

- Definitions

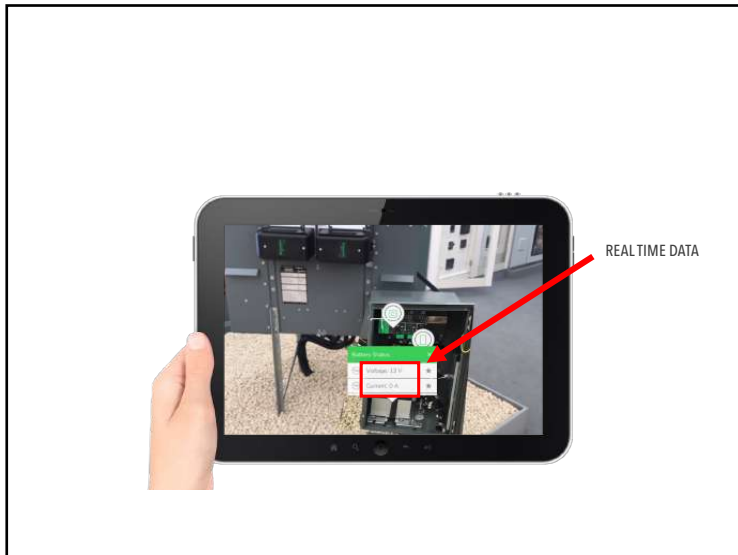
- **Handheld AR/AV**

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

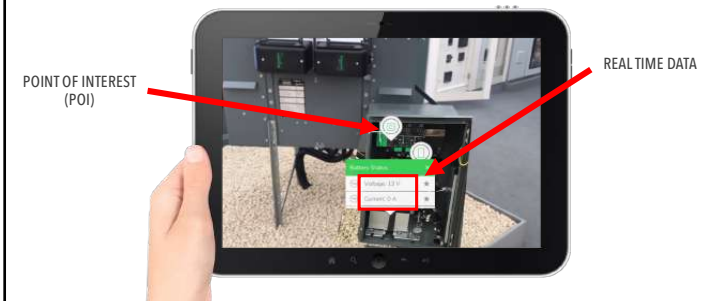
- HMD-based AR/AV

- 3D pointing

Augmented Reality/Virtuality (AR/AV)



Pointing in handheld AR



Pointing in handheld AR

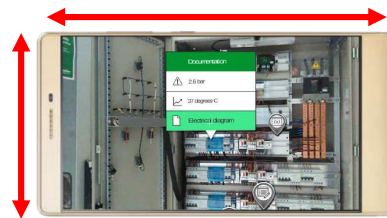


Pointing in handheld AR



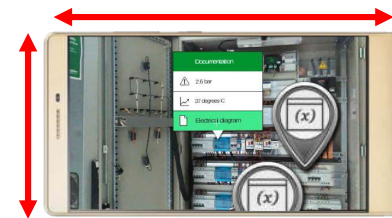
Pointing in handheld AR

- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



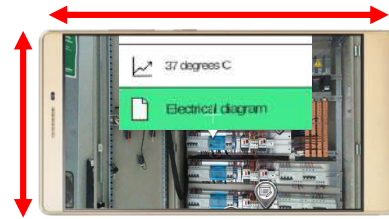
Pointing in handheld AR

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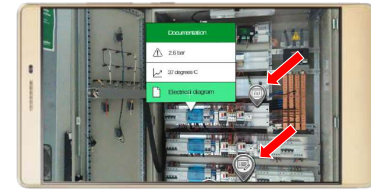
Pointing in handheld AR

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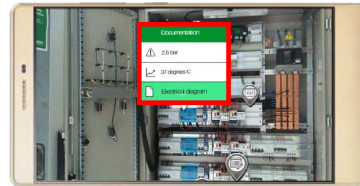
Pointing in handheld AR

- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



Pointing in handheld AR

- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



Pointing in handheld AR



Limited intrusion on screen



Digital - physical link



Access AR information

Types of pointing

Direct pointing



Indirect pointing



Problems with direct pointing

- **Target occultation**
- Ambiguous selection area
- Unreachable screen areas
- Instability



Problems with direct pointing

- **Target occultation**
- Ambiguous selection area
- Unreachable screen areas
- Instability



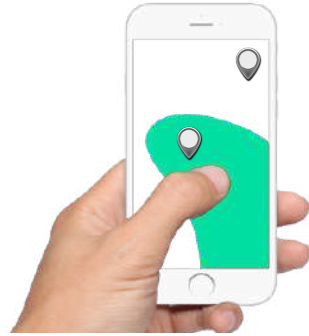
Problems with direct pointing

- Target occultation
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Problems with direct pointing

- Target occultation
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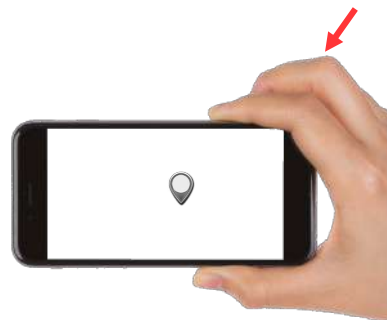
Problems with direct pointing

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Problems with direct pointing

- Target occultation
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Problems with direct pointing

- Target occultation
- Ambiguous selection area
- Unreachable screen areas
- Instability**



Solution

Indirect pointing



Solution

Indirect pointing

✓ No target occultation



Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area



Solution

Indirect pointing

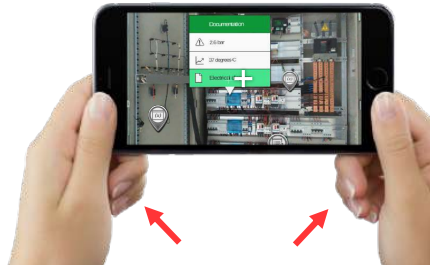
- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas



Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability



Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability



Solution

Indirect pointing

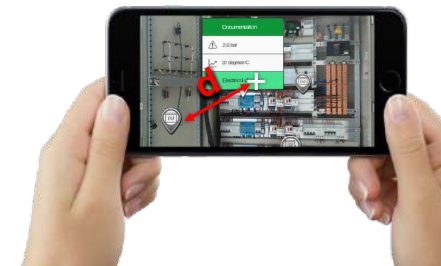
- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
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Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability



Solution

- ✓ No target occlusion
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability






Solution

- ✓ No target occlusion
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability




Cursor-targets distance

• Strategies

-  Move targets towards cursor
-  Increase number of cursors
-  Make cursor jump on targets

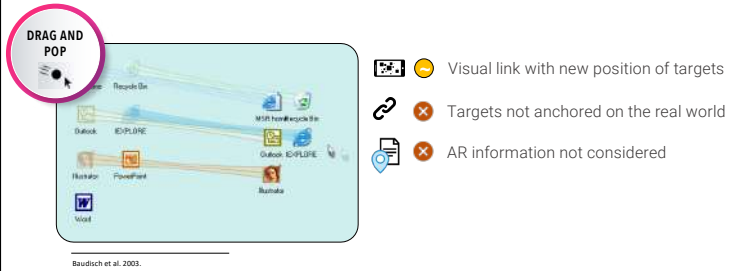
Cursor-targets distance

• Strategies

-  Move targets towards cursor
-  Increase number of cursors
-  Make cursor jump on targets

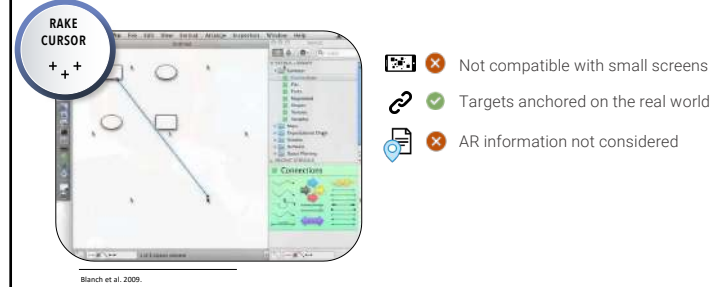
Cursor-targets distance

- Move targets towards cursor



Cursor-targets distance

- Increase number of cursors



Summary

Indirect pointing



Solution

Indirect pointing

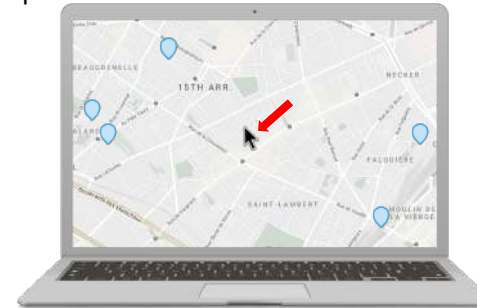


Increasing the size of targets



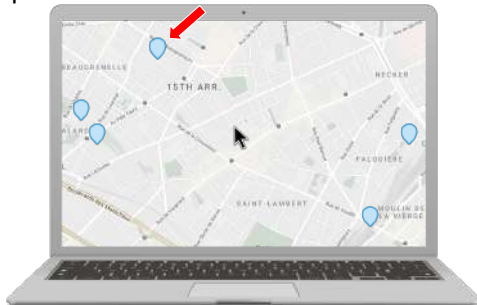
Target expansion

- Example



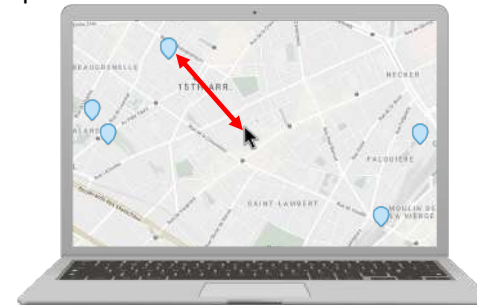
Target expansion

- Example



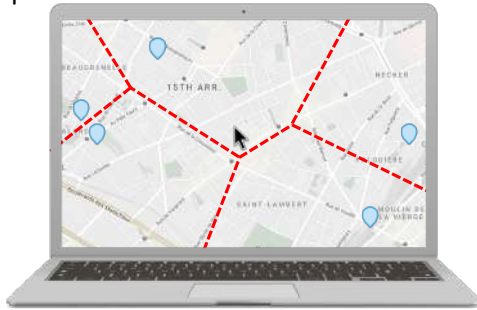
Target expansion

- Example



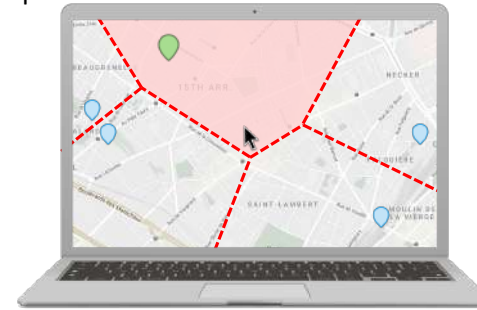
Target expansion

- Example



Target expansion

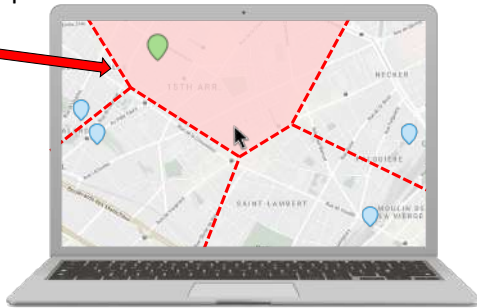
- Example



Target expansion

- Example

VORONOÏ



Target expansion

- Example



Target expansion

- Example



Target expansion

- Example



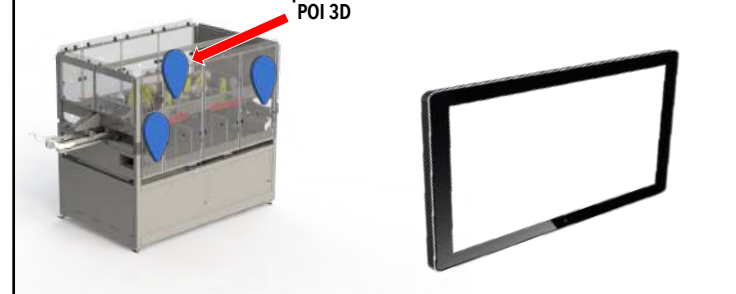
Target expansion

- Example



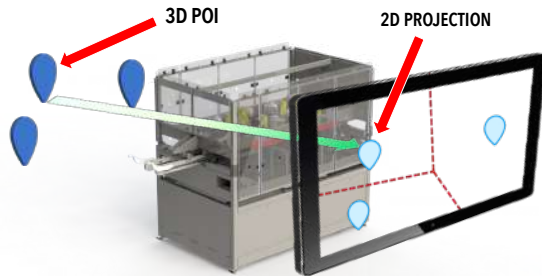
Target expansion

- Handheld AR adaptation



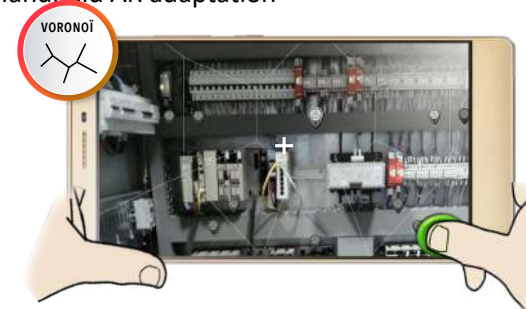
Target expansion

- Handheld AR adaptation



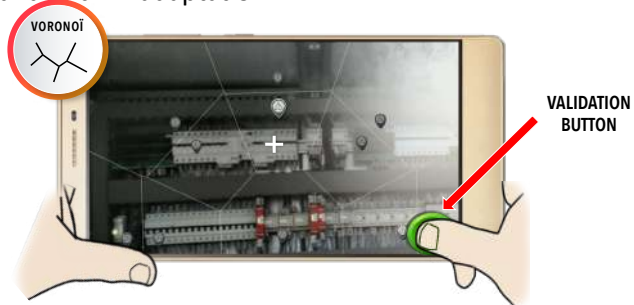
Target expansion

- Handheld AR adaptation

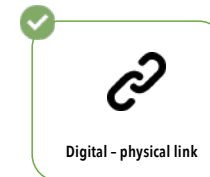
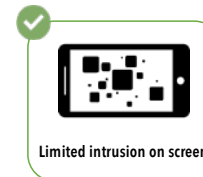


Target expansion

- Handheld AR adaptation



Summary



Summary



Limited intrusion on screen



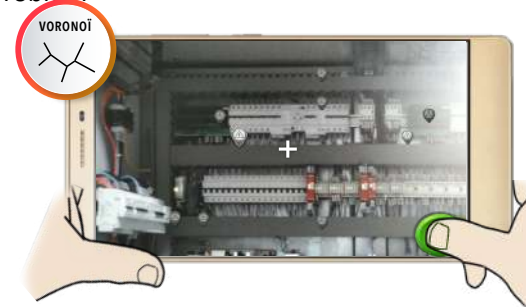
Digital - physical link



Access AR information

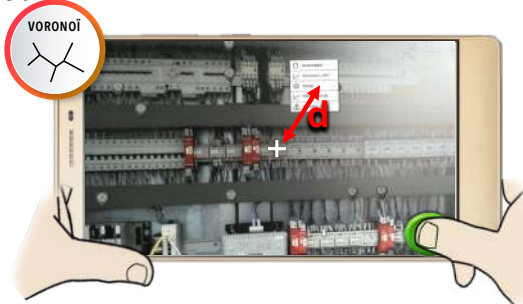
Digital information access

• Problem



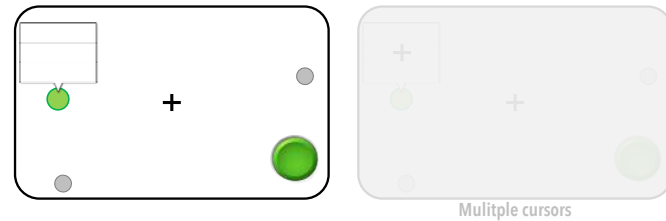
Digital information access

• Problem



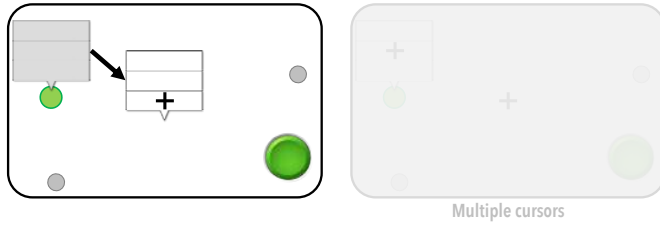
Digital information access

• Different strategies



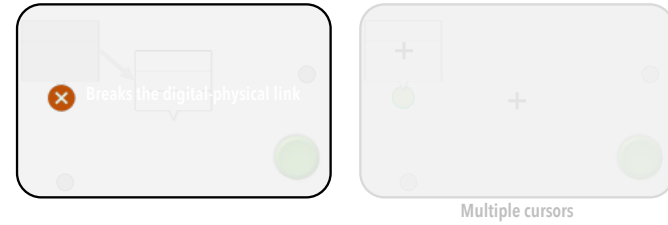
Digital information access

- Different strategies



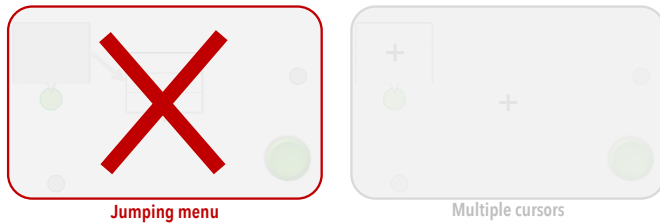
Digital information access

- Different strategies



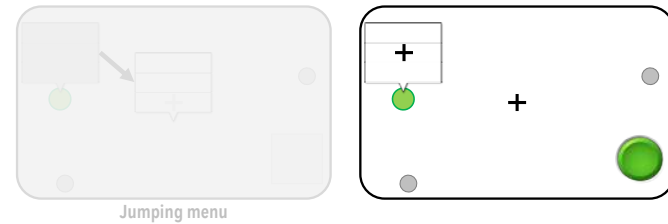
Digital information access

- Different strategies



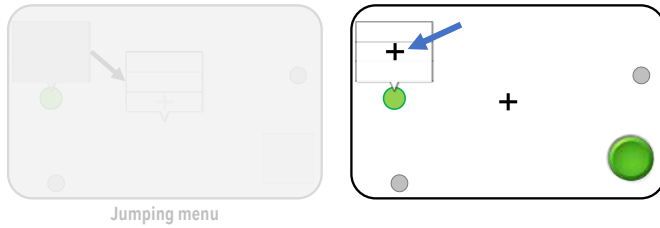
Digital information access

- Different strategies



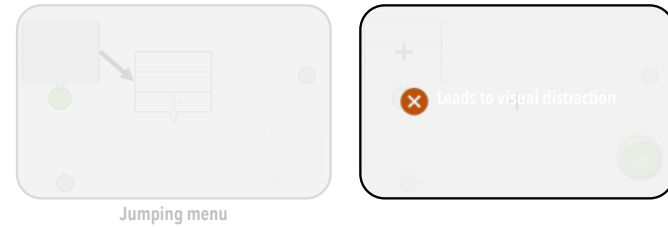
Digital information access

- Different strategies



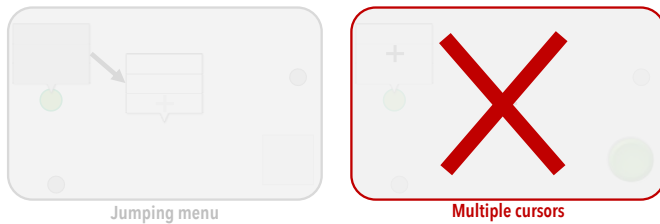
Digital information access

- Different strategies



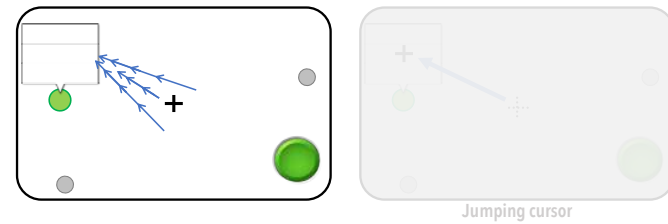
Digital information access

- Different strategies



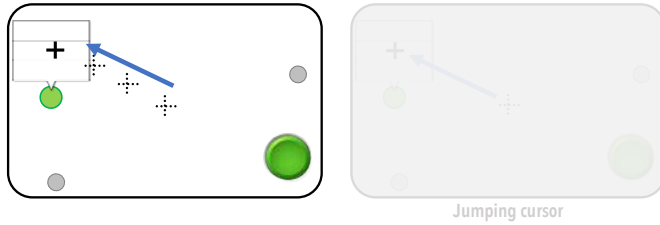
Digital information access

- Different strategies



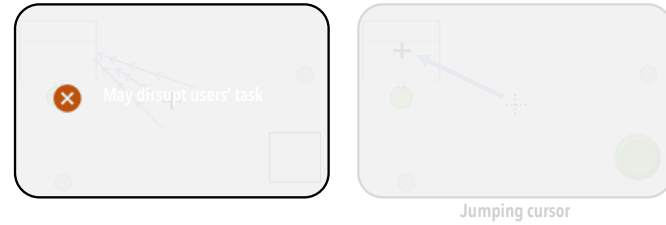
Digital information access

- Different strategies



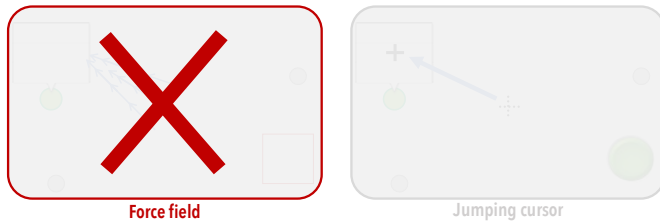
Digital information access

- Different strategies



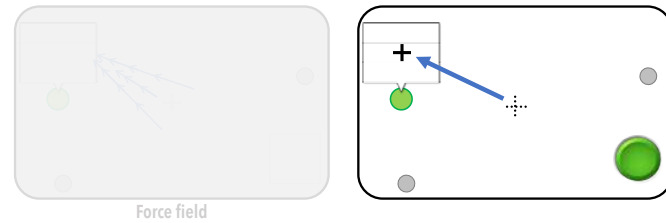
Digital information access

- Different strategies



Digital information access

- Different strategies

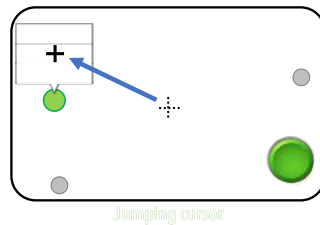


Digital information access

- Different strategies

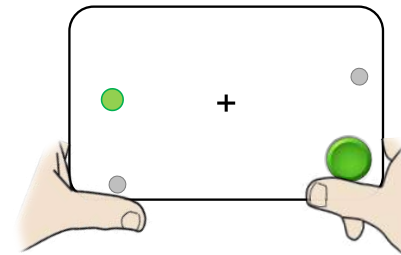
1 How to make the cursor **jump** ?

2 How to **manipulate** the cursor?



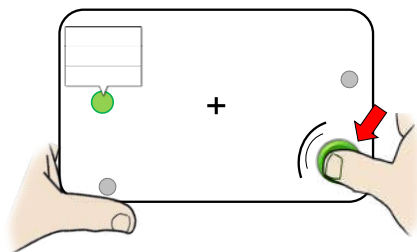
Digital information access

- Jumping cursor



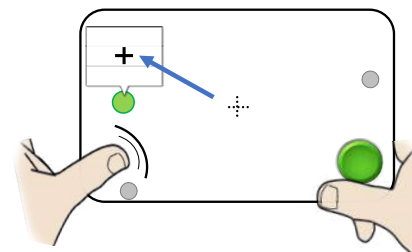
Digital information access

- Jumping cursor



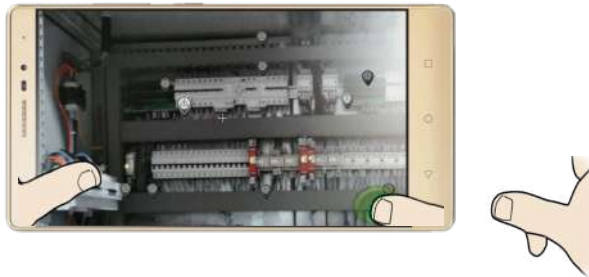
Digital information access

- Jumping cursor



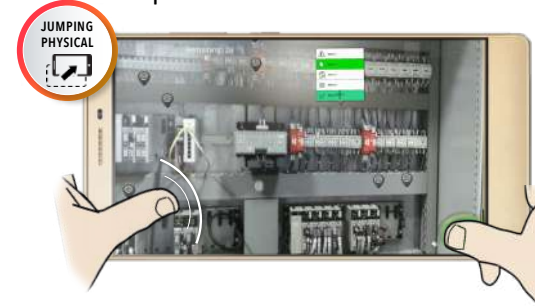
Digital information access

- Jumping cursor



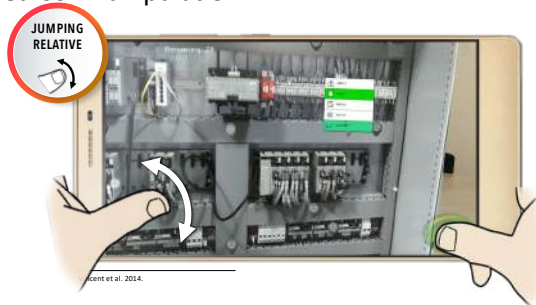
Digital information access

- Cursor manipulation



Digital information access

- Cursor manipulation



User study

- Access to information contained inside digital targets

4 Techniques



User study

- Access to information contained inside digital targets

 12 participants

① POI selection



② Menu item selection



User study

- Access to information contained inside digital targets



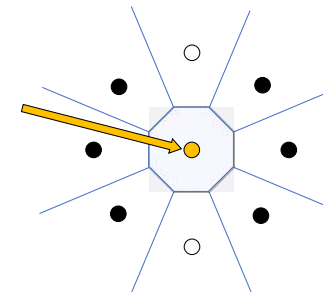
User study

- Experimental task



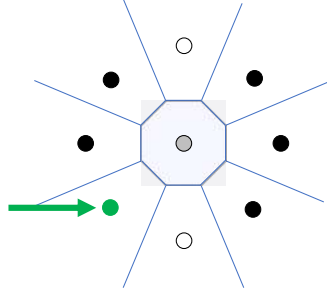
User study

- Experimental task



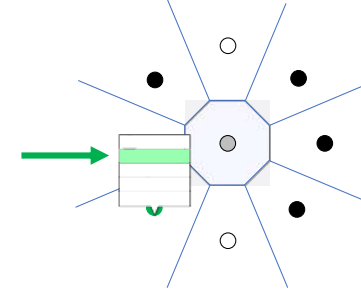
User study

- Experimental task



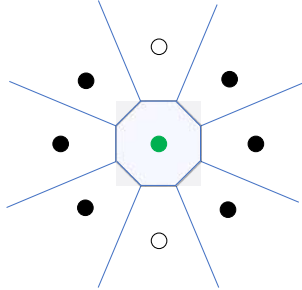
User study

- Experimental task



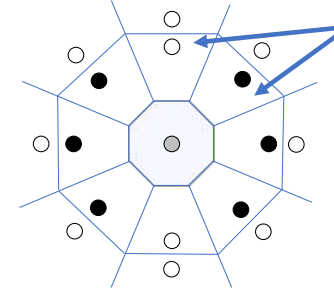
User study

- Experimental task



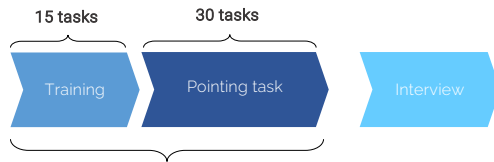
User study

- Experimental task



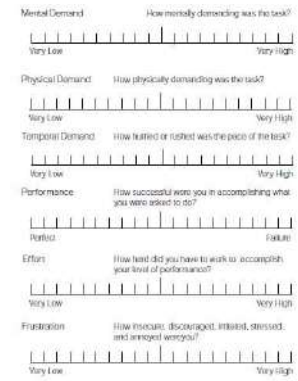
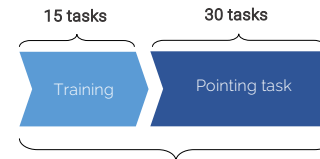
User study

• Procedure



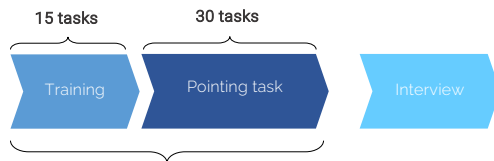
User study

• Procedure



User study

• Procedure



User study

I found the settings an mentally tiring

Align *

Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree

Distant opening *

Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree

Fixed cursor jump *

Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree

Mobile cursor jump *

Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree

Interview

User study

I found the technique physically tiring

Align *

1 2 3 4 5

Strongly disagree Strongly agree

Distant opening *

1 2 3 4 5

Strongly disagree Strongly agree

Fixed cursor jump *

1 2 3 4 5

Strongly disagree Strongly agree

Mobile cursor jump *

1 2 3 4 5

Strongly disagree Strongly agree

Interview

User study

I found the technique easy to learn

Align *

1 2 3 4 5

Strongly disagree Strongly agree

Distant opening *

1 2 3 4 5

Strongly disagree Strongly agree

Fixed cursor jump *

1 2 3 4 5

Strongly disagree Strongly agree

Mobile cursor jump *

1 2 3 4 5

Strongly disagree Strongly agree

Interview

User study

Overall note

Align *

1 2 3 4 5

Very bad Very good

Distant opening *

1 2 3 4 5

Very bad Very good

Fixed cursor jump *

1 2 3 4 5

Very bad Very good

Mobile cursor jump *

1 2 3 4 5

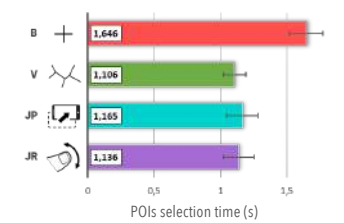
Very bad Very good

Interview

User study

• Results

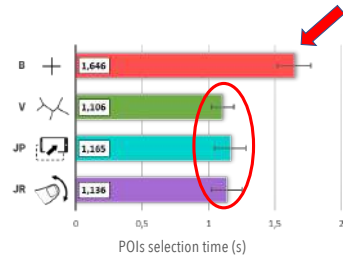
1 POIs selection



User study

• Results

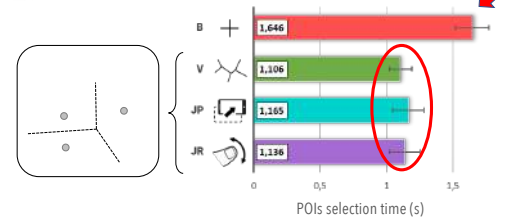
1 POIs selection



User study

• Results

1 POIs selection



User study

• Results

1 POIs selection

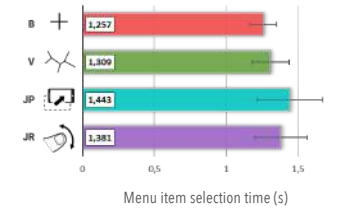
Target expansion techniques :

- 1 Make pointing tasks easier
- 2 Are suitable for handheld AR

User study

• Results

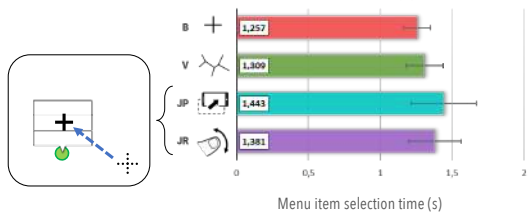
2 Menu item selection



User study

- Results

2 Menu item selection



User study

- Results

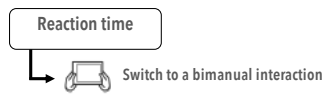
2 Menu item selection

Reaction time

User study

- Results

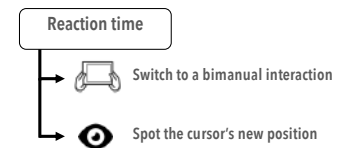
2 Menu item selection



User study

- Results

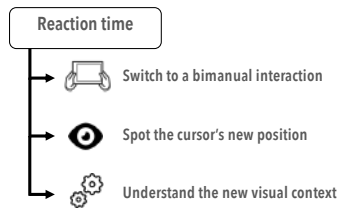
2 Menu item selection



User study

- Results

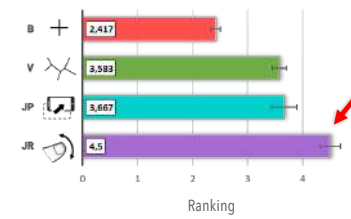
2 Menu item selection



User study

- Results

3 Preferences



User study

- Results

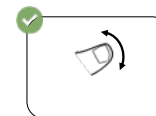
3 Preferences



User study

- Results

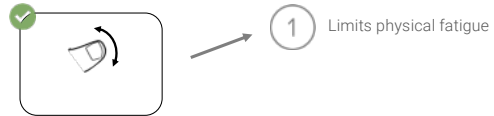
3 Preferences



User study

- Results

3 Preferences



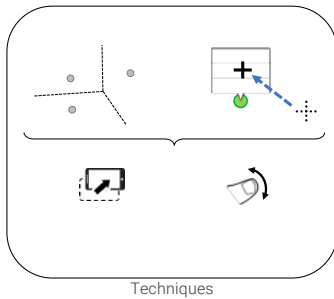
User study

- Results

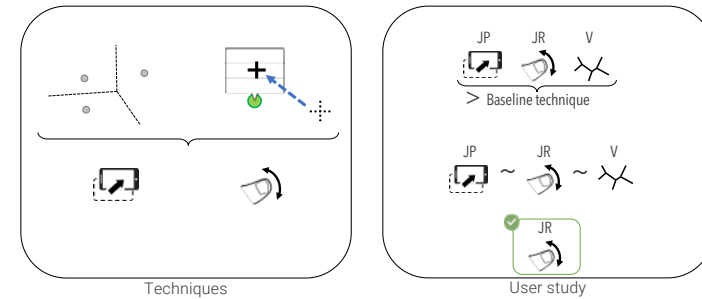
3 Preferences



Techniques and experimental results



Techniques and experimental results



Extension

1. Test in a professional industrial context

2. Direct pointing and target expansion



Augmented Reality/Virtuality (AR/AV)

- Challenges

- Tracking

- Rendering

- Interaction

