

Sensing Tablet Grasp + Micro-mobility for Active Reading

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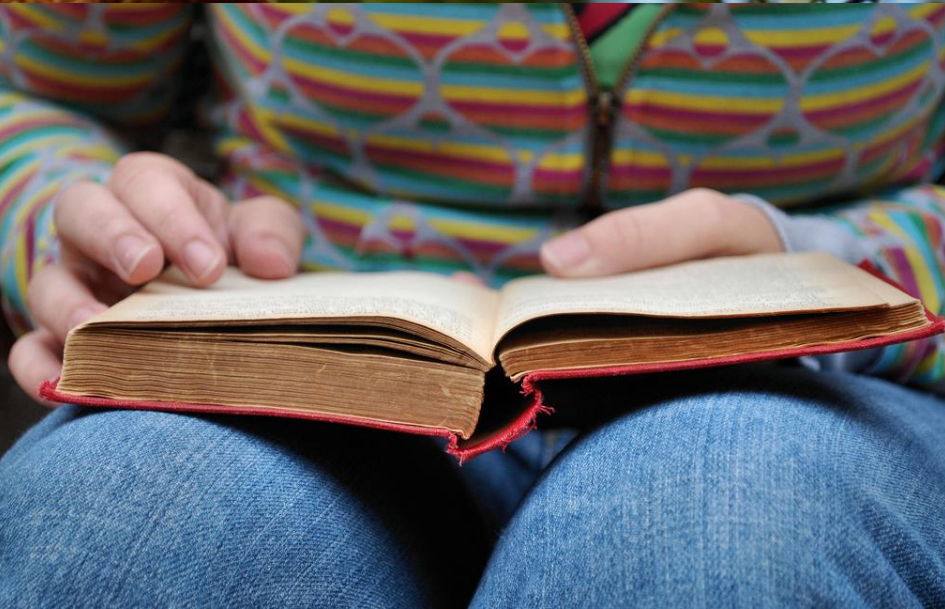
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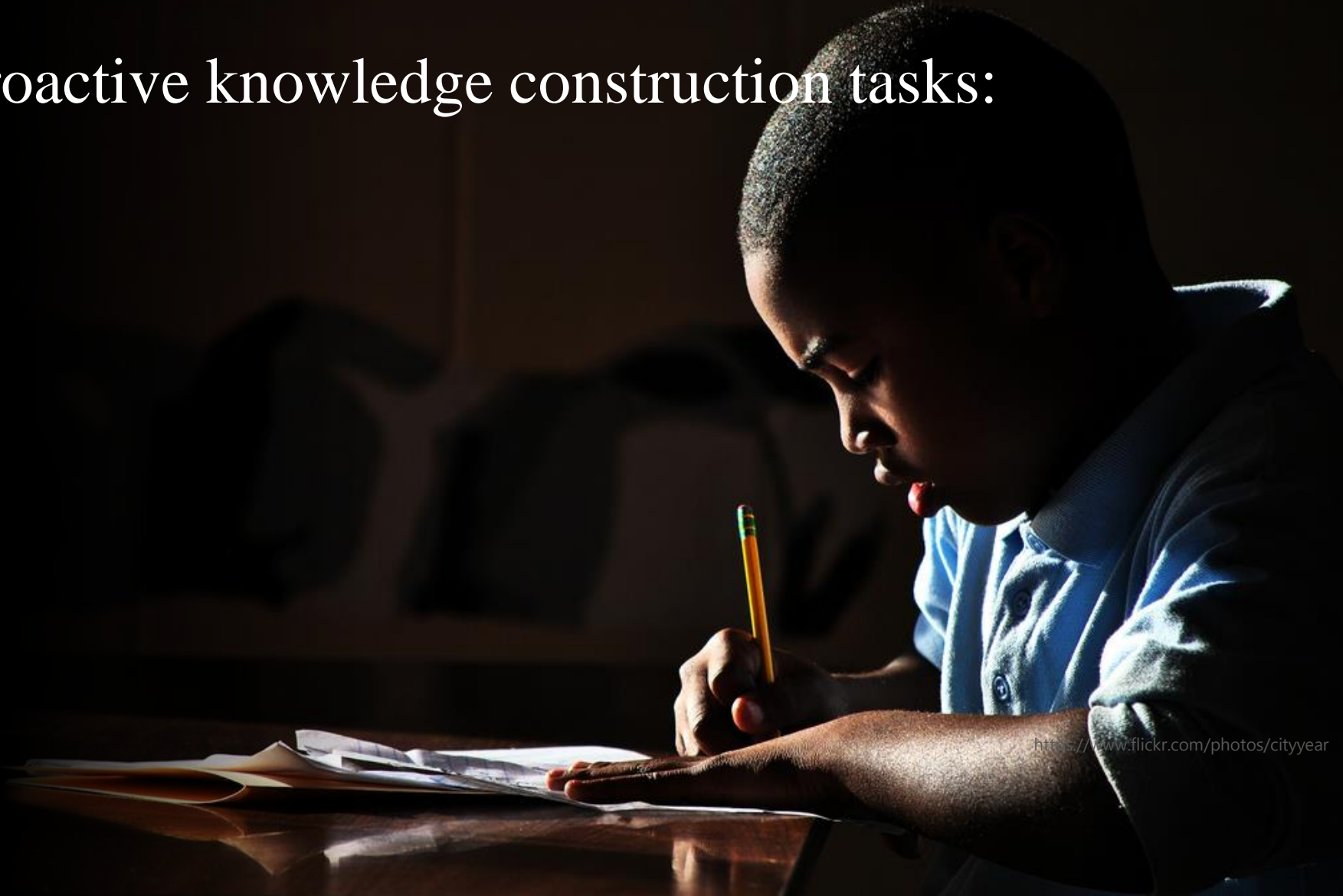
UIST
2015

Physical Manipulation of Objects



Supporting Active Reading

Proactive knowledge construction tasks:



Supporting Active Reading

Proactive knowledge construction tasks:
Nonlinear Navigation

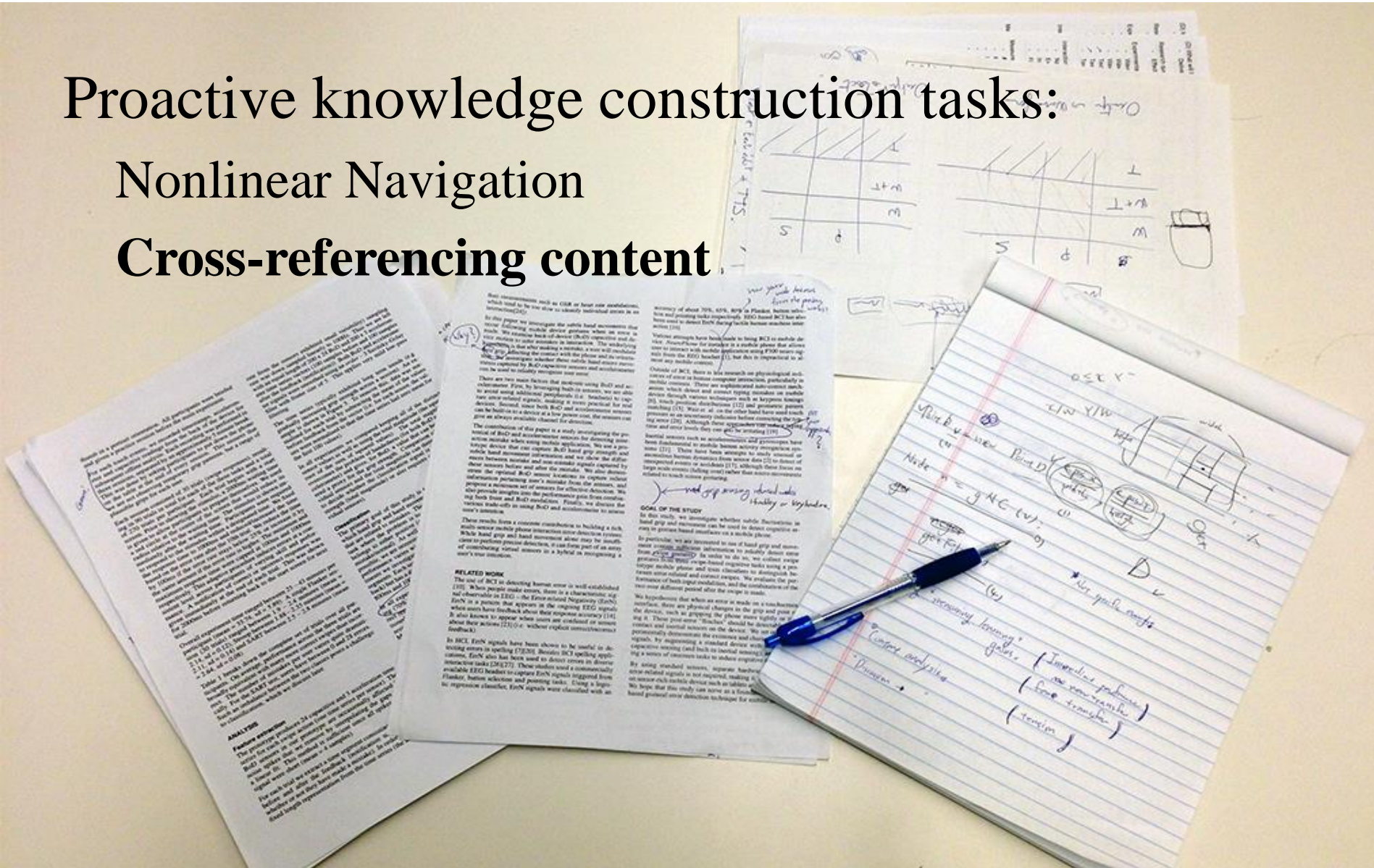


Supporting Active Reading

Proactive knowledge construction tasks:

Nonlinear Navigation

Cross-referencing content



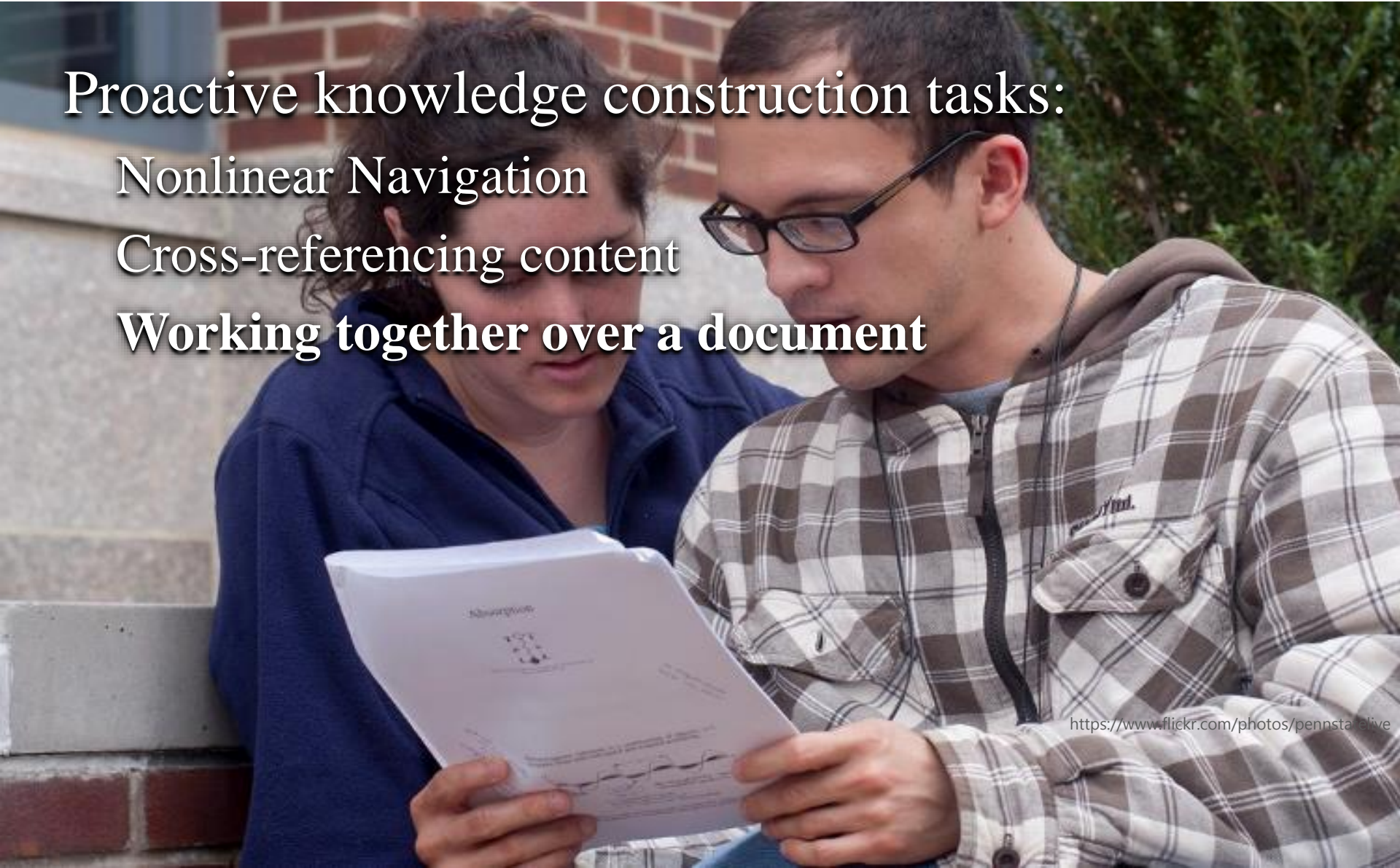
Supporting Active Reading

Proactive knowledge construction tasks:

Nonlinear Navigation

Cross-referencing content

Working together over a document



Supporting Active Reading

Maintaining the Flow of Reading
Needs for effective UI

Embodied Interactions for Active Reading



Embodied Interactions for Active Reading

Turning pages

A close-up, blurred image of an open book. The pages are fanned out, creating a sense of motion and depth. The lighting is warm and golden, highlighting the texture of the paper and the spine of the book. The background is dark, making the book the central focus.

Embodied Interactions for Active Reading

Turning pages

Lifting for a closer look



<https://www.flickr.com/photos/21032517@N01/>

Embodied Interactions for Active Reading

Turning pages

Lifting for a closer look

Multiple document layout



Embodied Interactions for Active Reading

Turning pages

Lifting for a closer look

Multiple document layout

Orienting toward others



Micro-mobility:

Orienting and repositioning physical artifacts



Grasp in Micro-mobility: *'Hand grips'* coming into play



Grasp + Micro-mobility Interactions



Grasp + Micro-mobility Interactions



Grasp + Micro-mobility Interactions



Formative Study:

We Know Too Little About *Grasp + Micro-mobility Actions*.

Observing *Naturally Occurring Grasp + Micro-mobility in Document Work*



Presentation
reading and explaining
infographics



Cooperation
discussion over a shared
infographics

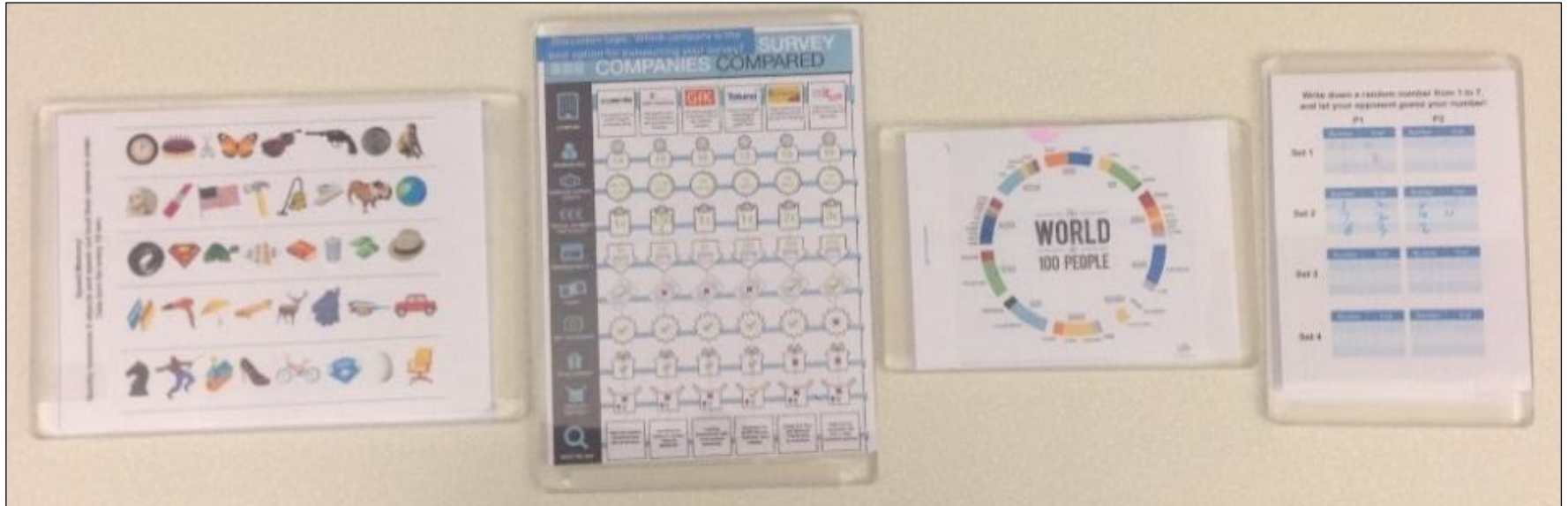


Competition
memorization /
guessing games

Formative Study:

Observing Grasp + Micro-mobility in Solo / Dyadic Document Work

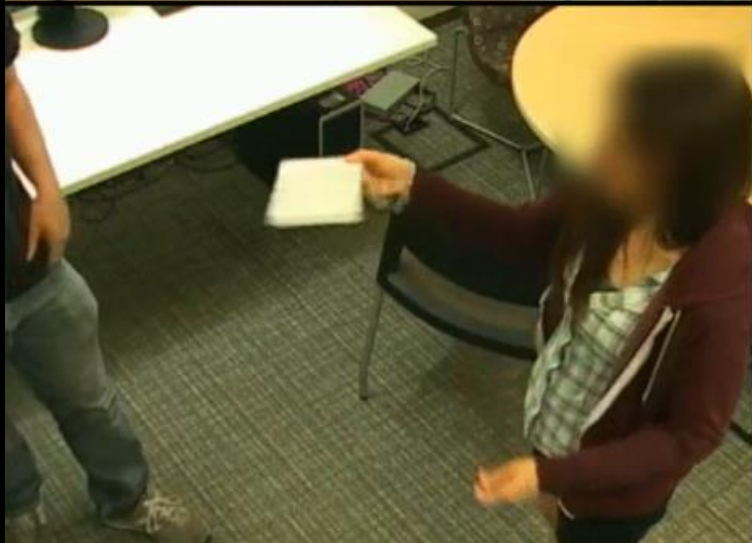
Capturing *naturally occurring behavior without digital bias*



Acrylic tablet mock-ups (iPad air or mini sized and weighted)

Observed Behaviors:

Lateral swing for face-to-face handoff



Observed Behaviors:

Bimanual symmetric grip
for immersive reading



Observed Behaviors:

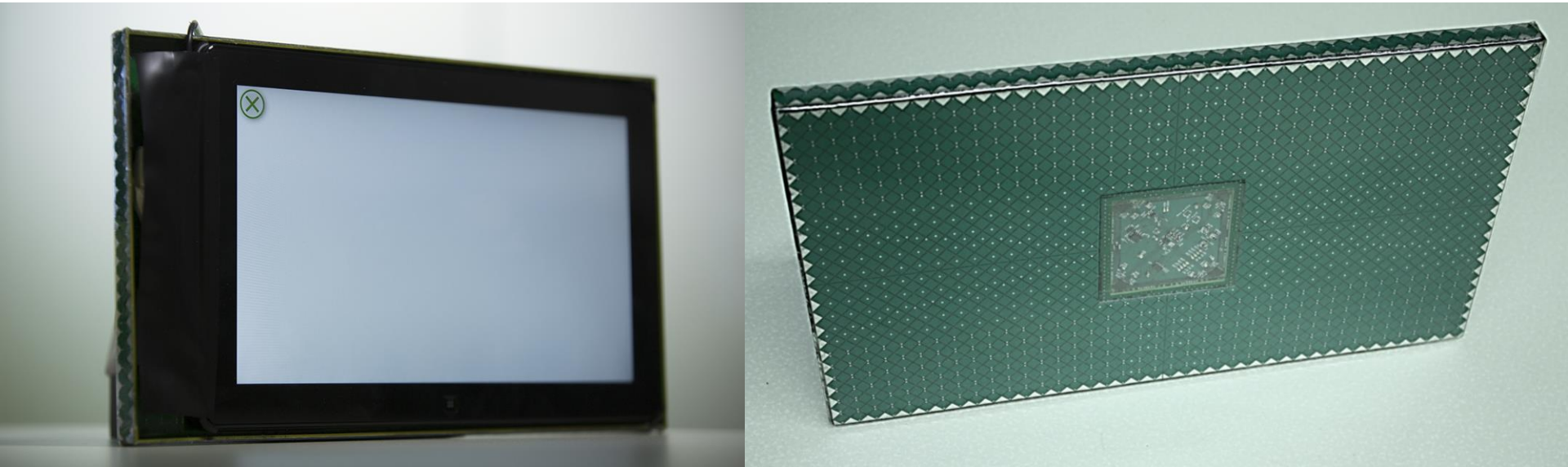
Bimanual symmetric grip
for immersive reading



Thumbing indicates
locus of attention



Sensing System for Grasp + Micro-mobility Interactions

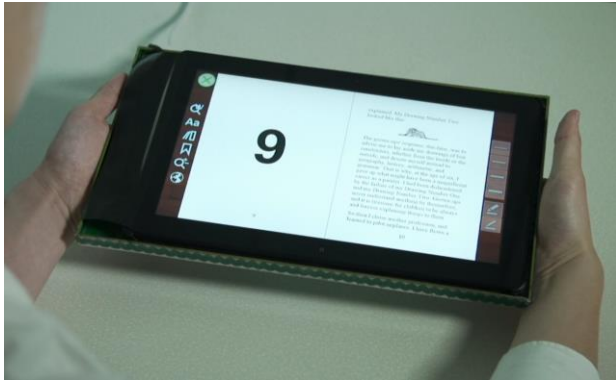


Tablet (11.6" Samsung ATIV tablet, 337×197×16 mm, 1.4 kg)

Capacitive Sensor Array (Back and Edges) (44×26, 50Hz)

Inertial Sensors (3-DOF, 100Hz)

Recognizing Multi-hand Grasp



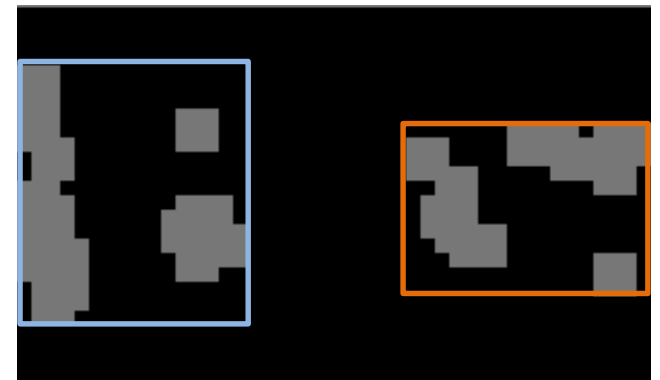
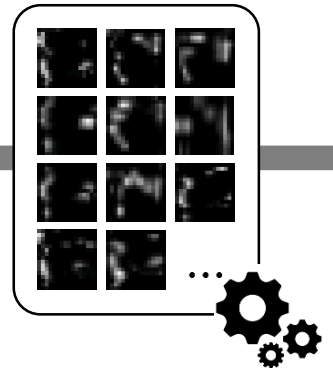
De-noise
→



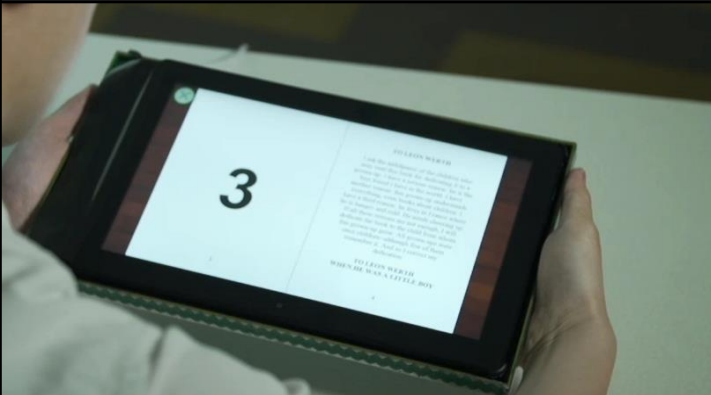
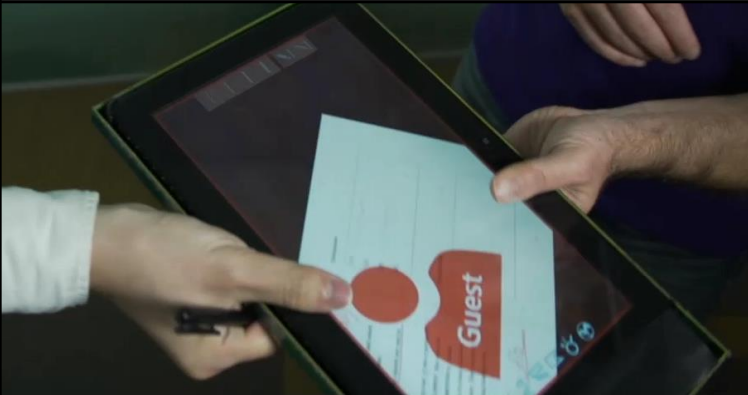


Segment
↓



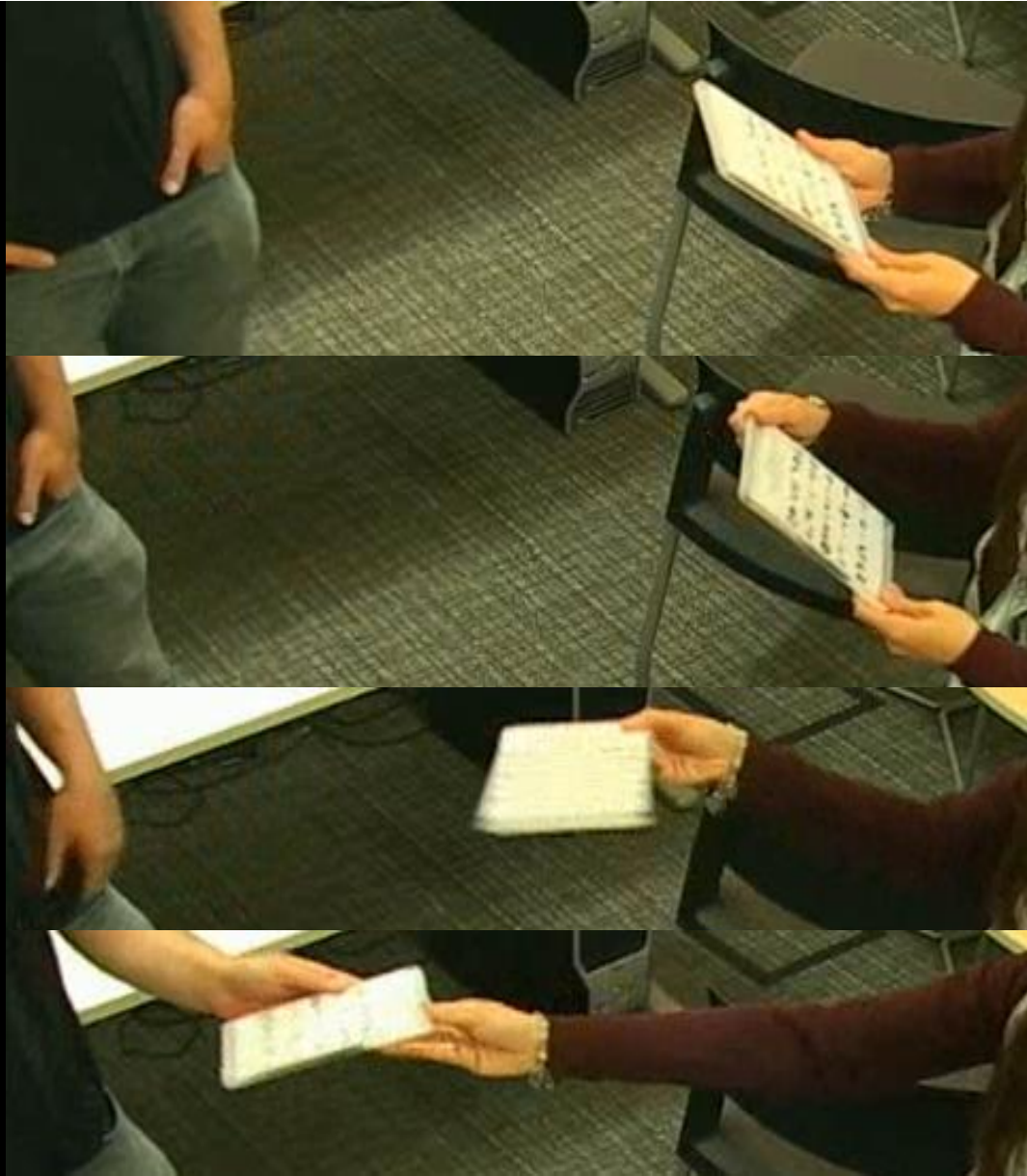
Classify



Designing Interactions: Design space

	Single User	Multiple User
Single Device		
Multiple Device		 <p>Marquardt et al.'s Micro-mobility Interaction (2012)</p>

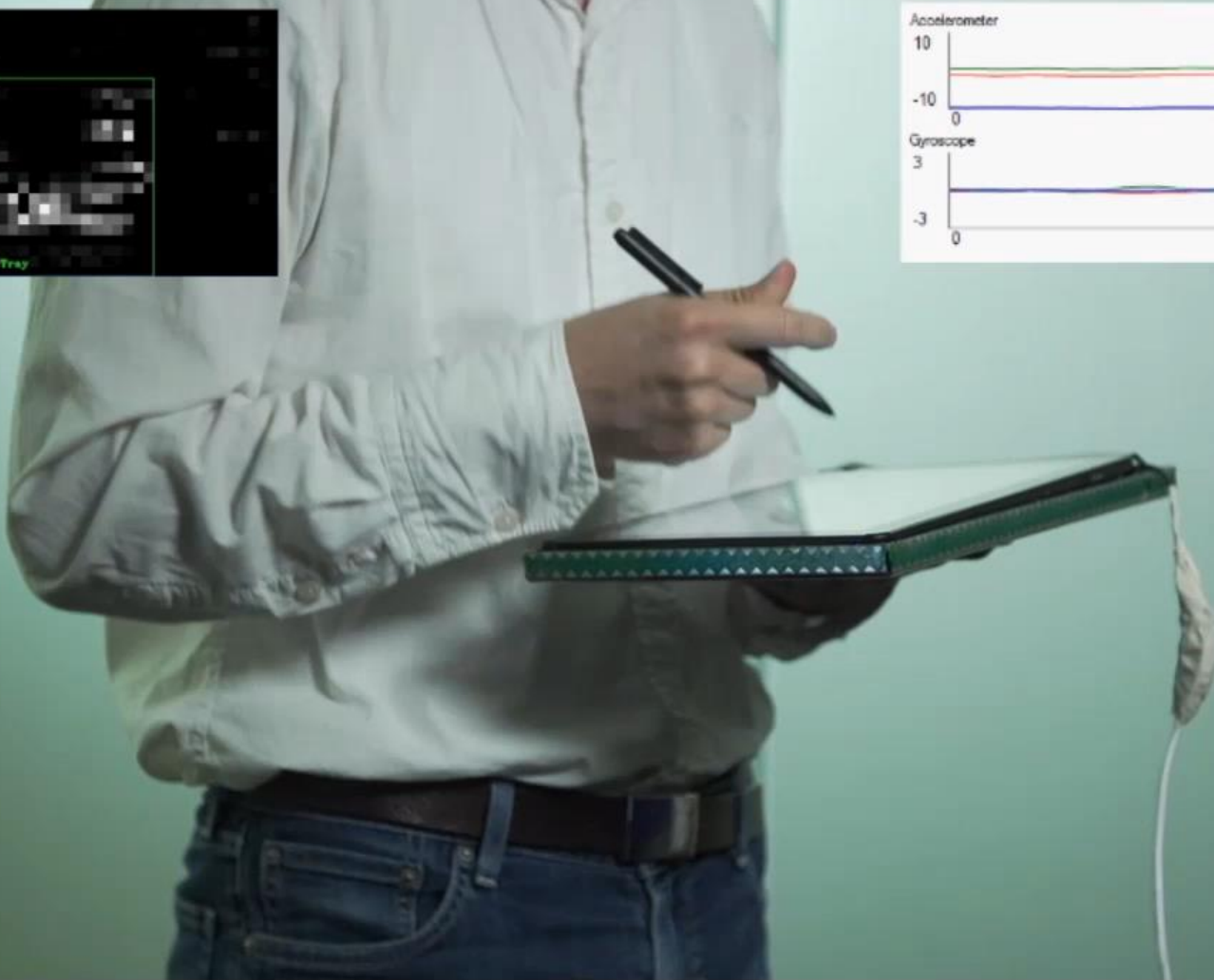
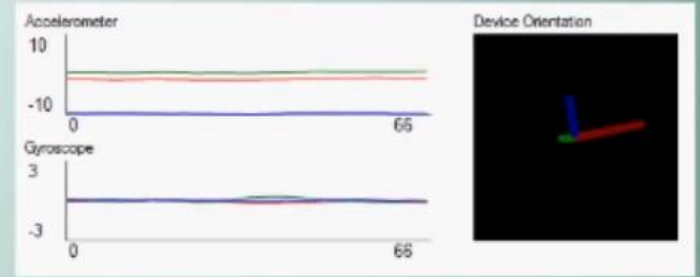
Face-to-Face Handoff (Multi-User, Single-Device)



Face-to-Face Handoff (Multi-User, Single-Device)



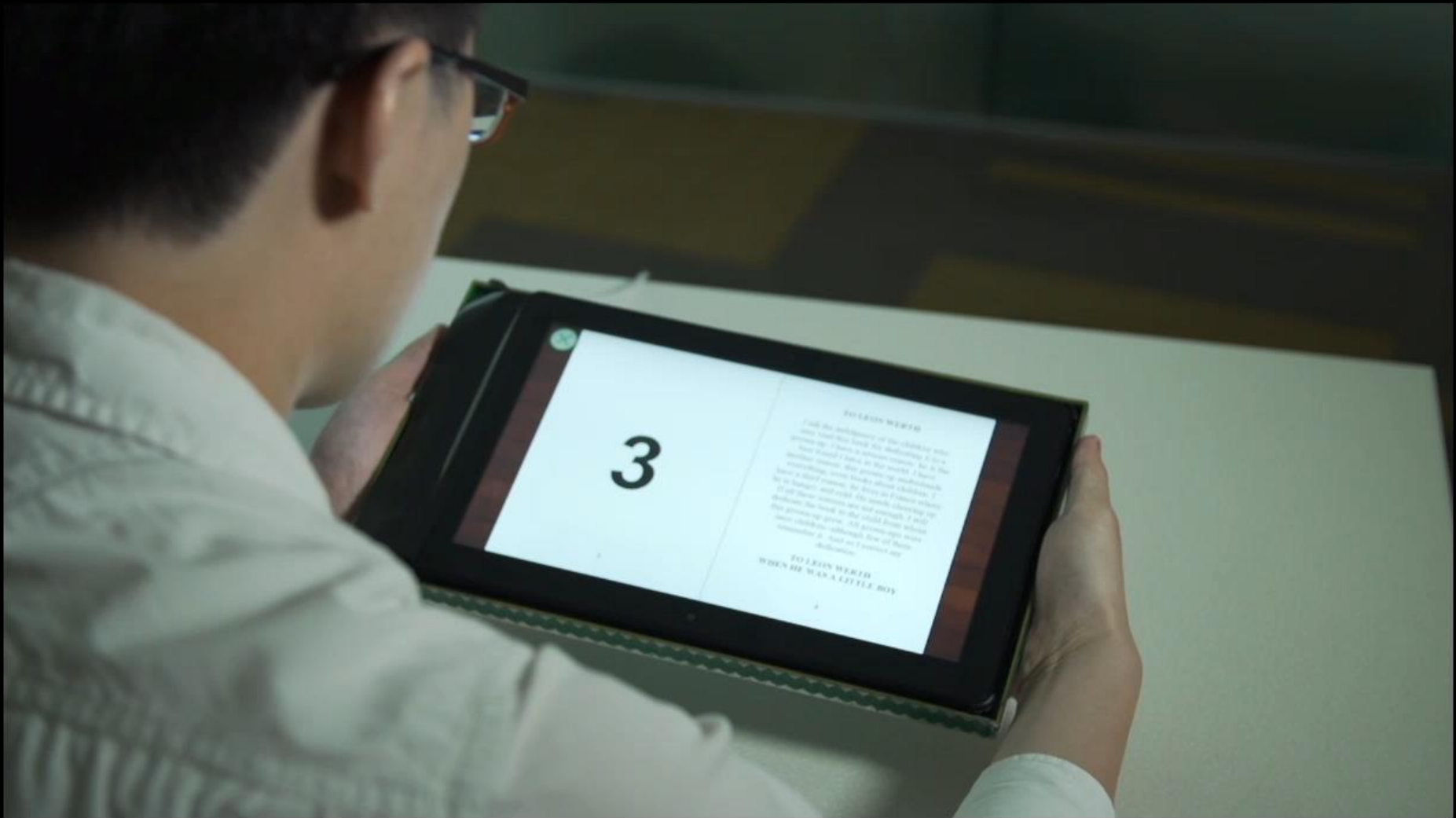
Face-to-Face Handoff (Multi-User, Single-Device)



Immersive Reading (Single-User, Single-Device)



Immersive Reading (Single-User, Single-Device)



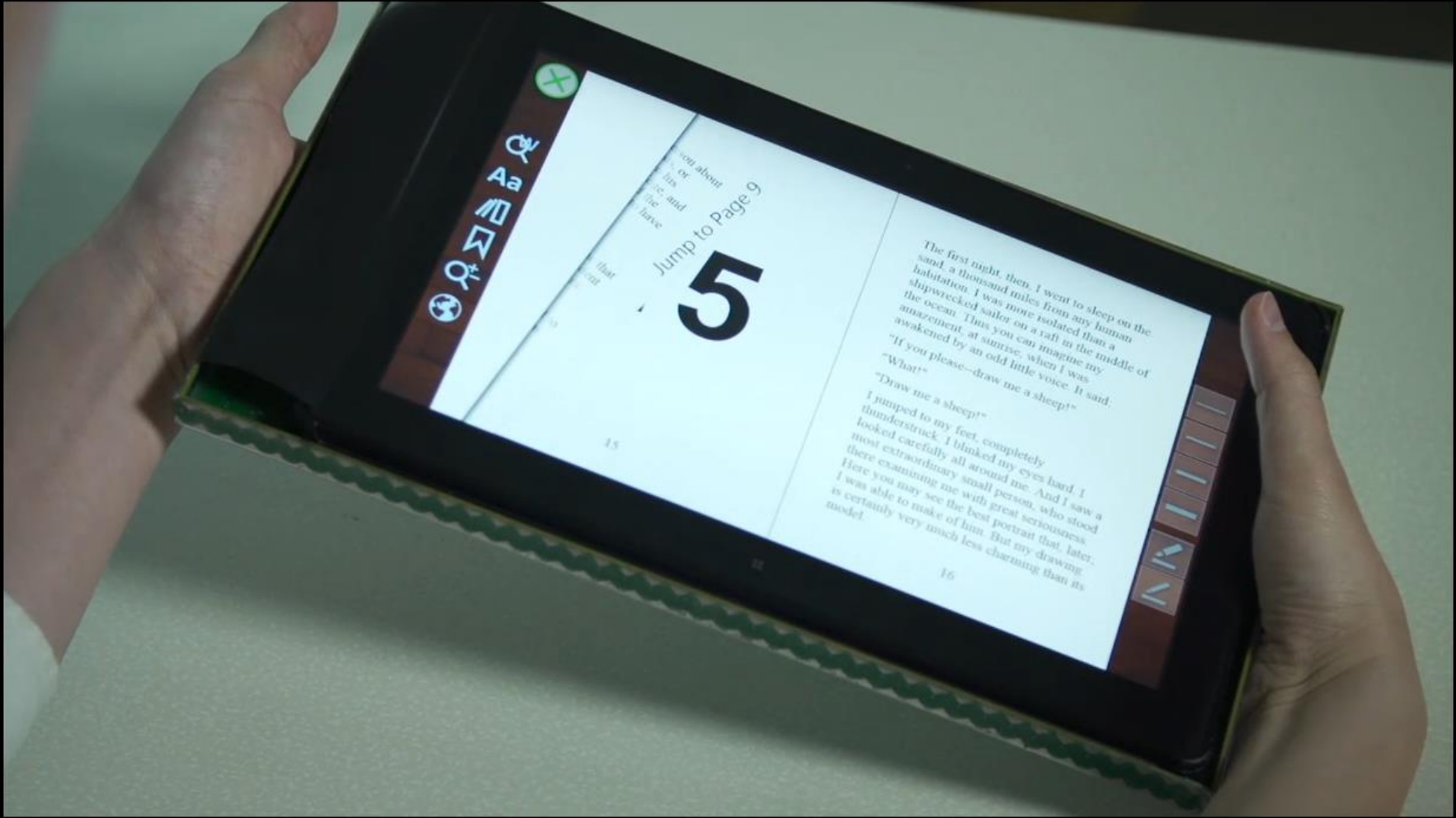
Thumb Bookmark with 'Tip-to-Flip'

(Single-User, Single-Device)



Thumb Bookmark with 'Tip-to-Flip'

(Single-User, Single-Device)



Fine-Grained Reference + Hold to Refer Back

(Single-user, Multi-device)



Fine-Grained Reference + Hold to Refer Back

(Single-user, Multi-device)



Evaluation Results and Design Insights: Familiarity of Natural Grasp + Micro-mobility Interactions



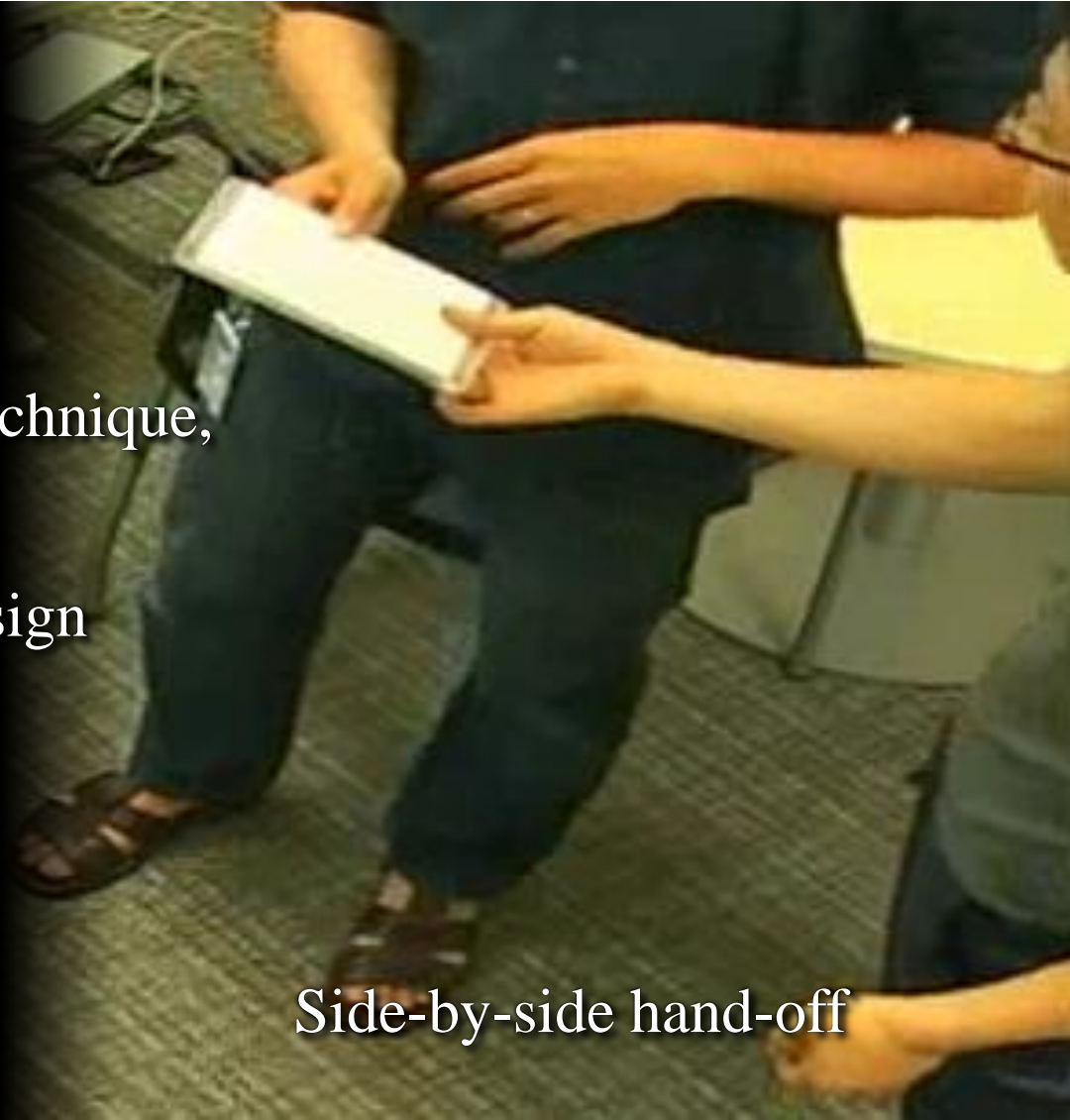
Evaluation Results and Design Insights: Context sensing vs. Gesture interaction



Evaluation Results and Design Insights:

Capturing flexibility and diversity of behaviors

Comprehensive recognition technique,
or
Not recognizing it by design



Side-by-side hand-off

Conclusion and Takeaway

Capturing *Naturally Occurring Grasp + Micro-mobility* behaviors provides *a Mutually Reinforcing Signal of User Context*

Observational Findings from the Behavioral Study

Handoff, Immersive reading, Thumbing

Design Space and Interaction Techniques

Single / Multi-user, and Single / Multi-device

Combination of Grasp and Micro-mobility

Not just about grip, nor just about movements

Supplementary Slides

Related Work

Micro-mobility: Orienting and repositioning in collaboration

(Luff and Heath, 98, Marquardt et al., 2012, Greenberg et al., 99)

+ *Grasp*, + *Individual level micro-mobility*

Grasp Sensing: Bezel, Back-of-device touch

(Kim et al., 2013) (Wolf et al., 2012, Noor et al., 2014)

Entire back surface and sides touch + inertial motion

Grasp Applications: Handedness, Screen orientation and virtual

(Wimmer et al., 2009)

(Cheng et al., 2012, Cheng et al., 2013)

keyboard,

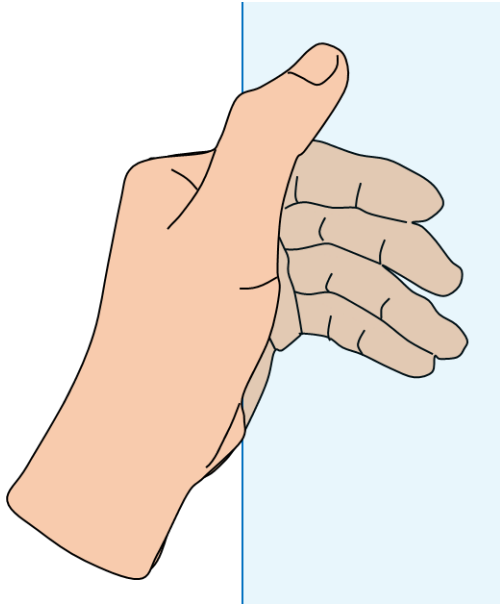
Grip-dependent functions, Front + back gestures

(Kim et al., 2006, Taylor et al., 2009, Wimmer, 2011)

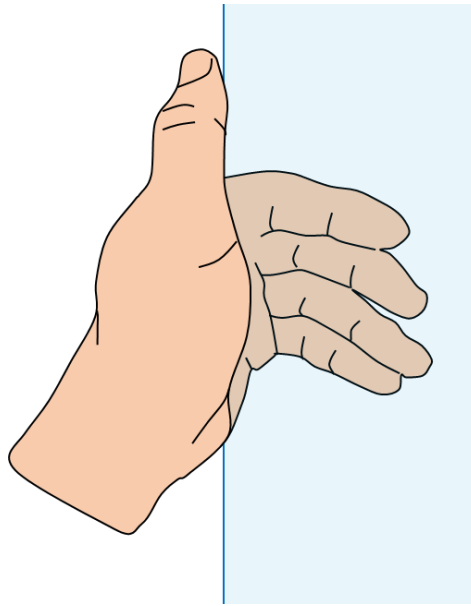
(Wolf et al., 2012, Noor et al., 2014)

Active reading contexts

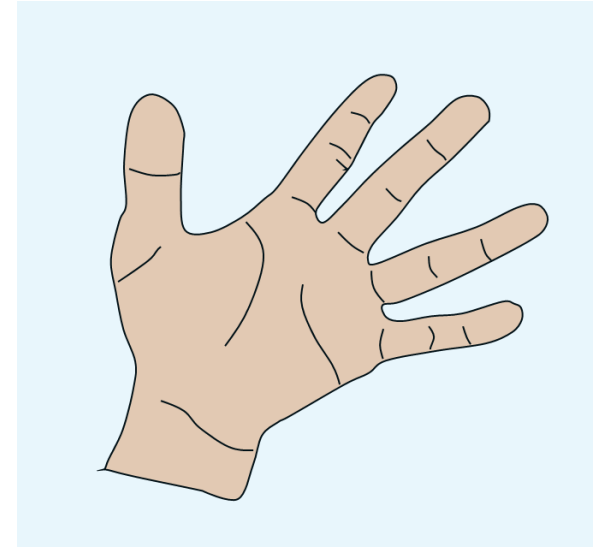
Observed Behaviors: Grips



Thumb Left grip

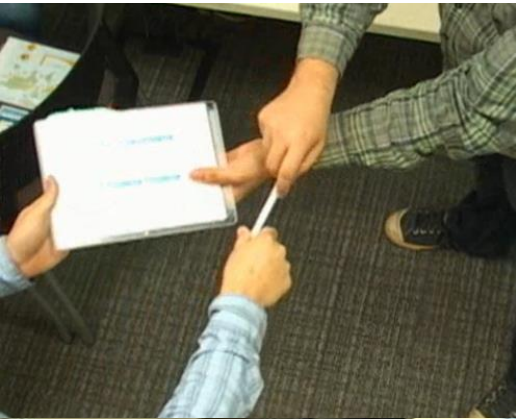


Thumb Left-Edge grip



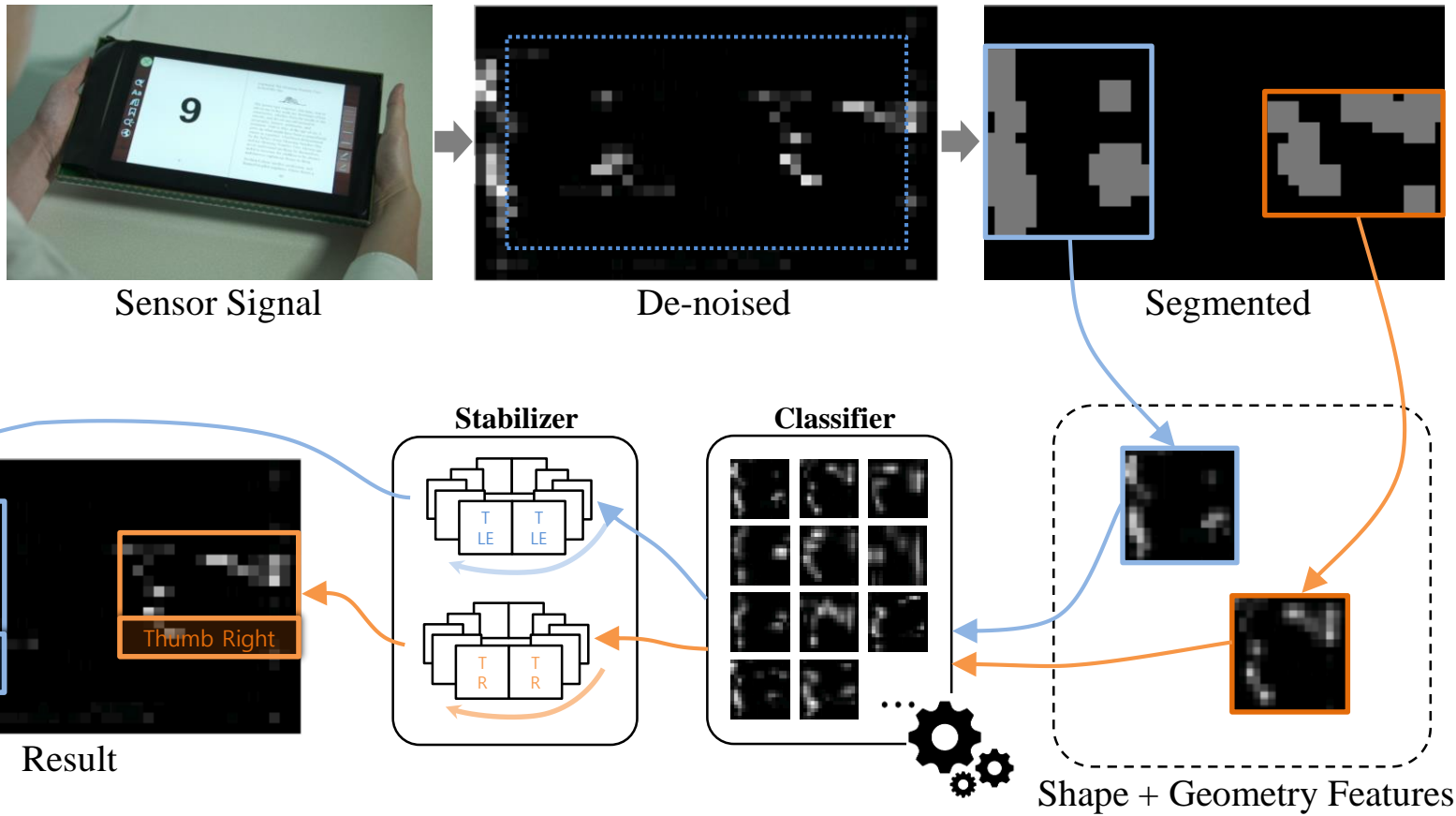
Tray grip

Observed Behaviors: with a Pen

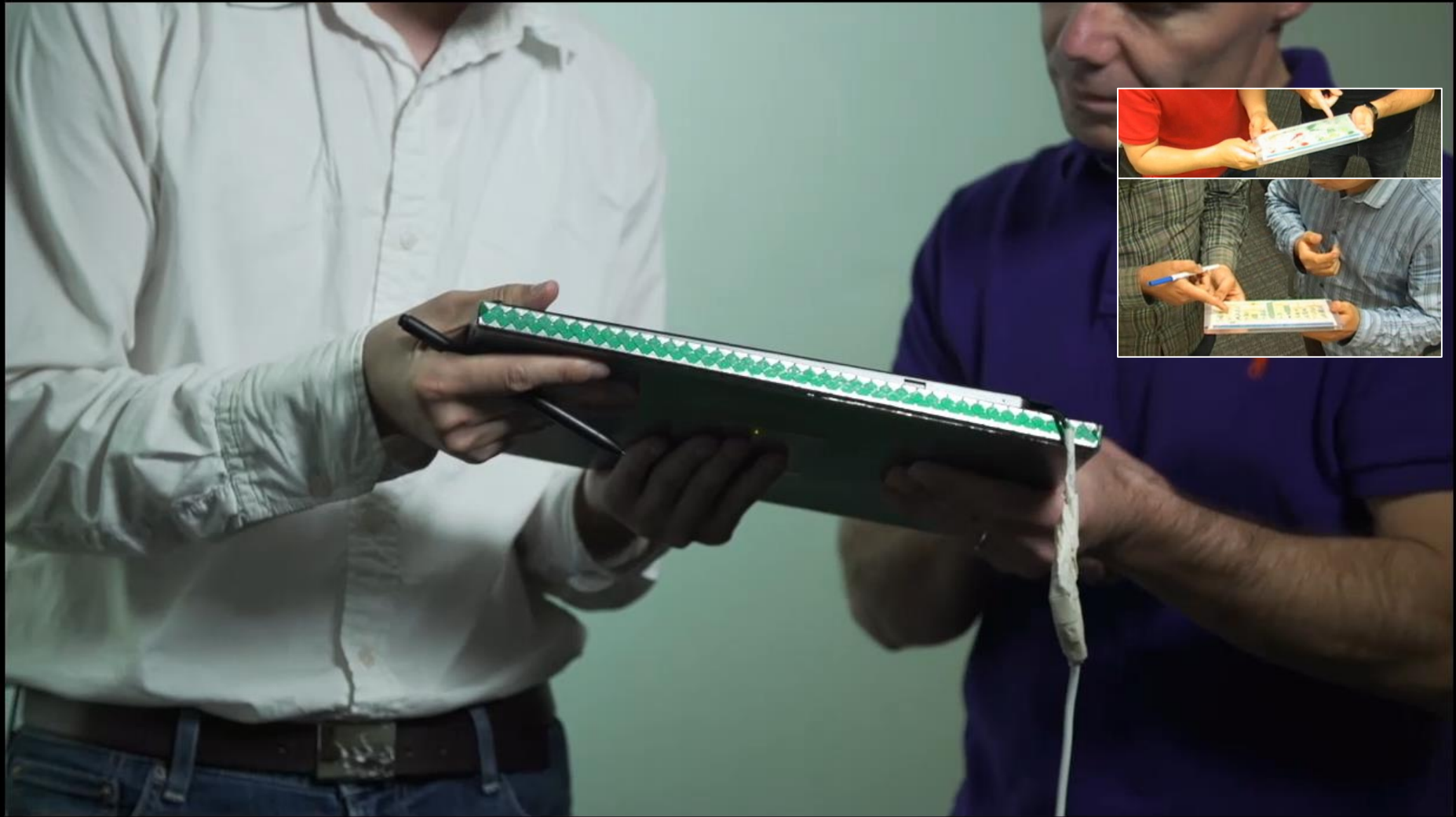


Recognizing Multi-hand Grasp

De-noise
Segment
Classify
Stabilize



Side-by-Side Micro-Territoriality (Multi-User, Single-Device)



Preliminary Evaluation:

Assessing Reactions to Grasp + Mobility Interaction Techniques

Procedure

Instruction and demonstration (total 5 min)

Participant practicing (total 10 min)

Tasks (total 45 min)

Interview (30 min)

Tasks

Reading and navigating a document (single-user, single-device interactions)

Archiving information in a document (single-user, multi-device interactions)

Cooperative discussion and markup (multi-user, multi-device interactions)

Participants

16 people (8 pairs, all right-handed, 4 female, 25-48 years old, $M = 28.5$)