

# GESTURE-AWARE REMOTE CONTROLS: GUIDELINES & INTERACTION TECHNIQUES

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# Interactive television

More and more services and contents:

- Electronic program guide
- Video on demand
- Web based widgets
- Web applications
- Personal content

The screenshot shows a program guide for the NBC show "Law & Order". The main header includes the NBC peacock logo, the show title "Law & Order", and the episode title "'Kid Pro Quo'". It specifies the airing date and time: "Wed Apr 30, 10:00 pm - 11:00 pm". A synopsis follows: "Several people are suspects when the head of admissions for a private school is killed." A small video thumbnail shows two men in suits. The current time is "10:23 pm" and the status is "Not Recording".

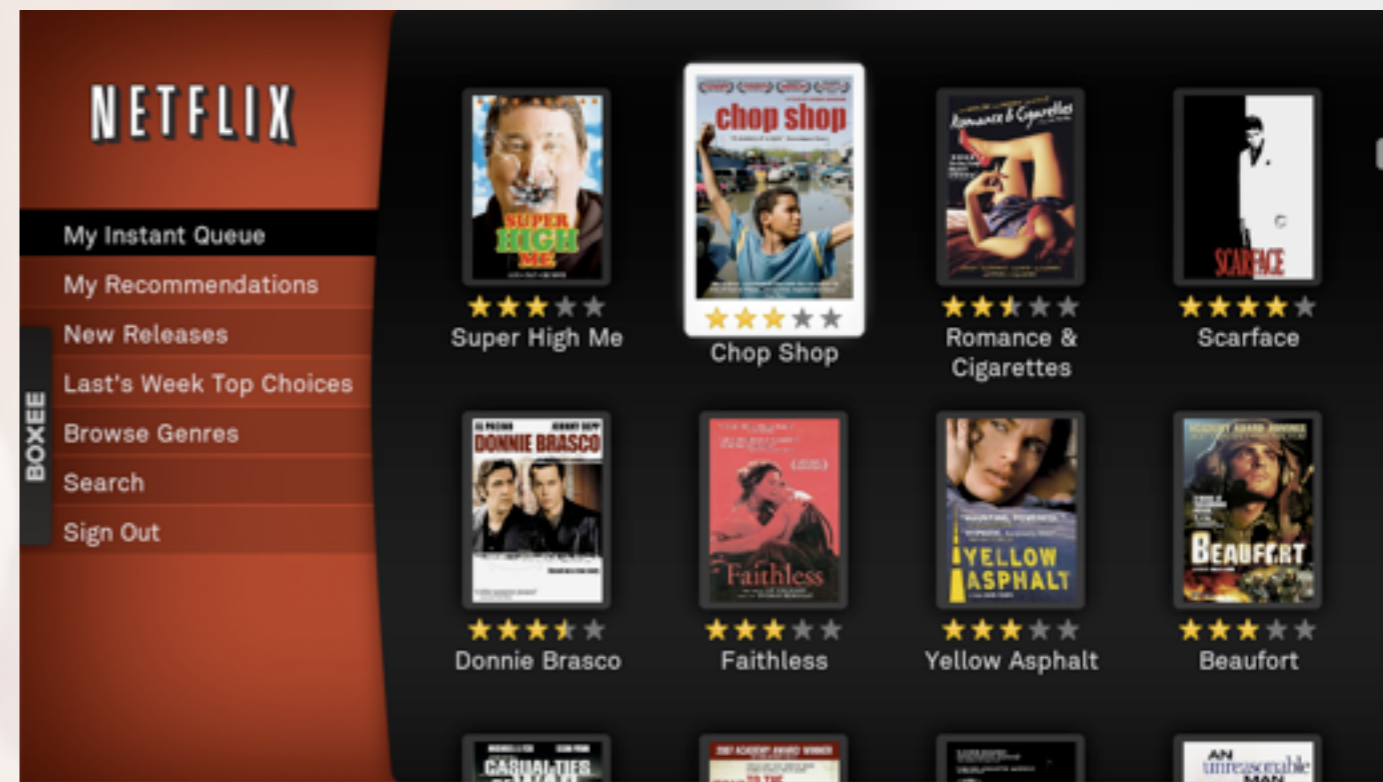
Below the header is a grid of program listings for Wednesday. The columns represent time slots: 10:00 pm, 10:30 pm, 11:00 pm, and 11:30 pm. The rows represent different channels:

Channel	10:00 pm	10:30 pm	11:00 pm	11:30 pm
70 FX	The World's Worst Driver...		The Practice (Crime)	
73 TRAV	< World Poker Tour (Travel)		Top Ten Predators Up Clo...	
3 WKYC	Law & Order (Crime)		Channel 3 Ne...	The T... >
4 WUAB	Action News at Te...	Sp...	Seinfeld ()	Seinfeld ()
5 WEWS	< ... Extreme Makeover (M...		Newschanne...	Nightlin...

# Interactive television

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# Interactive television

More and more services and contents:

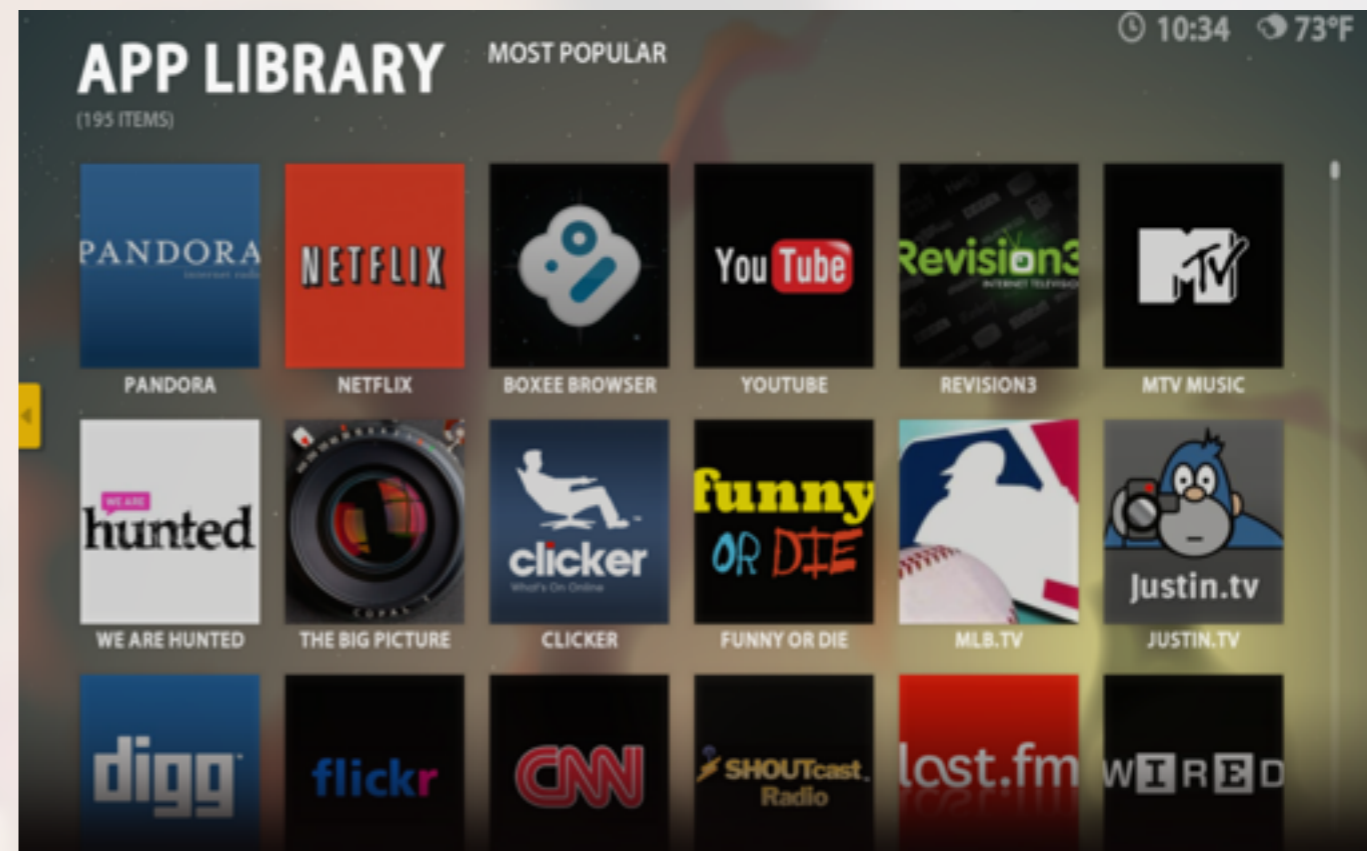
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# Interactive television

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# Interactive television

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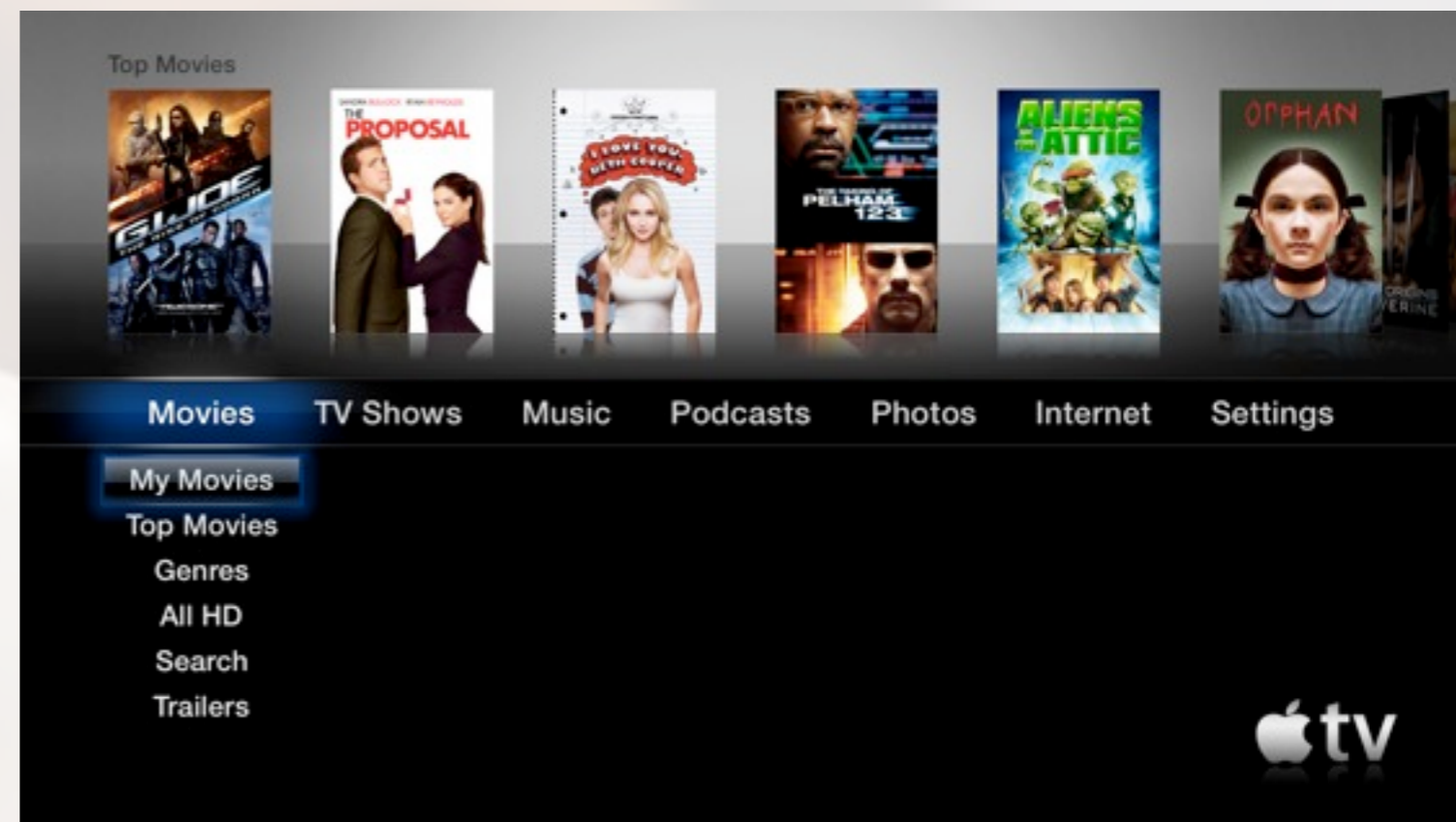
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# Interacting with interactive television

Inspired from computer interaction:

- Deep hierarchical menus
- Long lists



# Interacting with interactive television

Inspired from computer interaction:

- Deep hierarchical menus
- Long lists

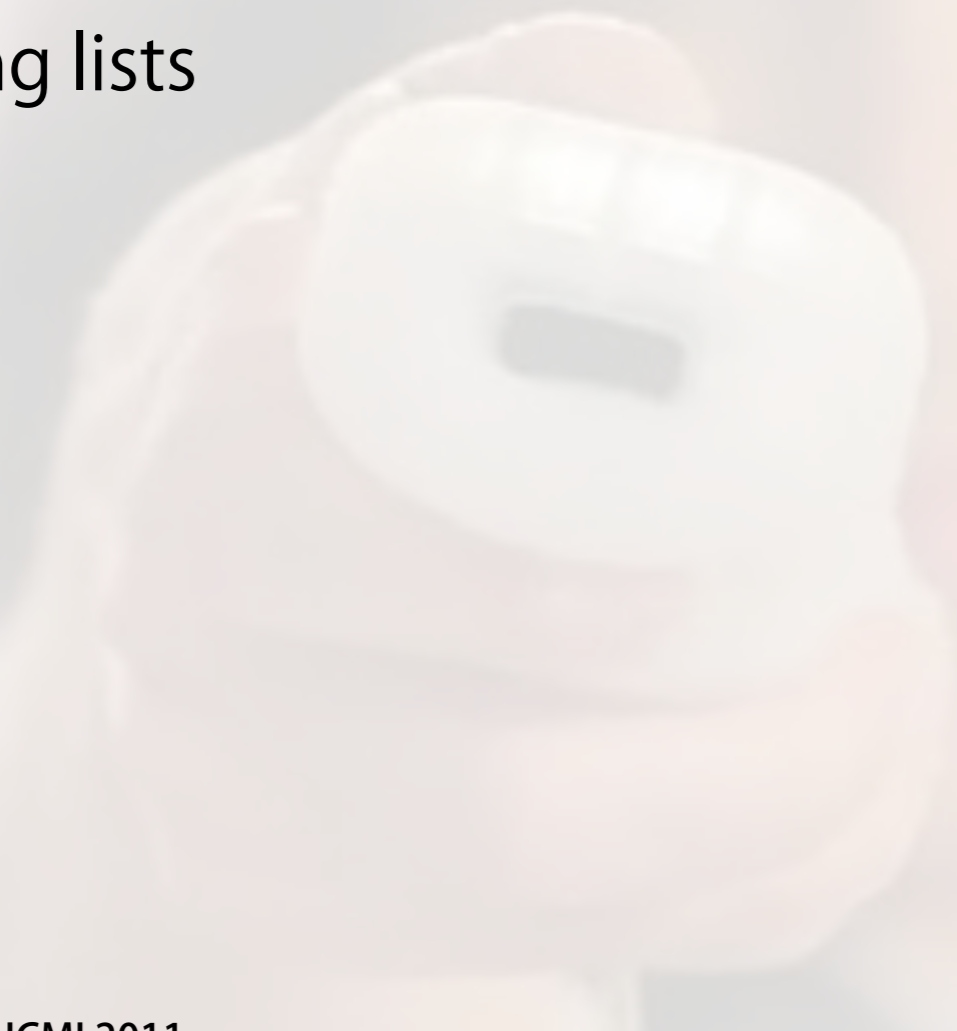




# Interacting with interactive television

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# Interacting with interactive television

Inspired from computer interaction:

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# Remote control

## Problems:

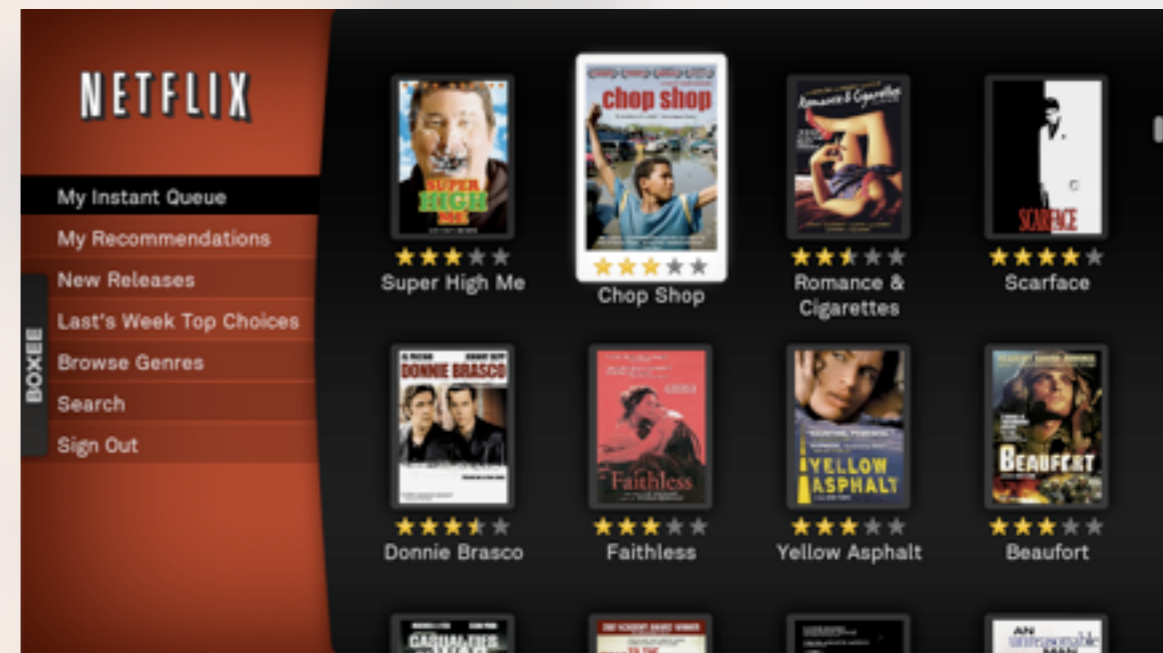
- Browsing
- Commands



# Remote control

## Problems:

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# Remote control

## Problems:

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# Remote control

## Problems:

- Browsing
- Commands



Limited  
expressiveness

# Improving expressiveness

## Solution?

- Add a new button for each new command



# Improving expressiveness

## Solution?

- Add a new button for each new command

Pultius TV remote control  
[Arlebedev'07]

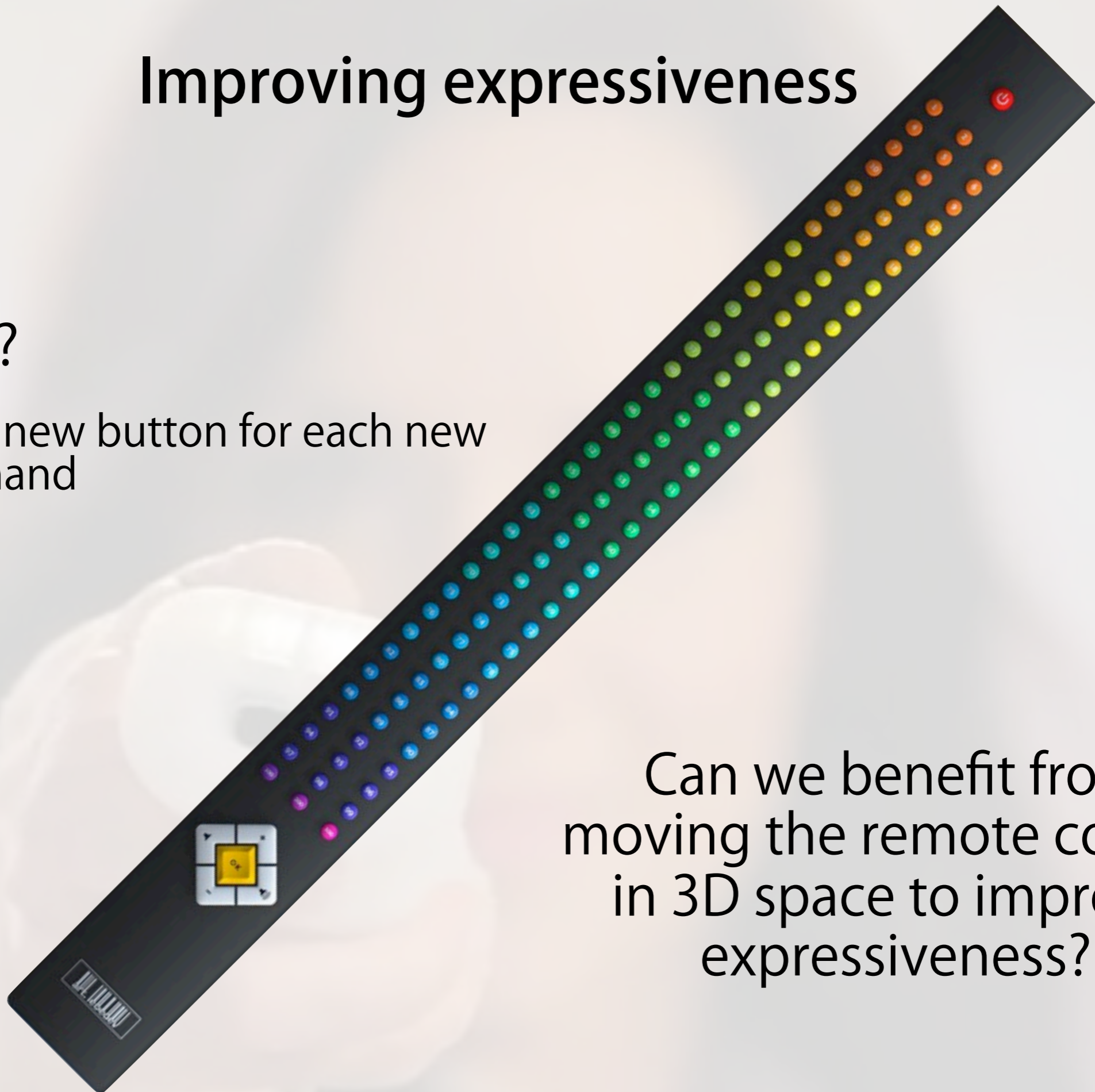




# Improving expressiveness

## Solution?

- Add a new button for each new command



Can we benefit from moving the remote control in 3D space to improve expressiveness?

# Approach

## Advantages of 3D gestures:

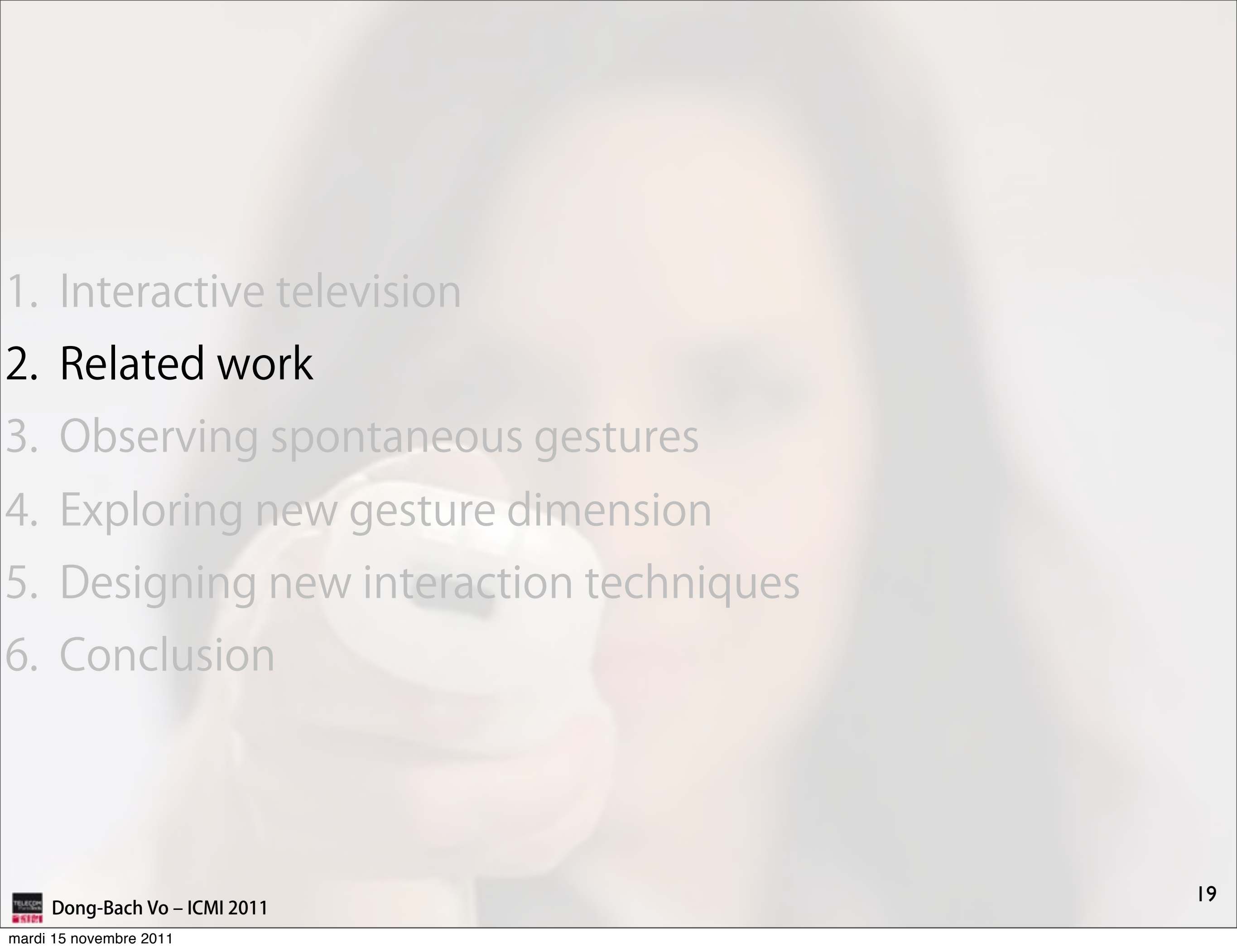
- Allow large vocabulary of gestures
- Can be easy to remember
- Free visual focus from the remote control
- Comfortable to perform gestures at home [Rico et al.'10]
- Remote controls can remain small and easy to hold

# Approach

## Advantages of 3D gestures:

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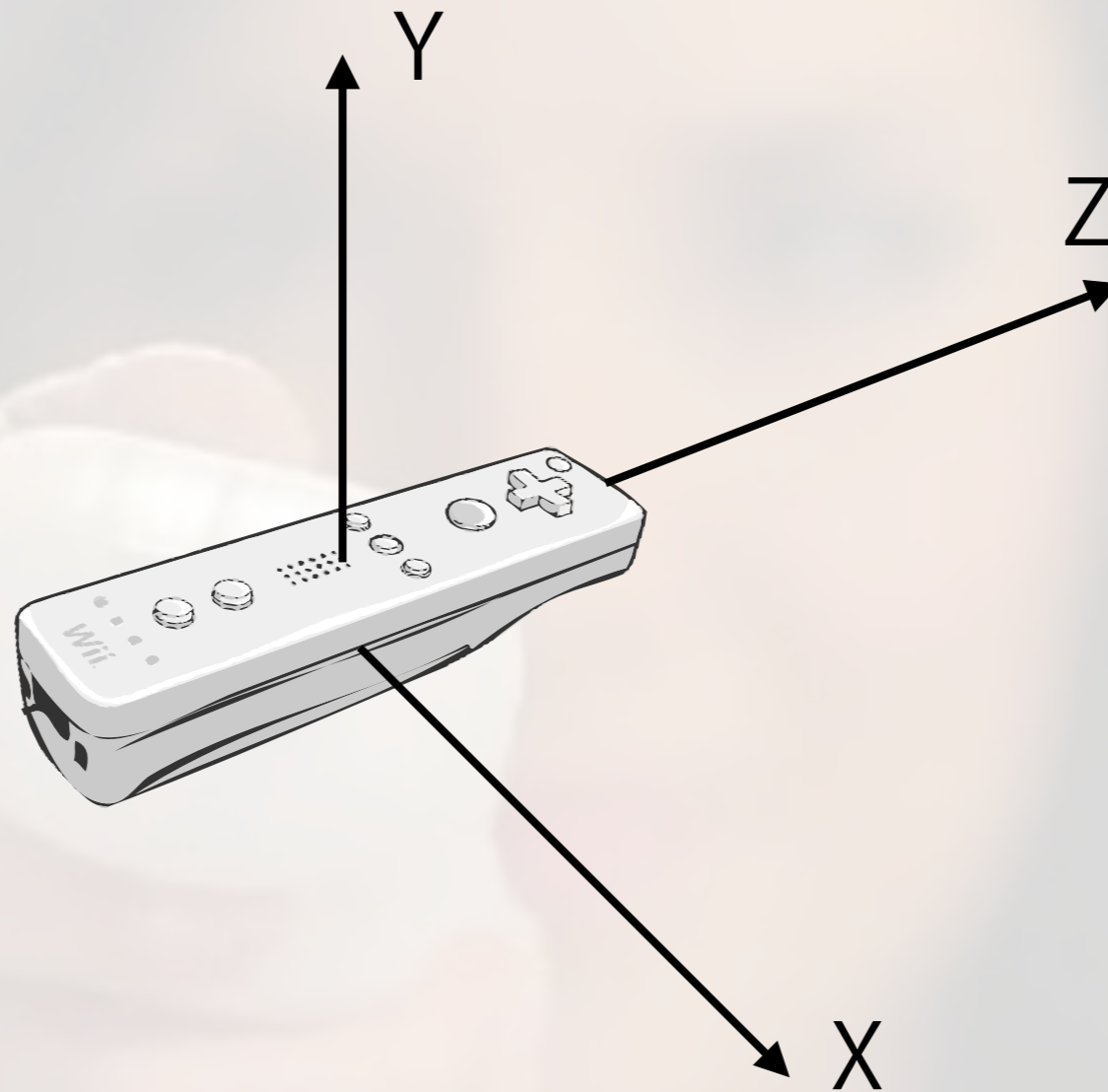


- 
1. Interactive television
  - 2. Related work**
  3. Observing spontaneous gestures
  4. Exploring new gesture dimension
  5. Designing new interaction techniques
  6. Conclusion

# Related work

3D gestures offer 6 degrees of freedom:

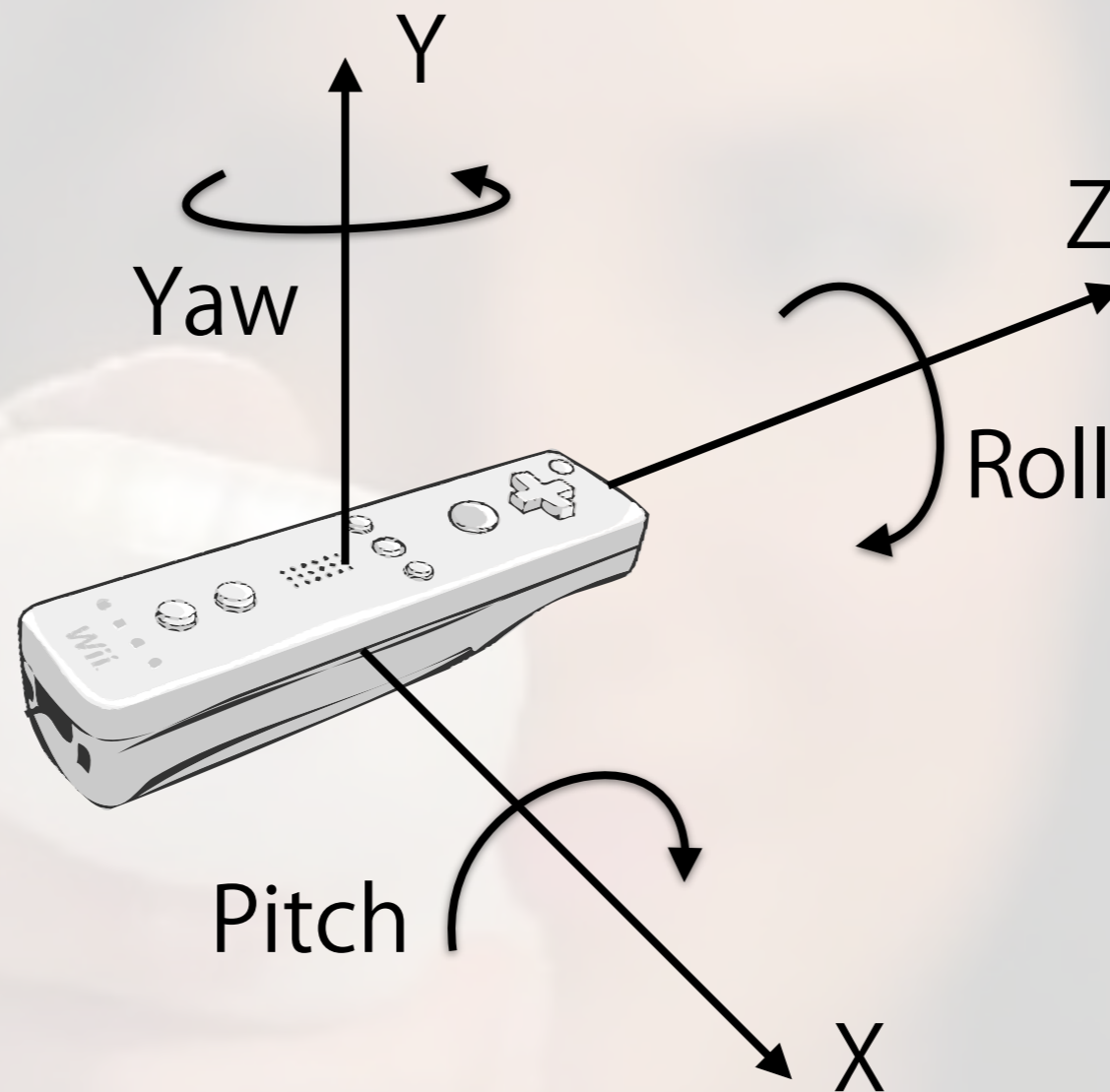
- 3 translations
- 3 rotations



# Related work

3D gestures offer 6 degrees of freedom:

- 3 translations
- 3 rotations



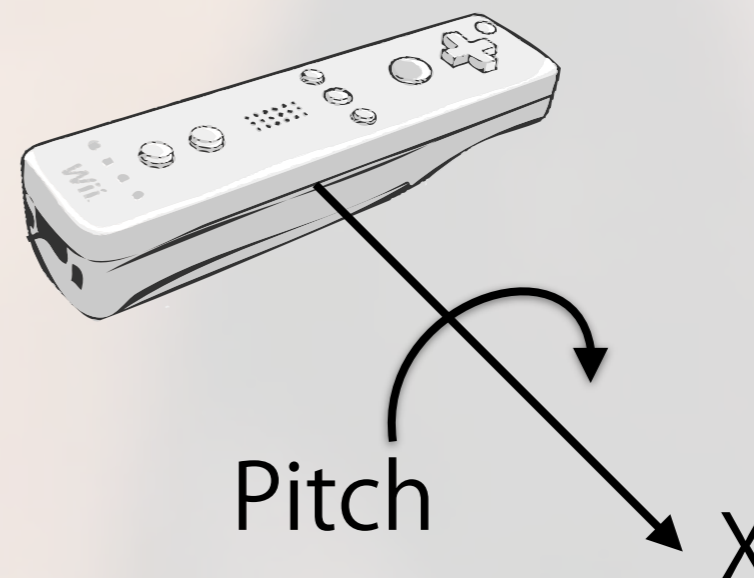
# Related work

## Rotations:

- 1 dimension
- 2 dimensions
- Discretization of tilt angle with visual feedback [Rahman et al.'09]



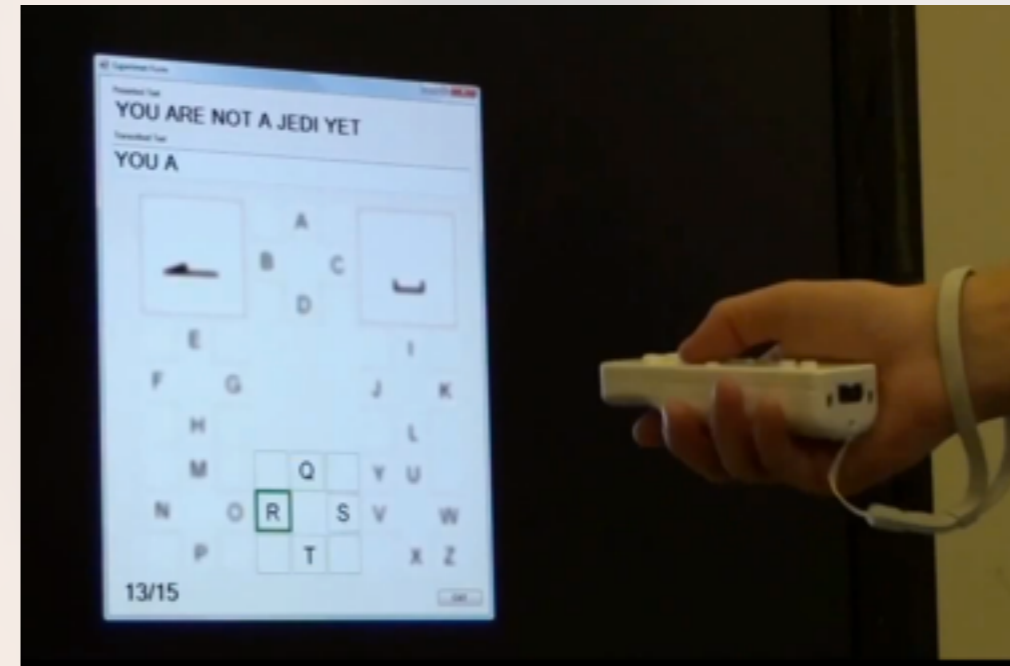
Motion marking menu system [Oakley'03]



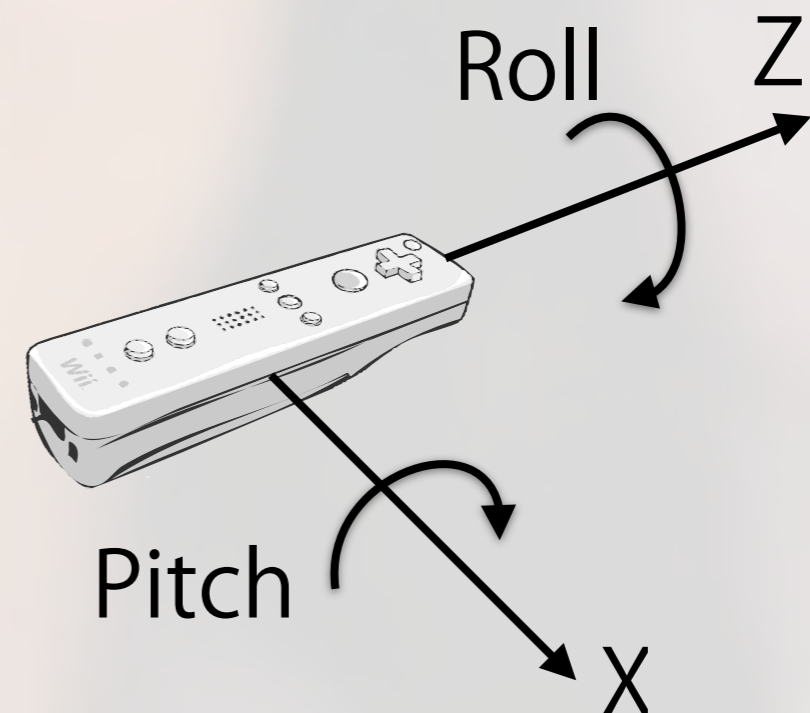
# Related work

## Rotations:

- 1 dimension
- 2 dimensions
- Discretization of tilt angle with visual feedback [Rahman et al.'09]



GesText [Jones et al.'10]

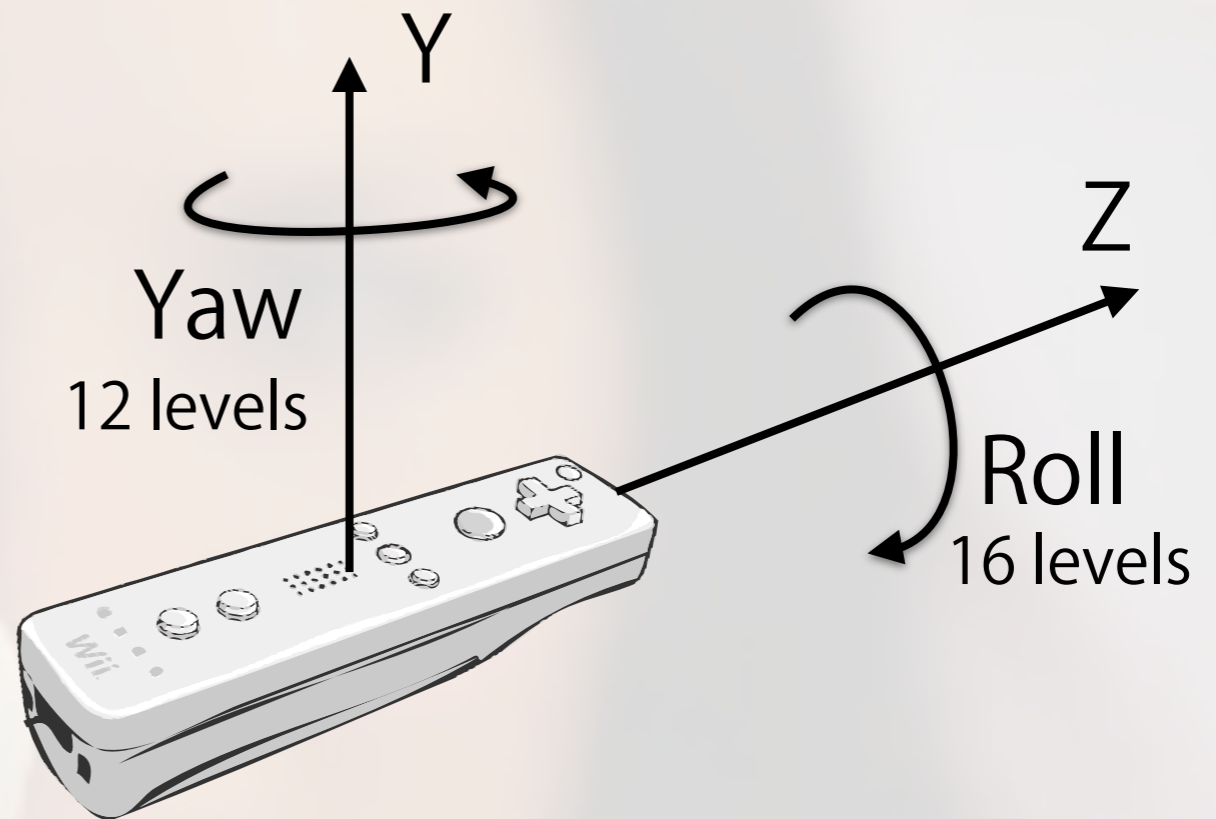




# Related work

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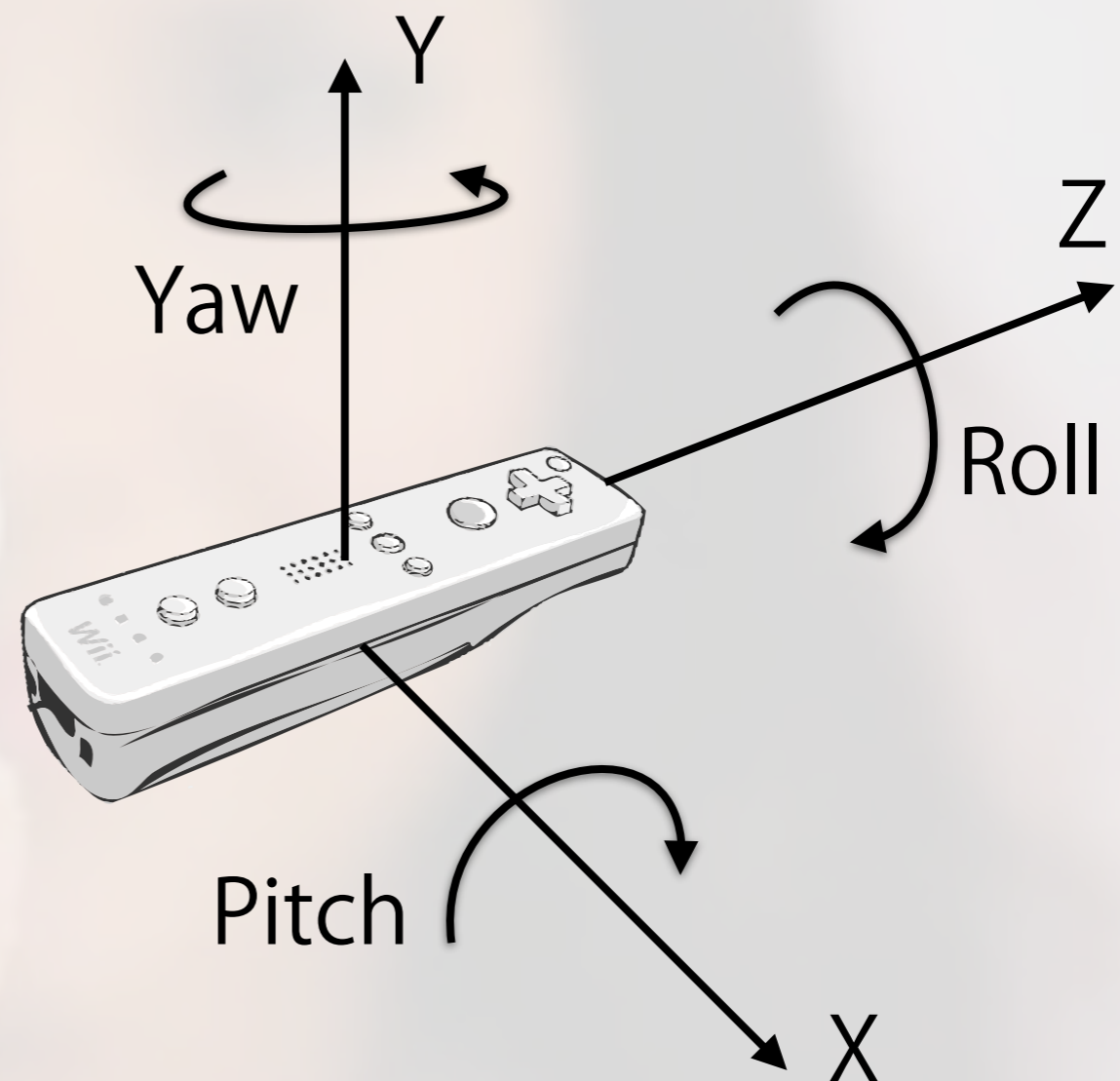


1. Interactive television
2. Related work
- 3. Observing spontaneous gestures**
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# Experiment 1: spontaneous gestures

What gestures users perform spontaneously for moving targets?

- Which degree(s) of freedom?
- Is it context dependant (smartphone vs. remote controls)?



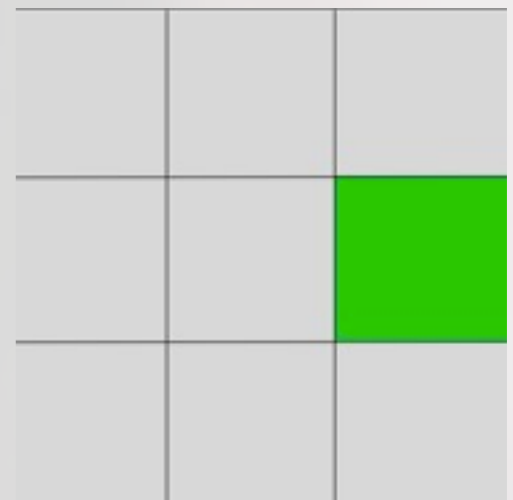
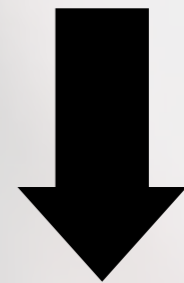
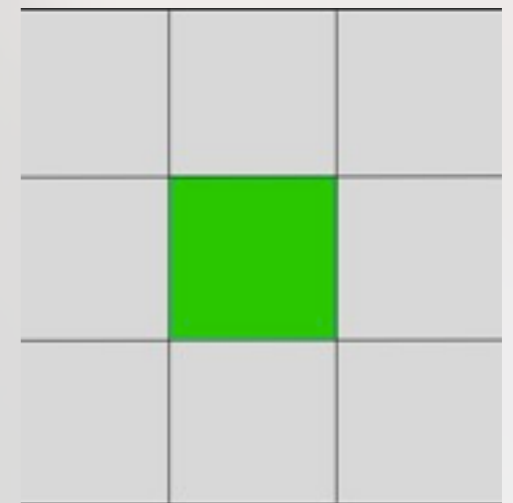
# Experiment 1: spontaneous gestures

## Task:

- Perform the gesture that would move the target to this position

## Procedure:

- Smartphone vs. Remote control
- Observation from video recordings



# Experiment 1: spontaneous gestures

## Task:

- Perform a gesture which has produced this effect

## Procedure:

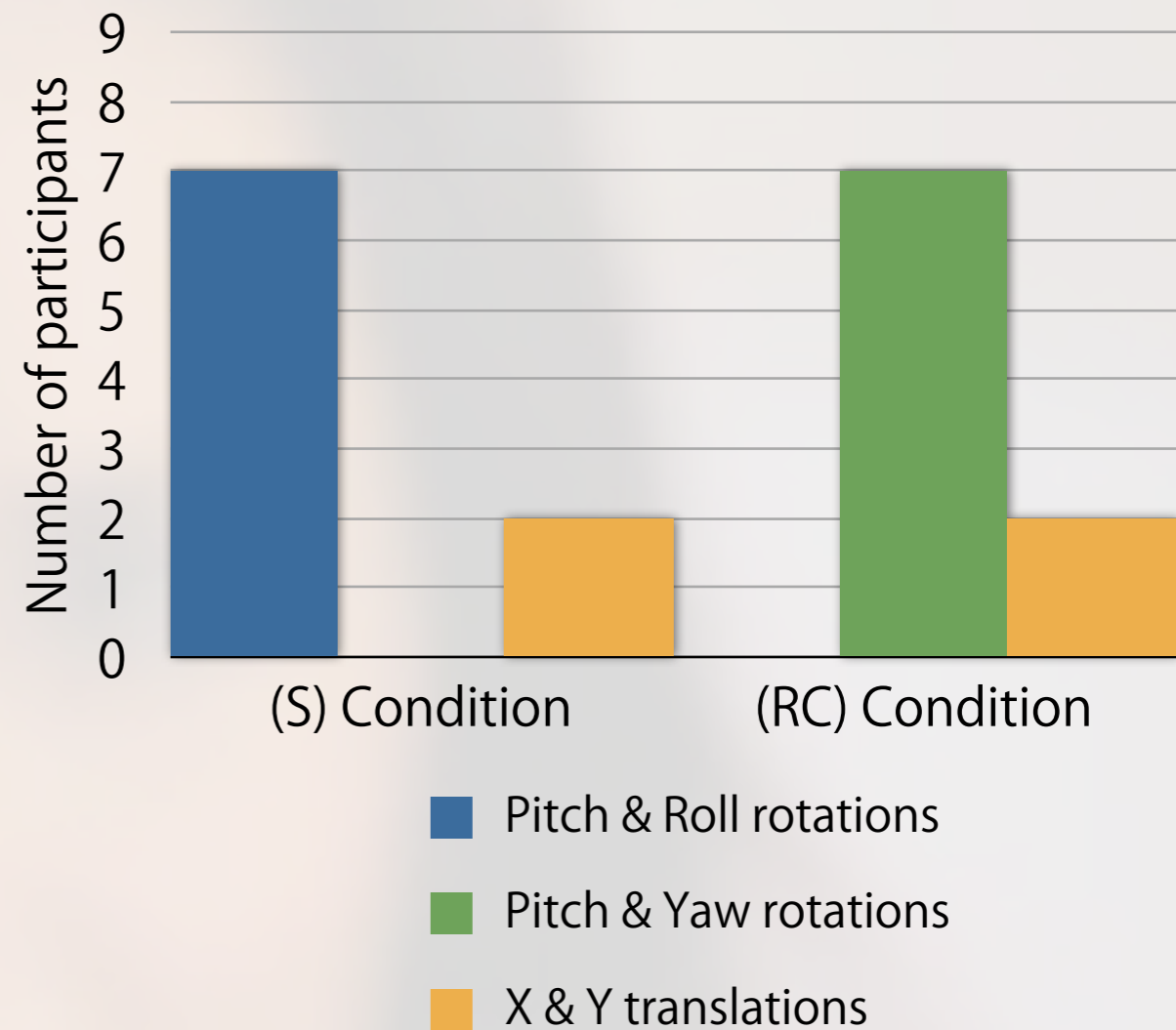
- Smartphone vs. Remote control
- Observation from video recordings



# Experiment 1: spontaneous gestures

## Results:

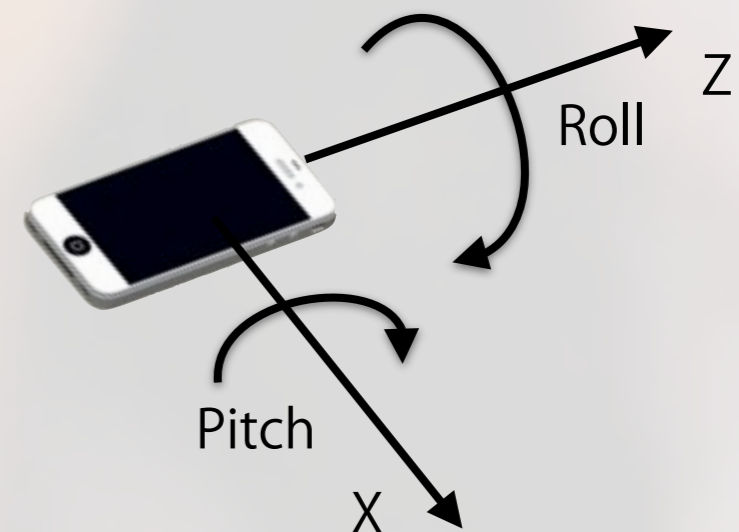
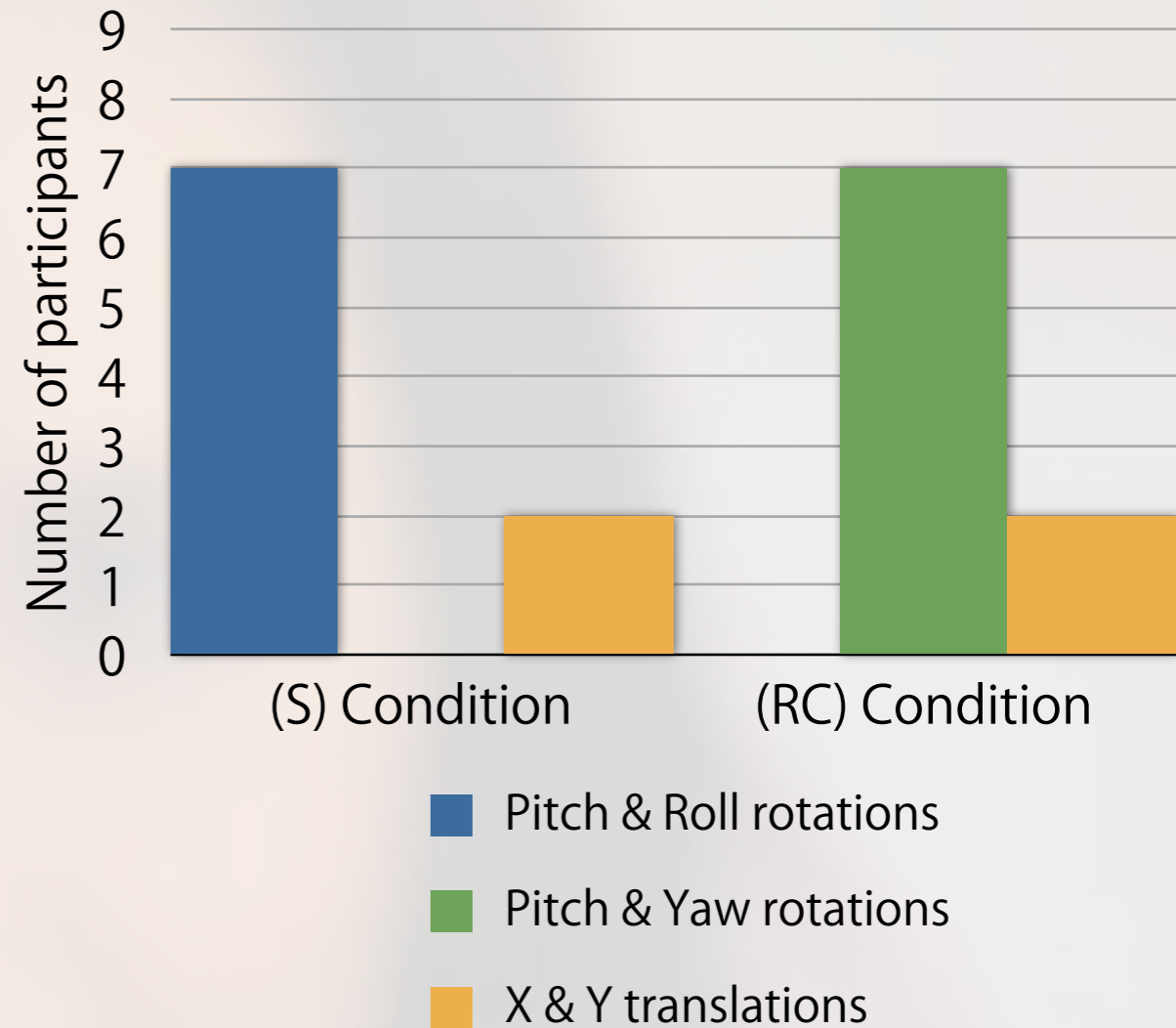
- Either rotations or translations
- 14 of 18 users perform rotations
- Pitch and Roll only in smartphone condition
- Pitch and Yaw in remote control condition
- Roll can be used for something else



# Experiment 1: spontaneous gestures

## Results:

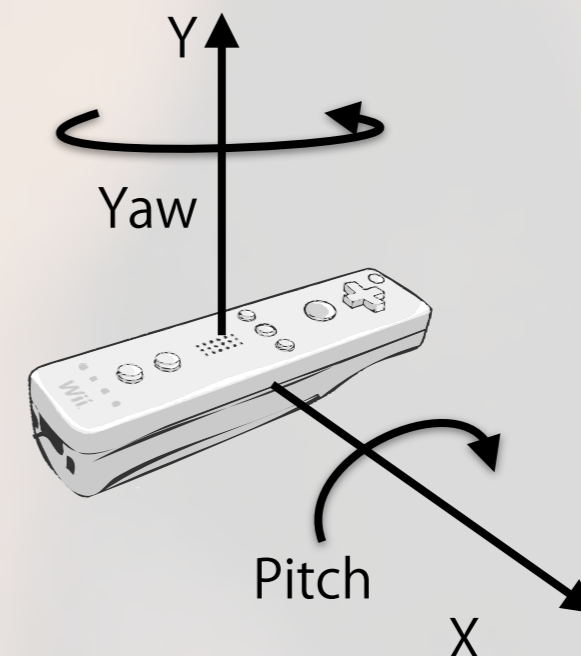
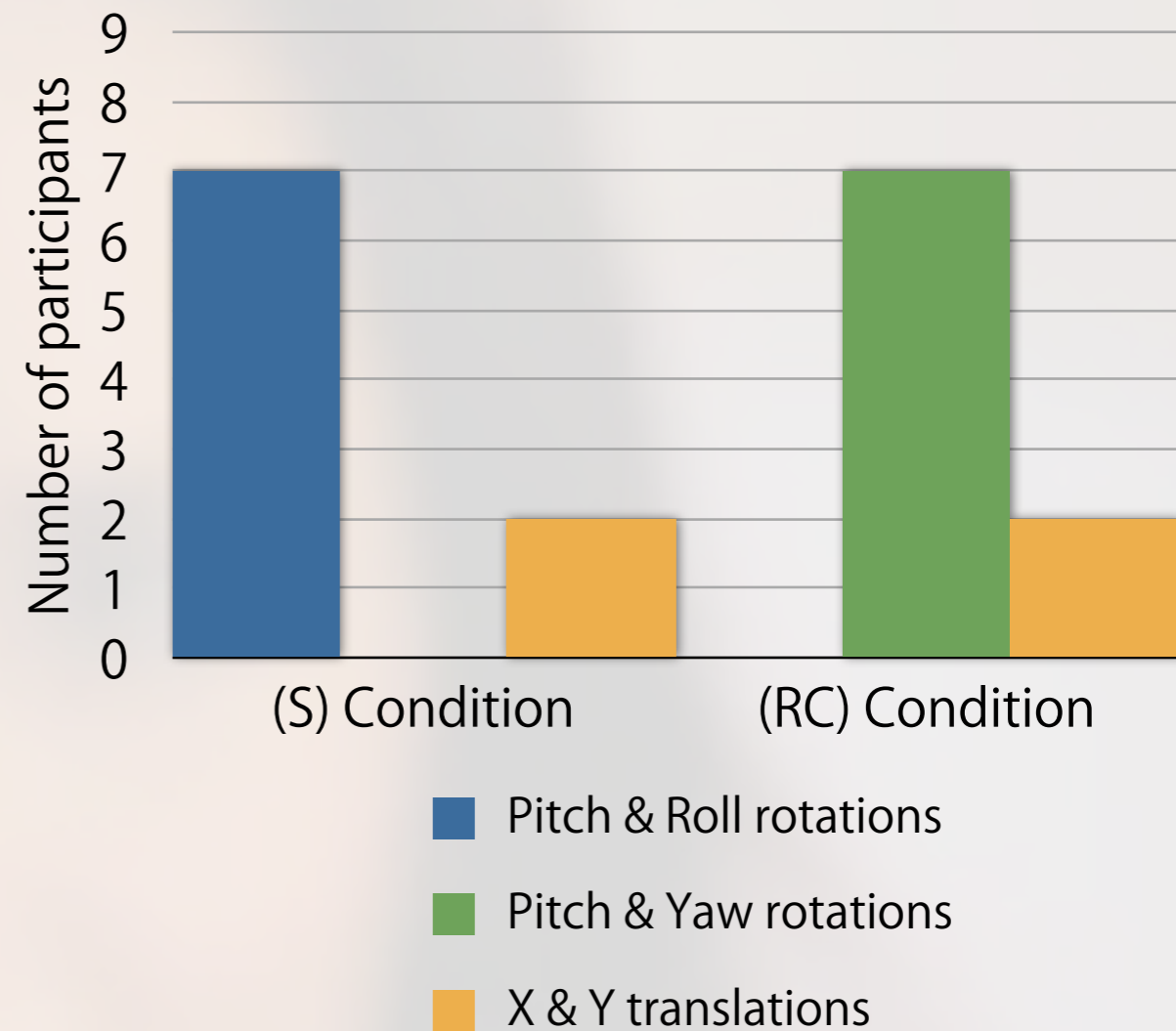
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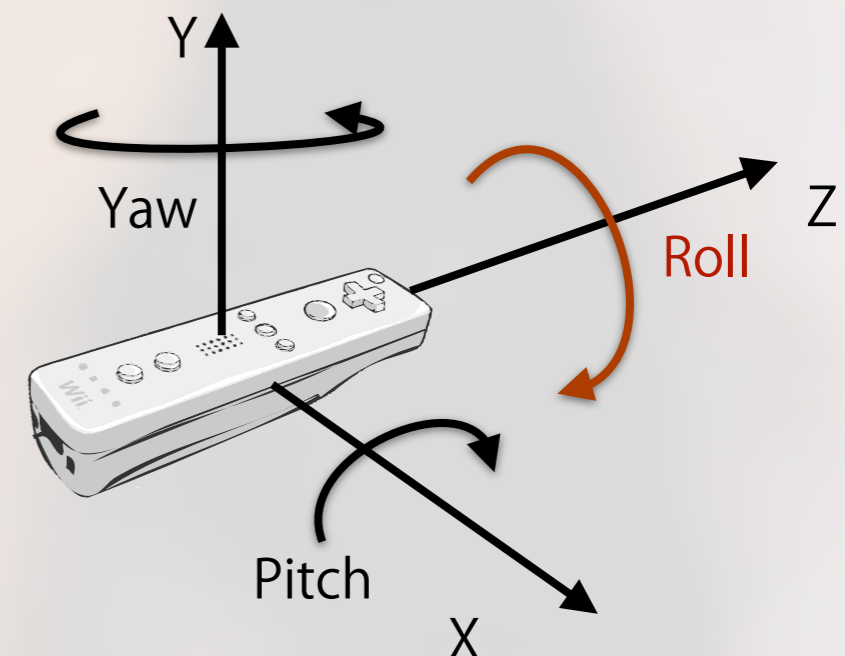
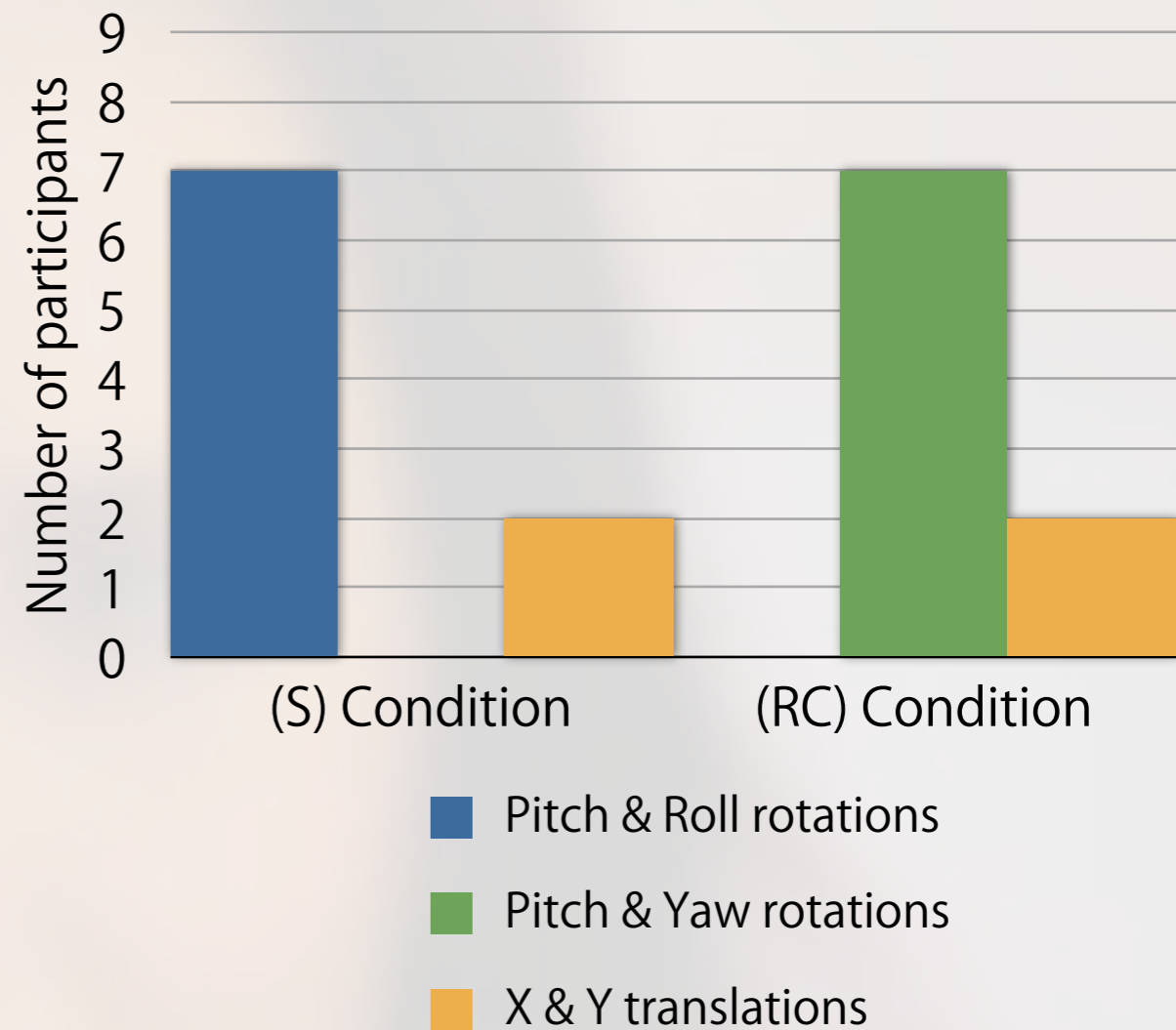


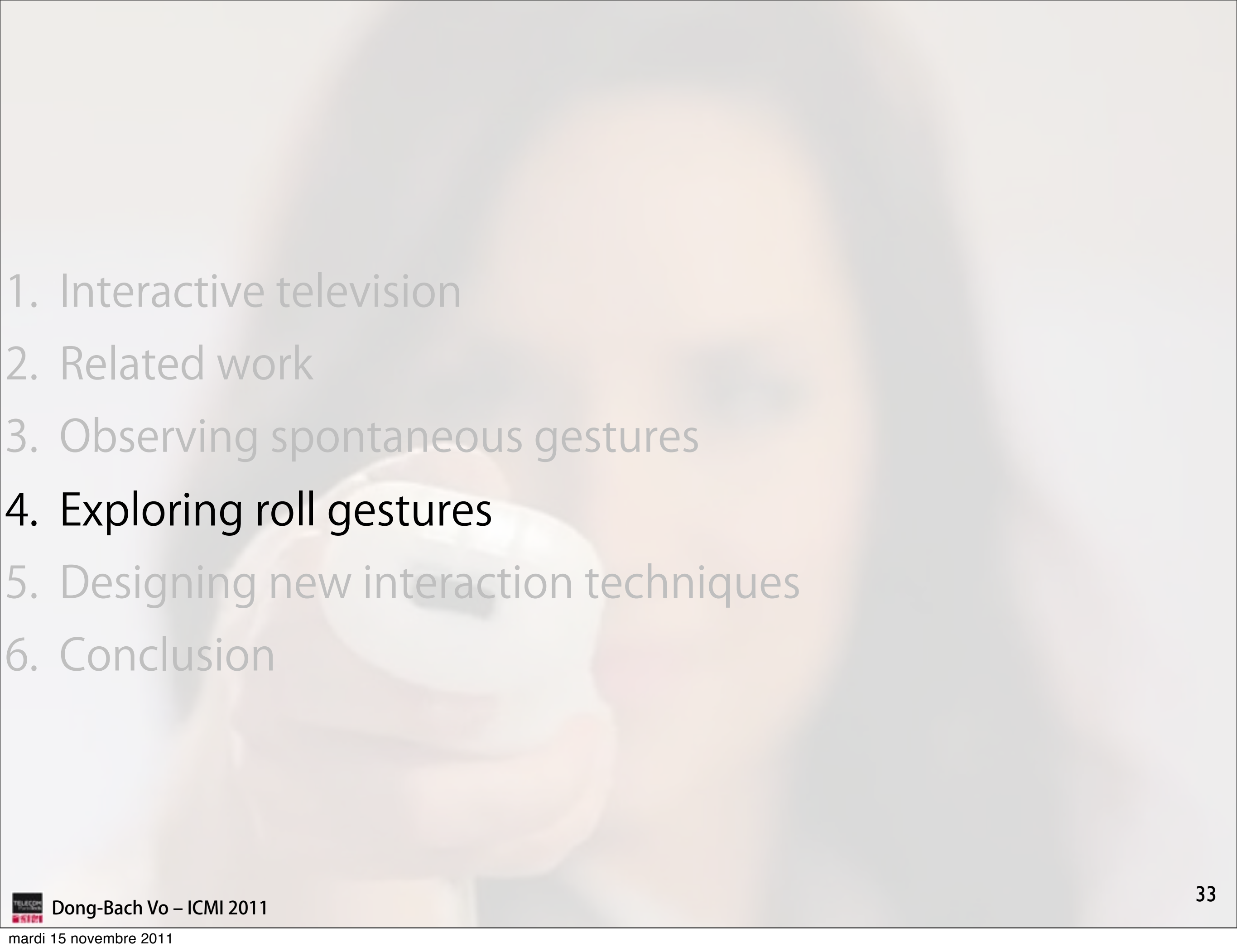
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➔ Roll can be used for something else

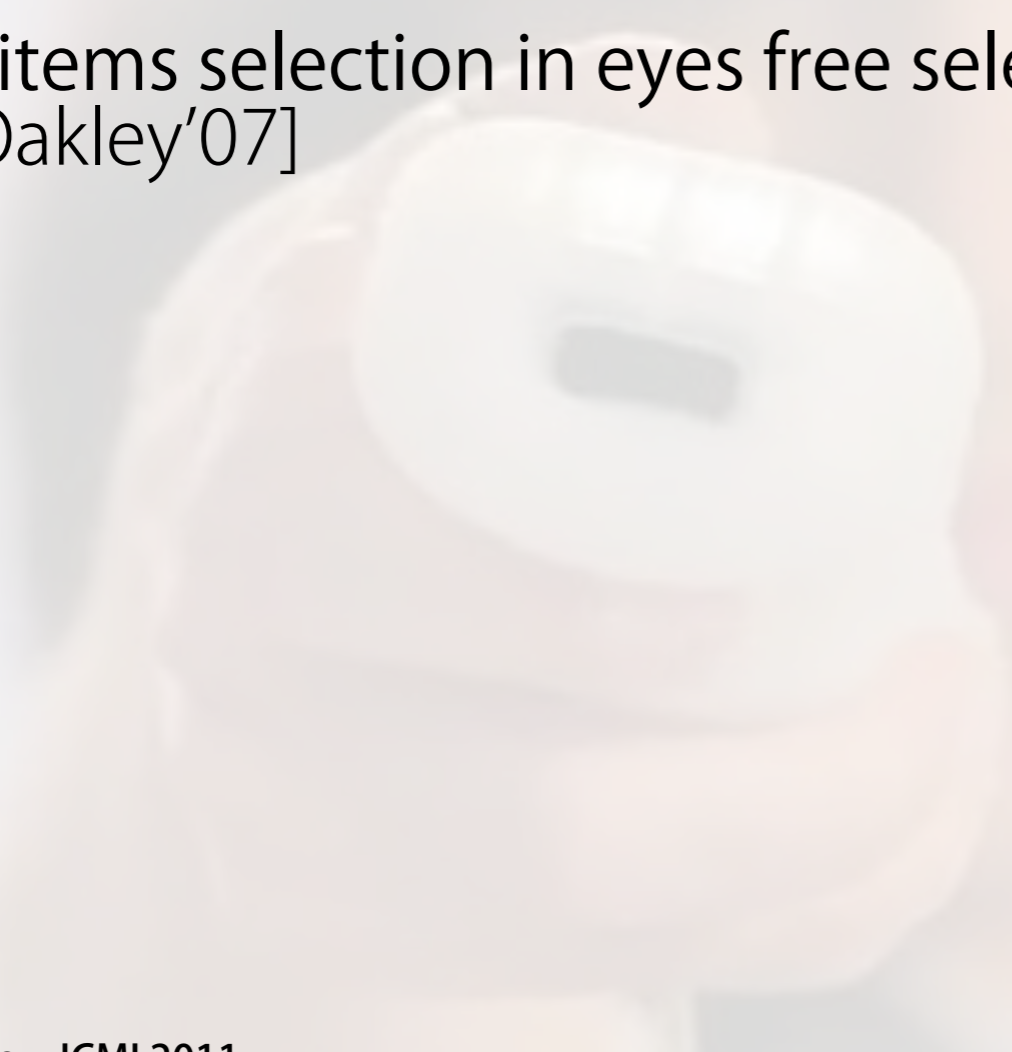


- 
1. Interactive television
  2. Related work
  3. Observing spontaneous gestures
  - 4. Exploring roll gestures**
  5. Designing new interaction techniques
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# Experiment 2: exploring roll gestures

## What we know:

- 16 items selection with visual feedback [Rahman'09]
- 3 items selection in eyes free selection [Oakley'07]



# Experiment 2: exploring roll gestures

## Question:

How many levels users can control without visual feedback?

## Task:

Use any roll amplitude you need to reach the target

- Roll - Press - Roll - Release strategy
- No feedback provided

## Procedure:

- 9 participants
- Items set size (5, 7, 9, 11 items)

# Experiment 2: exploring roll gestures

## Question:

How many levels users can control without visual feedback?

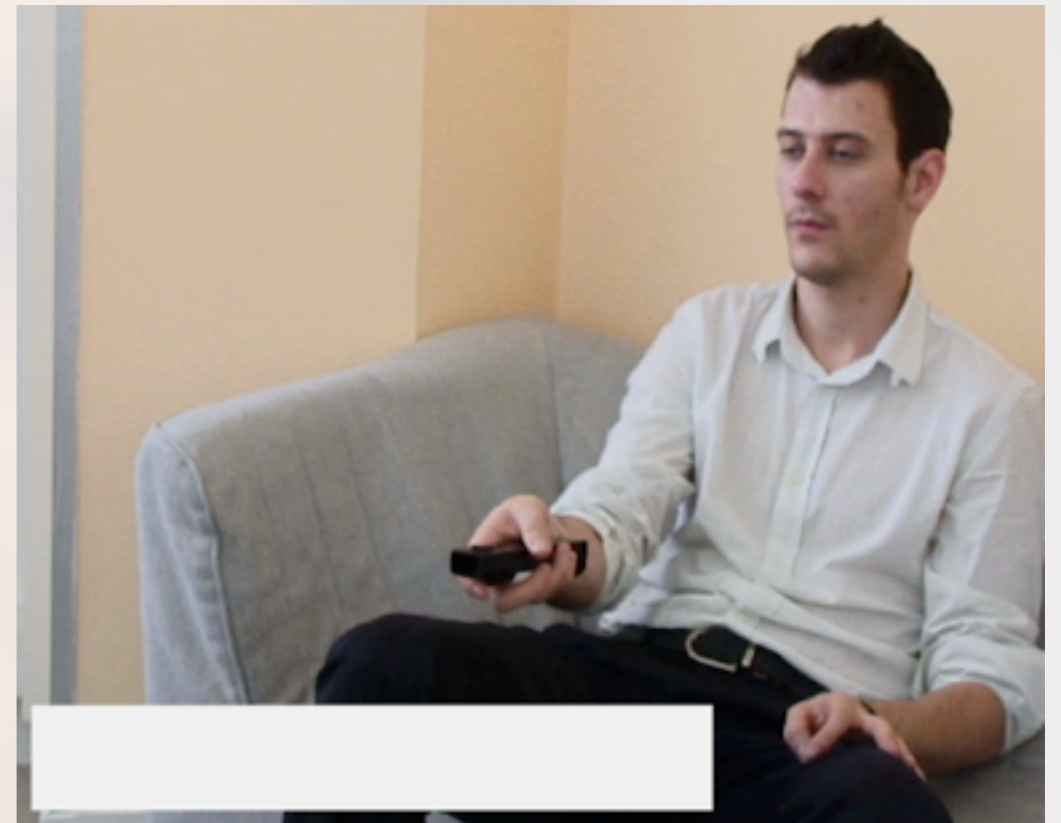
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Step 1: Roll to prepare the gesture

# Experiment 2: exploring roll gestures

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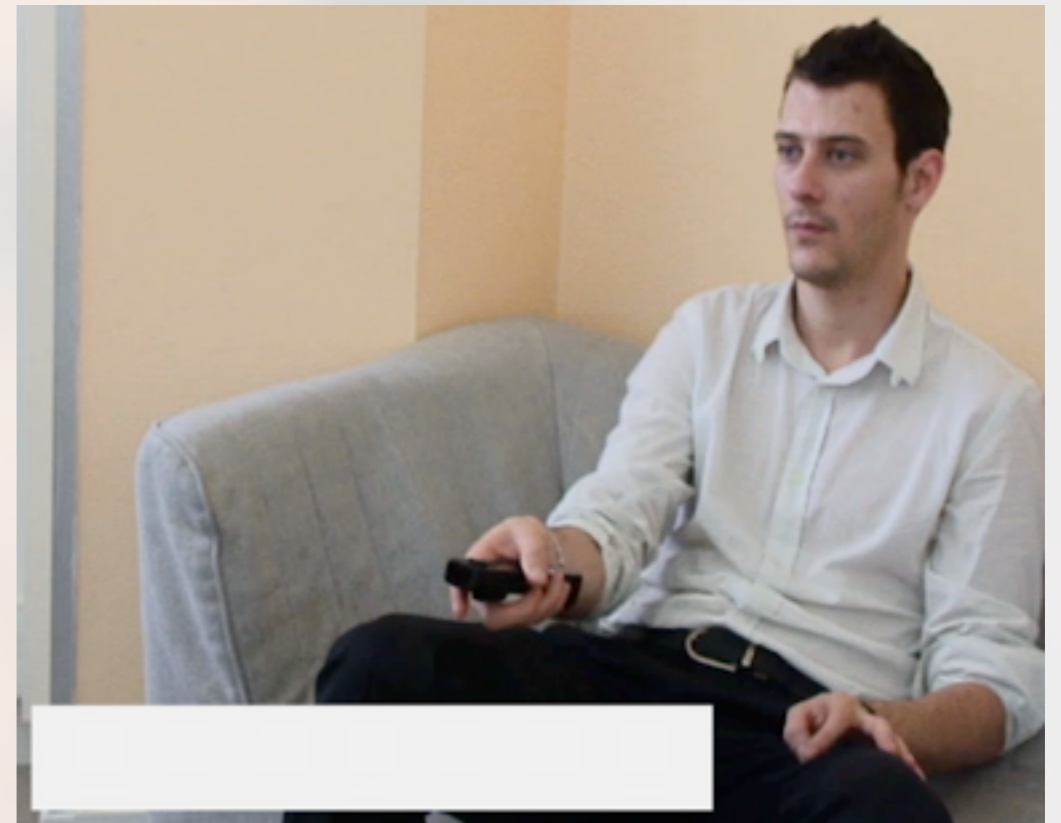
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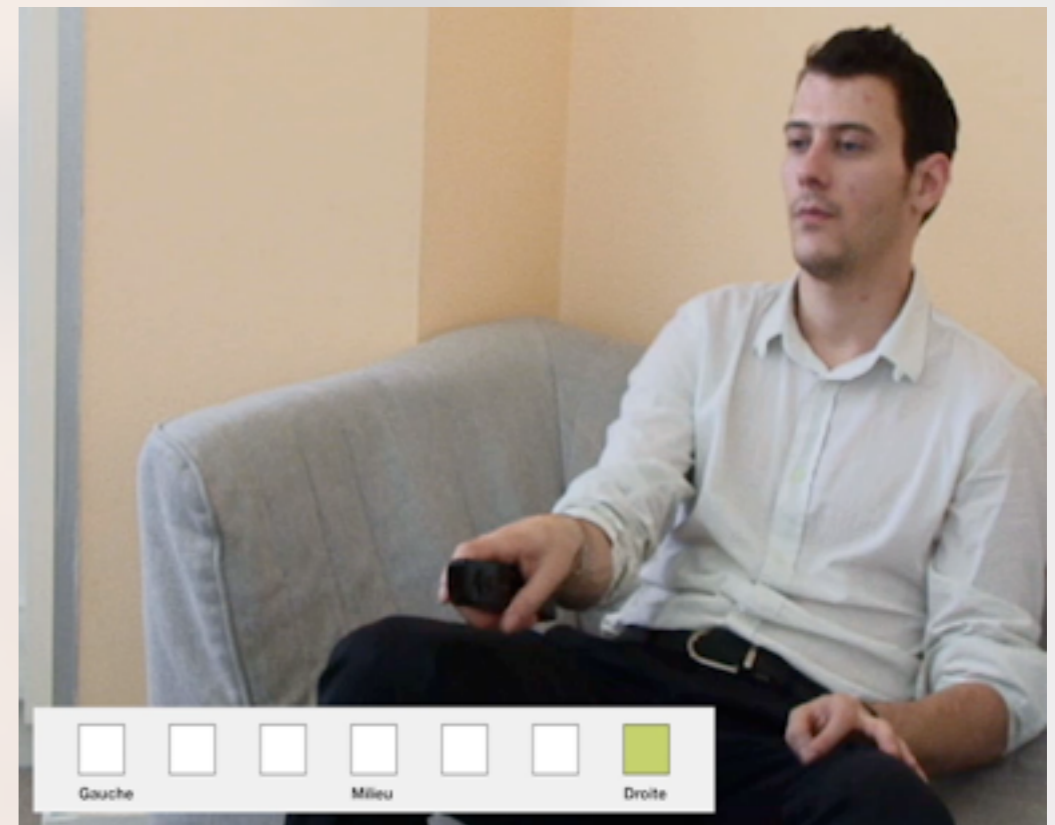
## Task:

Use any roll amplitude you need to reach the target

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Step 2: Press the trigger



# Experiment 2: exploring roll gestures

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How many levels users can control without visual feedback?

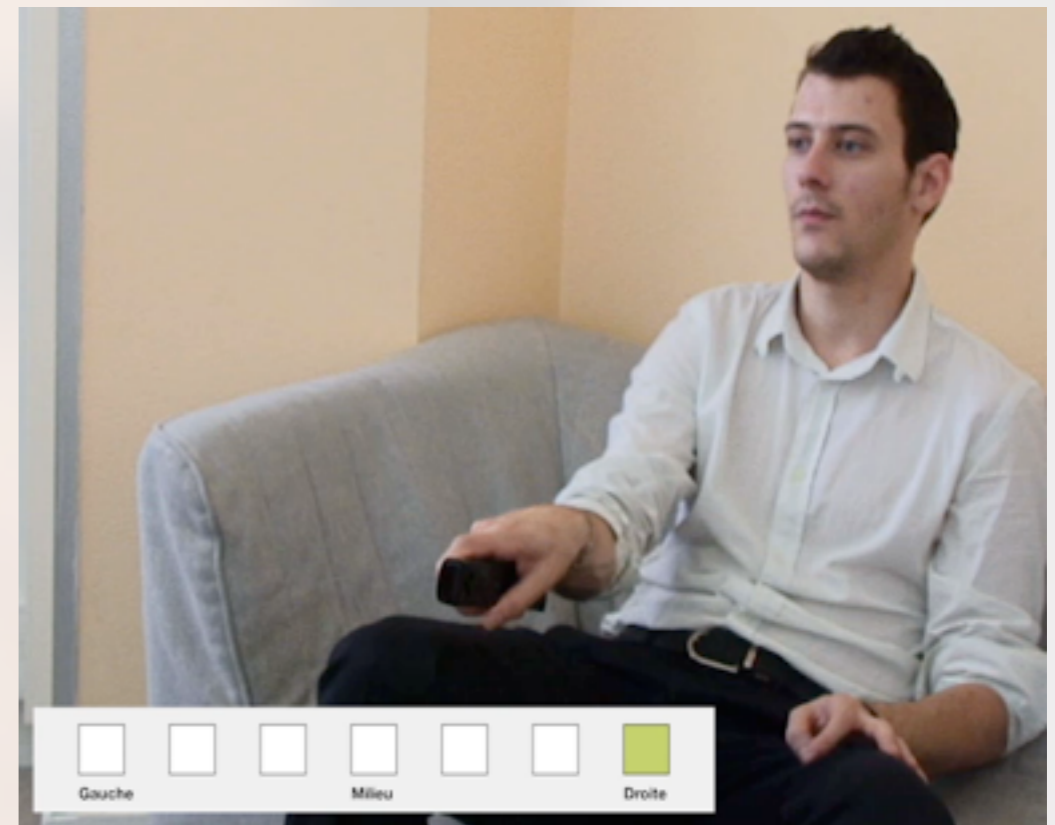
## Task:

Use any roll amplitude you need to reach the target

- Roll - Press - Roll - Release strategy
- No feedback provided

## Procedure:

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Step 3: Roll gesture

# Experiment 2: exploring roll gestures

## Question:

How many levels users can control without visual feedback?

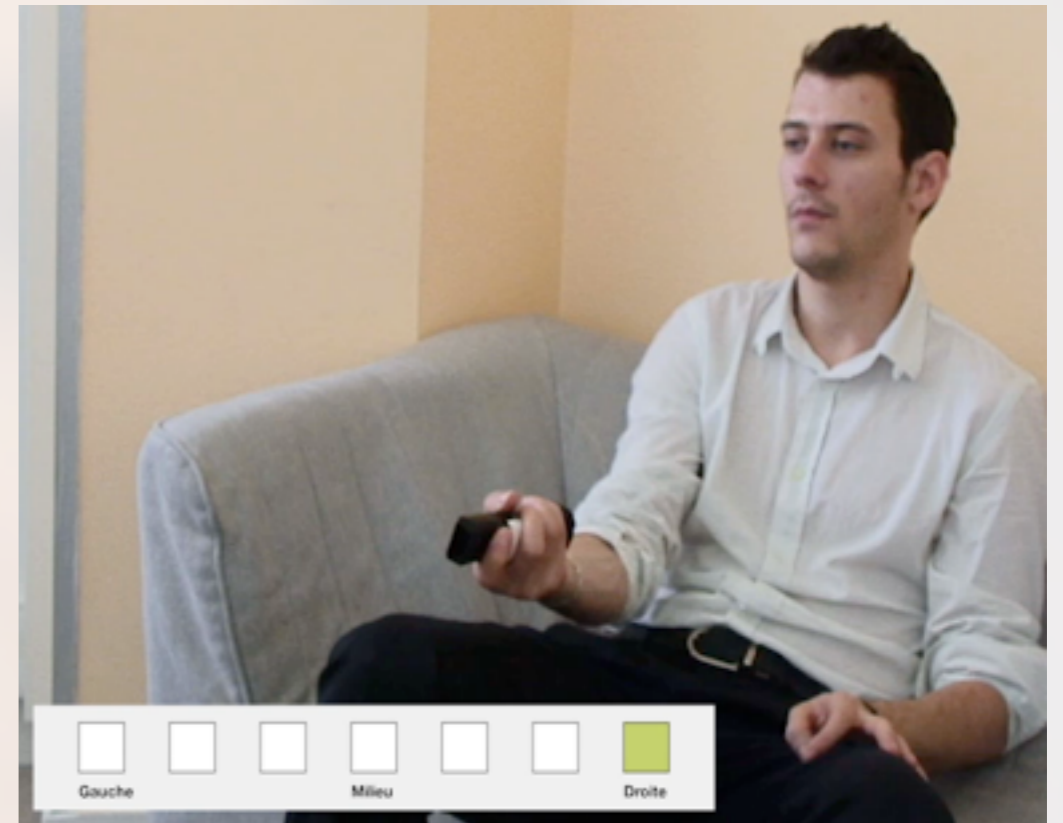
## Task:

Use any roll amplitude you need to reach the target

- Roll - Press - Roll - Release strategy
- No feedback provided

## Procedure:

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Step 4: Release the trigger

# Experiment 2: exploring roll gestures

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How many levels users can control without visual feedback?

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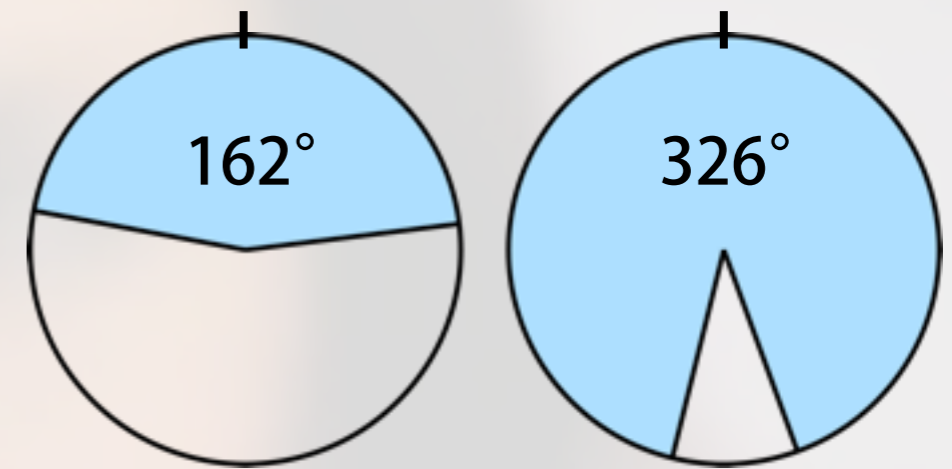
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# Experiment 2: results

## Angular range:

- Differs largely among participants
- Depends on item-set size



Minimum and maximum angular range for 7 items

## Angular variation:

- Constant variation between two contiguous items

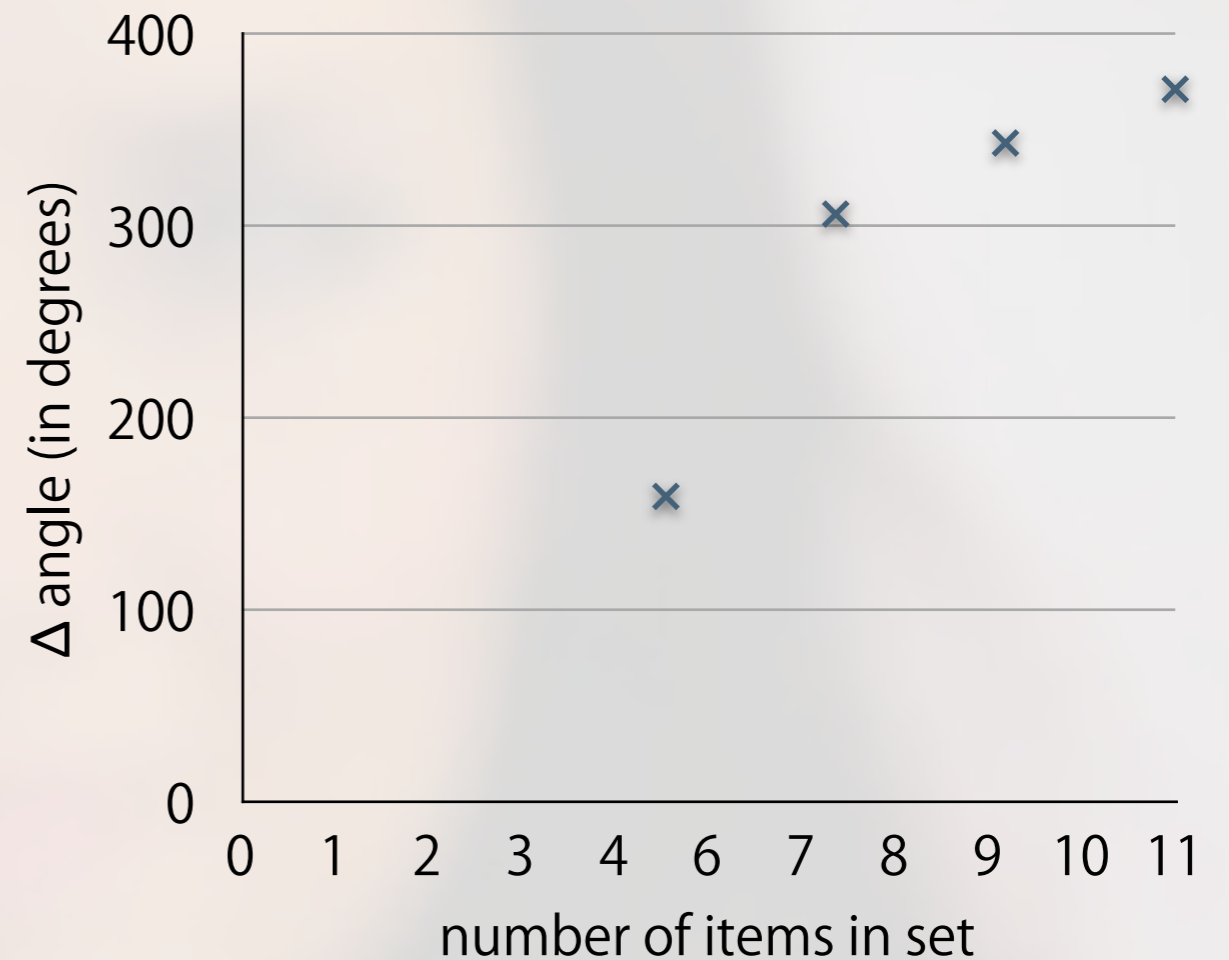
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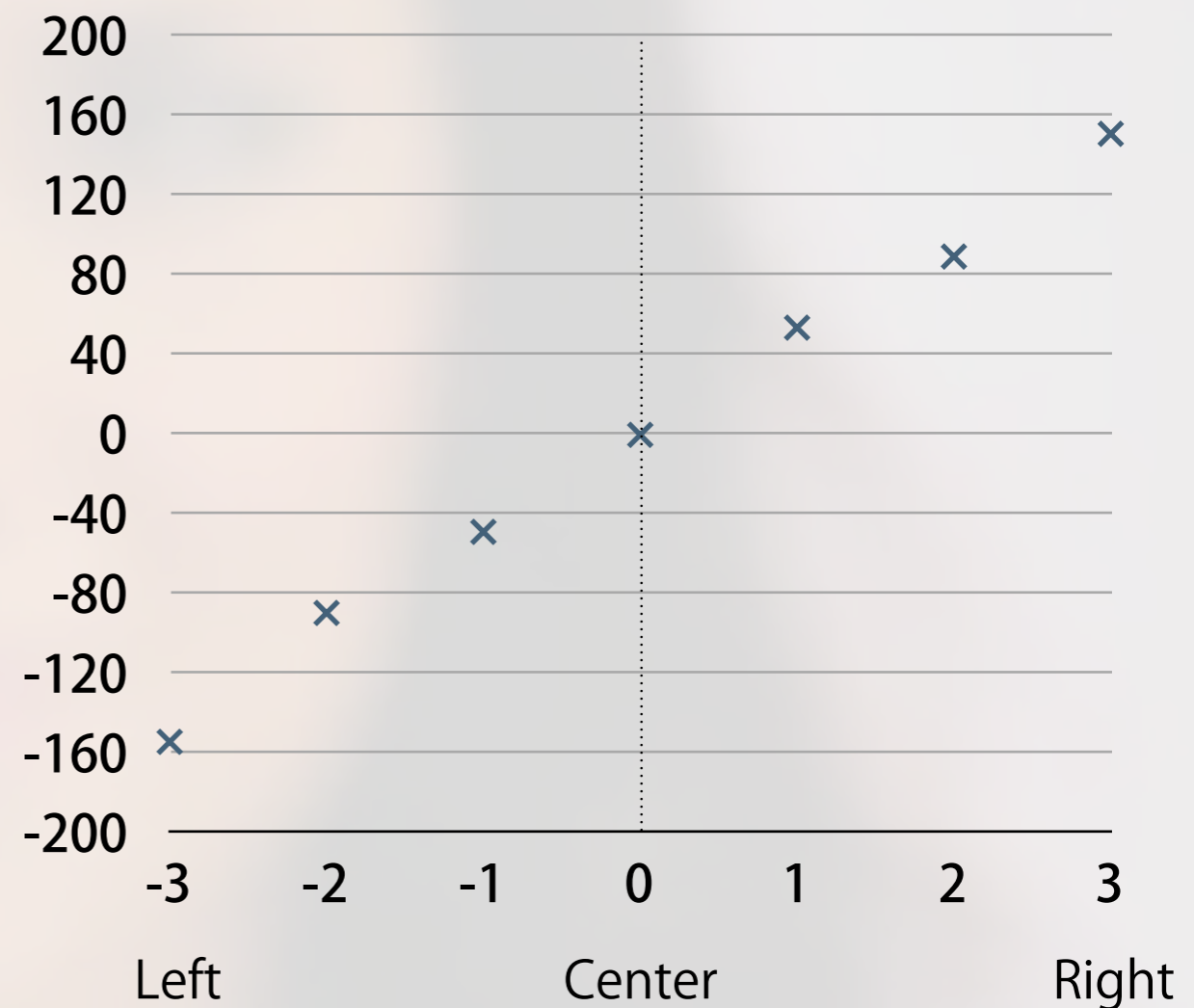
## Angular range:

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## Angular variation:

- Constant variation between two contiguous items

Mean angular variation for 7 items



# Experiment 2: results

## Recognition:

- KNN algorithm
  - euclidian distance on angular variation
  - cross-validation technique

## Results:

- Very good for 5 items (96.3%)
- Insufficient for 9 and 11 items
- 7 items:
  - 87.7% for cross-validation
  - 96% with user specific training



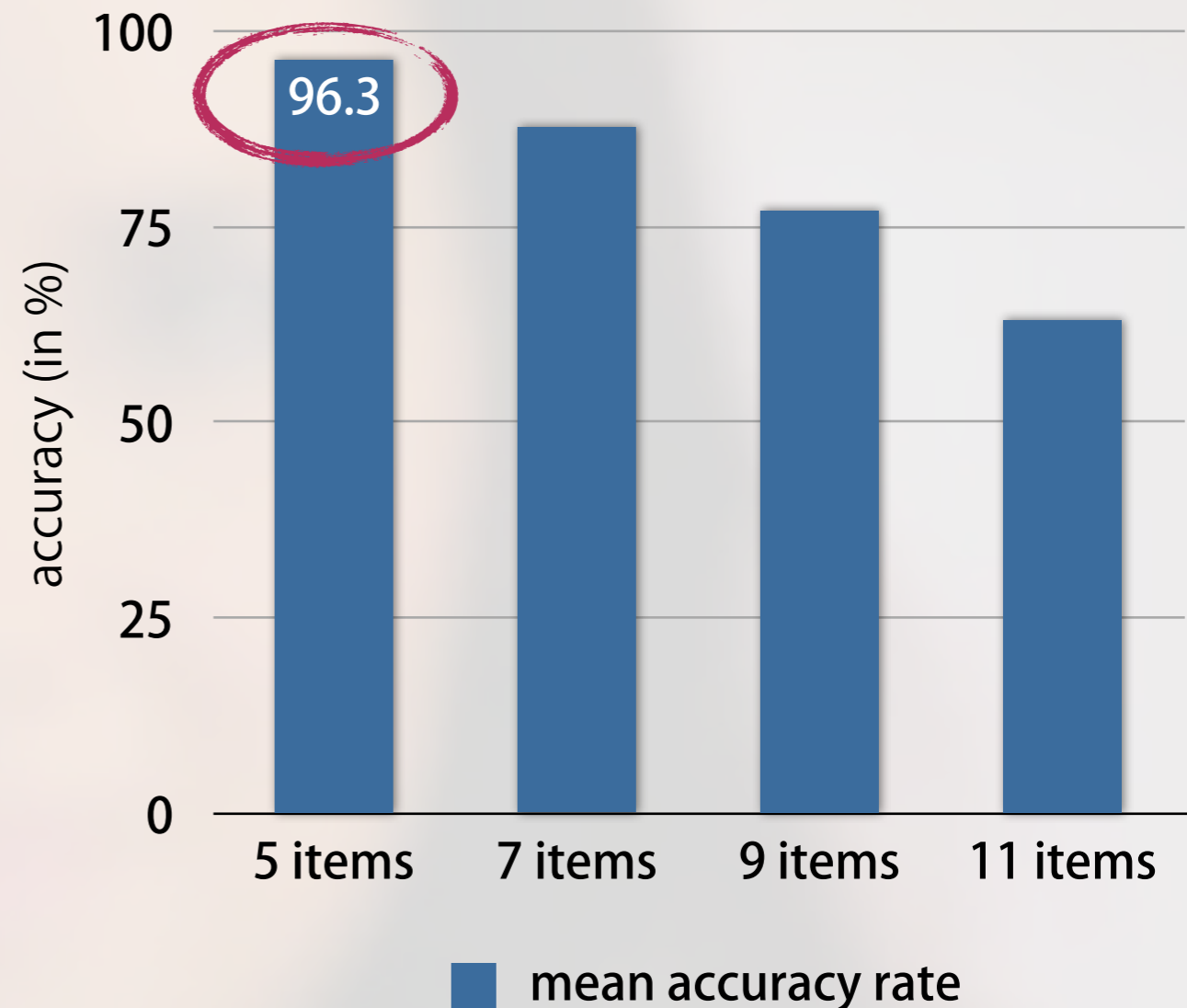
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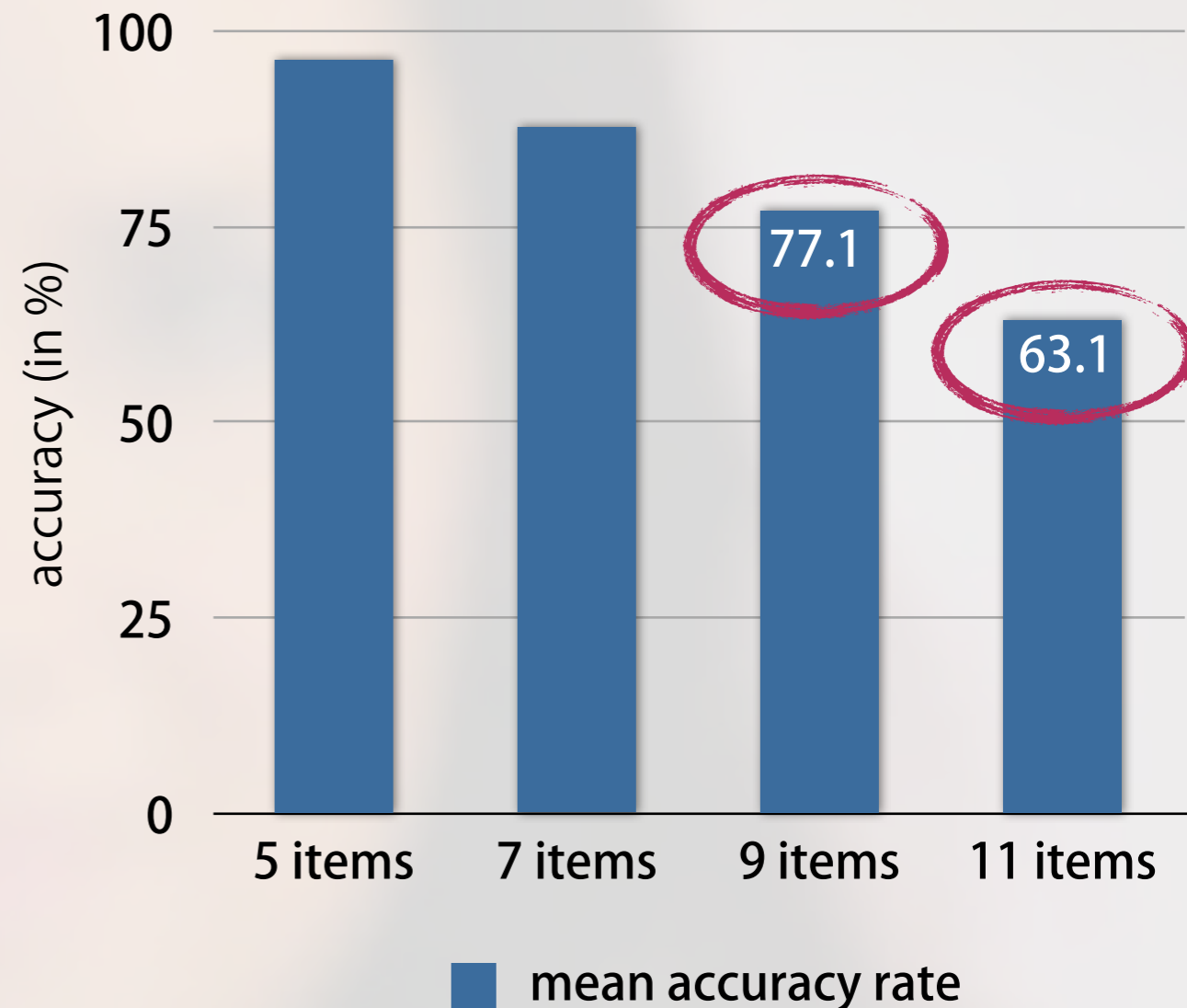
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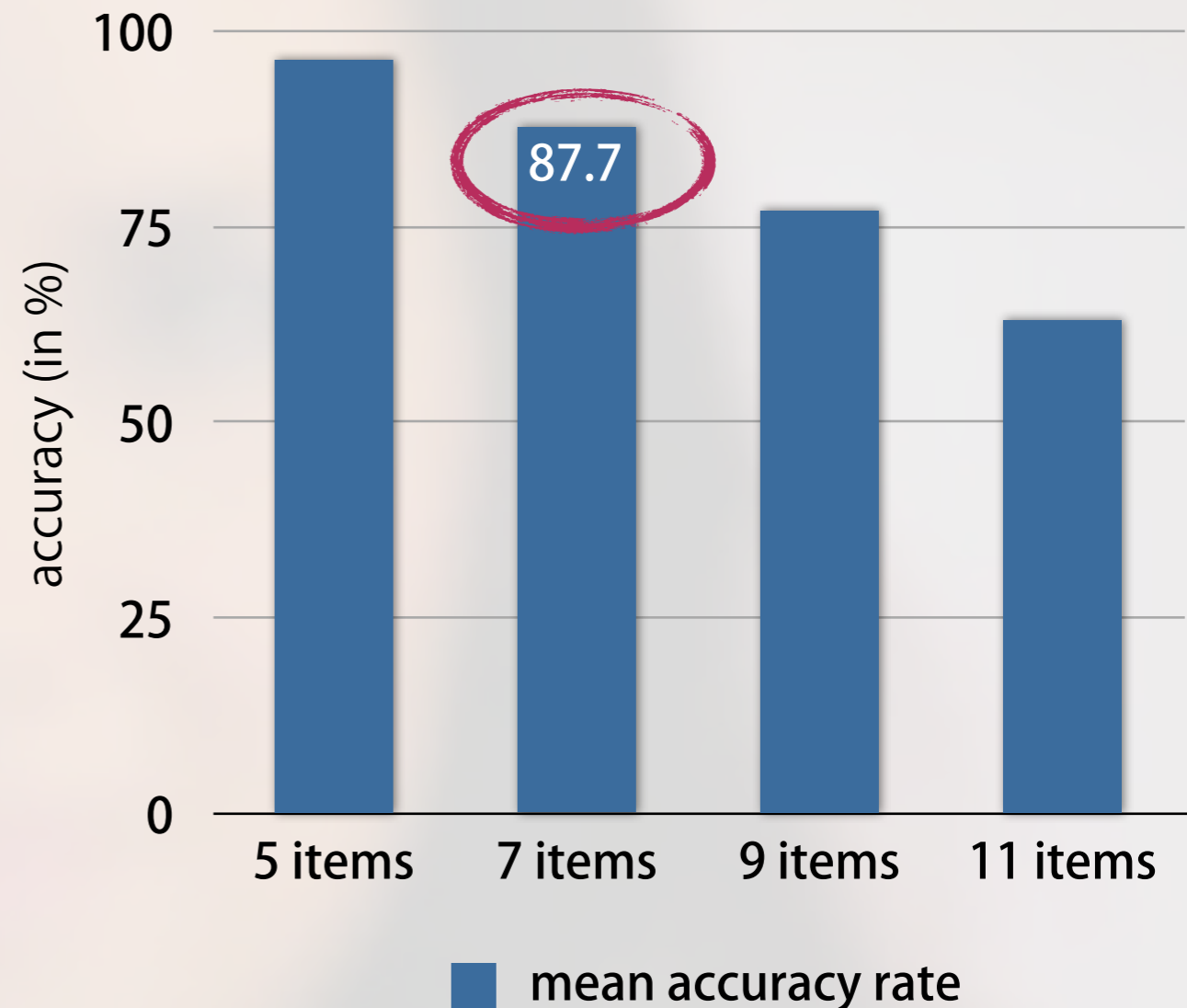
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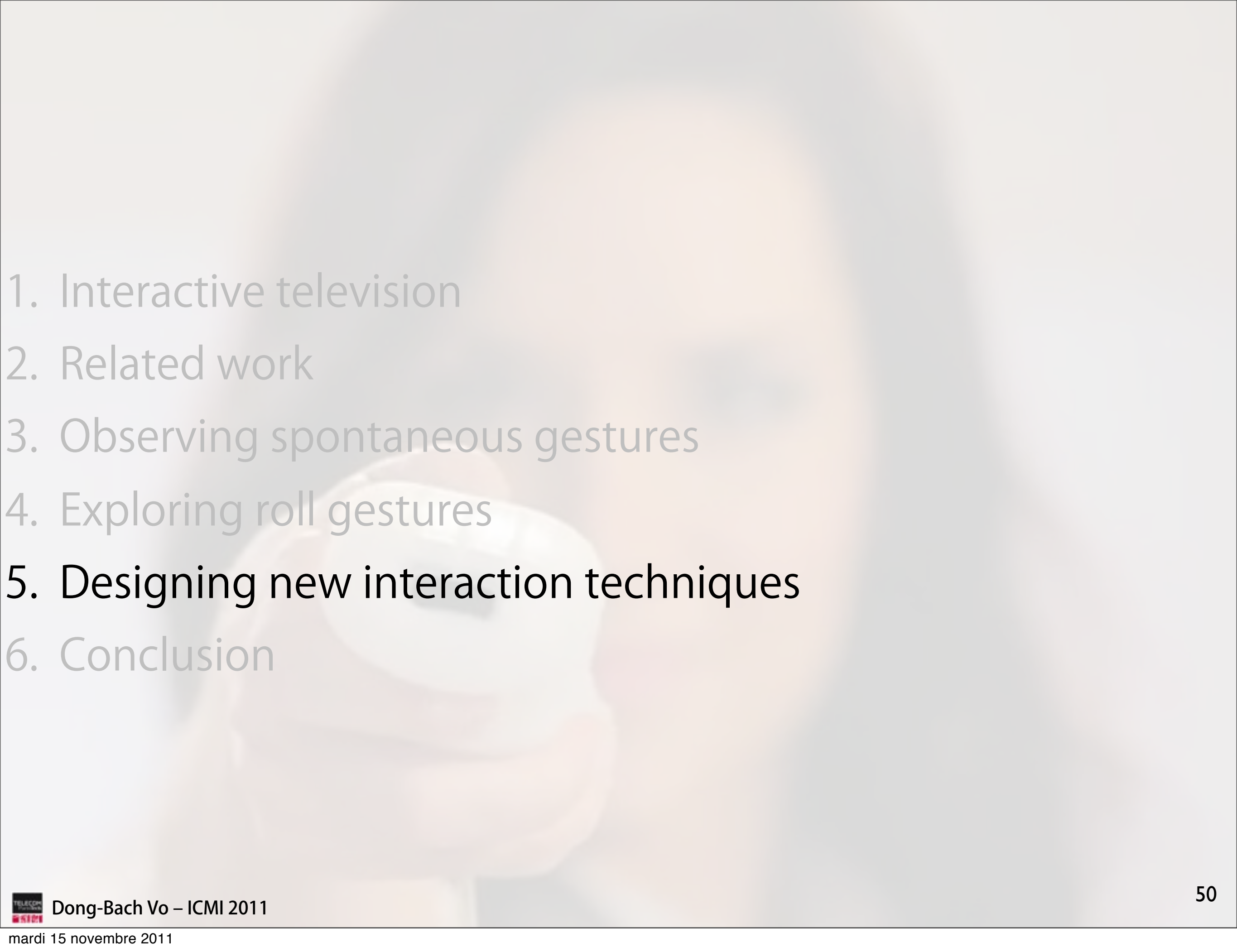
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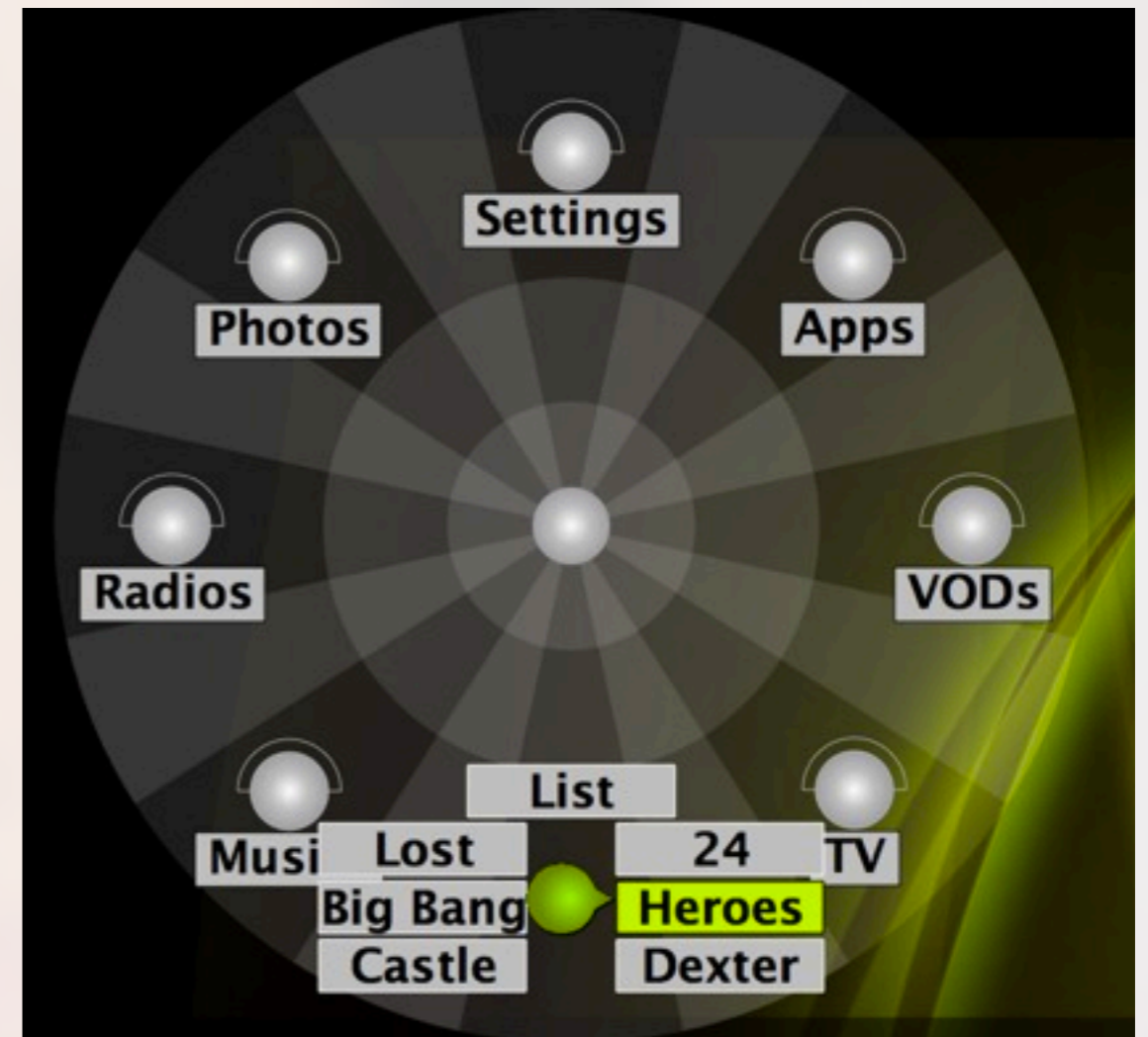


- 
1. Interactive television
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# Designing interaction techniques

## Goals:

- two-level circular menus
- that combine gestural modalities
  - Pitch & Yaw
  - Roll
  - Directional pad buttons



# Designing interaction techniques

## Design space:

- 1 modality per menu level
- D-pad used as a baseline
- Unpromising techniques dismissed at pretest

# Designing interaction techniques

## Design space:

- 1 modality per menu level
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2nd Level \ 1st Level	Pitch & Yaw	Roll	Directional Pad
Pitch & Yaw			
Roll			
Directional Pad			

# Designing interaction techniques

## Design space:

- 1 modality per menu level
- D-pad used as a baseline
- Unpromising techniques dismissed at pretest

2nd Level \ 1st Level	Pitch & Yaw	Roll	Directional Pad
Pitch & Yaw			
Roll			
Directional Pad			Baseline



# Designing interaction techniques

## Design space:

- 1 modality per menu level
- D-pad used as a baseline
- Unpromising techniques dismissed at pretest

2nd Level \ 1st Level	Pitch & Yaw	Roll	Directional Pad
Pitch & Yaw			Gesture trigger penalty
Roll	Biomechanical constraint	Poor results in pretests	Gesture trigger penalty
Directional Pad			Baseline

# Designing interaction techniques

## Design space:

- 1 modality per menu level
- D-pad used as a baseline
- Unpromising techniques dismissed at pretest
- 5 techniques to evaluate

2nd Level \ 1st Level	Pitch & Yaw	Roll	Directional Pad
Pitch & Yaw	3D multi-strokes menu	3D gestures parallelization	Gesture trigger penalty
Roll	Biomechanical constraint	Poor results in pretests	Gesture trigger penalty
Directional Pad	2D/3D gestures parallelization	2D/3D gestures parallelization	Baseline

# Experiment 3: interaction techniques

## Procedure:

- Menu with 4 \* 4 items
- Combination of modalities
- User feedback
- 13 participants

## Task:

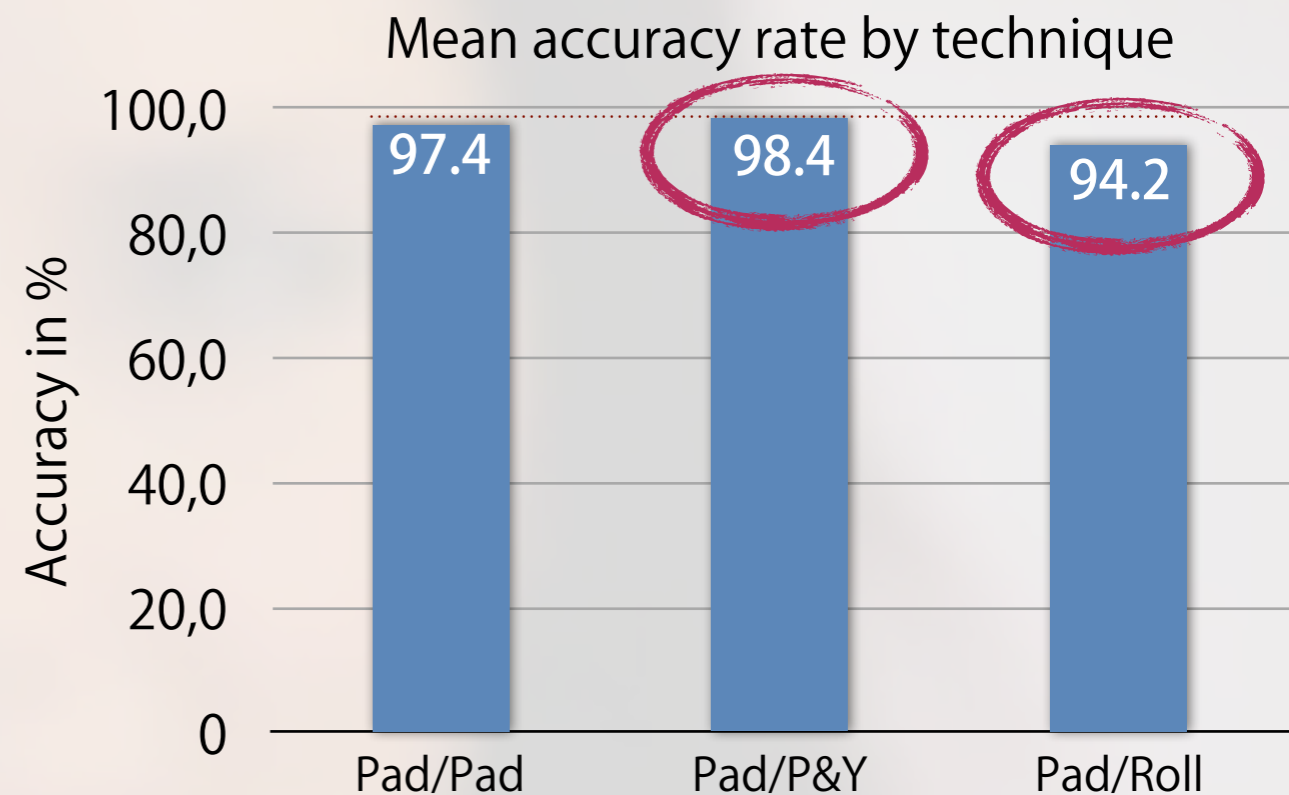
- Perform the gesture corresponding to the symbolic stimulus



# Experiment 3: results

## Best modality combinations for accuracy:

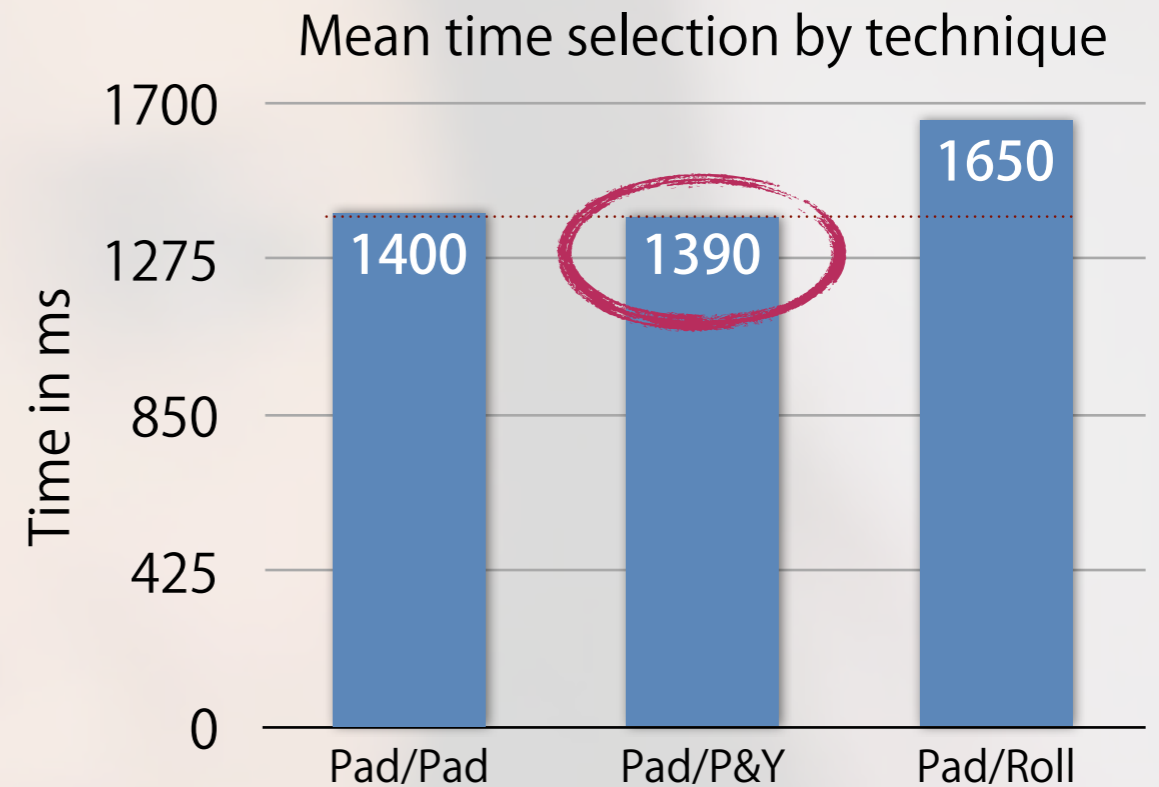
- Pad / Pad (baseline)
- Pad / Pitch & Yaw (better than baseline)
- Pad / Roll



# Experiment 3: results

## Best modality combinations for speed:

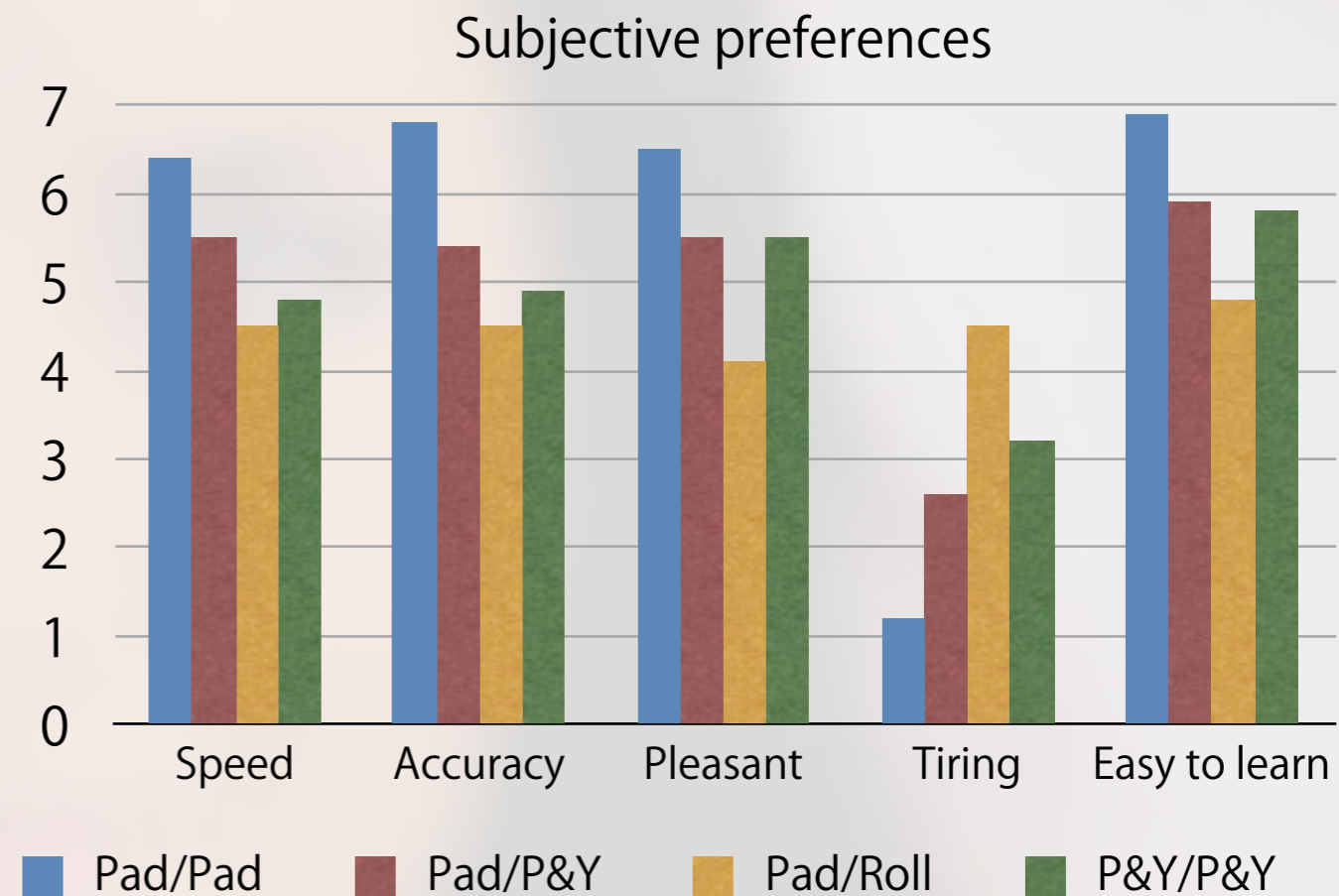
- Similar results
- Pad / Roll is a bit slower



# Experiment 3: results

## User satisfaction:

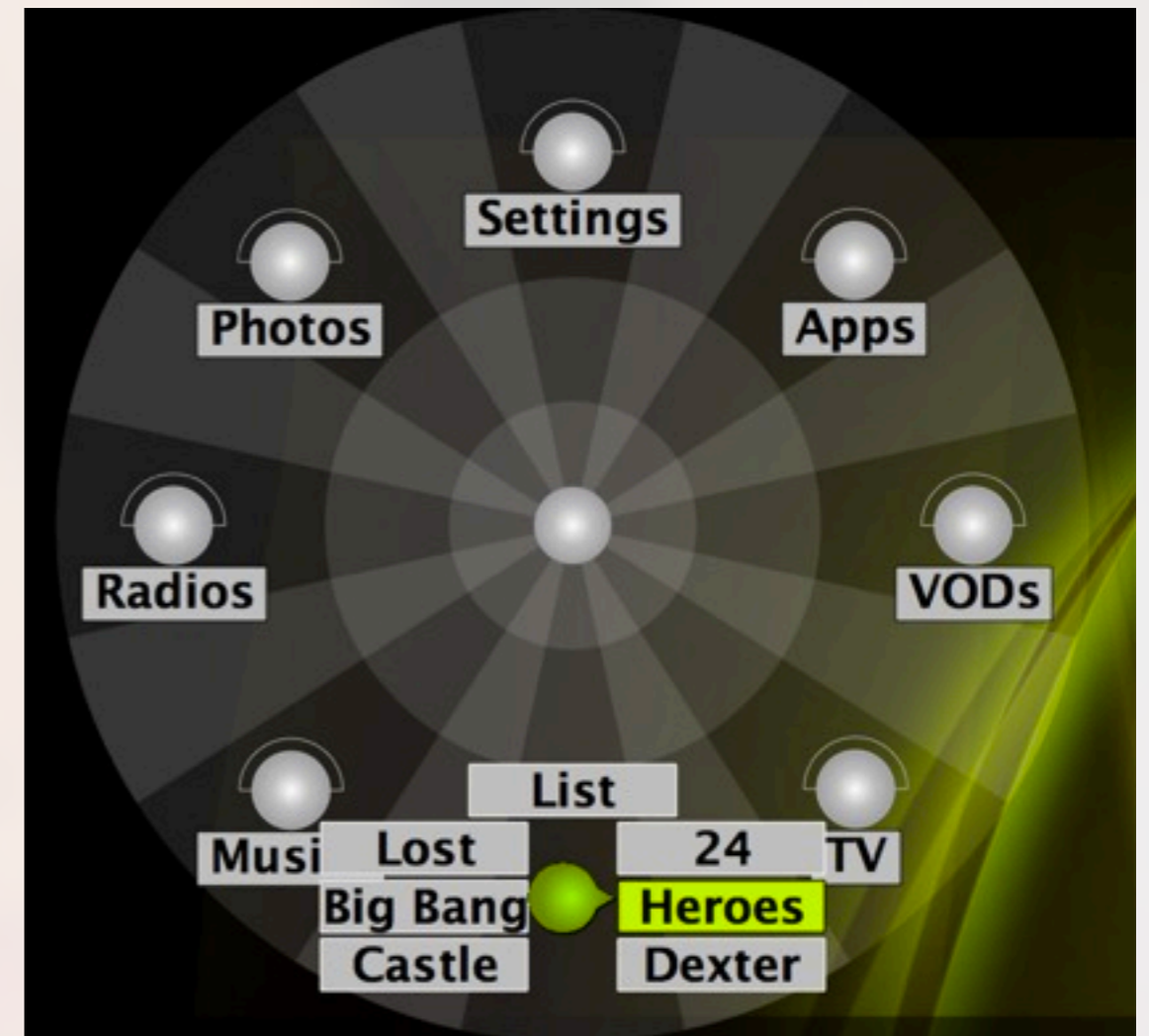
- Pad / Pad
- then Pad / Pitch & Yaw
- then P&Y / P&Y
- then Pad / Roll



# Multimedia system menu

## Novice mode:

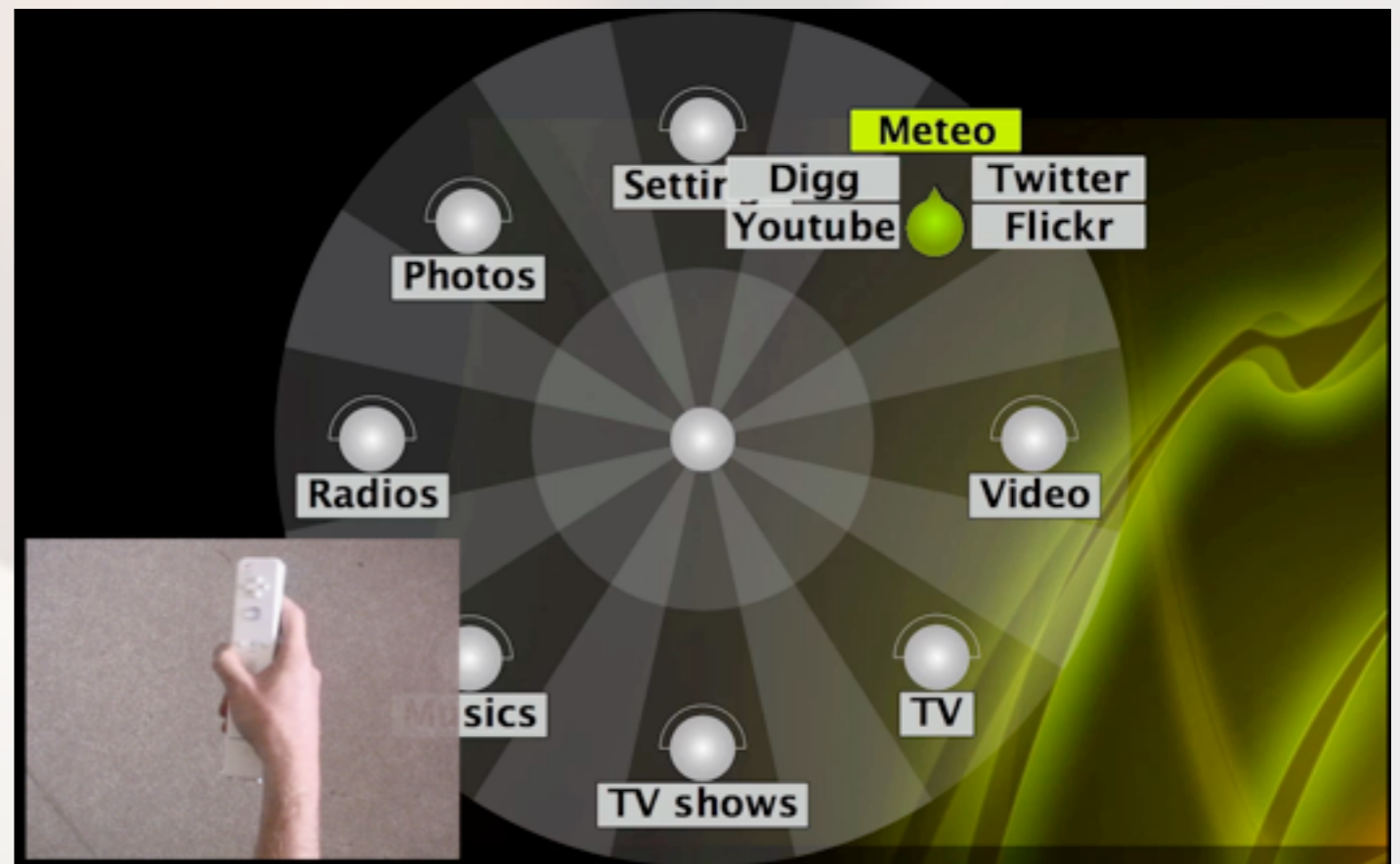
- 2-level circular menu
- 2 modalities
- Novice mode:
- 1st level : Pitch and Yaw
- 2nd level : Roll



# Multimedia system menu

## Novice mode:

- 2-levels circular menu
- 1st level selection
- 2nd level selection

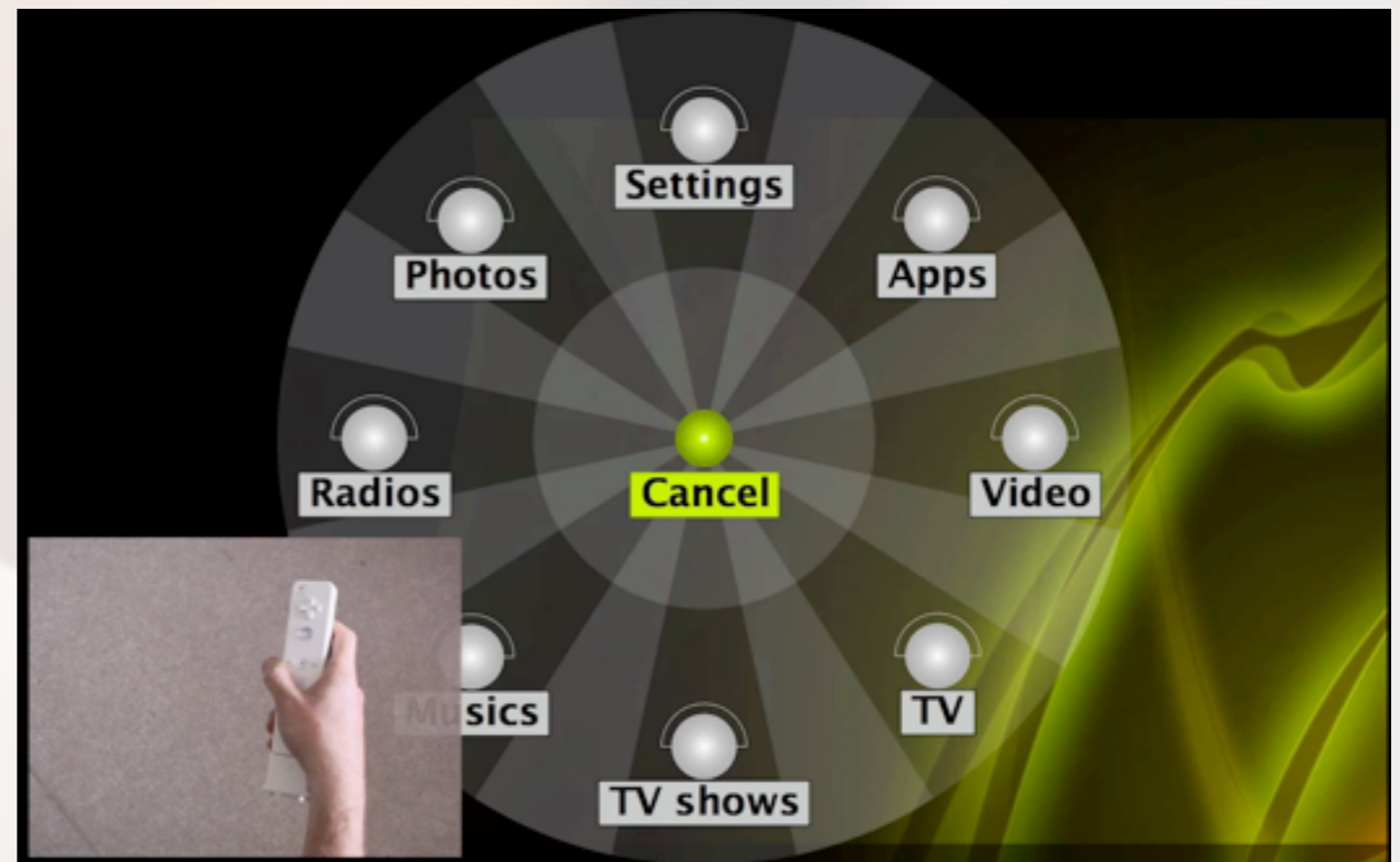




# Multimedia system menu

## Novice mode:

- 2-levels circular menu
- 1st level selection
- 2nd level selection

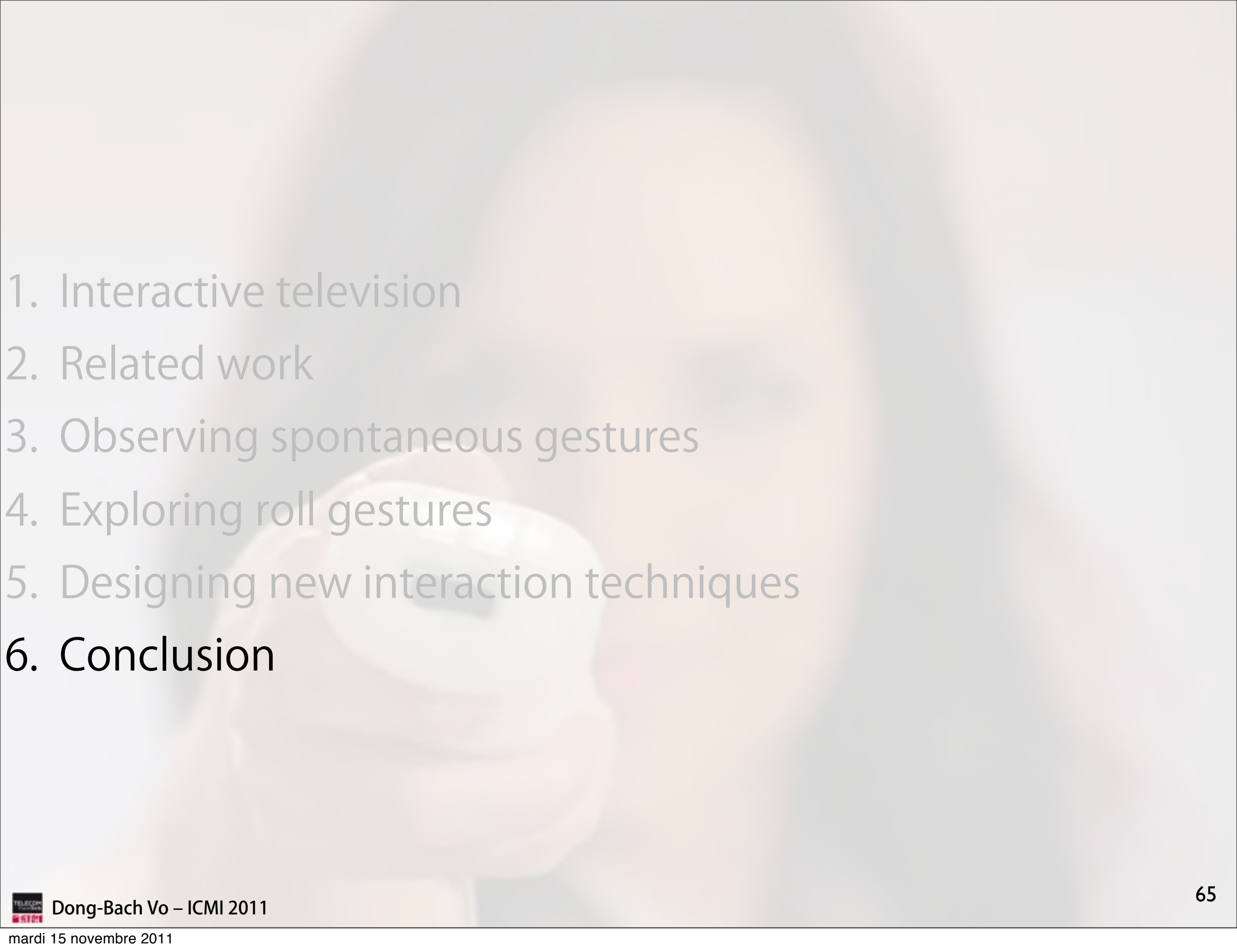


# Multimedia system menu

## Expert mode:

- Same gestures
- But the menu does not appear
- Implicit learning of gestures



- 
1. Interactive television
  2. Related work
  3. Observing spontaneous gestures
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  5. Designing new interaction techniques
  - 6. Conclusion**

# Conclusion

## What we have learned:

- Experiment 1:
  - Users rather use rotations when interacting with handheld devices
  - With a remote control, they use pitch and yaw to interact with a distant screen
- Experiment 2: Roll gestures without feedback work fine:
  - for 5 levels
  - for 7 levels with user specific training
- Using button and 3D gestures can efficiently augment remote control expressiveness

# Conclusion

## What we have learned:

- Experiment 3:
  - 3D gestures provide good performance
  - especially when combined with d-pad buttons
- Conclusion:
  - Moving the remote control into space is indeed an effective way to improve expressiveness

Thank you for your attention!

**GESTURE-AWARE REMOTE CONTROLS:  
GUIDELINES & INTERACTION TECHNIQUES**

[http://perso.telecom-paristech.fr/~via/MIA\\_Project.html](http://perso.telecom-paristech.fr/~via/MIA_Project.html)

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