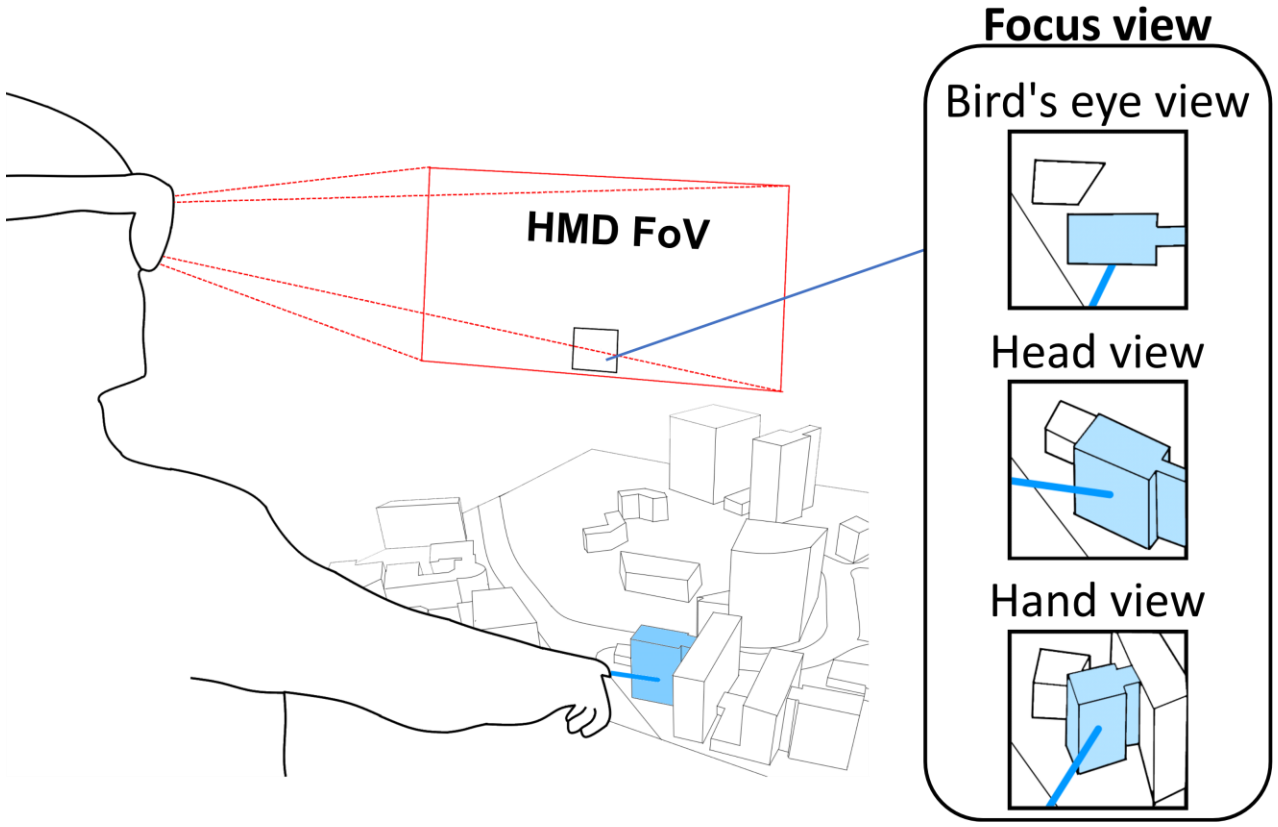
Point at a physical referent

- **in** the HMD Field of View directly
- **around** the HMD Field of View, but in the Human Field of Vision with feedback

**Feedback display** in the Focus View:

- area centered on the ray's impact point from the virtual camera

# DESIGN FACTORS – VIRTUAL CAMERA POSITION




**Bird's eye:** 2D layout of the objects

**Head view:** consistent with how users perceive the environment

**Hand view:** allow adaptation of the camera orientation and exploration

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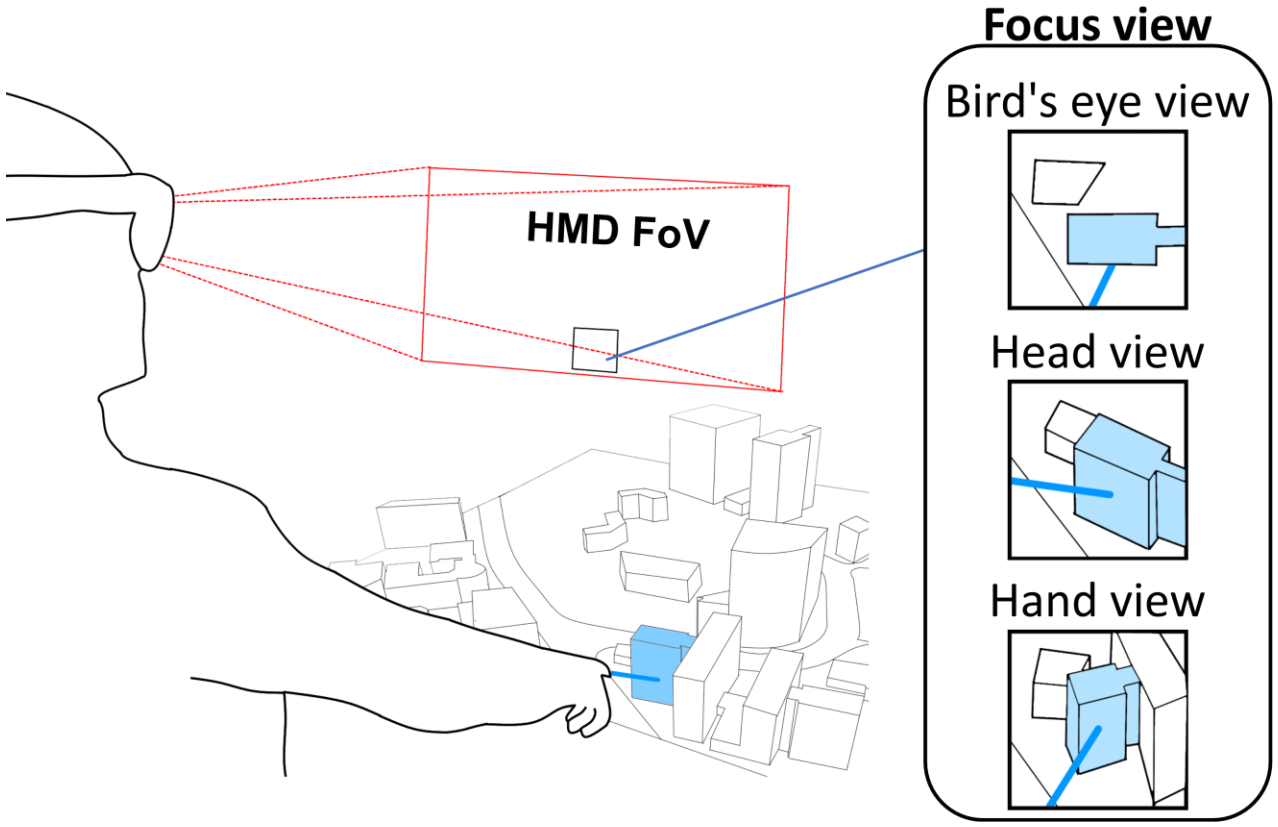


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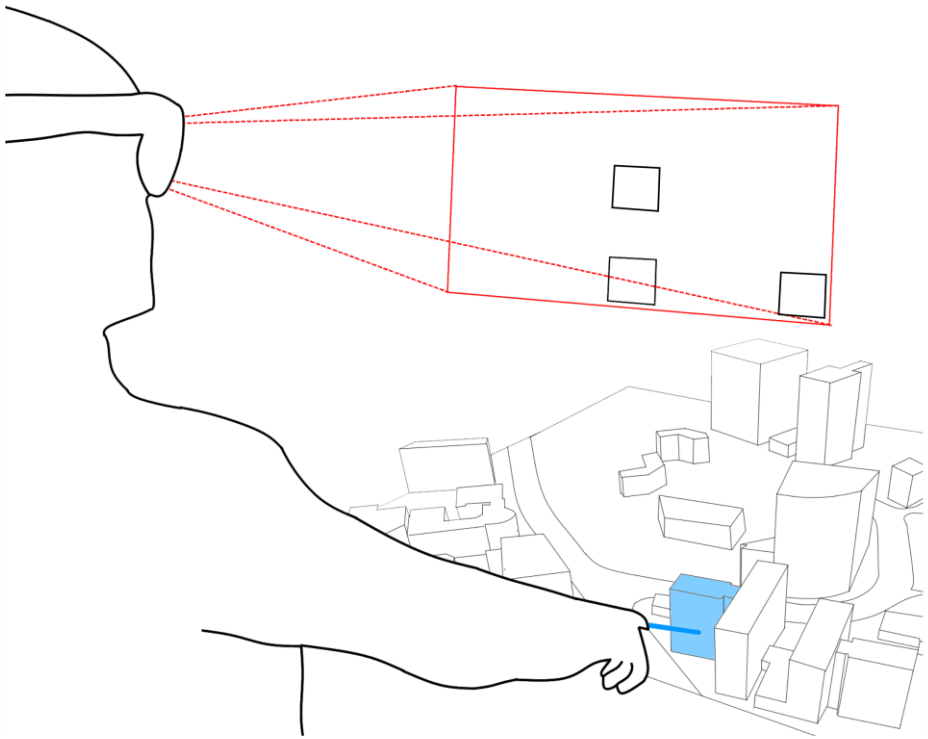

**Center:** always visible but may occlude the scene

**Corner:** reduce the occlusion but may be difficult to see

**Bottom center:** always visible and reduce the occlusion

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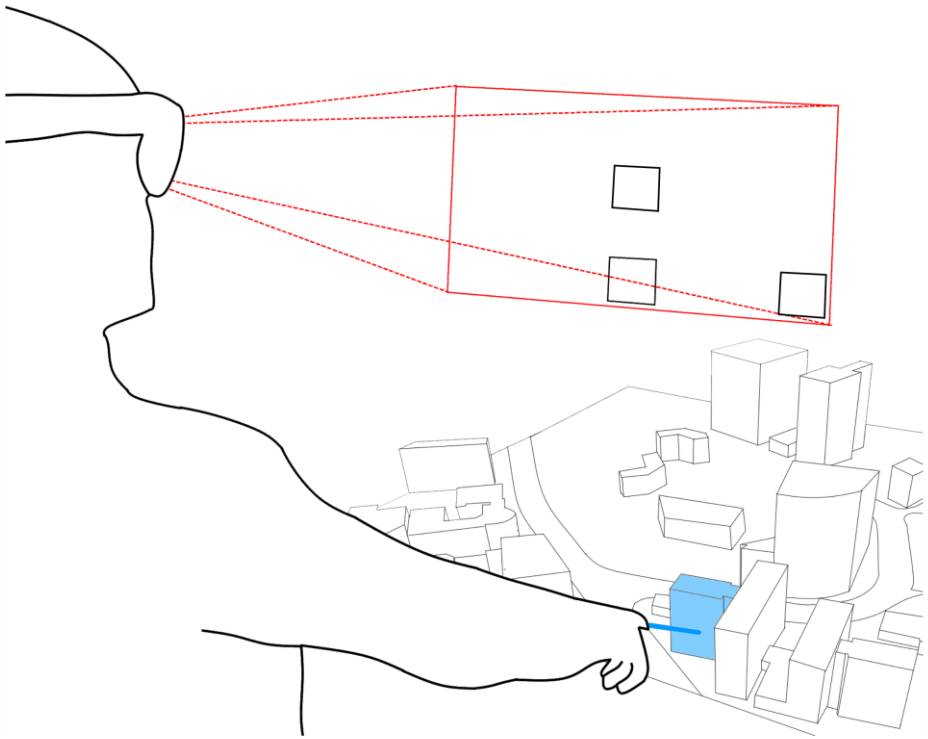

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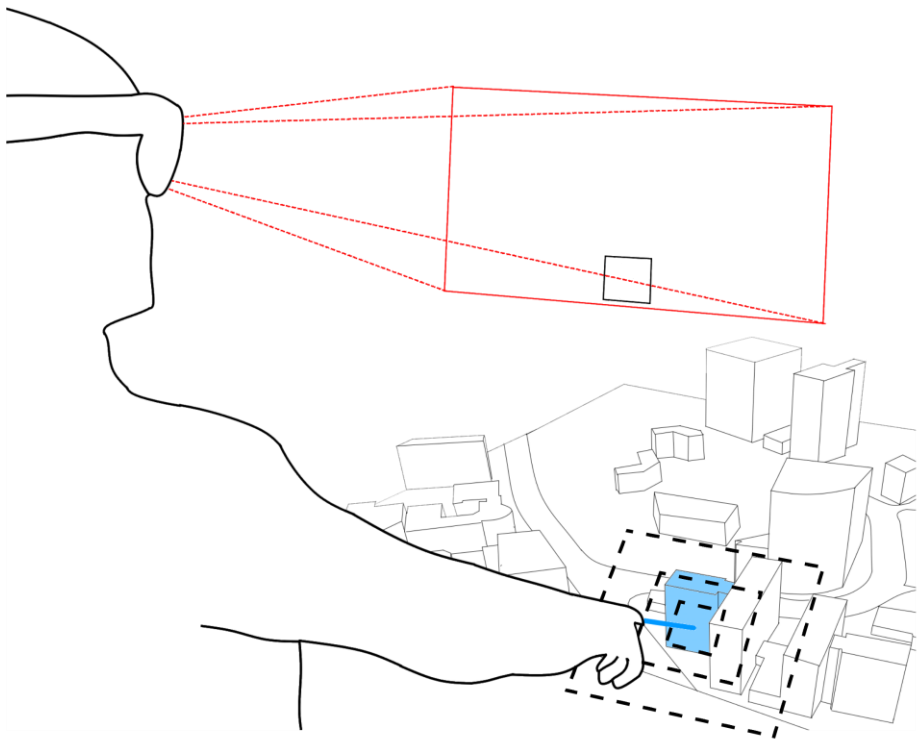
# DESIGN FACTORS –AREA AROUND THE RAY'S IMPACT POINT



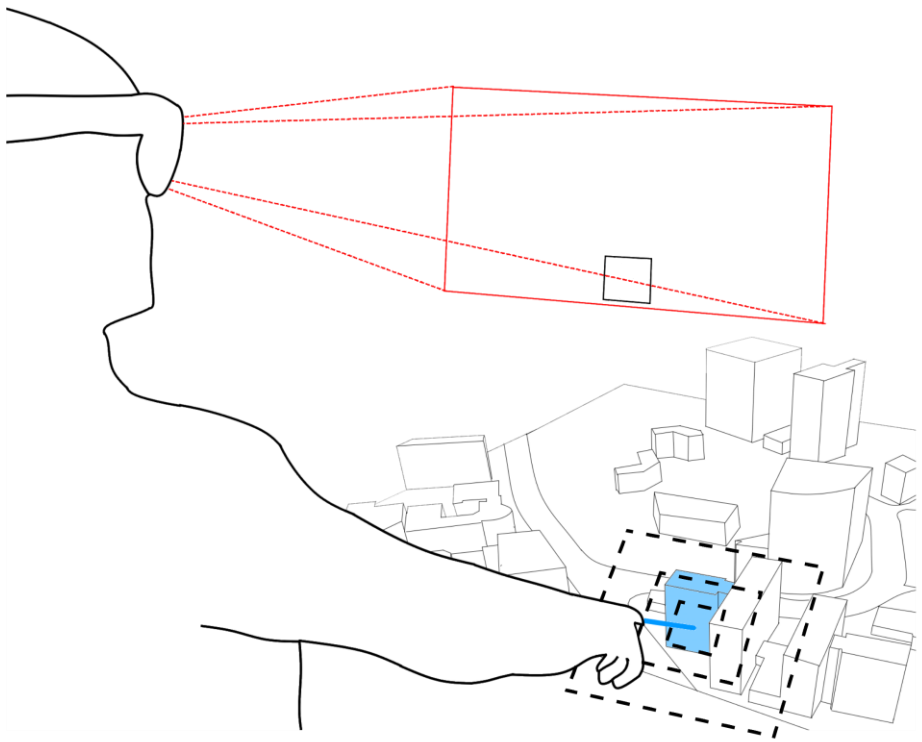
**Too small:**

- Display a big representation of the physical objects.
- Difficulty in locating them in their surroundings

**Too big:**

- Easy to locate objects in the Focus View
- But difficult to select them

# DESIGN FACTORS –AREA AROUND THE RAY'S IMPACT POINT



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**Too big:**

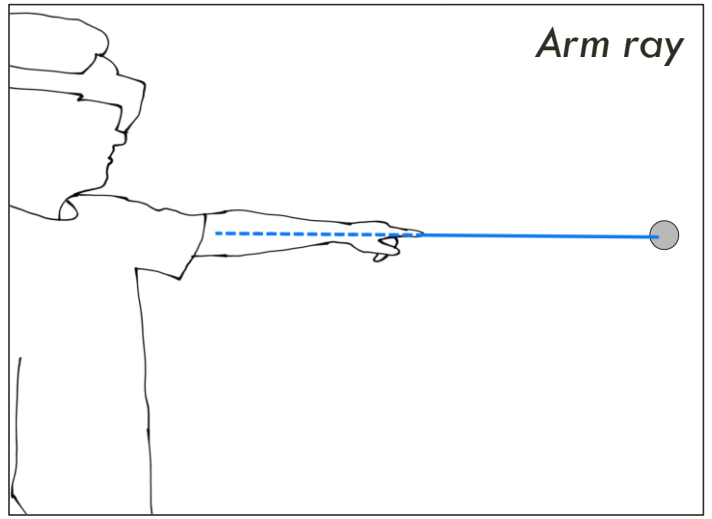
- Easy to locate objects in the Focus View
- But difficult to select them

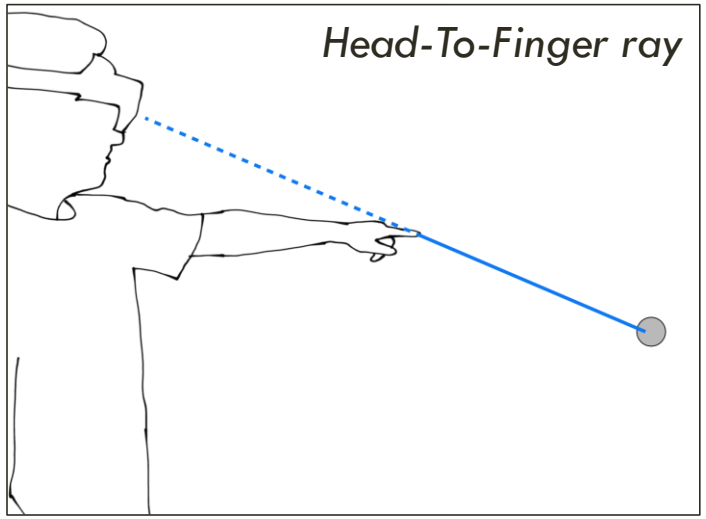
**Empirically** define 20x20cm

# DESIGN FACTORS – FORM OF THE RAY

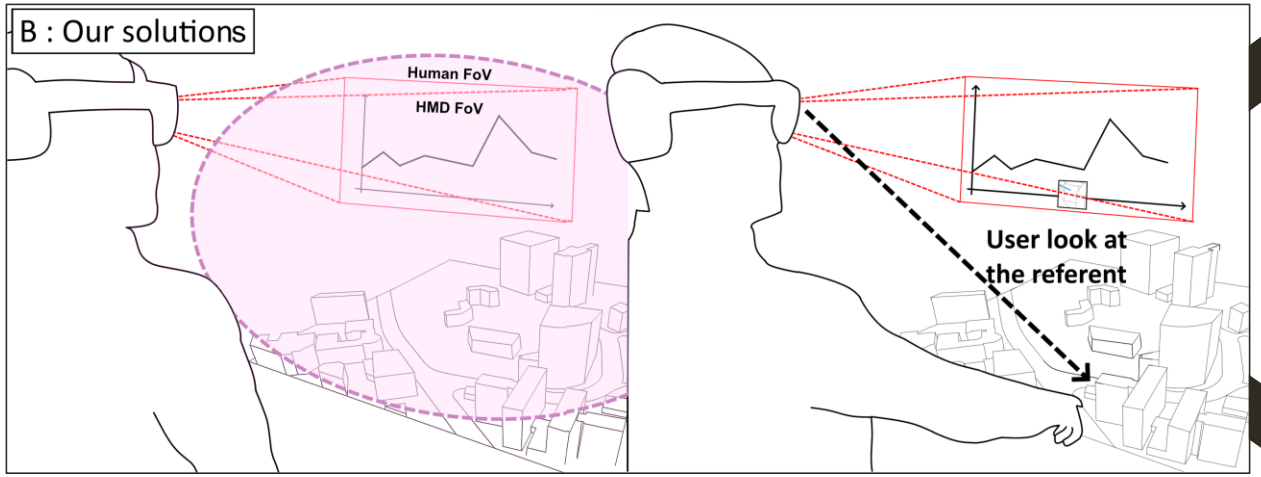
**Arm ray:** traditional raycasting

**Head-To-Finger:** users need to align their finger with the target to select it

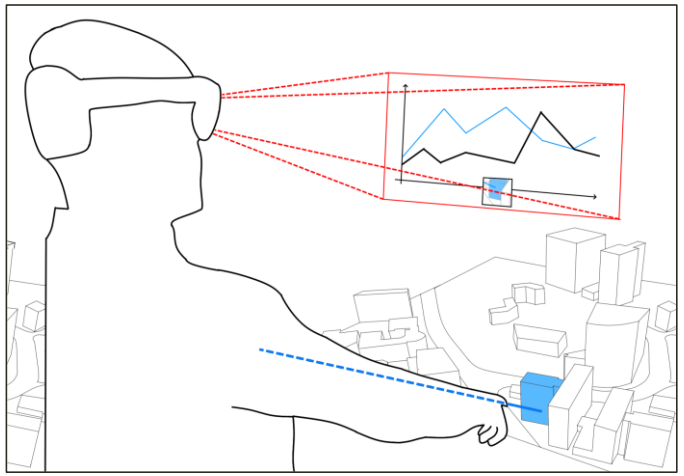


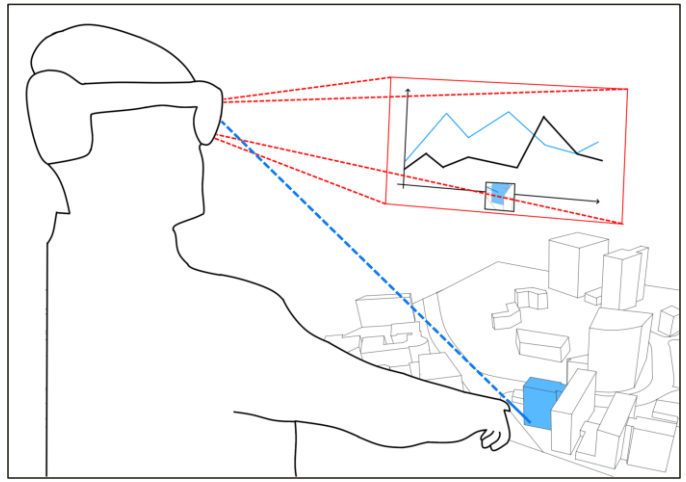
# TWO STUDIED TECHNIQUES




*Arm technique*



*Head-To-Finger technique*

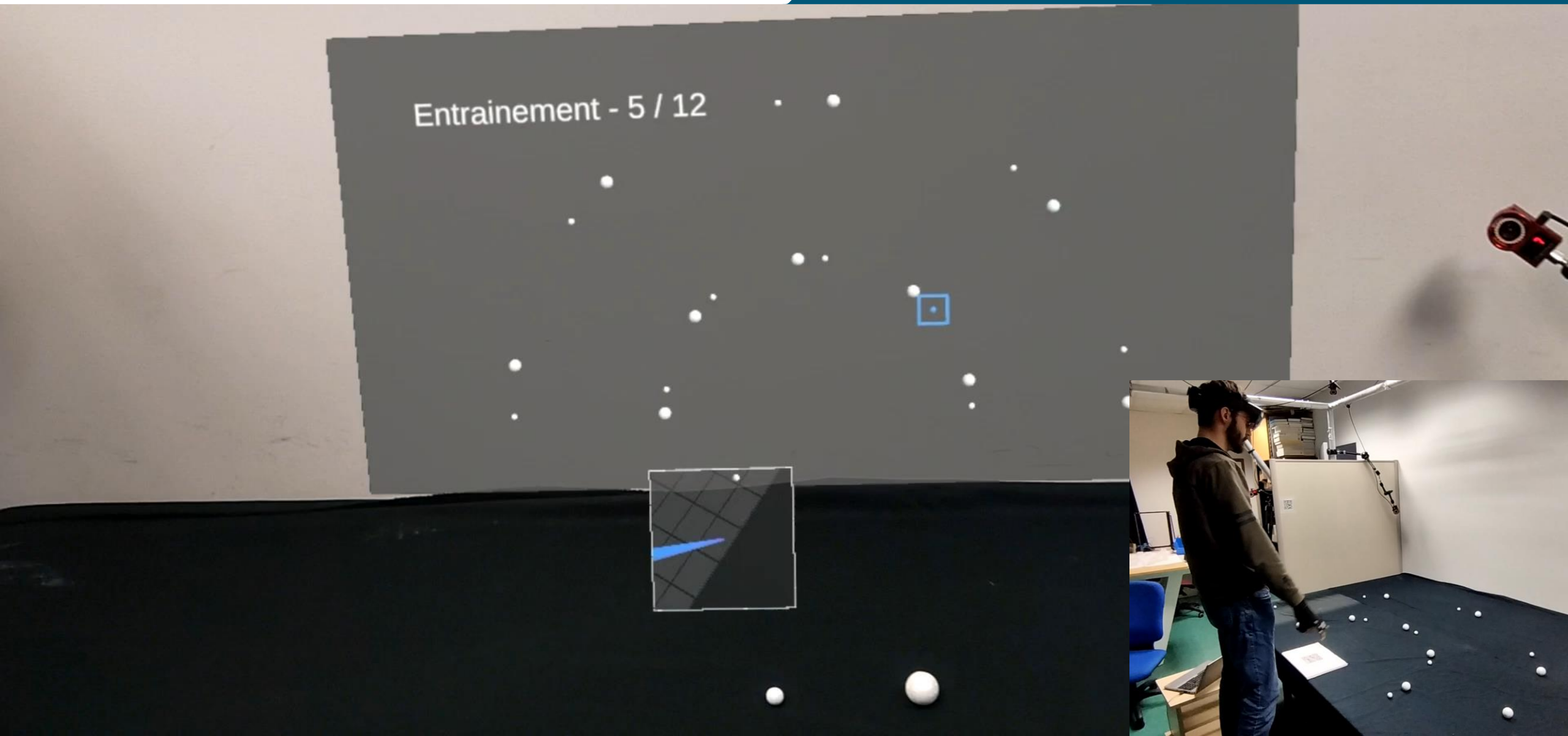


# Direct View

Coarse-pointing

# Focus View

Fine-pointing



# USER STUDY: AROUND-FOV POINTING

## Techniques

- Arm
- Head-To-Finger
- Baseline: Direct Pointing

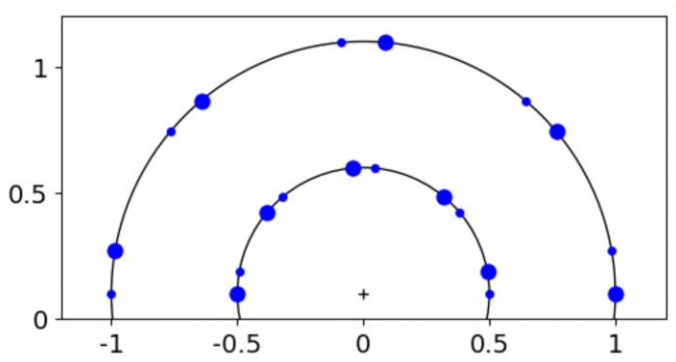
## Targets

- Two distances (0.5m and 1m)
- Two sizes (2cm and 4cm)

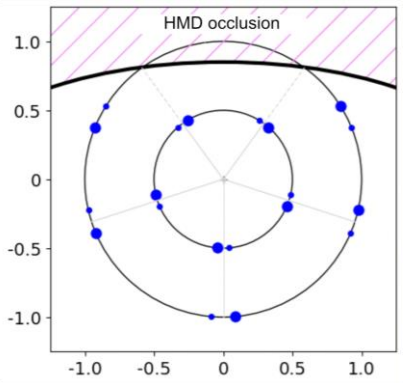
## N=12 participants

## Surfaces

*Horizontal surface*




*Vertical surface*




# EXPERIMENTAL PROTOCOL

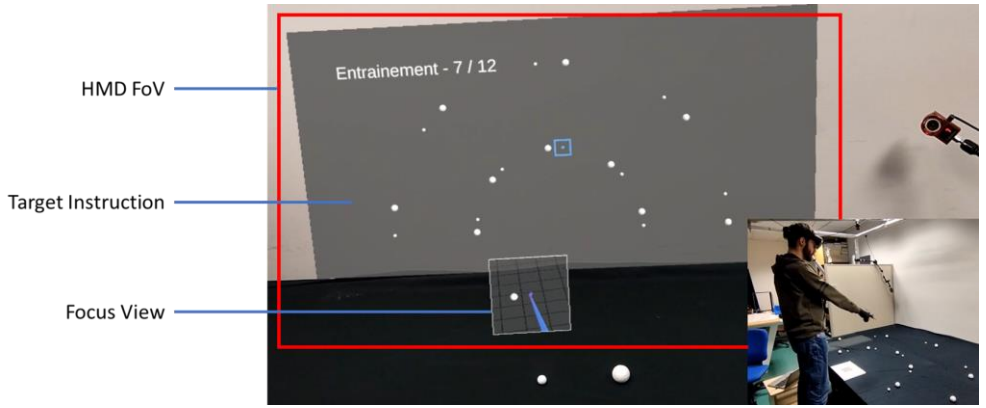
- **Factors**
  - Surface
  - Pointing Technique
  - Targets distance
  - Target size

- **Instruction:** Point as quickly and accurately as possible at each physical target

- Lasted around 60 min

**Collected Data**

- Completion time
- Target crossing
- Hand's height during pointing
- Ranking of technique
- NASA-TLX



# ON THE HORIZONTAL SURFACE

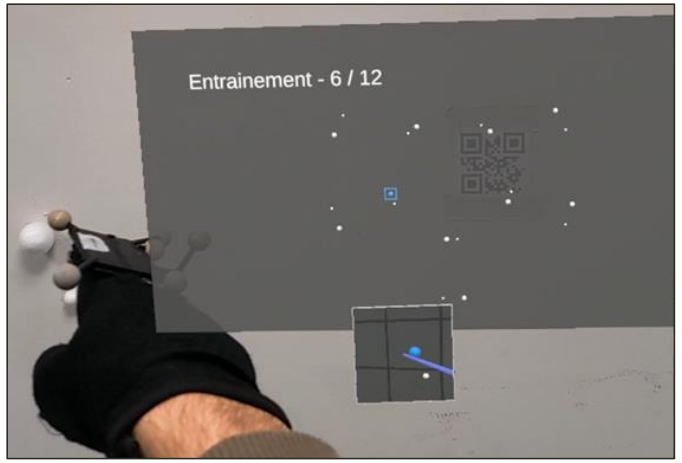
- **Completion time**
  - **Arm** and **Head-To-Finger** require less time than **Direct Pointing**
  - **Remains true** with any combination of target size and distance **except for Far Small ones**

- **Target Crossing**
  - **Head-To-Finger** produces the lowest target crossing
  - Ability to support **precise** target pointing


# ON THE VERTICAL SURFACE

- **Completion time**
  - **No significant difference** between **Head-To-Finger** and **Direct Pointing** with any combination of target size and distance
  - Arm **is slower** than Direct Pointing

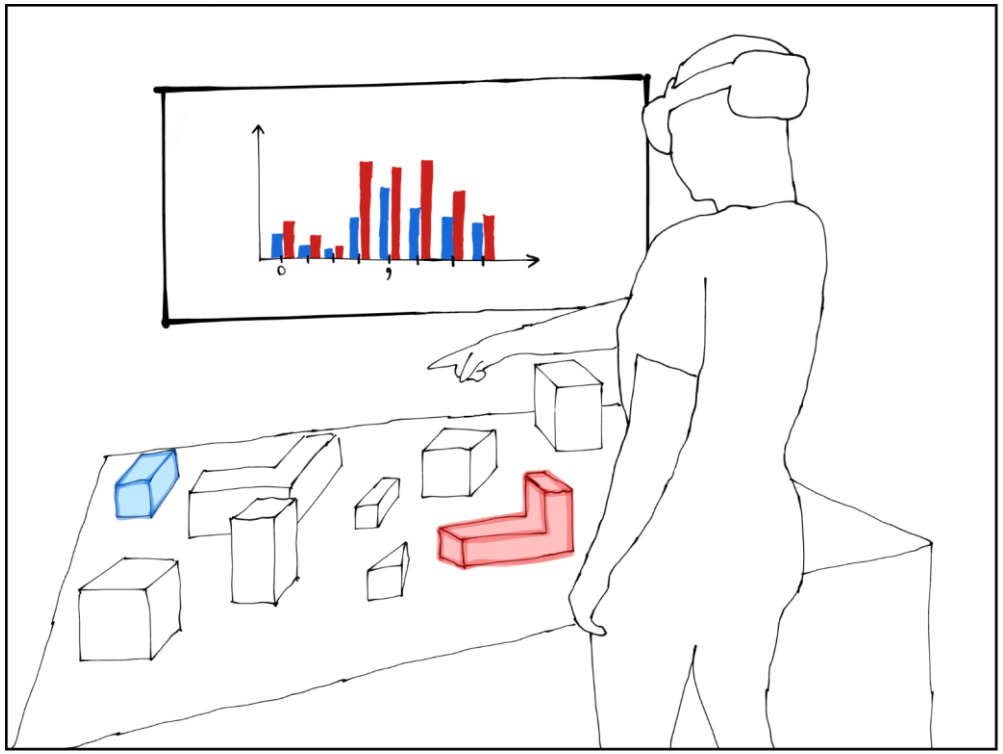
- **Target Crossing**
  - **No significant difference** between **Direct Pointing** and **Head-To-Finger**
  - Both performed better than **Arm**




# IMPACT ON THE USAGE SCENARIOS

**Augmented Physical Model for data analysis**

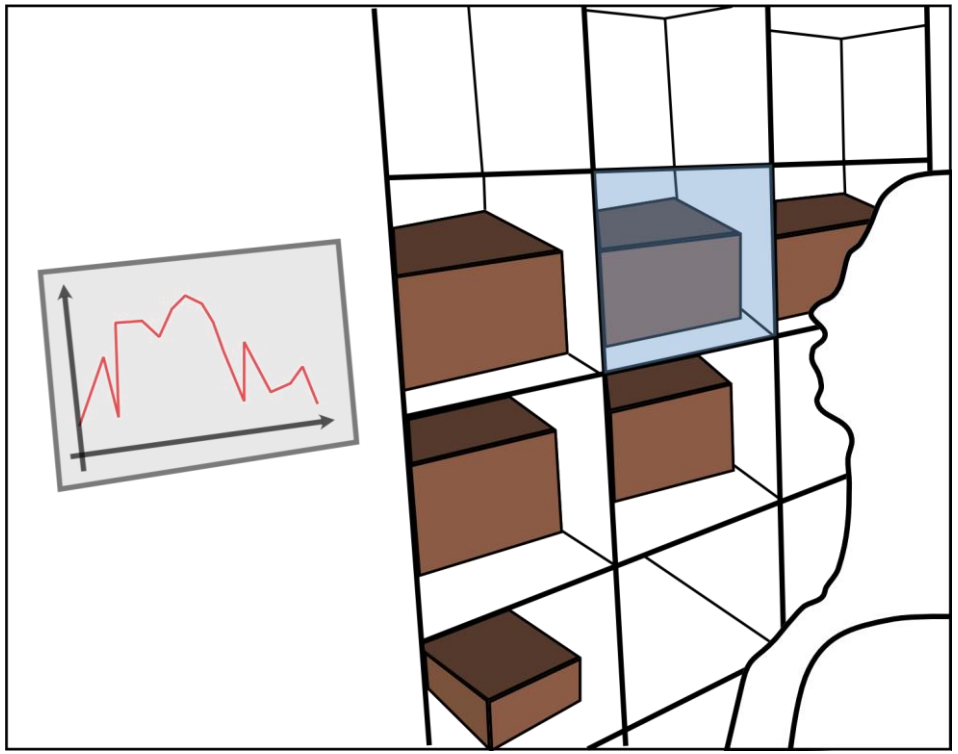
- The physical model is placed on a **horizontal surface**
- **Direct Pointing** should be avoided
- Arm and Head-To-Finger should be preferred
- Arm is **embedded in the HoloLens 2** device
- Head-To-Finger **minimizing the risk of target crossing**



# IMPACT ON THE USAGE SCENARIOS

**Logistic management**

- The physical model is place on a **vertical surface**
- The Arm technique **should be avoided**
- Head-To-Finger is recommended when interacting with **shelves of reduced height**
- Direct Pointing would be more appropriate when accessing products **on tall shelves**



# PERSPECTIVES

- **Acceptable level of mismatch between viewpoint**
  - Currently: User combines the **direct view** and the **Focus View** (indirect view) to point
  - To witch extend the users can understand the **level of mismatch**?
  - **Occlusion context**: a Focus View to see the back of targets?

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- **A Mobile Focus View**
  - Currently: Our Focus View **is static** (bottom center of the HMD FoV)
  - **Convenient** for the horizontal surface, but for the vertical one?
  - Study a **mobile Focus View** according to the user's gaze direction

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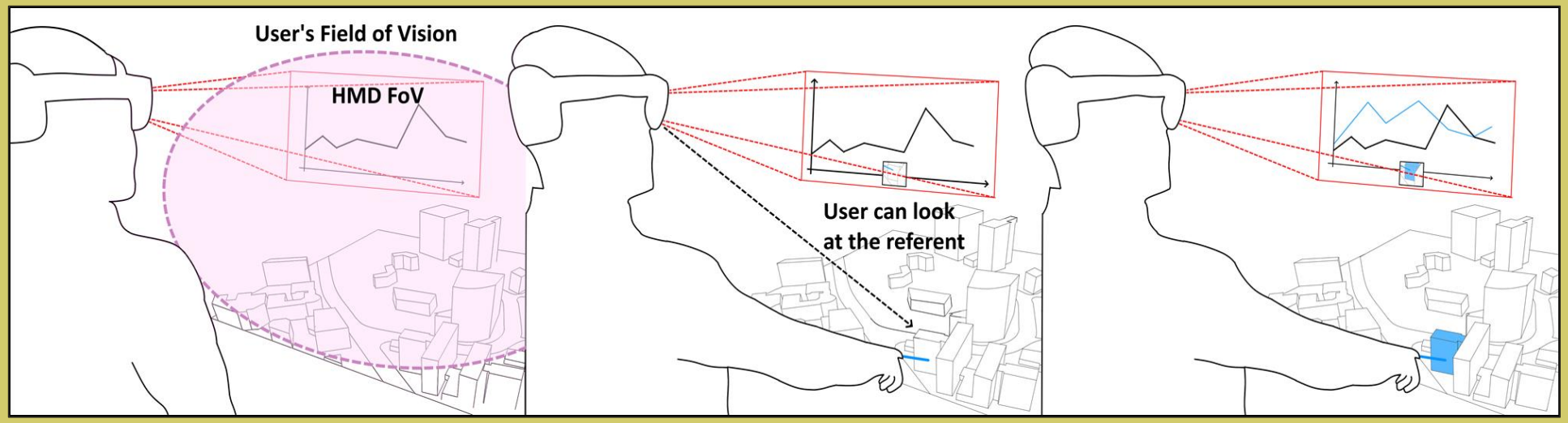
  - Currently: Our Focus View **is static** (bottom center of the HMD FoV)
  - **Convenient** for the horizontal surface, but for the vertical one?
  - Study a **mobile Focus View** according to the user's gaze direction

- **Pointing** in **and** around **the HMD FoV**
  - What are the results where we need to point **alternatively in and around** the HMD FoV?

INTERACT 2025

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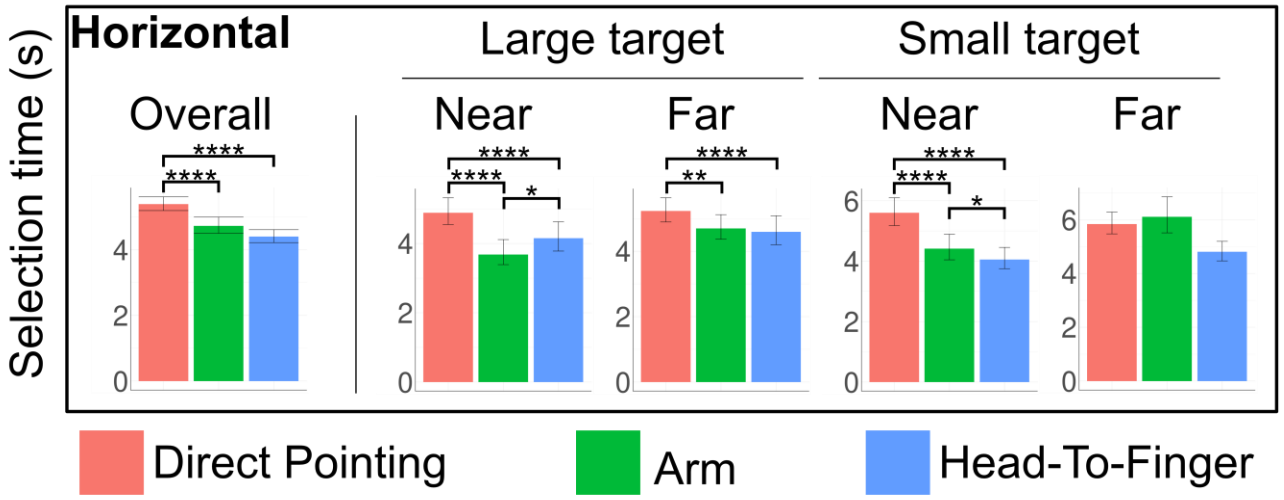



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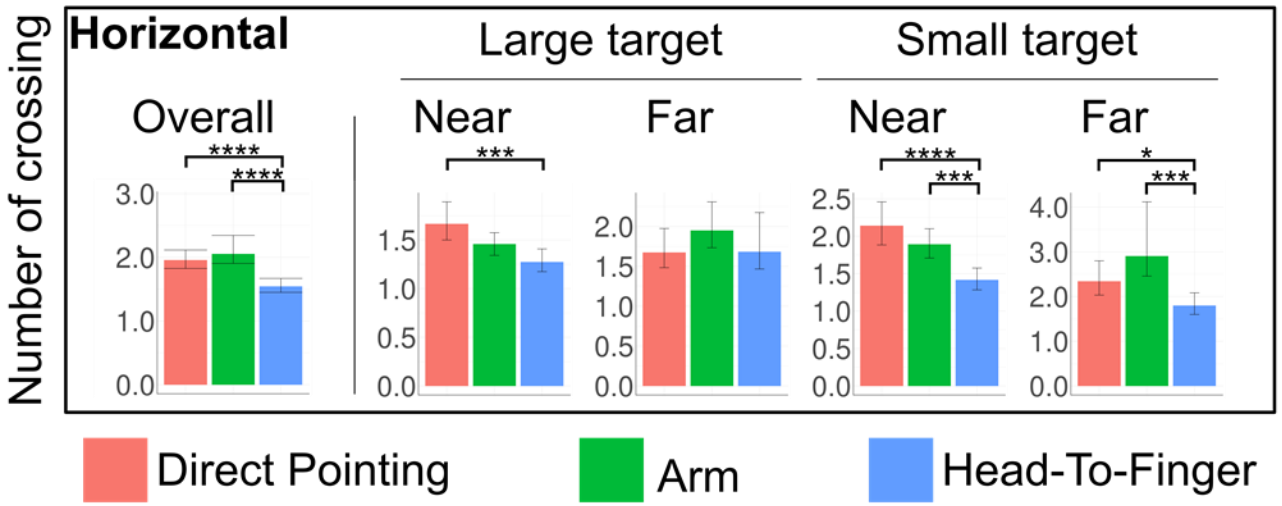

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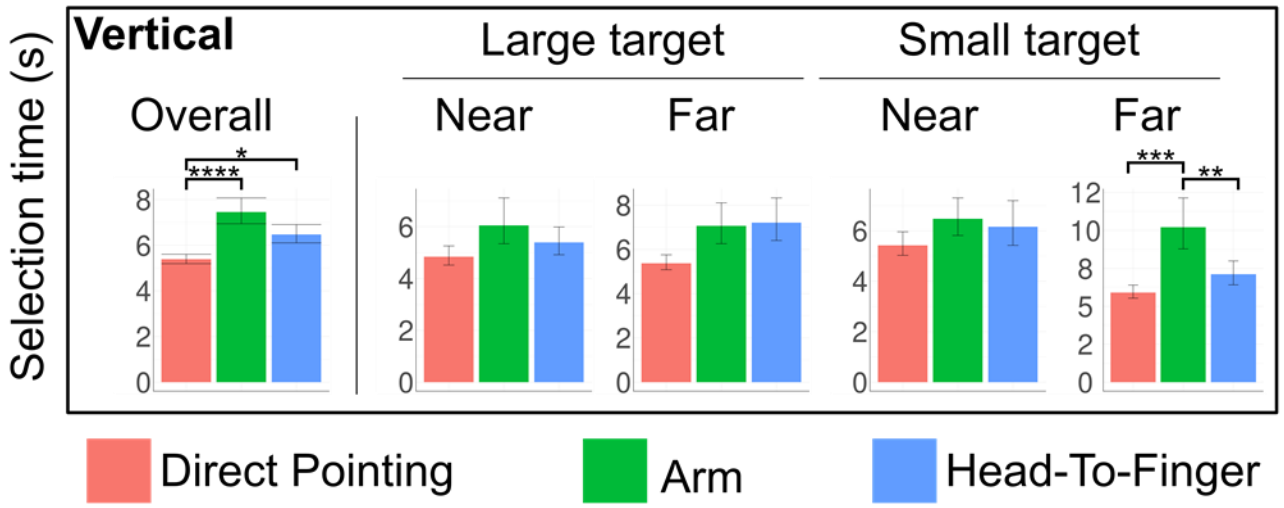


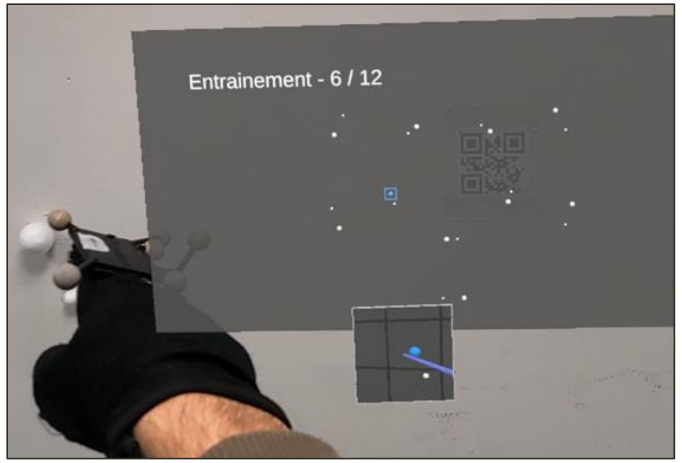


# ON THE VERTICAL SURFACE

- **Target Crossing**
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  - Both performed better than **Arm**