INFOMSCIP 2019-2020
lecture 11
Oct 10, 2019

Overview of empirical research

- Research goal / general aim
- Research question, hypothesis, other specification?
- Variables (independent, dependent)? Measures?
- Methodology?

- For empirical user studies: study design
  - Subjects: who, number, …
  - Environment
  - Equipment / material used
  - Other contexts
  - Tasks to perform, instructions given, …
  - Within/between-subjects design
  - Order (for within-subjects design) and other mappings (for both)

- Conclusions (answer to research question)
- Contributions (also with respect to goal/aim)

How about **ethics and integrity**?

Moral implications of my research?

Treatment of subjects and guaranteeing their wellbeing?

Analysis of the results and conclusions drawn? (Correctness, flaws, honesty, …)

Some comments on ethics and integrity

Always treat people correctly

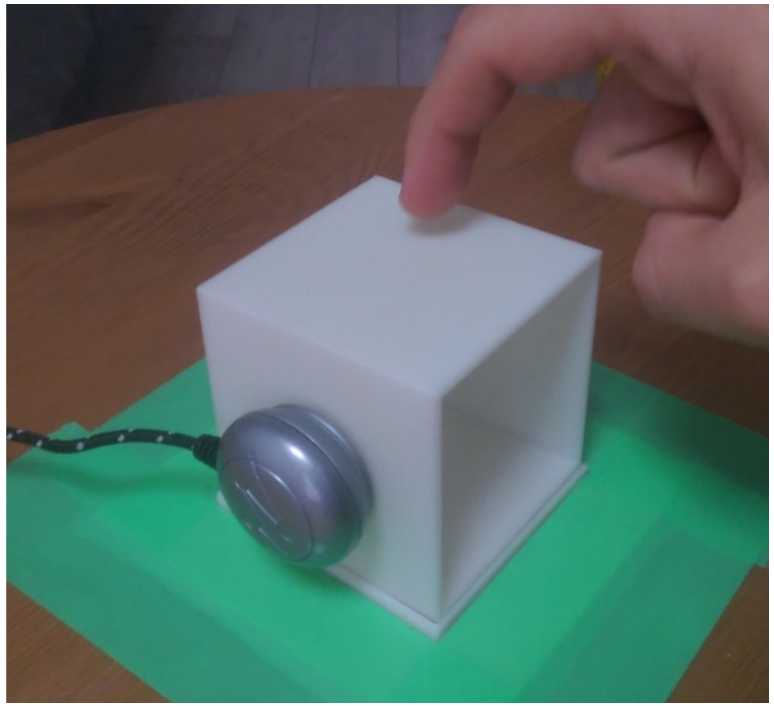
- Moral and ethical obligation
- It impacts your results if you don't

Treat them friendly and respectfully.
Have them sign a consent form if necessary.

Design experiment so no one feels discriminated.
Design experiment so no one gets any physical or psychological harm.

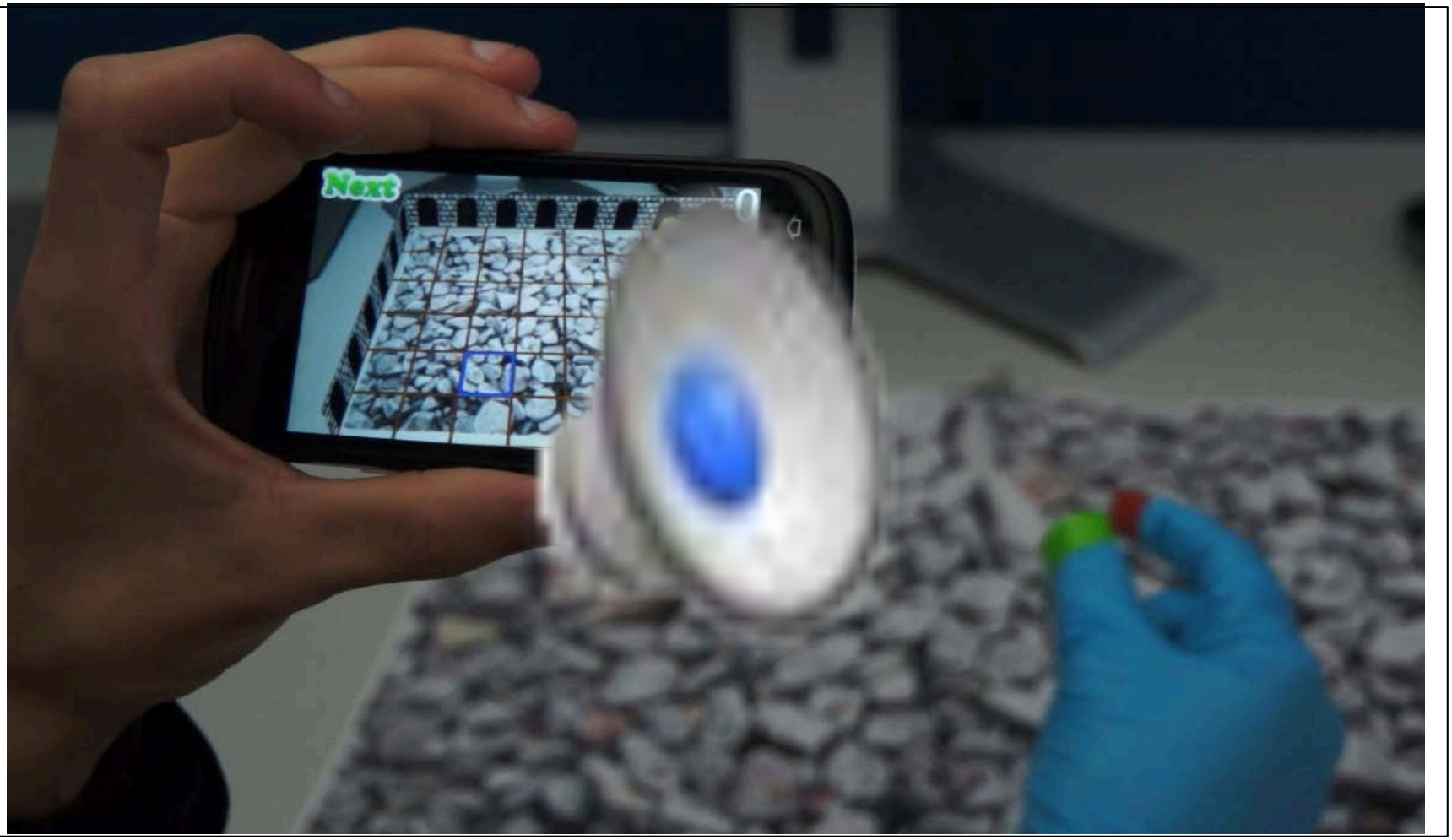
Tell them that they can stop at any time without giving reasons.
Tell them that the system is tested, not them.
Be neutral (avoid observer bias).

Geert Lugtenberg, Wolfgang Hürst, Nina Rosa, Christian Sandor, Alexander Plopski, Takafumi Taketomi, Hirokazu Kato:
Multimodal Augmented Reality – Augmenting Auditory-Tactile Feedback to Change the Perception of Thickness
MMM 2018, Bangkok, Thailand



Psychophysical experiment testing human perception under varying stimuli

Wolfgang Hürst and Kevin Vriens:
Multimodal feedback for finger-based interaction in mobile augmented reality.
18th ACM International Conference on Multimodal Interaction (ICMI 2016).

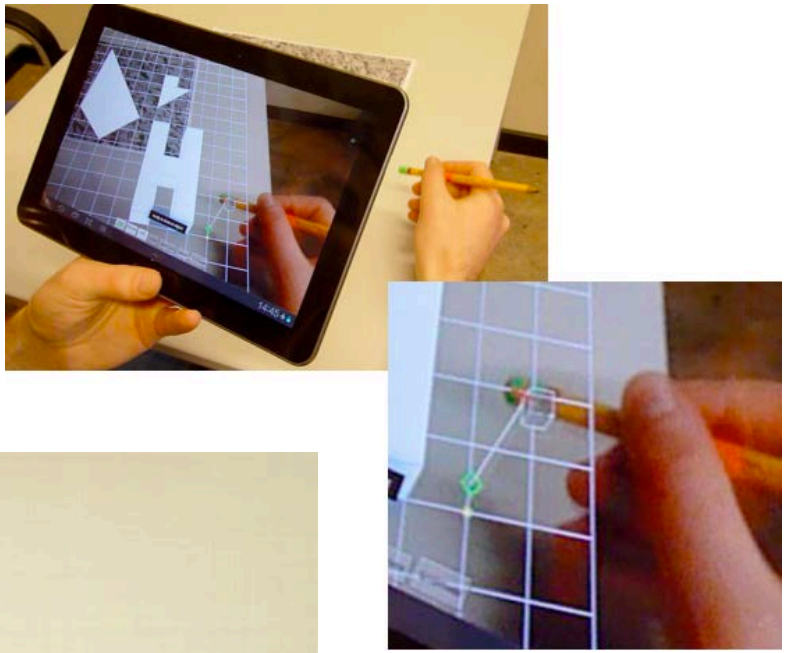


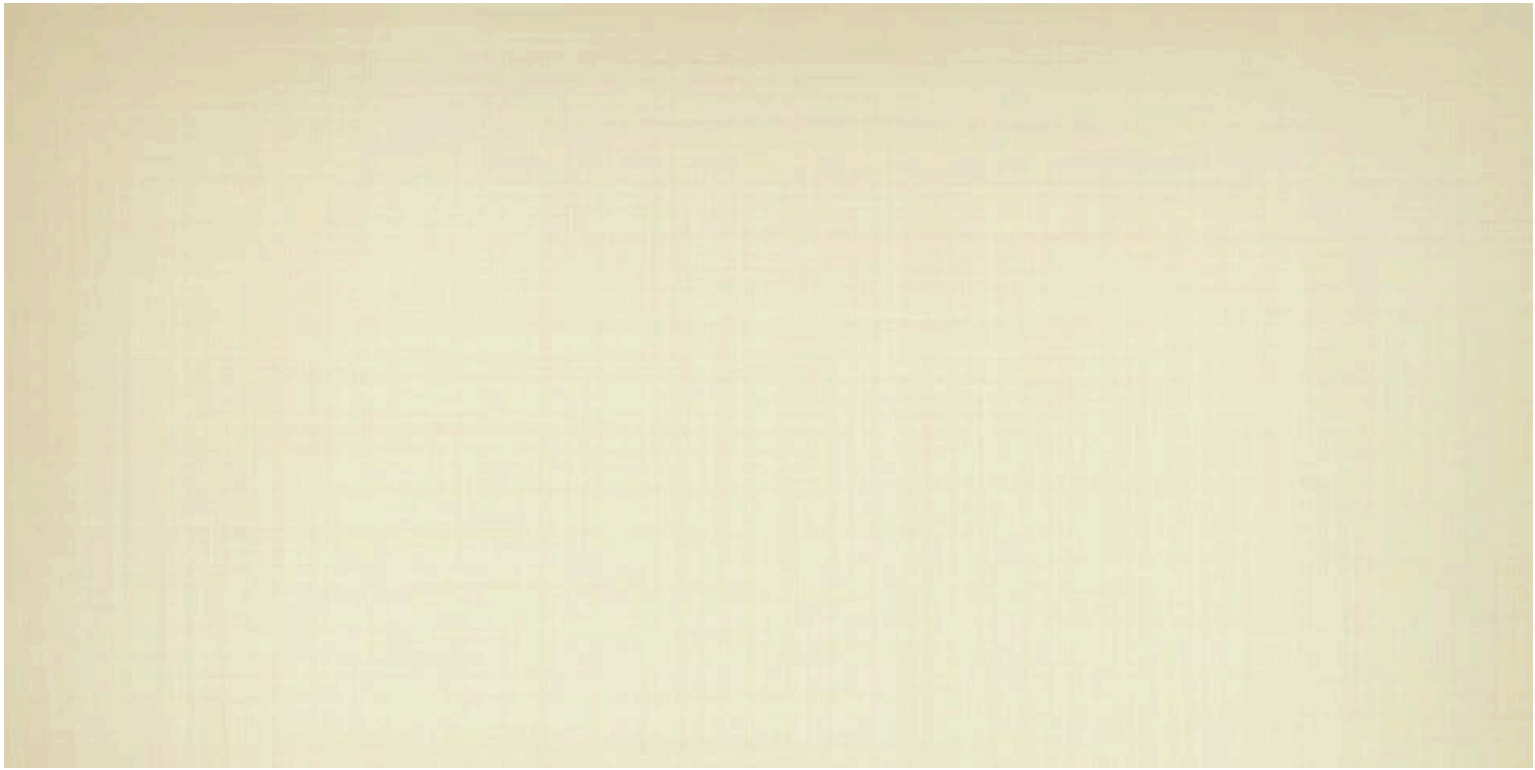
Empirical user study to verify performance
under varying feedback types with different modalities.

W. Hürst, C. van Wezel:
Gesture-based interaction via finger tracking for mobile augmented reality.
Multimedia Tools and Applications 62 (1), 233-258

User study verifying different implementation options
for finger-based AR interaction.

Wolfgang Hürst and Joris Dekker:
Tracking-based interaction for object creation in mobile augmented reality.
ACM Multimedia (MM '13).





User study testing the feasibility of
AR authoring via ”grid-based drawing”

Psychophysical experiments

Psychophysics quantitatively investigates the relationship between physical stimuli and the sensations and perceptions they produce.

From Wikipedia ("Psychophysics")

Psychophysical experiments: study psychological phenomena by measuring human physiological activity.

Often done in GMT when we are interested in perception and/or experiences. For example to measure game experience.

See, e.g., the following paper for an interesting review:

Kivikangas, J. M. et al. (2011).
A review of the use of psychophysiological methods in game research.
Journal of gaming & virtual worlds, 3(3), 181-199.

Psychophysical experiments

Basic idea / approach:

Present humans with different stimuli and measure their psychological response

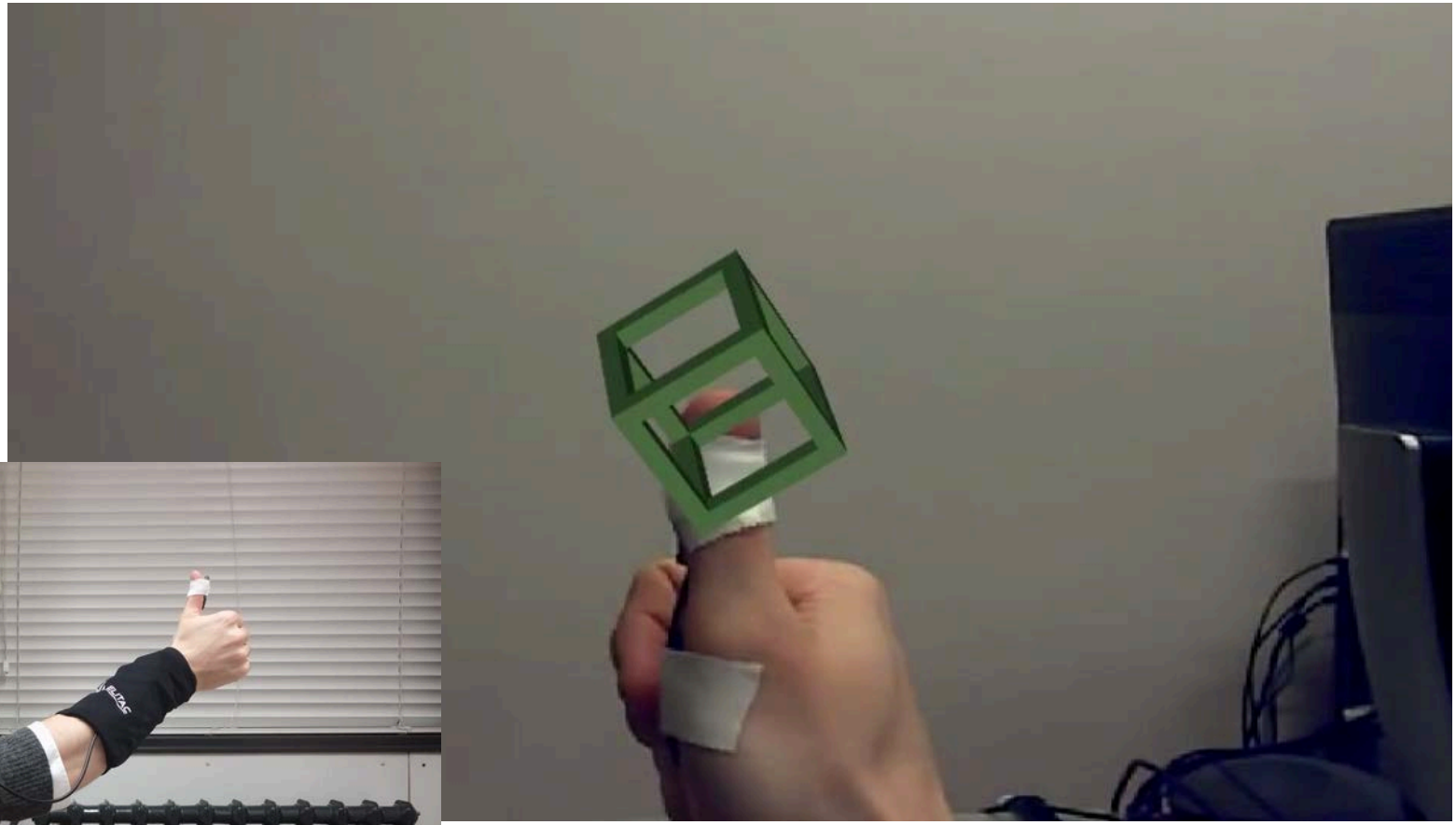
Objective measures include:

- Facial electromyography (EMG),
  e.g., electrical activities of muscles involved in emotional facial expressions
- Electrodermal activity (EDA) or skin conductance,
  which is, e.g., associated with emotional arousal
- Cardiac activity (e.g., heart rate, HR),
  which can be related to, e.g., valence and arousal, attention,
  cognitive effort, stress and orientation reflex during media viewing

Depending on the experiment design, **simple tasks & questions** can be used, too.

- E.g., two-alternative forced choice (2AFC) tasks

N. Rosa, W. Hürst, P. Werkhoven and R. Veltkamp:
Visuotactile Integration for Depth Perception in Augmented Reality
ICMI 2016 - Tokyo, Japan

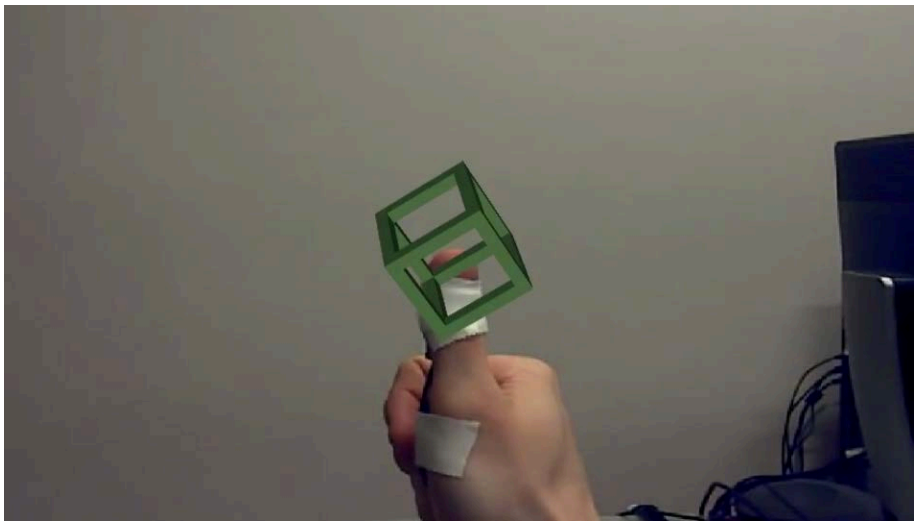


Empirical user study to measure performance in dependence of varying haptic stimuli

DEPTH PERCEPTION IN AR

Problem/motivation:

Depth perception in AR based on visual signal commonly biased due to rendering at fixed distance



Research question:

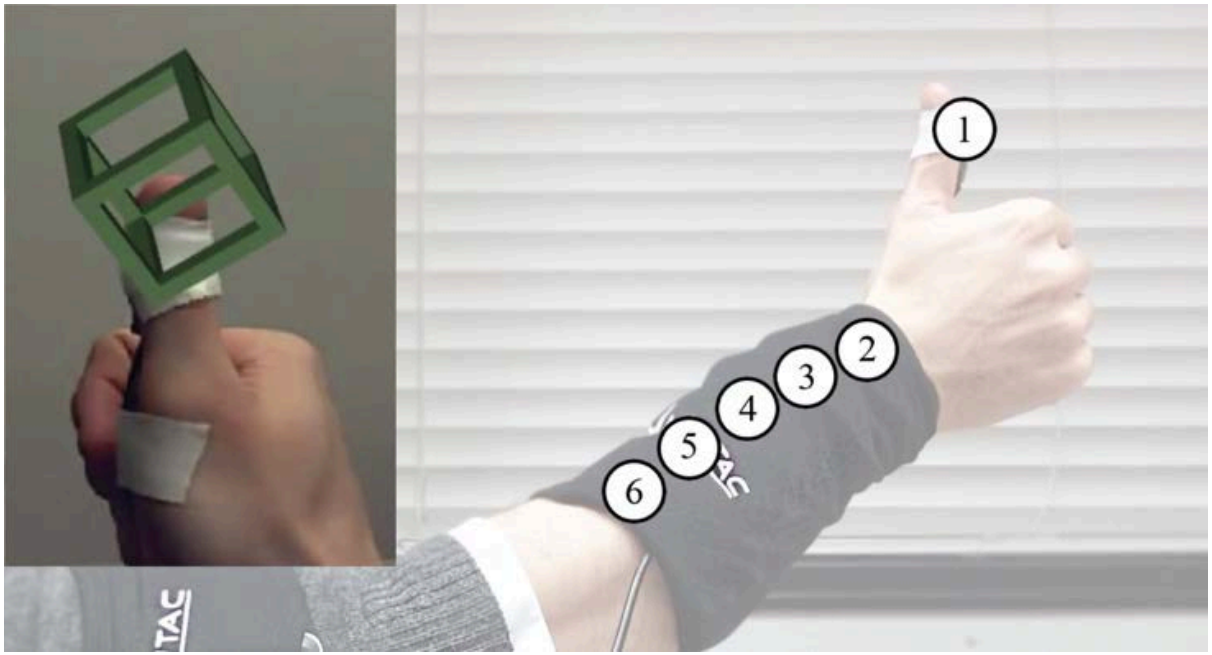
In an active reaching task in AR: Can tactile feedback correct the depth estimation bias?

Matching task:

Measure the perceived depth of virtual objects by placement of the real hand, which is guided by vibration gradient.

2 setups & 2 variations

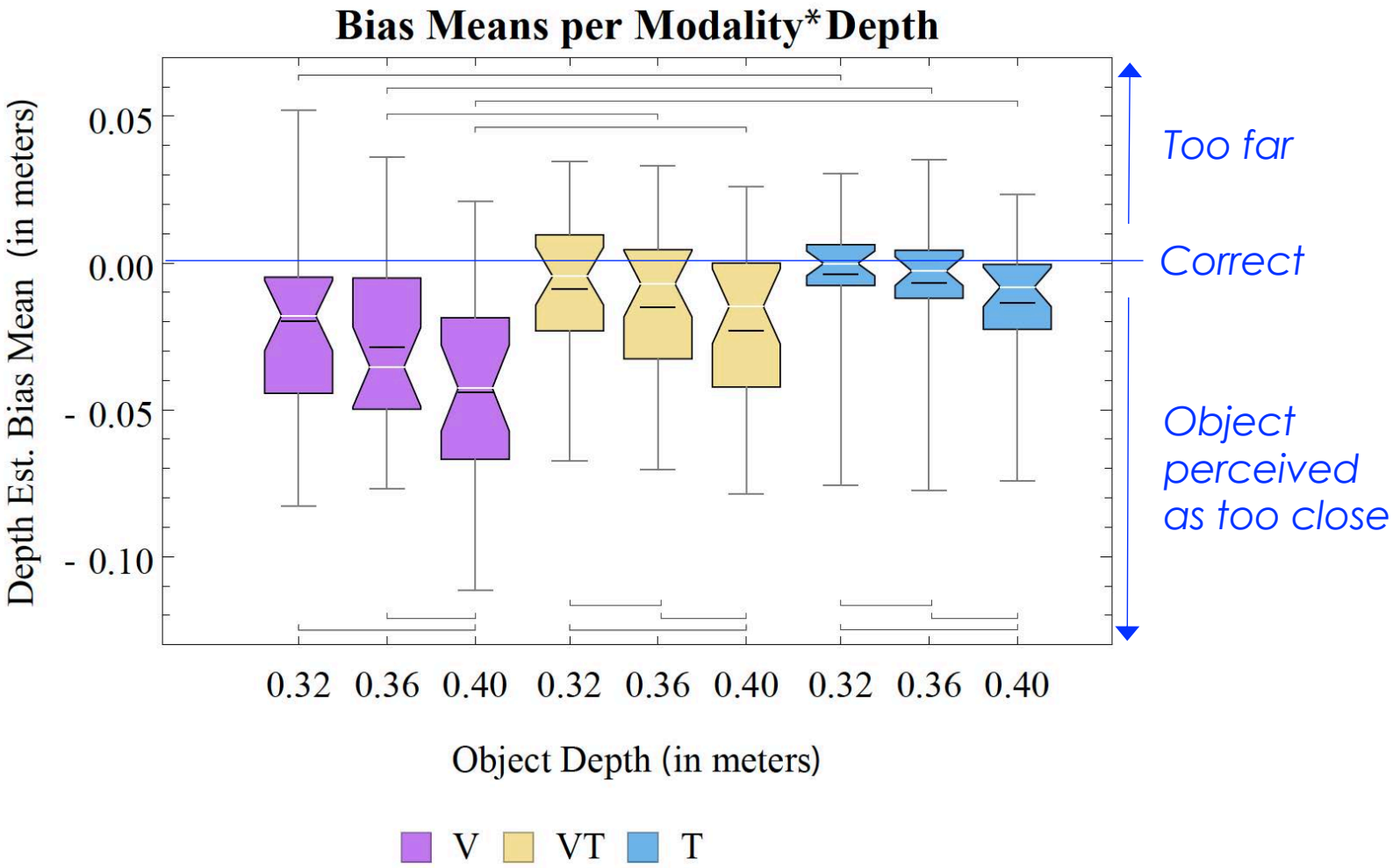
1. Intensity gradients
   a) Thumb
   b) Wrist
2. Positional gradients
   a) Wrist = near
   b) Wrist = far



Three conditions:

- Visual (V)
- Visuotactile (VT)
- Tactile (T)

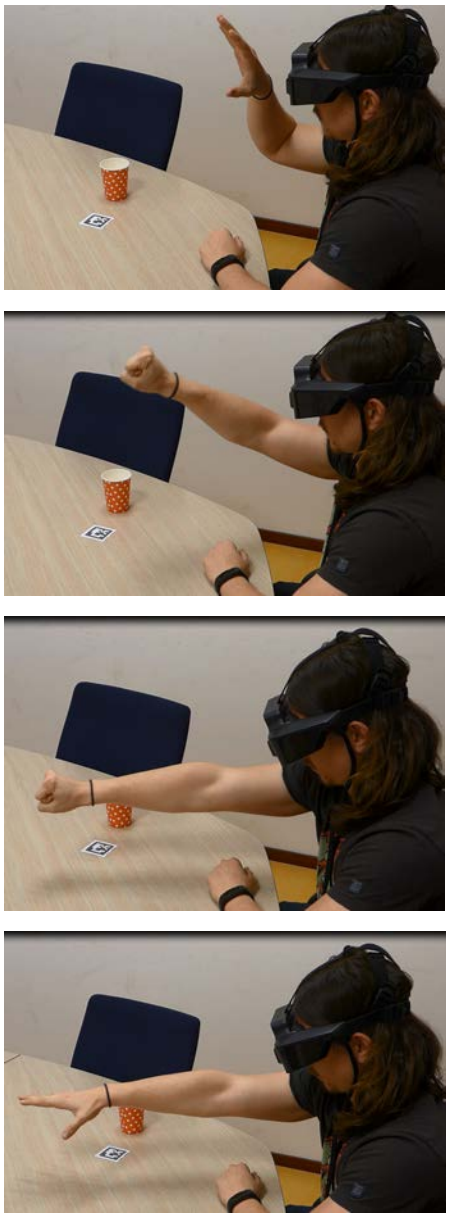
27 subjects (24m/3f, 23.1 y)

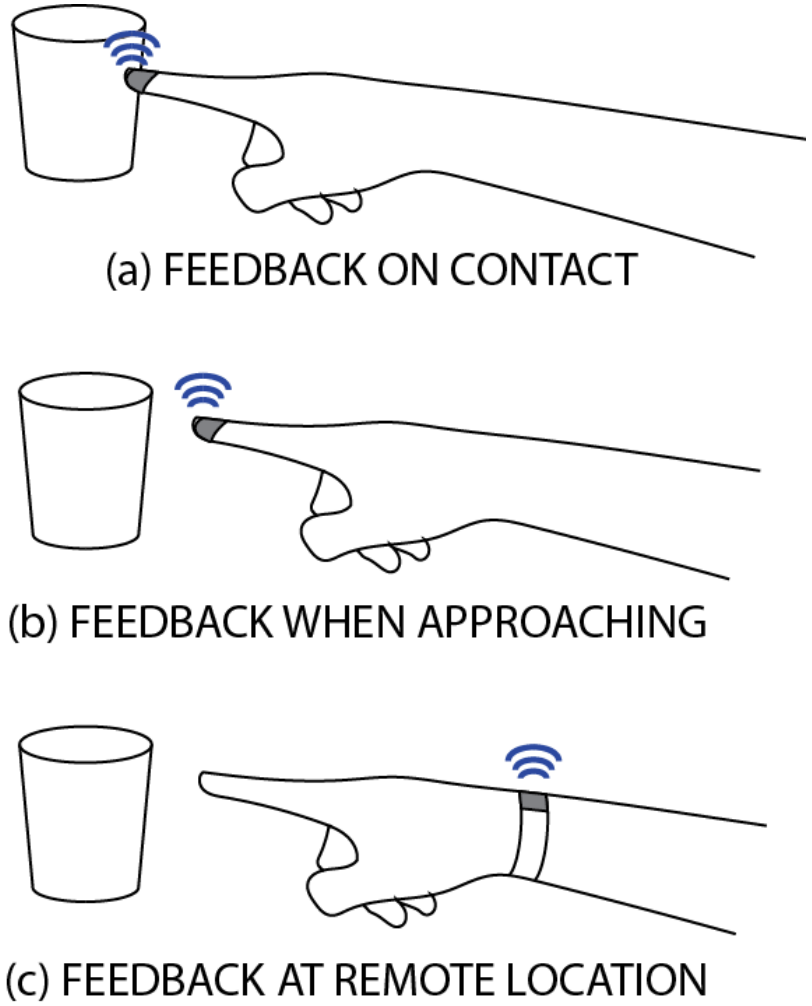


Major observation in plain English: Providing visuotactile feedback significantly improves depth perception

Conclusion: tactile stimuli can be used to assist in depth perception for active reaching tasks

W. Hürst, N. Rosa, and J.-P. van Bommel:
Vibrotactile Experiences for Augmented Reality
Demo paper at ACM Multimedia 2016





Demo paper applying controlled experiment results
to real-world contexts (AR games)