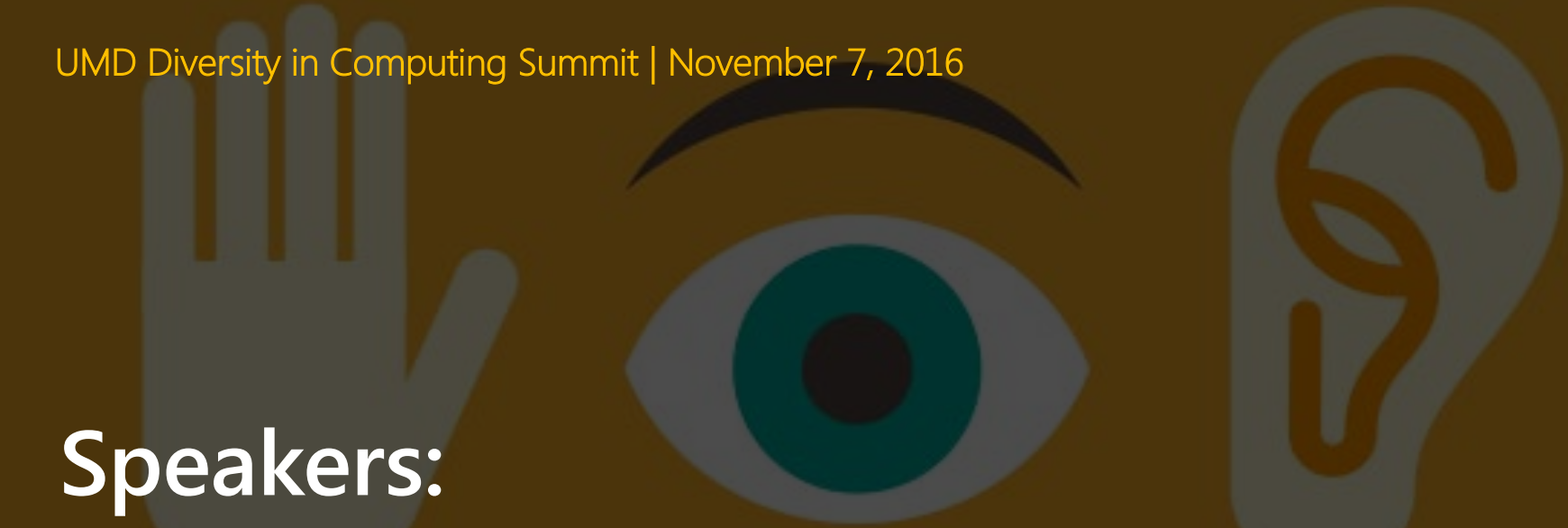
Interactive Computational Tools for Accessibility

UMD Diversity in Computing Summit | November 7, 2016



Speakers:

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makeability lab

inclusive design lab

HCIL Human Computer Interaction Laboratory

COMPUTER SCIENCE
UNIVERSITY OF MARYLAND

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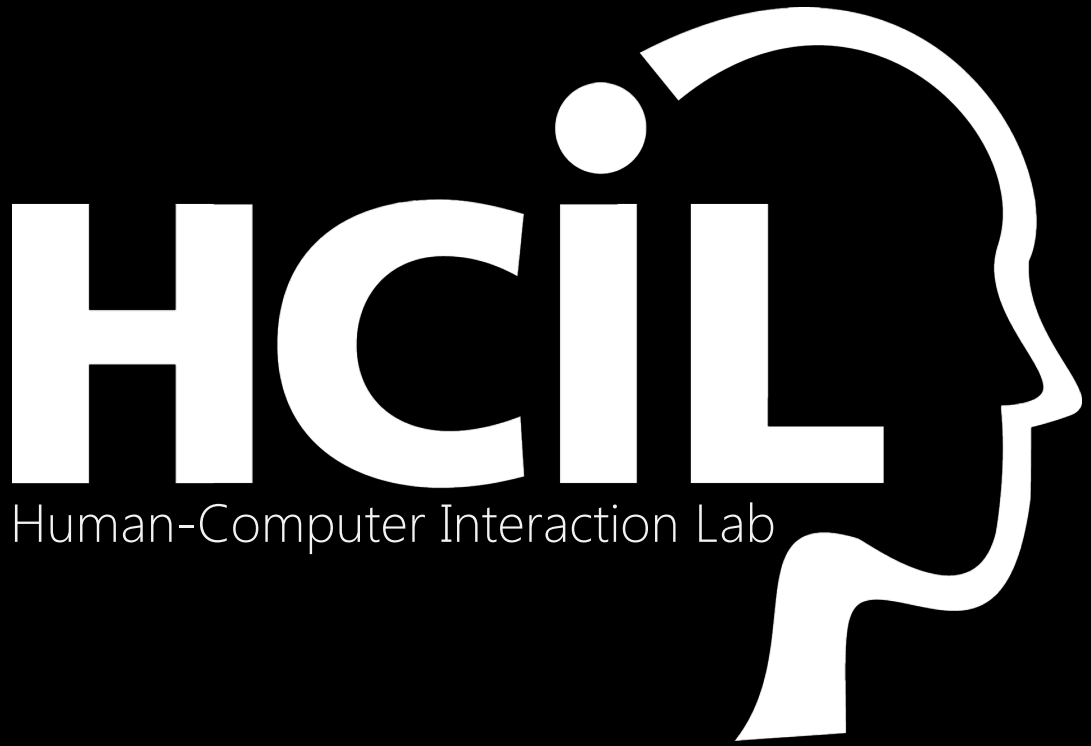
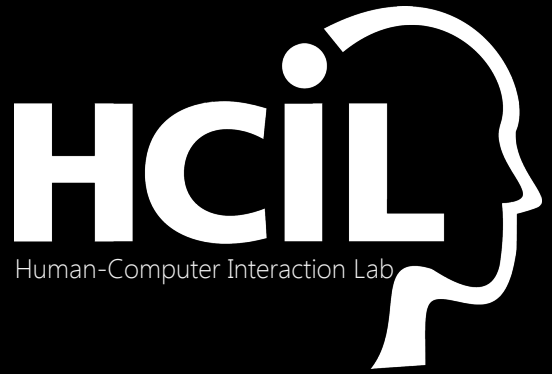

HCIL
Human-Computer Interaction Lab



Accessibility Research Team

makeability lab

Lablets within the HCIL

makeability lab

Jon Froehlich

inclusive design lab

Leah Findlater


Accessibility is an important part of diversity

Session Outline

Part 1: Mobility Impairments

Part 2: Visual Impairments

Characterizing Physical World Accessibility at Scale

UMD Diversity in Computing Summit | November 7, 2016

Presenter: Manaswi Saha

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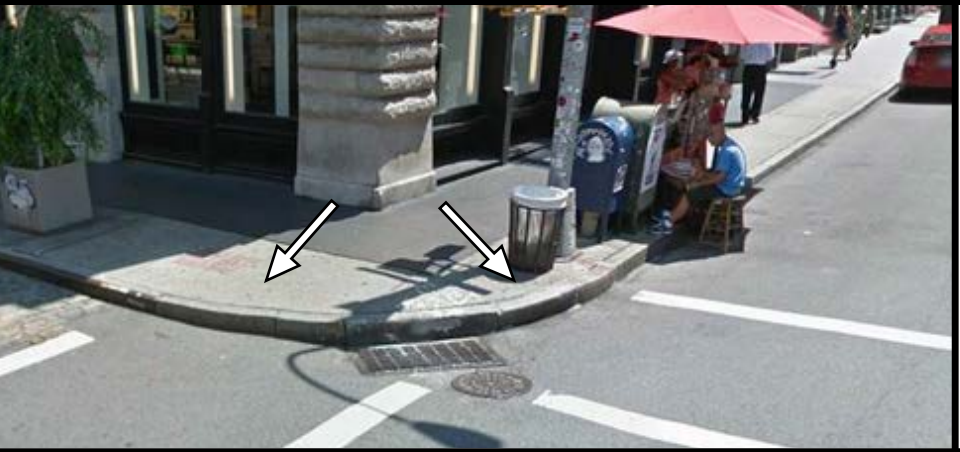
makeability lab


30.6
million U.S. adults with mobility impairment


15.2
million use an assistive aid

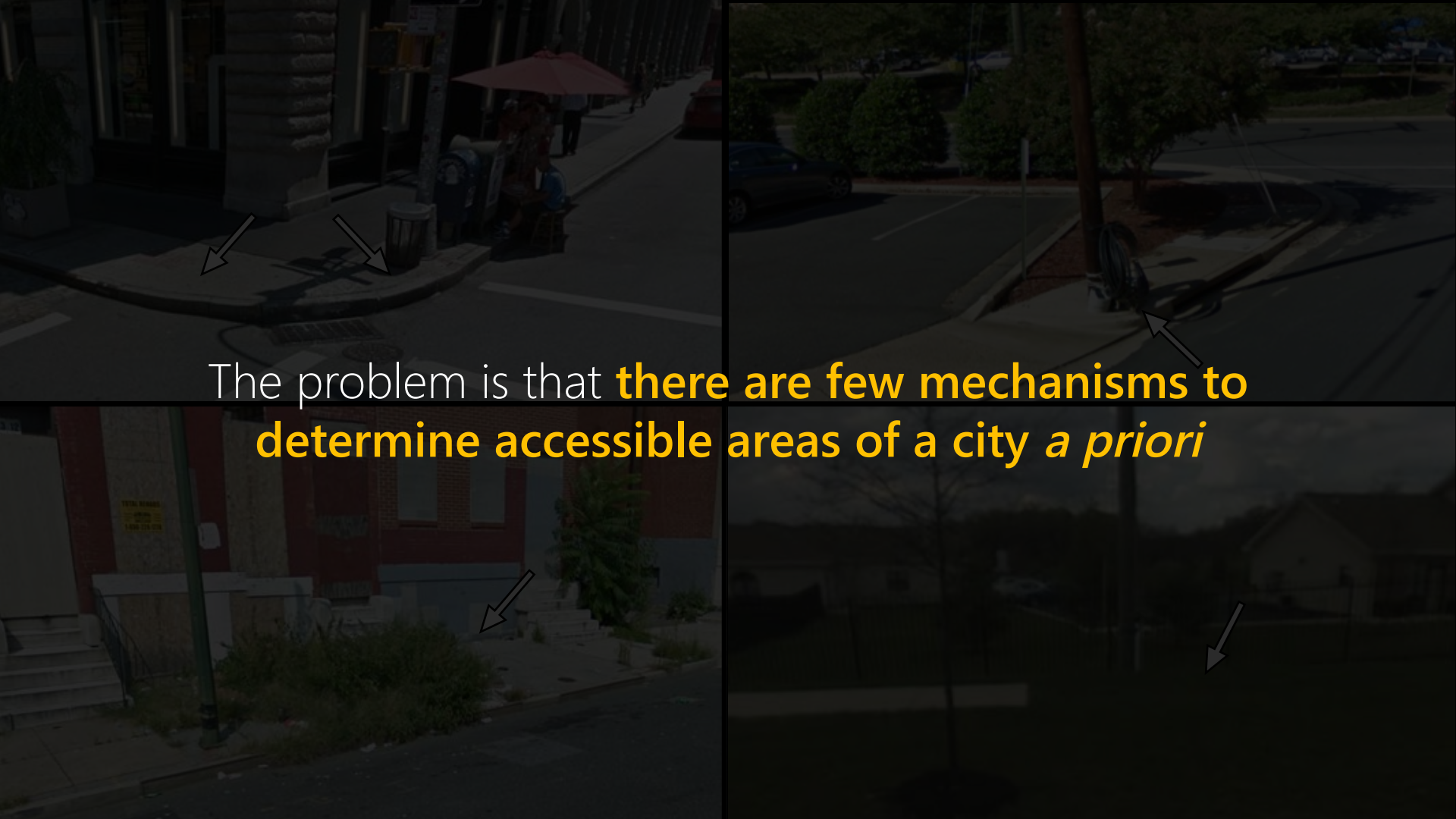
Missing Curb Ramp



Obstacle

Surface Problem

No Sidewalk

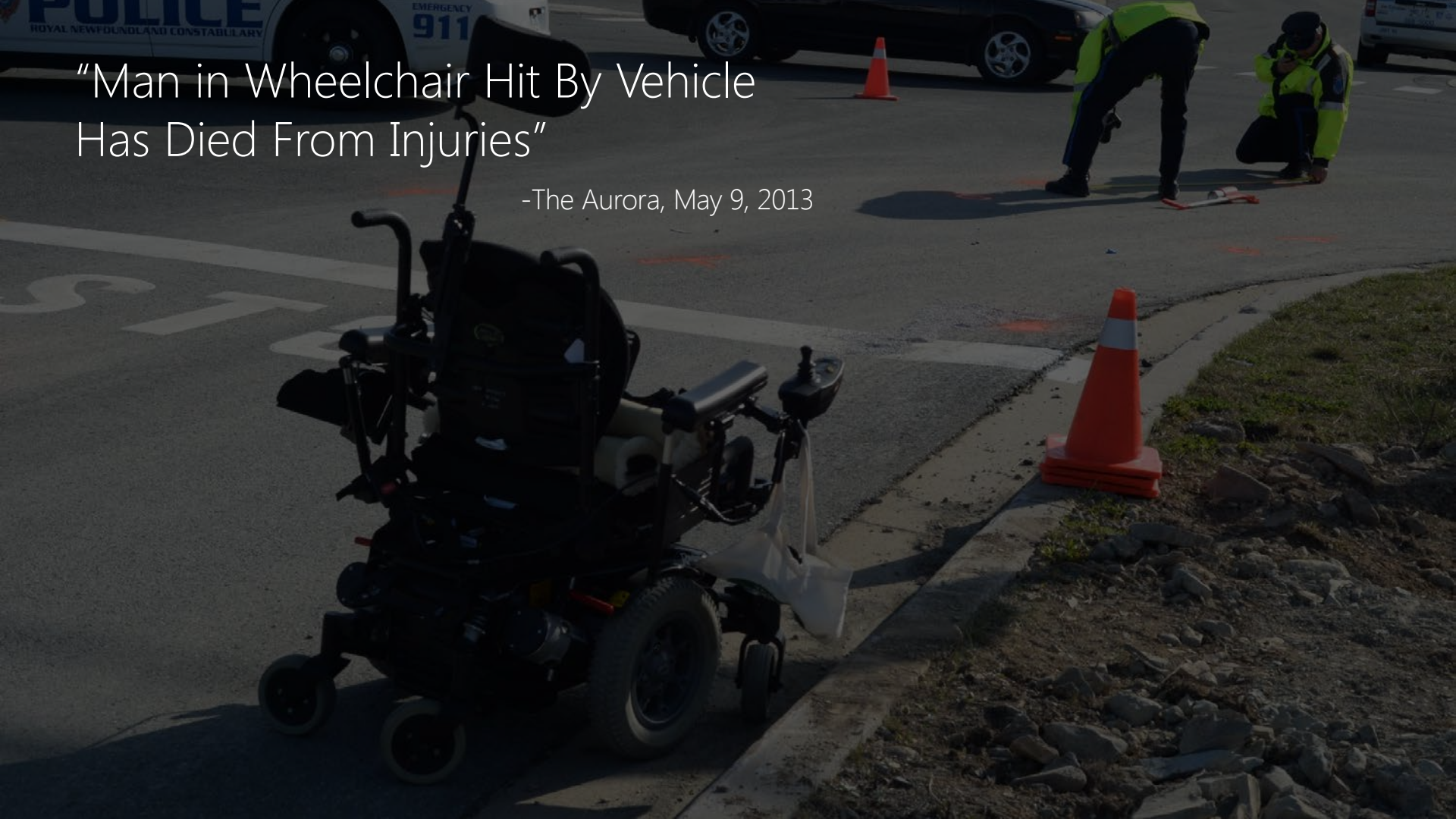


The problem is that **there are few mechanisms to determine accessible areas of a city *a priori***

The National Council on Disability noted that there is **no comprehensive information** on "the degree to which sidewalks are accessible" in cities.

National Council on Disability, 2007
The impact of the Americans with Disabilities Act: Assessing the progress toward achieving the goals of the ADA

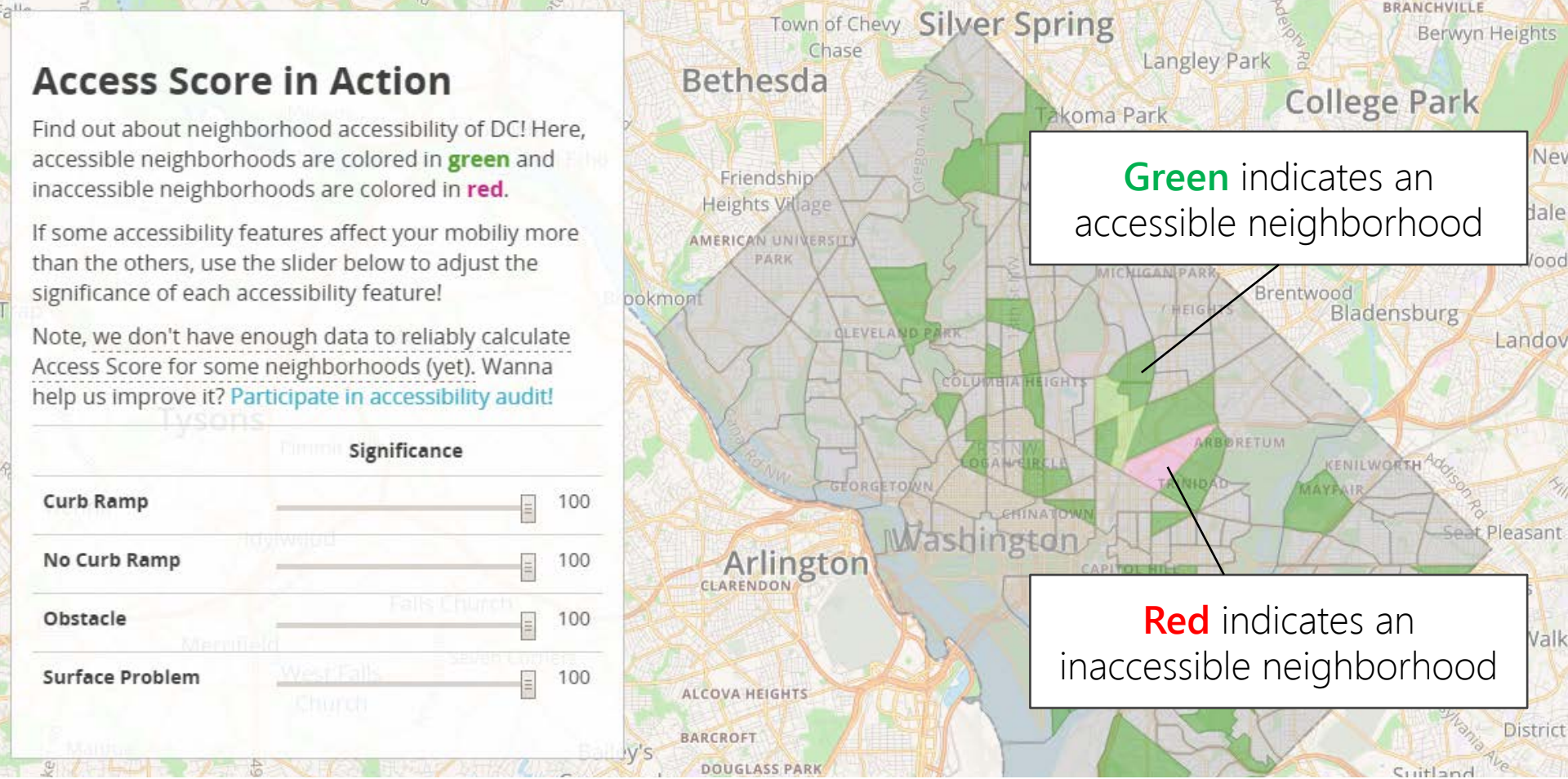
cf. Nuernberger, 2008; Thapar *et al.*, 2004



“Man in Wheelchair Hit By Vehicle Has Died From Injuries”

-The Aurora, May 9, 2013


OUR VISION
Design systems that transform the way accessibility information is **collected** and **used**.



Proof-of-Concept Application of Accessibility Data

Accessibility-aware Navigation

THESE APPLICATIONS HAVE

HUGE DATA

REQUIREMENTS

THESE APPLICATIONS HAVE

HUGE DATA REQUIREMENTS

Where is this data going to come from?

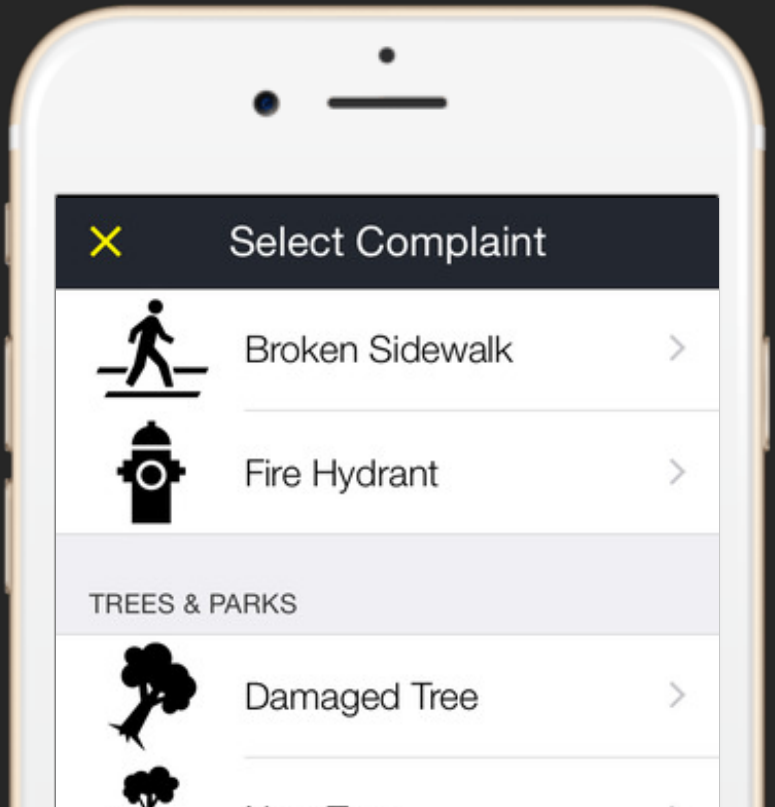
Traditional Walkability Audits

Walkability Audit
Wake County, North Carolina

Walkability Audit
Wake County, North Carolina

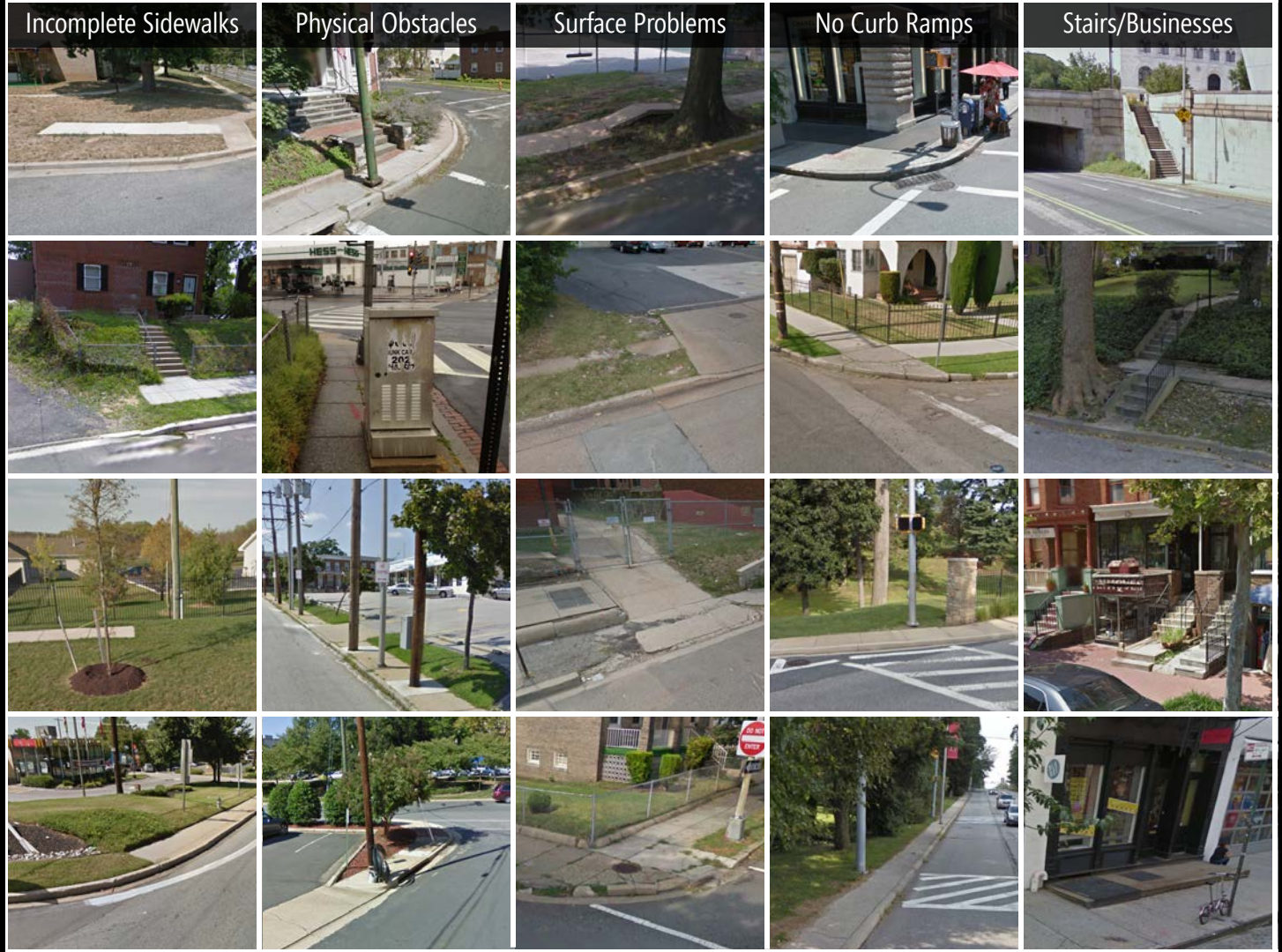
Safe Routes to School Walkability Audit
Rock Hill, South Carolina

Mobile Reporting Solutions



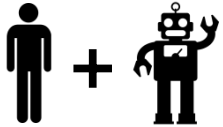
http://www1.nyc.gov/311/index.page


Our Approach: Remotely collect street-level accessibility information from Google Street View (GSV) using crowdsourcing and computation
St. Albans Track
St Albans Tennis Courts
Garfield St NW
34th St NW
34th Pl NW
33rd Pl NW
Amabel Wdc Lobeus
Map
Traffic


Incomplete Sidewalks
Physical Obstacles
Surface Problems
No Curb Ramps
Stairs/Businesses

How can we combine automated methods to increase the data collection efficiency?

Crowdsourced Data Collection



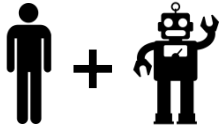
Semi-automated Data Collection

Accessibility-aware Application Design

How can we leverage Google Street View and humans to collect accurate street-level accessibility data?

What location-based applications should we design with the collected accessibility data for people with mobility impairments?

Crowdsourced
Data Collection



Semi-automated
Data Collection

Accessibility-aware
Application Design

Crowdsourced
Data Collection

Semi-automated
Data Collection

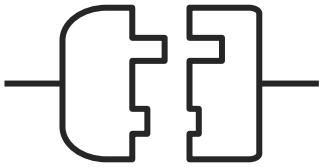
Accessibility-aware
Application Design

- How can we design a crowdsourcing system to collect street-level accessibility data from Google Street View?

- How accurately can minimally trained crowd workers label accessibility features in Google Street View imagery?

http://sidewalk.umiacs.umd.edu

Volunteered Accessibility Data Collection



Accessibility Data Serving APIs

Chrome File Edit View History Bookmarks People Window Help

Aug 14 3:44 PM

Project Sidewalk

Kotaro Hara

localhost:9000

Apps Gmail Calendar Google Maps Drive Scholar YouTube Chase GitHub Makeability Proxy SVG Crowbar Other Bookmarks

Project Sidewalk beta

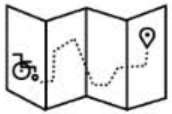
Demo FAQ **Start Auditing** Sign in

Help us make sidewalks more accessible for everyone

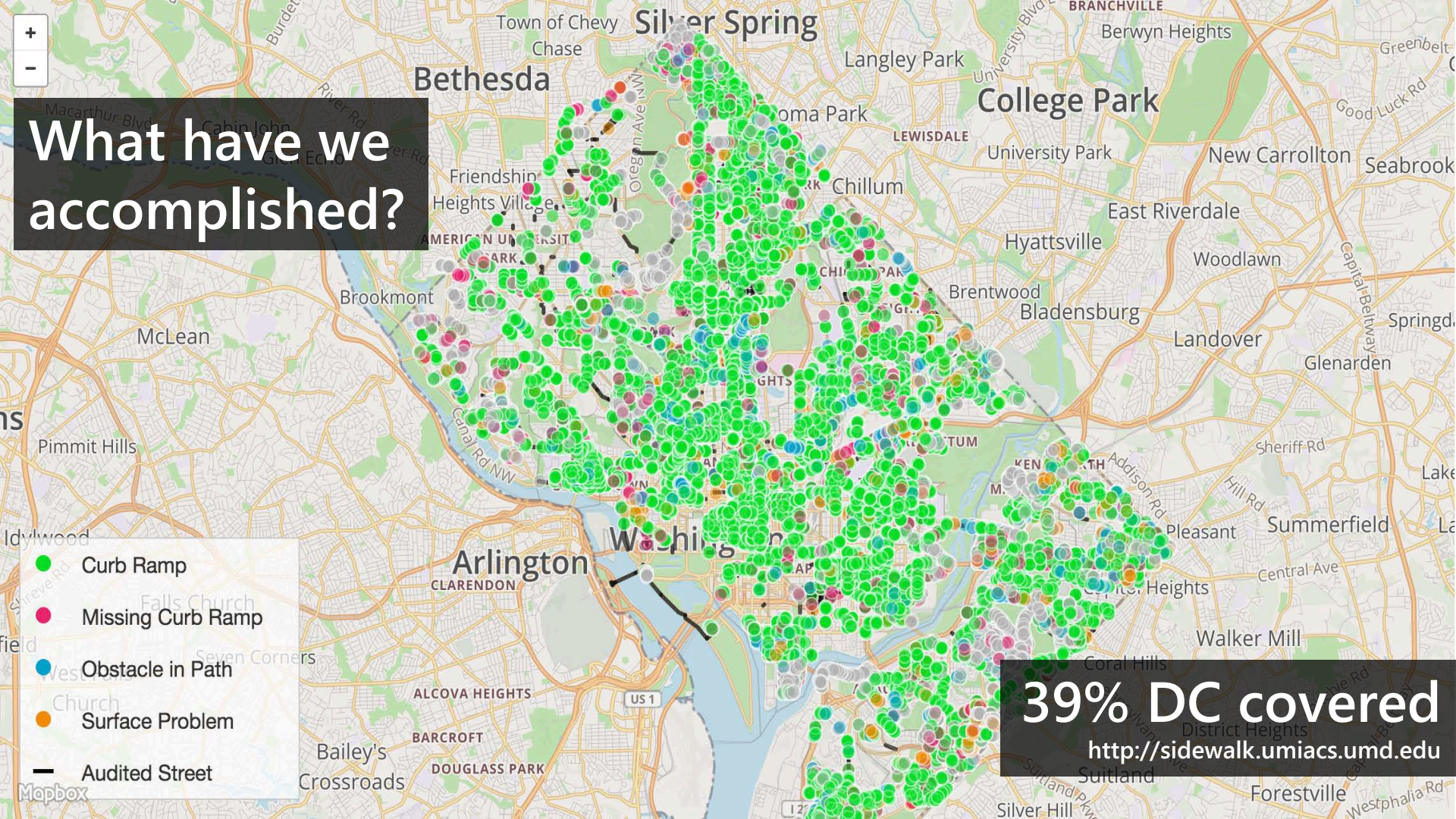
Participate

Use our tool to label accessibility attributes in

The collected data is stored on our server and



The data will be used to enable new accessibility-

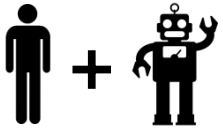

What have we accomplished?
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
Audited Street
39% DC covered
http://sidewalk.umiacs.umd.edu
Mapbox

Crowdsourced
Data Collection

Semi-automated
Data Collection

Accessibility-aware
Application Design

Crowdsourced
Data Collection

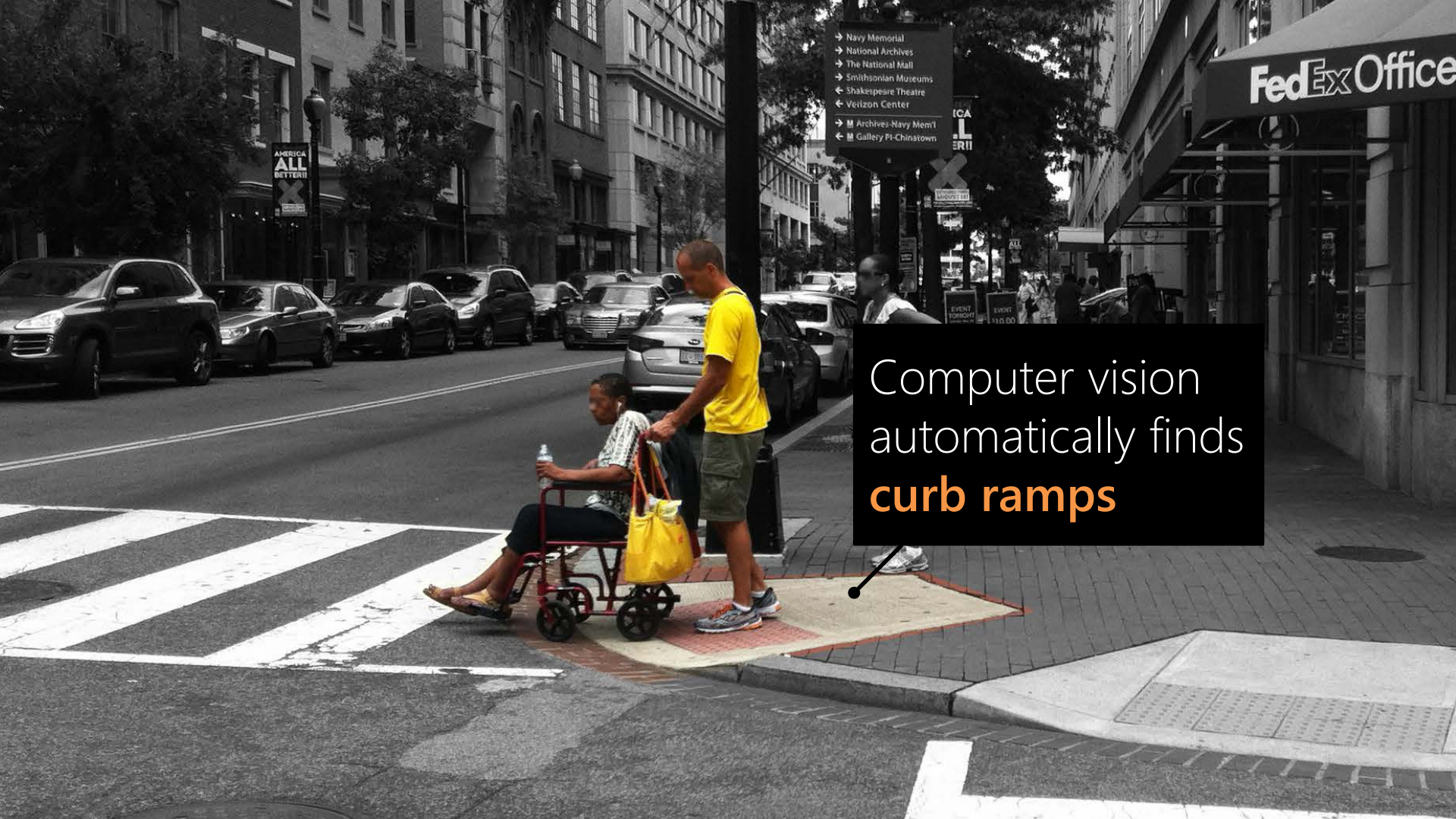


Semi-automated
Data Collection

Accessibility-aware
Application Design

- Can we use computer vision to automatically and accurately detect accessibility attributes?

- How can we combine crowdsourcing and computer vision to increase the data collection efficiency?

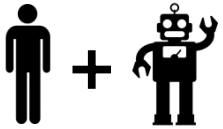

Navy Memorial
National Archives
The National Mall
Smithsonian Museums
Shakespeare Theatre
Verizon Center
Archives-Navy Mem'l
Gallery Pl-Chinatown
FedEx Office
Computer vision automatically finds
curb ramps

Curb Ramps are Visually Salient






Crowdsourced
Data Collection



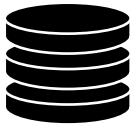
Semi-automated
Data Collection

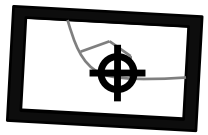
Accessibility-aware
Application Design

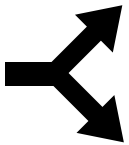
Semi-automated
data collection
system called:

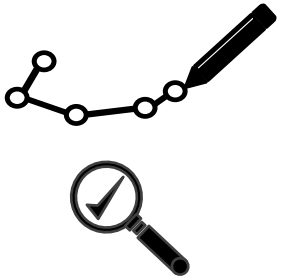
Tohme

遠目·*Remote Eye*



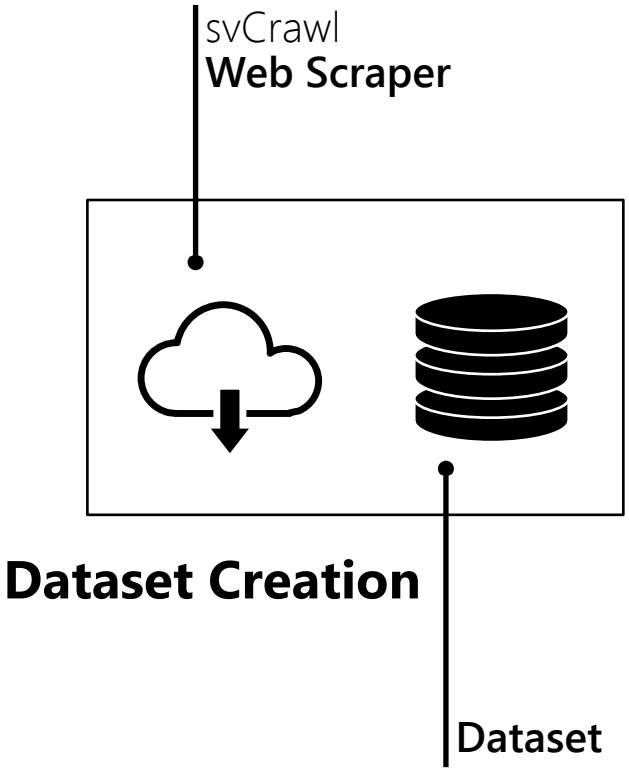






Tohme

遠目 · *Remote Eye*

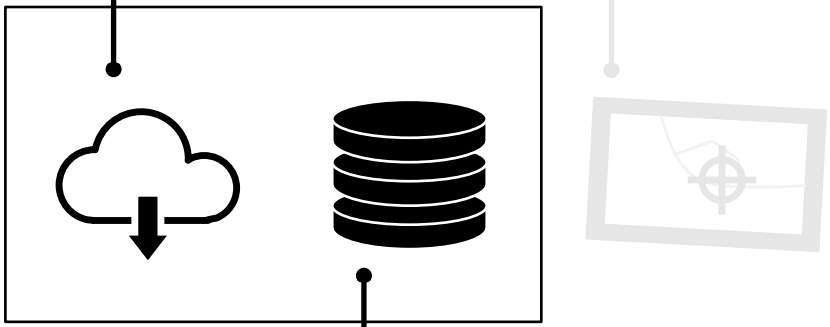


Tohme

遠目 · *Remote Eye*

svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection



Dataset Creation

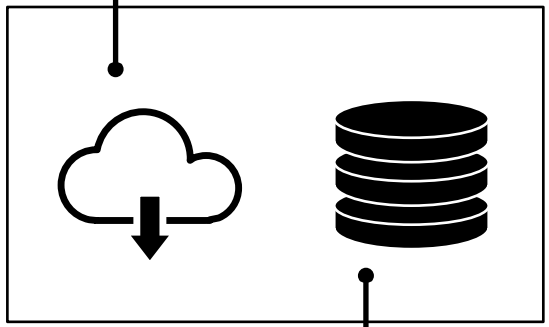
3D Depth Map
GIS Metadata (*e.g.,* topological data)
Top down map images
Street View image
Dataset

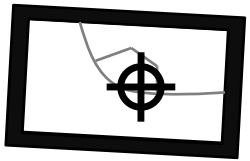
Tohme

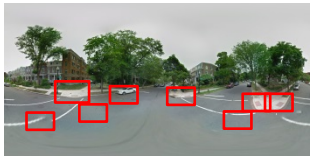
遠目 · *Remote Eye*

svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection







Dataset Creation

Dataset

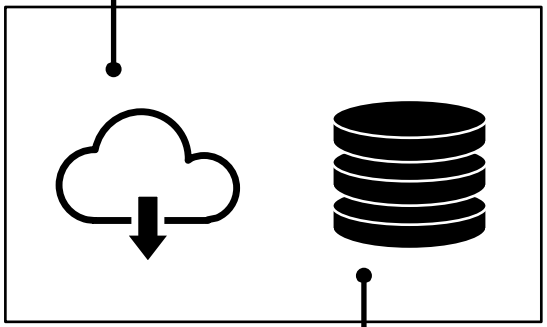
svControl
Automatic Task Allocation

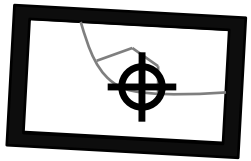
Tohme

遠目・*Remote Eye*

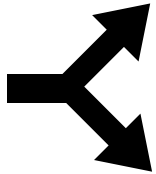
svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection





Dataset



Did our computer vision algorithm perform well?

svControl
Automatic Task Allocation

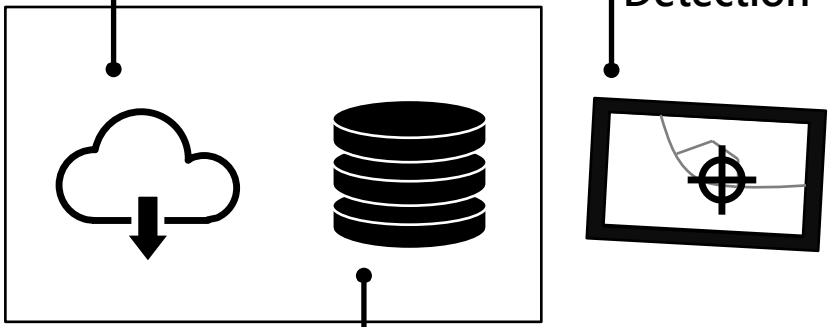
Complexity: 0.14
Cardinality: 0.33
Depth: 0.21
CV: 0.22

Tohme

遠目・*Remote Eye*

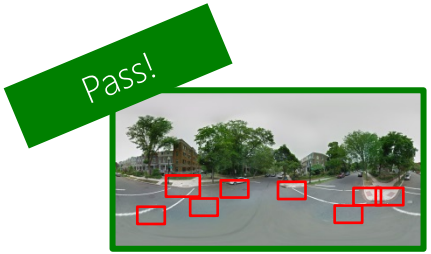
svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection



Dataset Creation

Dataset



Complexity: 0.14
Cardinality: 0.33
Depth: 0.21
CV: 0.22

svControl
Automatic Task Allocation

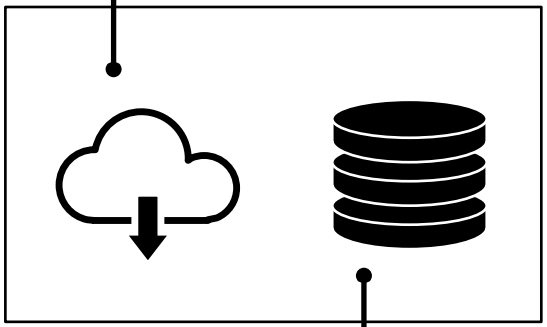
svVerify
Manual Label Verification

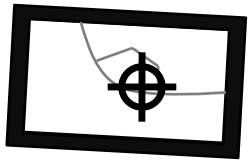
Tohme

遠目・*Remote Eye*

svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection

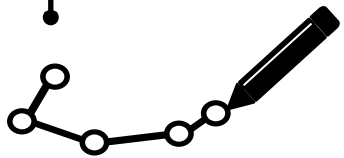




Dataset Creation

Dataset

svLabel
Manual Labeling



svControl
Automatic Task Allocation

svVerify
Manual Label Verification

Tohme
遠目・*Remote Eye*

svCrawl
Web Scraper

svDetect
Automatic Curb Ramp Detection

svLabel
Manual Labeling

13% reduction in **time cost** at the same level of **labeling accuracy** as manual labeling!

Dataset Creation

Dataset

svControl
Automatic Task Allocation

svVerify
Manual Label Verification

Crowdsourced
Data Collection

Semi-automated
Data Collection

Accessibility-aware
Application Design

How can we leverage this unprecedented level of accessibility data in new interactive location based tools?

Interview Studies with Mobility Impaired People

Hara, K., Le, V., Froehlich, J.E. CHI2013; **Hara, K.,** Chan, C., Froehlich, J.E. *CHI 2016*

Participatory Design Process

Recruited 20 people with varying levels of mobility from Washington, D.C. area

- Electric wheelchair/scooter users
- Manual wheelchair users
- Manual mobility aids (e.g. cane) users

Age ranged between 19-77

Recruited participants via local accessibility organizations, word-of-mouth, and email listserv on a rolling basis

The study was split into three parts

Study Method: Three-Part Study

Scenario-based Design

Semi-structured Interview

Design Probe

Part 1: Semi-Structured Interview

What are their needs?

Part 1: Semi-Structured Interview

To better understand how people with mobility impairments plan their trips, we asked:

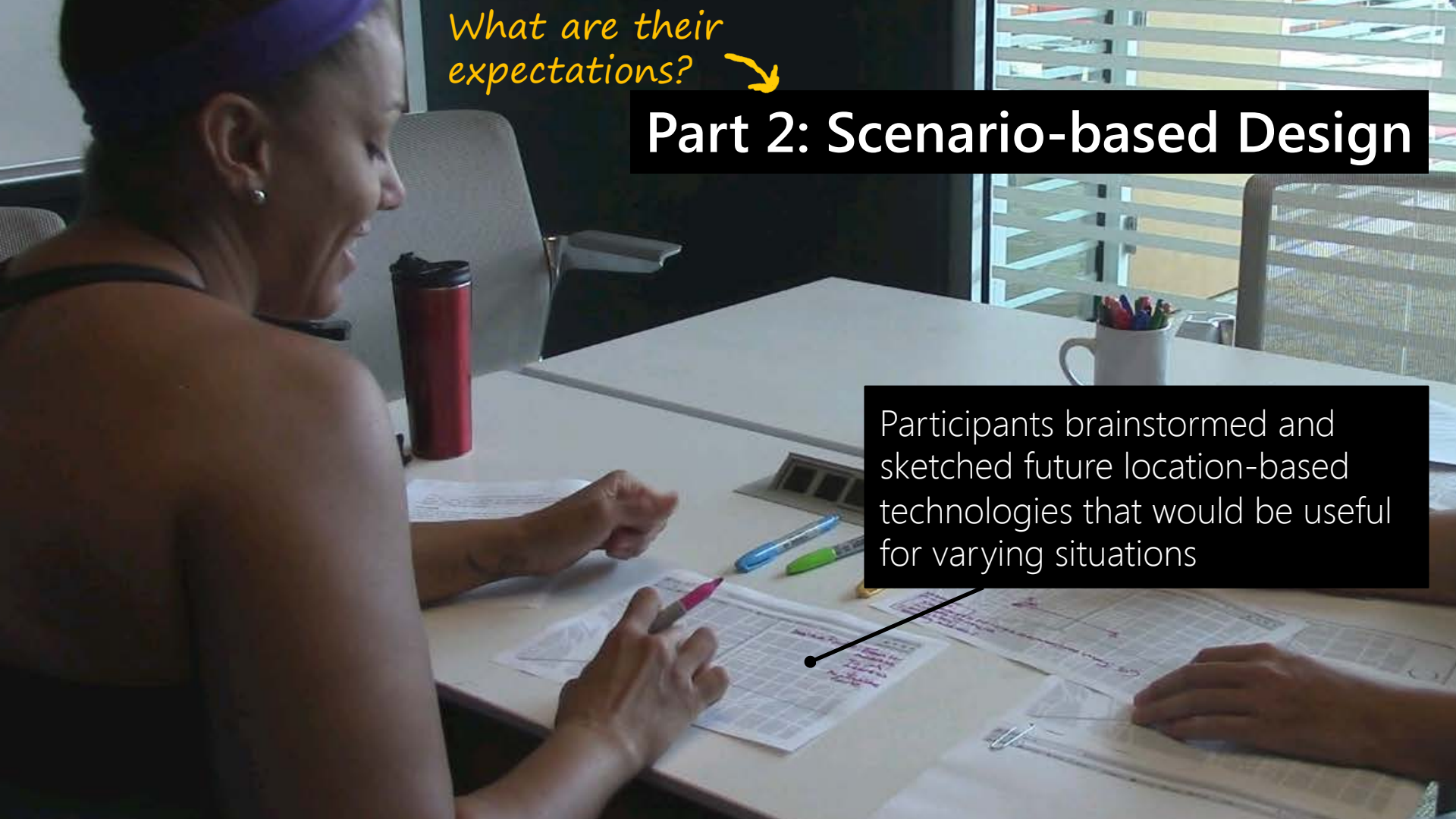
- How the accessibility problems in the built-environment affect their decisions to travel
- What tools and methods do they use to assess the accessibility before they travel

Study Method: Three-Part Study

Scenario-based Design

Semi-structured Interview

Design Probe

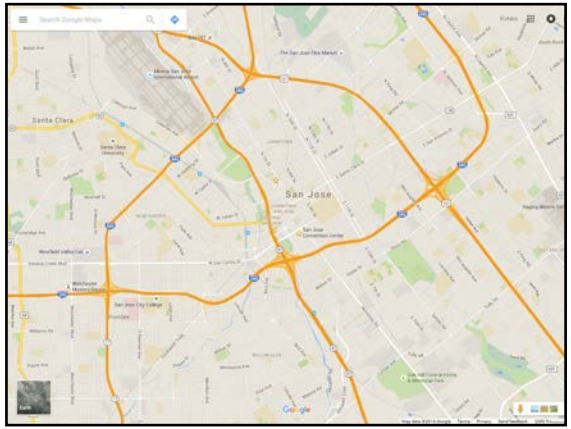


Part 2: Scenario-based Design

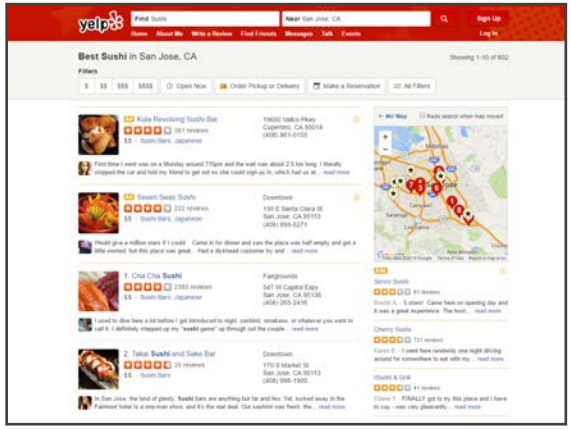
Participants brainstormed and sketched future location-based technologies that would be useful for varying situations

Scenarios

To help guide the design activity, we used three realistic scenarios



Scenario 1
Accessibility Exploration



Scenario 2
Accessible Location Search

Scenario 3
Accessibility-Aware Navigation

Scenario: Citywide Accessibility Exploration

You are planning to rent a room in an unfamiliar city that you will move to in a few months.

Scenario: Citywide Accessibility Exploration

You are planning to rent a room in an unfamiliar city that you will move to in a few months.

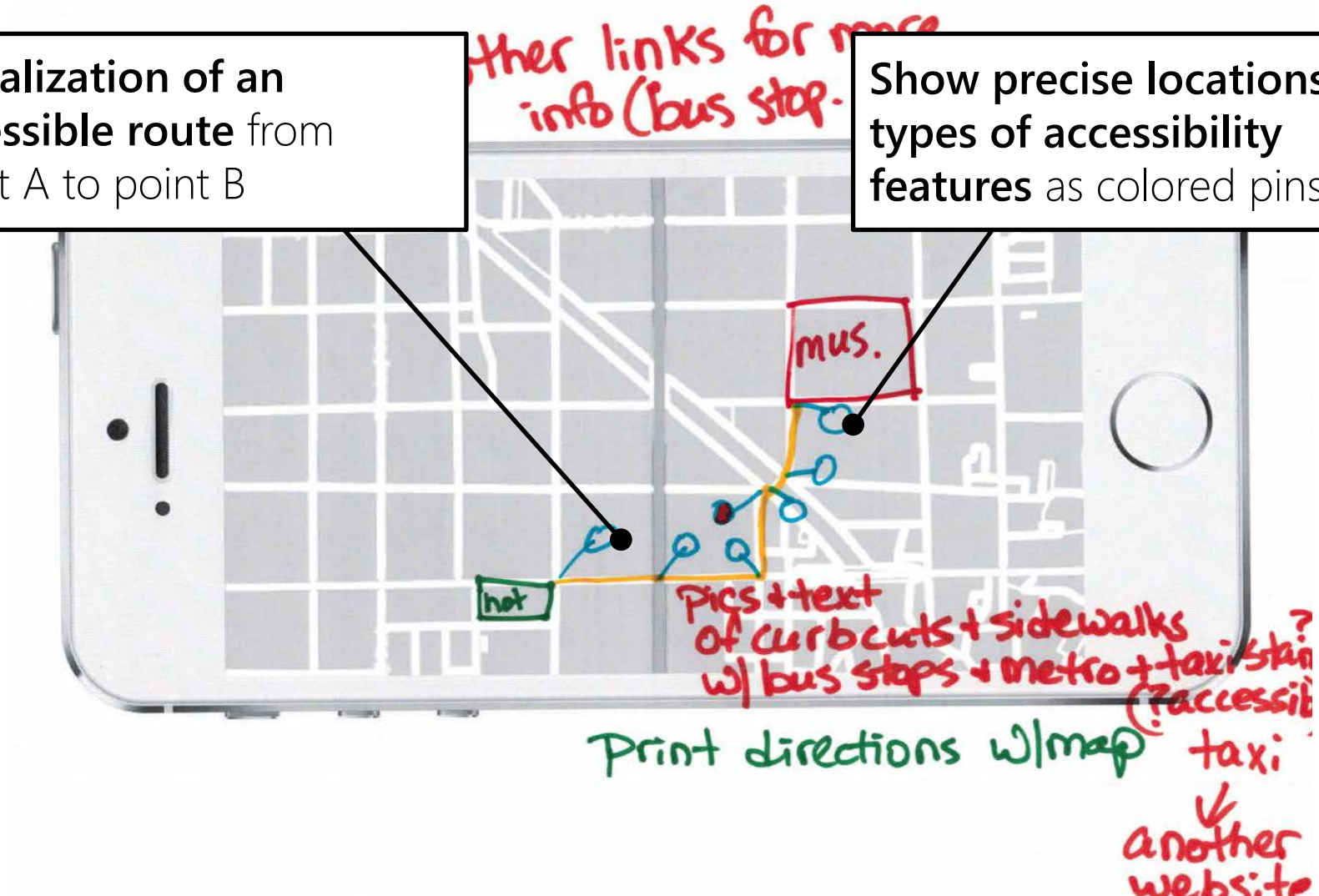
Imagine that there is a website that provides accessibility information about the city. What should that website look like?

Pictures of the building proximity and a video that walks you through the interior enable you to **visually inspect accessibility** of the place and assess whether it is **accessible for you**

P9, Muscular Dystrophy, Electric Wheelchair User

Visualization of an accessible route from point A to point B

Show precise locations and types of accessibility features as colored pins



Study Method: Three-Part Study

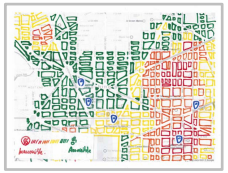
Scenario-based Design

Semi-structured Interview

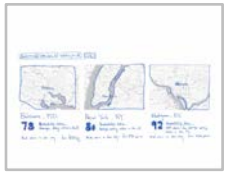
Design Probe


Are their expectations met?
Part 3: Design Probe
Participants critiqued researcher-prepared design mockups

Accessibility Score Visualizations
Map-based at-glance accessibility visualizations

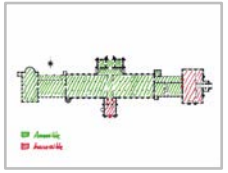
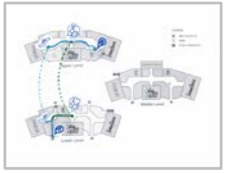
Accessibility Score Comparison
Compare accessibility levels between cities



Accessibility-aware Location Search
Location search augmented with accessibility data

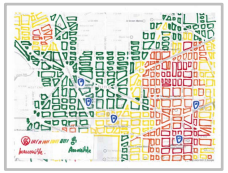
Accessible Bus Stop Finder
View proximal bus stops that are accessible

Indoor Accessibility Visualization
Indoor at-glance accessibility visualizations

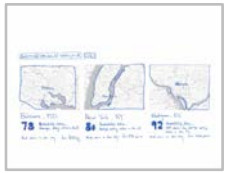




Outdoor Accessibility Navigation
Accessibility-aware pedestrian routing


Accessibility Score Visualizations
Map-based at-glance accessibility visualizations

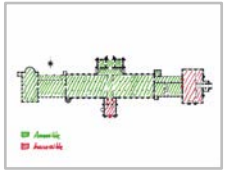
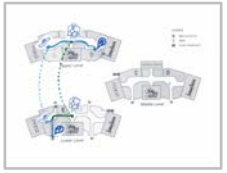
Accessibility Score Comparison
Compare accessibility levels between cities



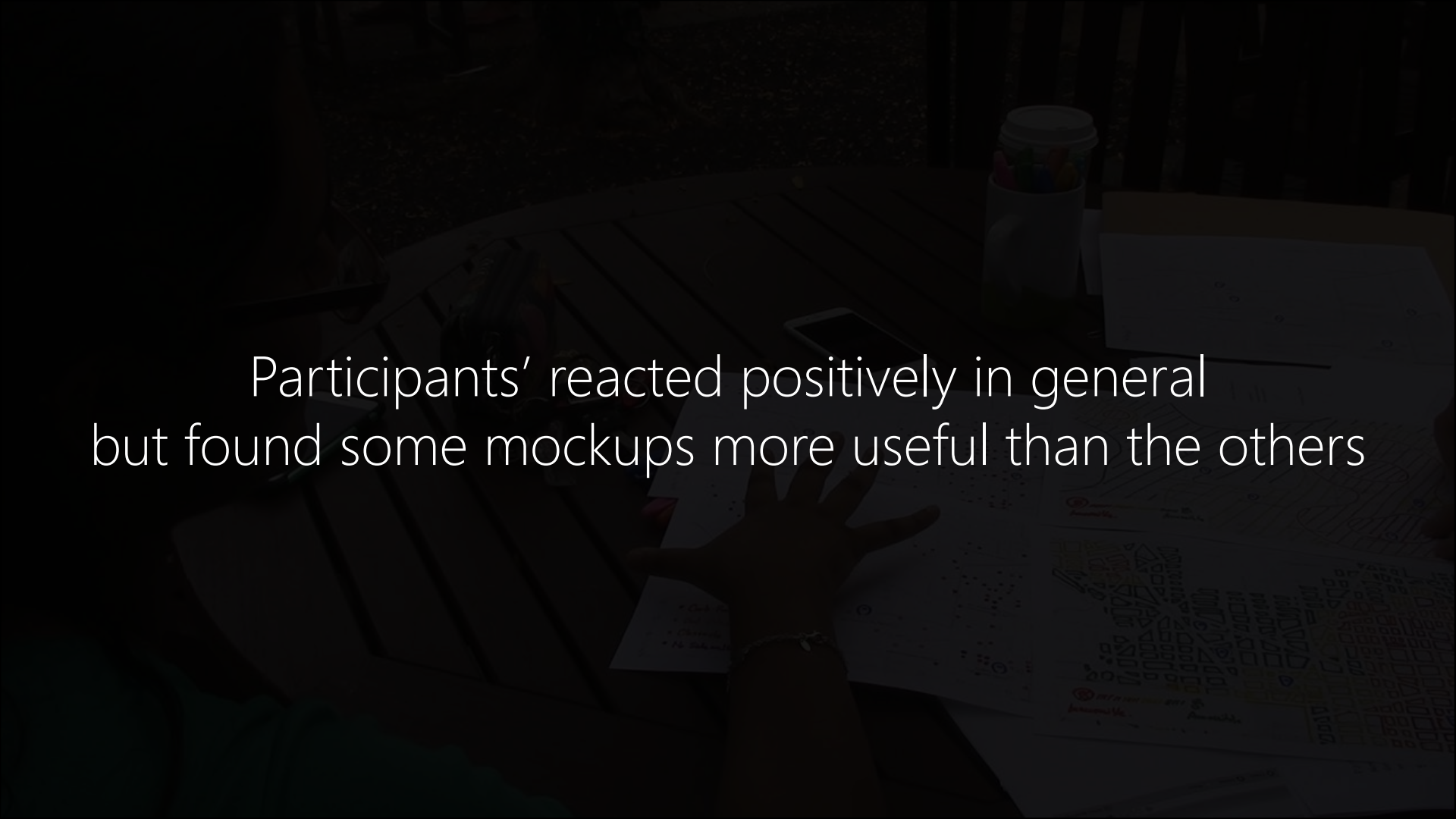
Accessibility-aware Location Search
Location search augmented with accessibility data

Accessible Bus Stop Finder
View proximal bus stops that are accessible

Indoor Accessibility Visualization
Indoor at-glance accessibility visualizations

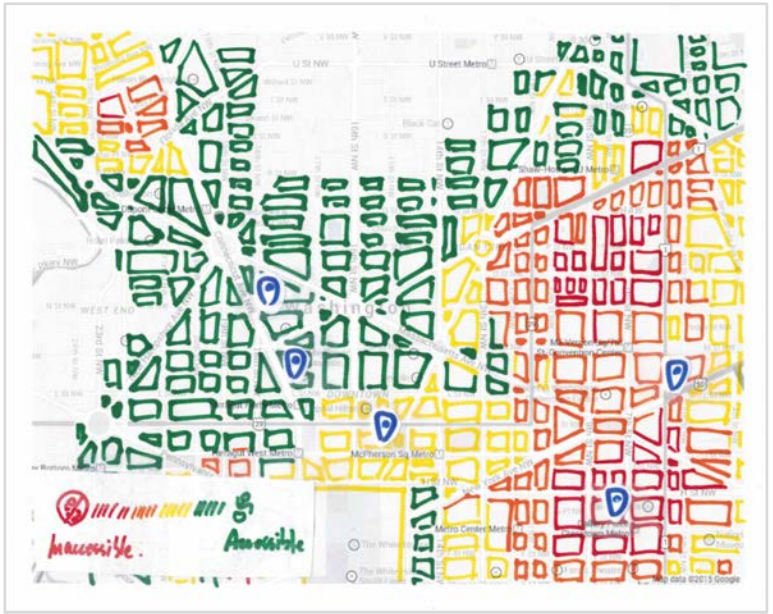
Outdoor Accessibility Navigation
Accessibility-aware pedestrian routing

Participants’ reacted positively in general
but found some mockups more useful than the others

Neighborhood-level Accessibility Visualization

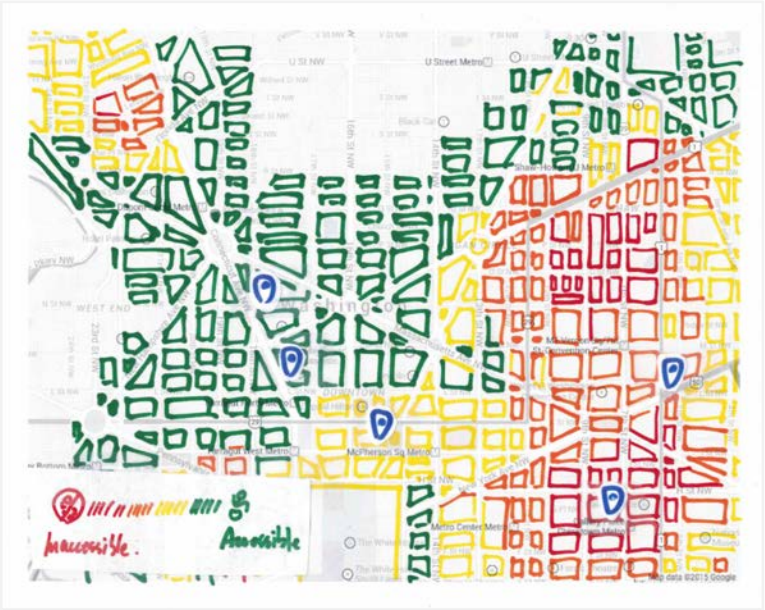
Sidewalk-level Accessibility Visualization



Two top-down map-based visualizations that show accessibility levels of city neighborhoods

Neighborhood-level Accessibility Visualization

Sidewalk-level Accessibility Visualization



The sidewalk-level visualization was preferred because it provided more **precise location information**

Summary

Ten Desired Features

- Street-level Visualization
- POI Accessibility Rating
- Detailed Description
- Floor Plan
- Visual Inspection
- Discussion and Review
- Search and Filter
- Routing
- Transportation
- Universal Design

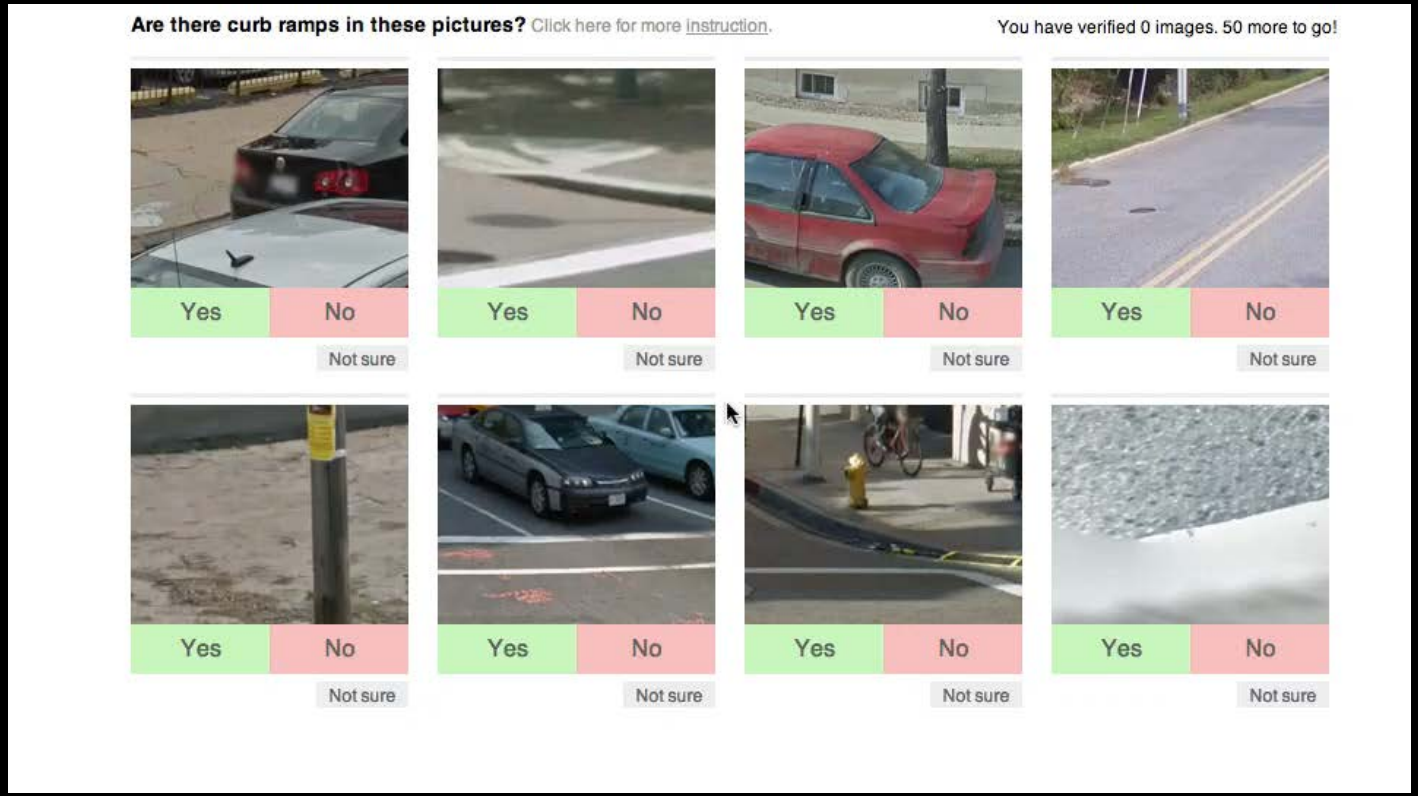
Six Data Qualities

- Granularity
- Relevance
- Credibility
- Recency of Information
- Coverage
- Location Precision

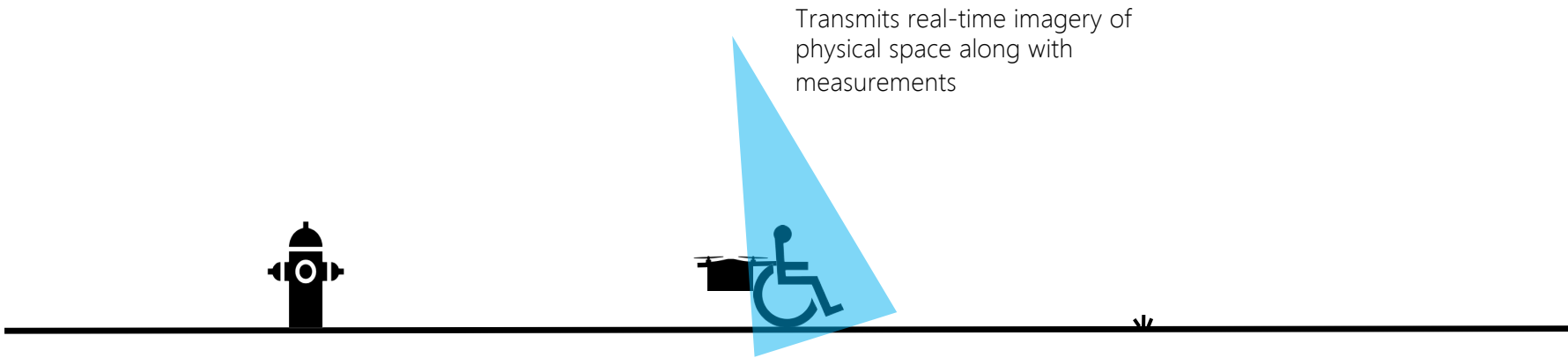
The result **guides the design of accessibility data collection methods and applications** enabled by the data

What next?

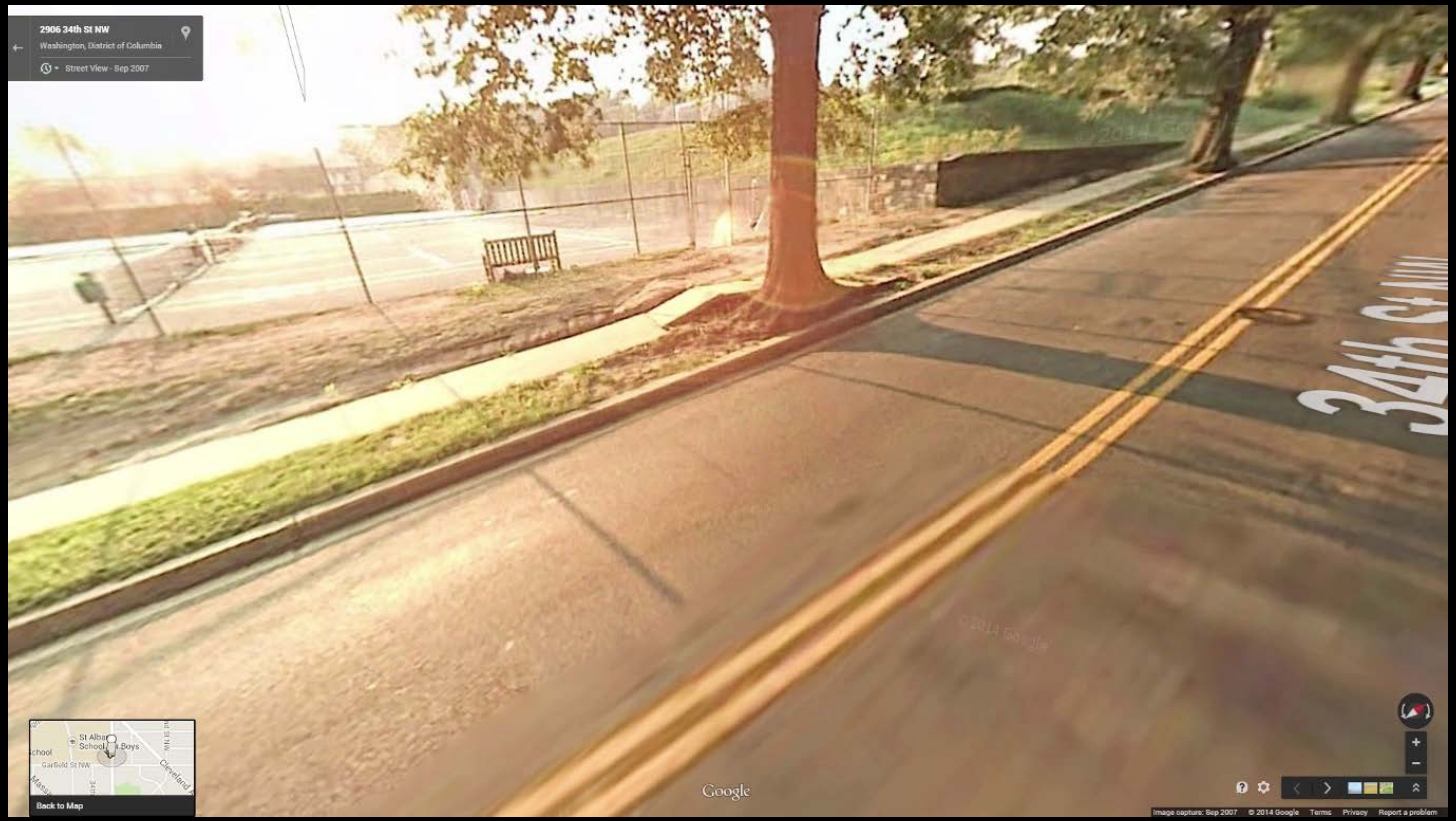
Future Work: Faster Labeling & Verification Interfaces



Future Work: Additional Surveying Techniques



In-Progress: Track Physical Accessibility Changes Over Time

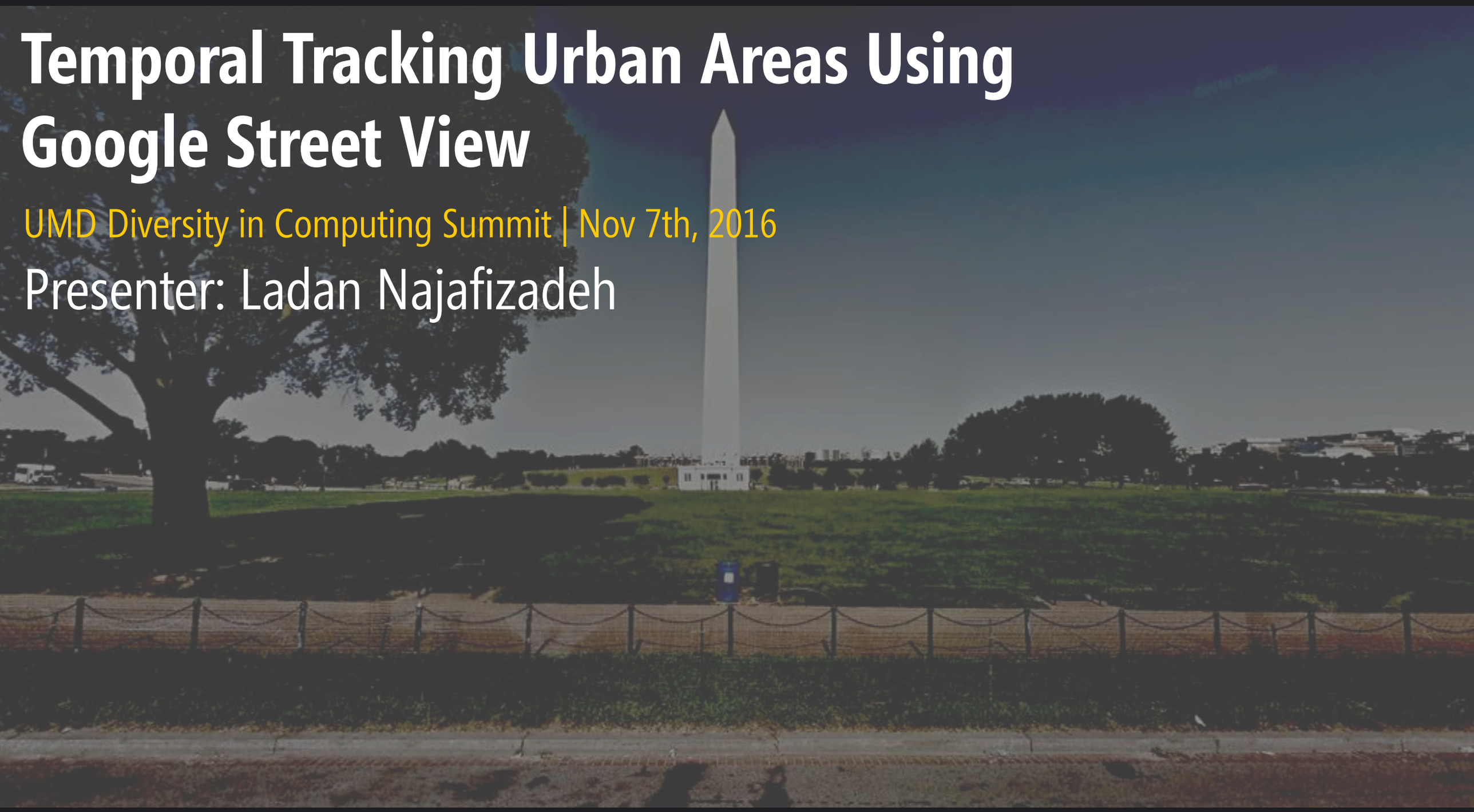


Street View

Temporal Tracking Urban Areas Using Google Street View

UMD Diversity in Computing Summit | Nov 7th, 2016

Presenter: Ladan Najafizadeh



Motivation

Related Work

Our Vision

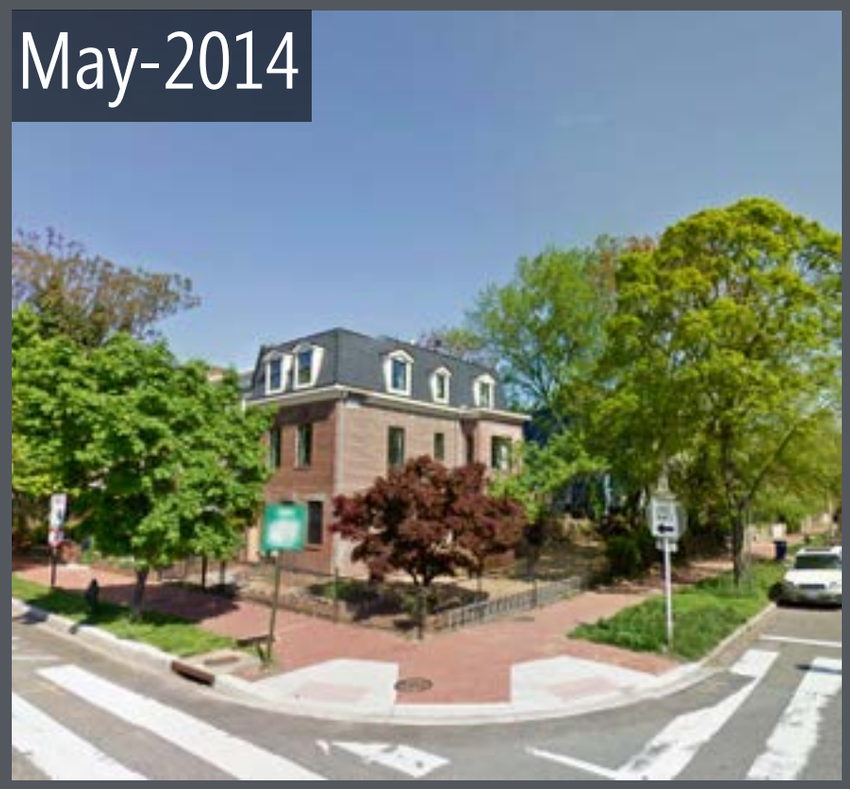
Method + Results

Street View

Aug-2011 ×

Motivation

What does “Temporal Tracking” mean?



Why is “Temporal Tracking” beneficial?

Understanding the dynamics of cities across time

Why is "Temporal Tracking" beneficial?

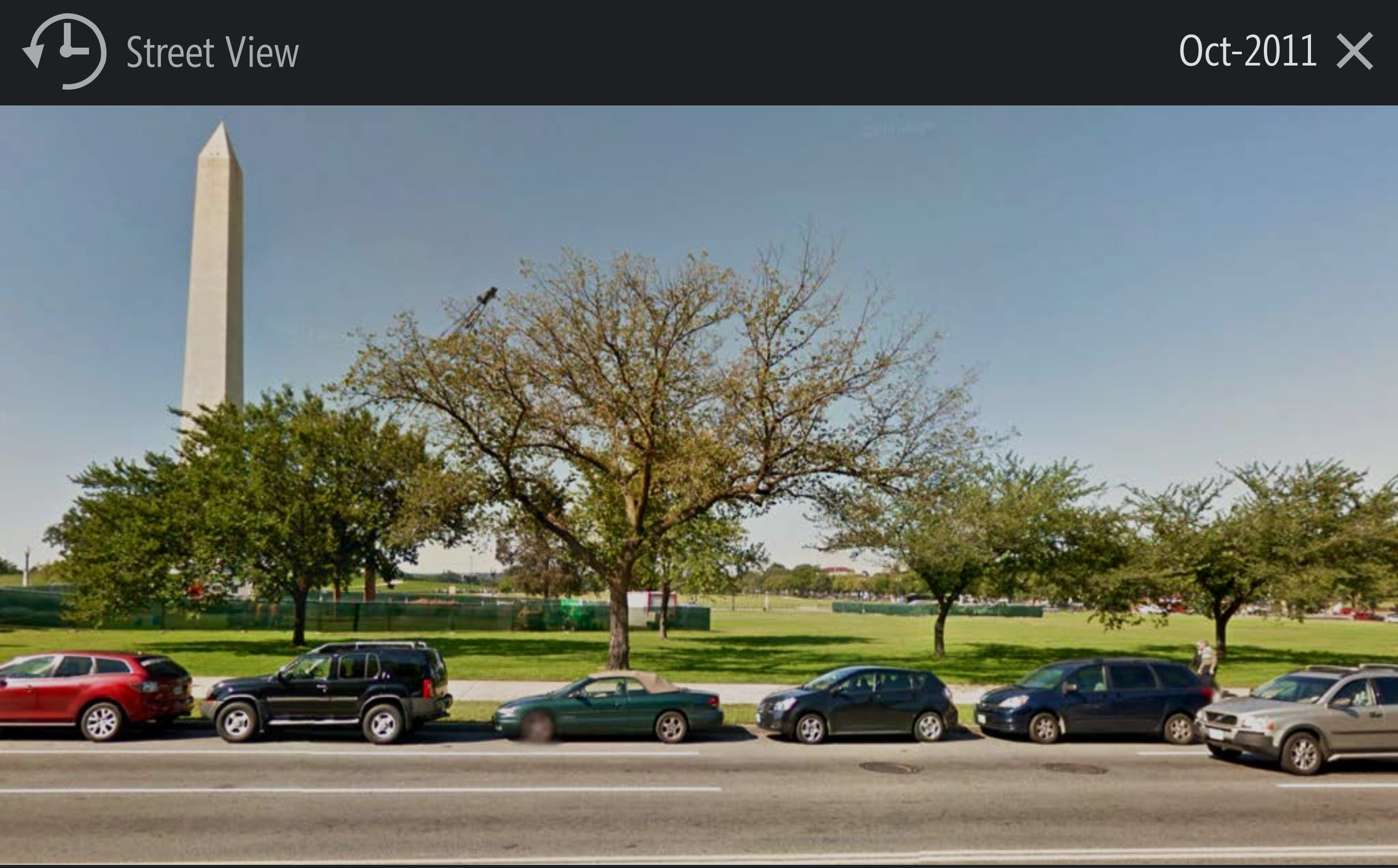
Understanding the dynamics of cities across time

- How often infrastructures need to be updated/changed
- Understand the dynamics of the city
  (e.g., how pedestrians interact with infrastructures)

Why is “Temporal Tracking” beneficial?

Accessibility improvements

Is there data available for temporal tracking urban areas?



Related Work

Timelapse mining from Internet photos

Ricardo Martin-Brualla, David Gallup & Steve M. Seitz

Proceedings of ACM SIGGRAPH 2015

We focus on Google Street View. Here's why:

- has high **spatial** coverage

We focus on Google Street View. Here's why:

- has high **spatial** coverage
- updates **frequently** over time

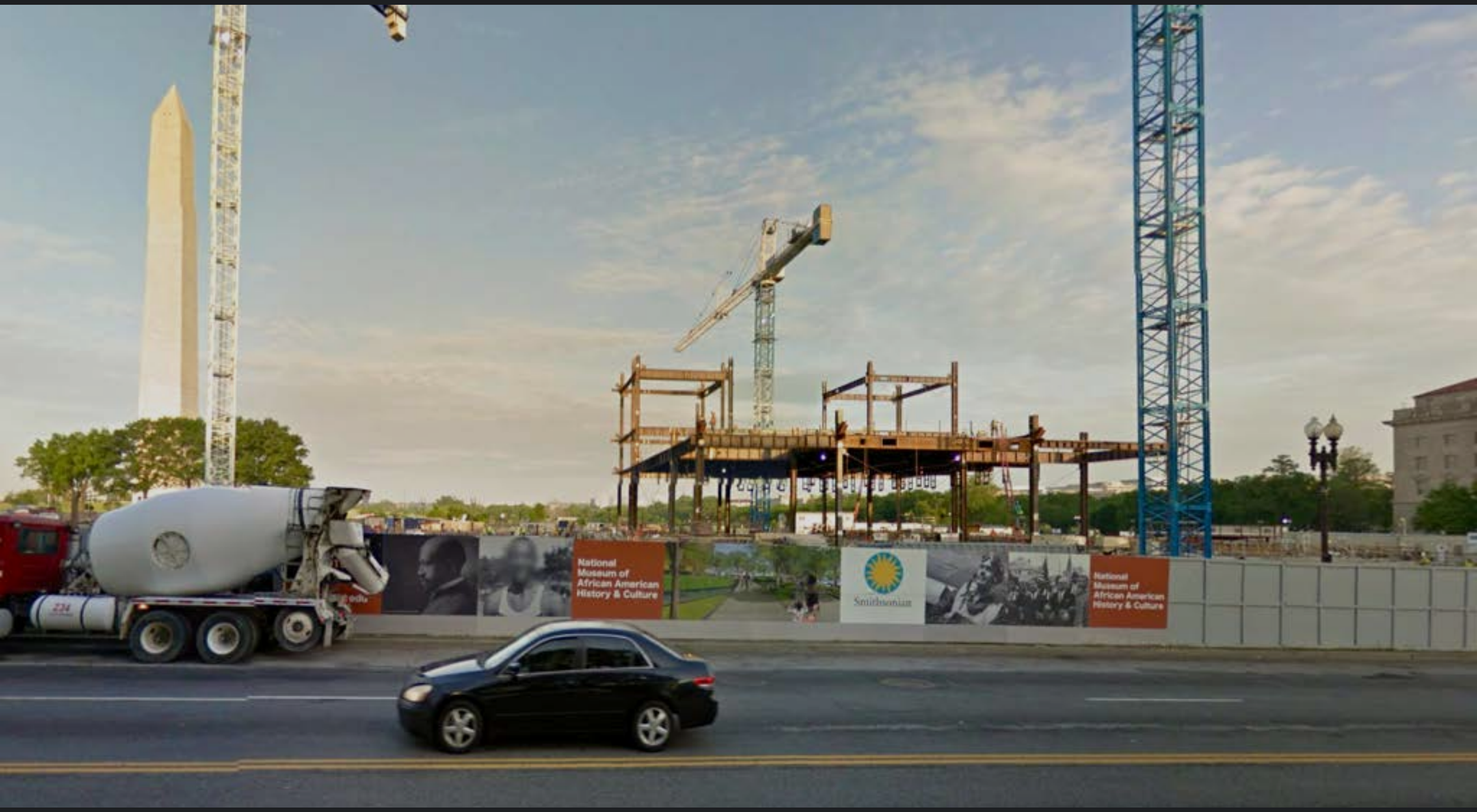
We focus on Google Street View. Here's why:

- has high **spatial** coverage
- updates **frequently** over time

- gives **enough** information about infrastructures
  (e.g., GPS coordinates, dynamics of cities)

Street View

May-2014 ×

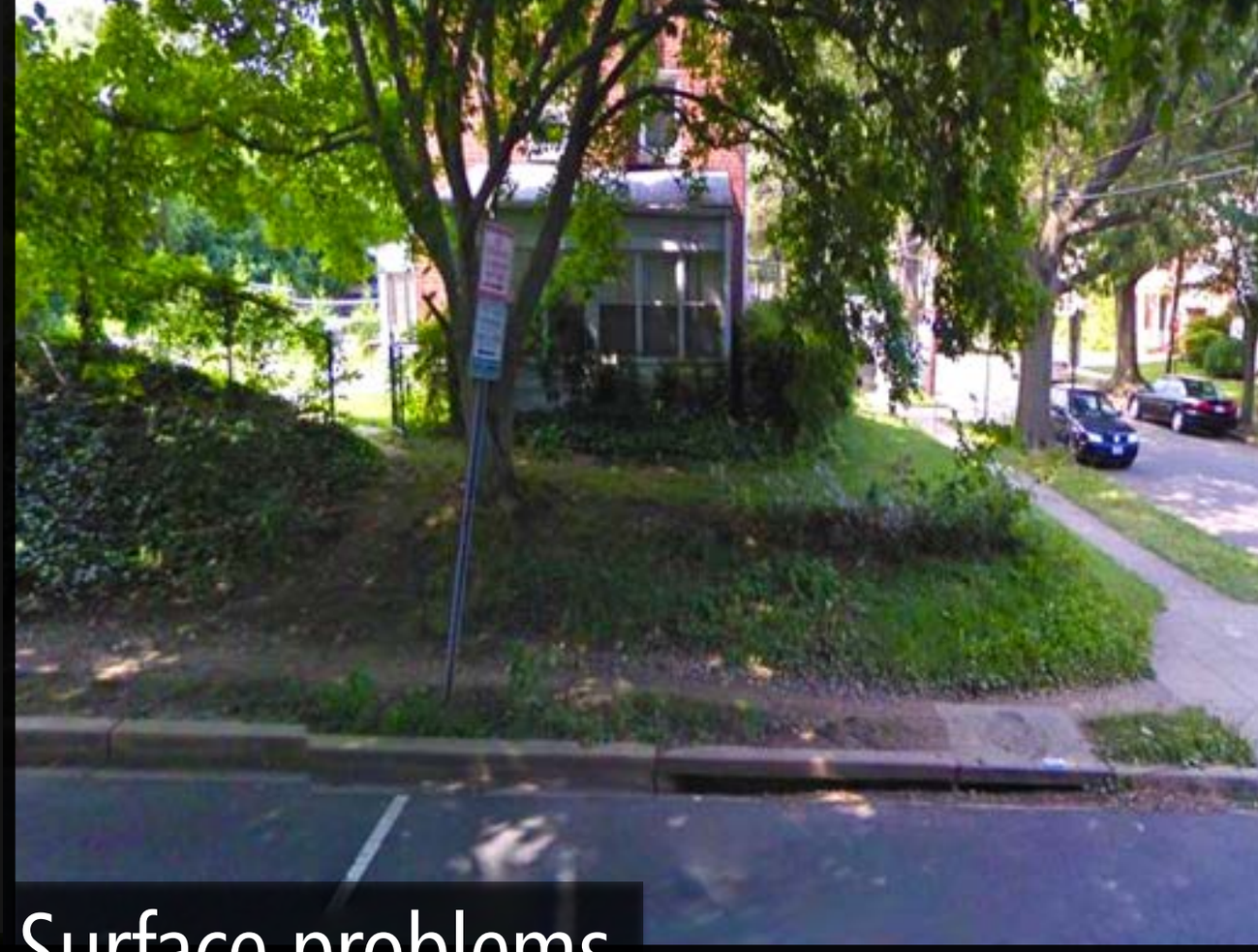


Our Vision

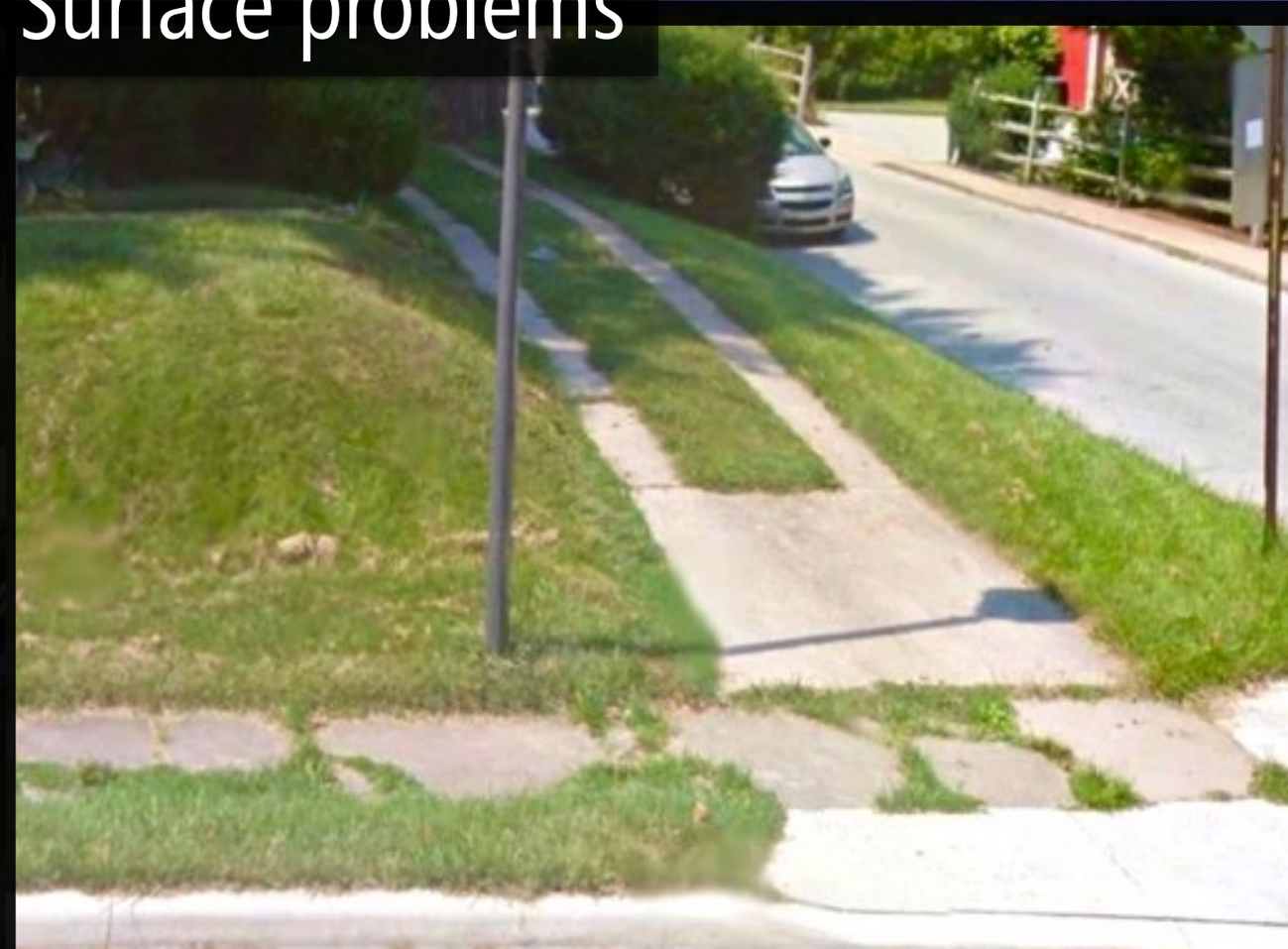
Types of accessibility problems in urban areas:

Object in path

Missing curb-ramps



Surface problems



Given multiple snapshots of a scene over time, our goal is:

1. Identifying the Accessibility Problems + Labeling them

Given multiple snapshots of a scene over time, our goal is:

1. Identifying the Accessibility Problems + Labeling them

2. Tracking the Accessibility Problems From Past-to-Present

Given multiple snapshots of a scene over time, our goal is:

1. Identifying the Accessibility Problems + Labeling them

2. Tracking the Accessibility Problems From Past-to-Present

3. Detecting the Changes of the Accessibility Problems

Street View

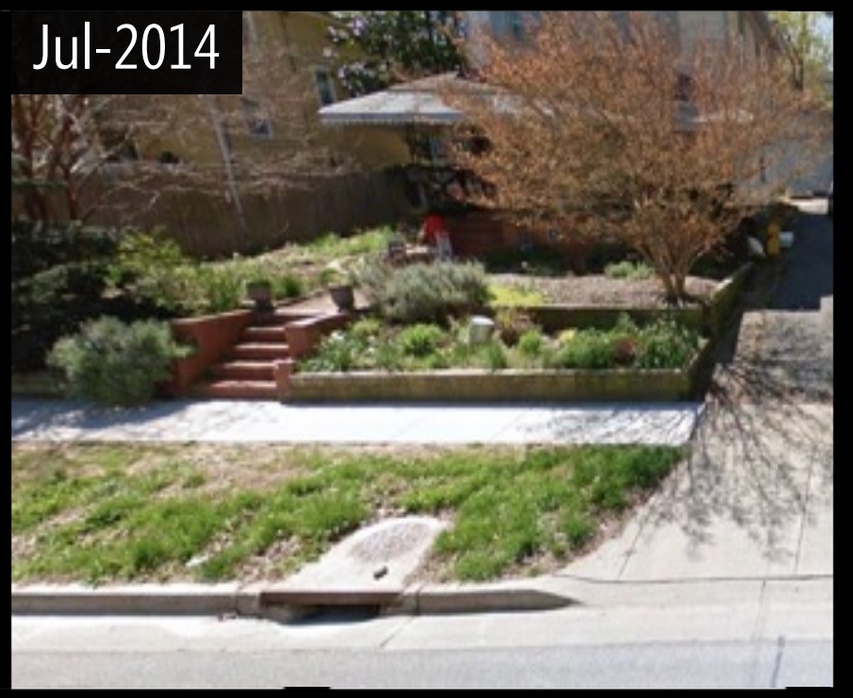
Jun-2014 ×

Method + Results

Example #1

Location:
520 Tulip Ave,
Washington,DC

Problem:
Surface Problem



Location:
520 Tulip Ave,
Washington,DC

Problem:
Surface Problem

Example #2

Location:
16th St NW,
Washington,DC

Problem:
Object in Path

Location:
16th St NW,
Washington,DC

Problem:
Object in Path

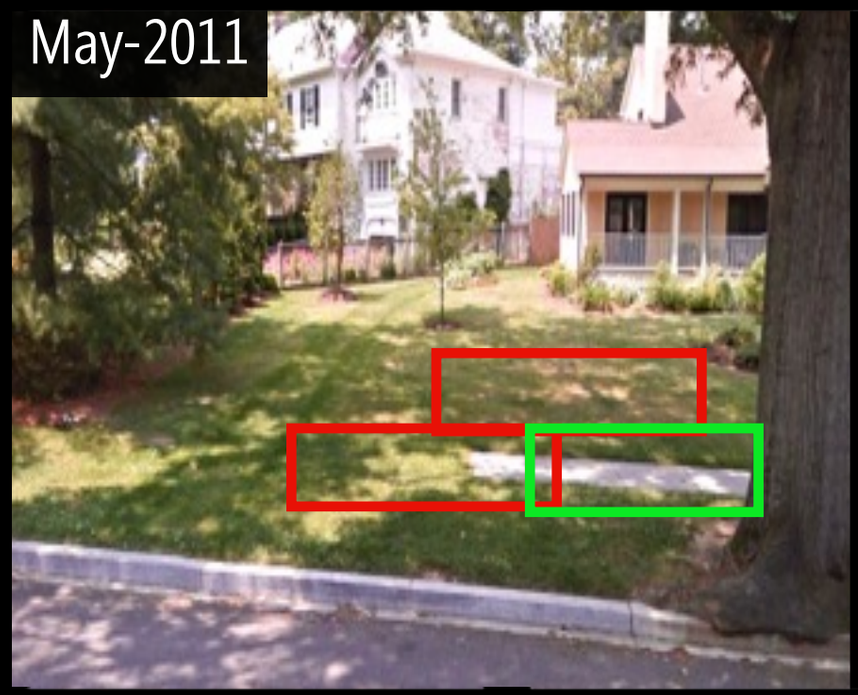
Example #3

Location:
6076 Western Ave, Washington,DC

Problem:
Surface Problem

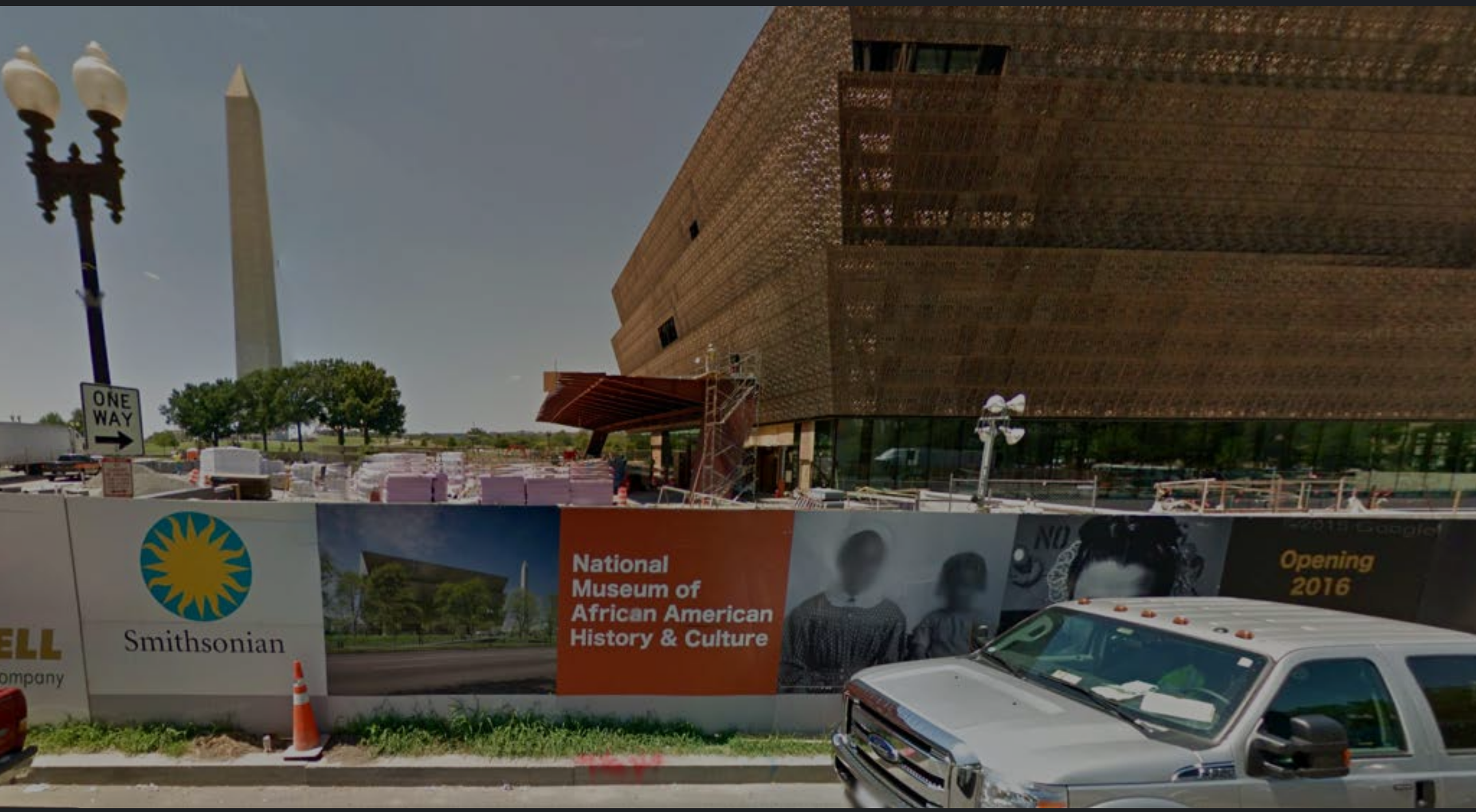
Location:
6076 Western Ave,
Washington,DC

Problem:
Surface Problem



Thank You!

Jul-2015



Toward Accessible Health and Fitness Tracking for People with Mobility Impairments

UMD Diversity in Computing Summit | November 7, 2016

Presenter: Meethu Malu

makeability lab

inclusive design lab

HCIL Human Computer Interaction Laboratory

COMPUTER SCIENCE UNIVERSITY OF MARYLAND

UNIVERSITY OF MARYLAND

How many of you here track

Steps taken

How many of you here track

Steps taken

Floors climbed

How many of you here track

Steps taken

Floors climbed

Hours you've walked/run

How many of you here track

Steps taken

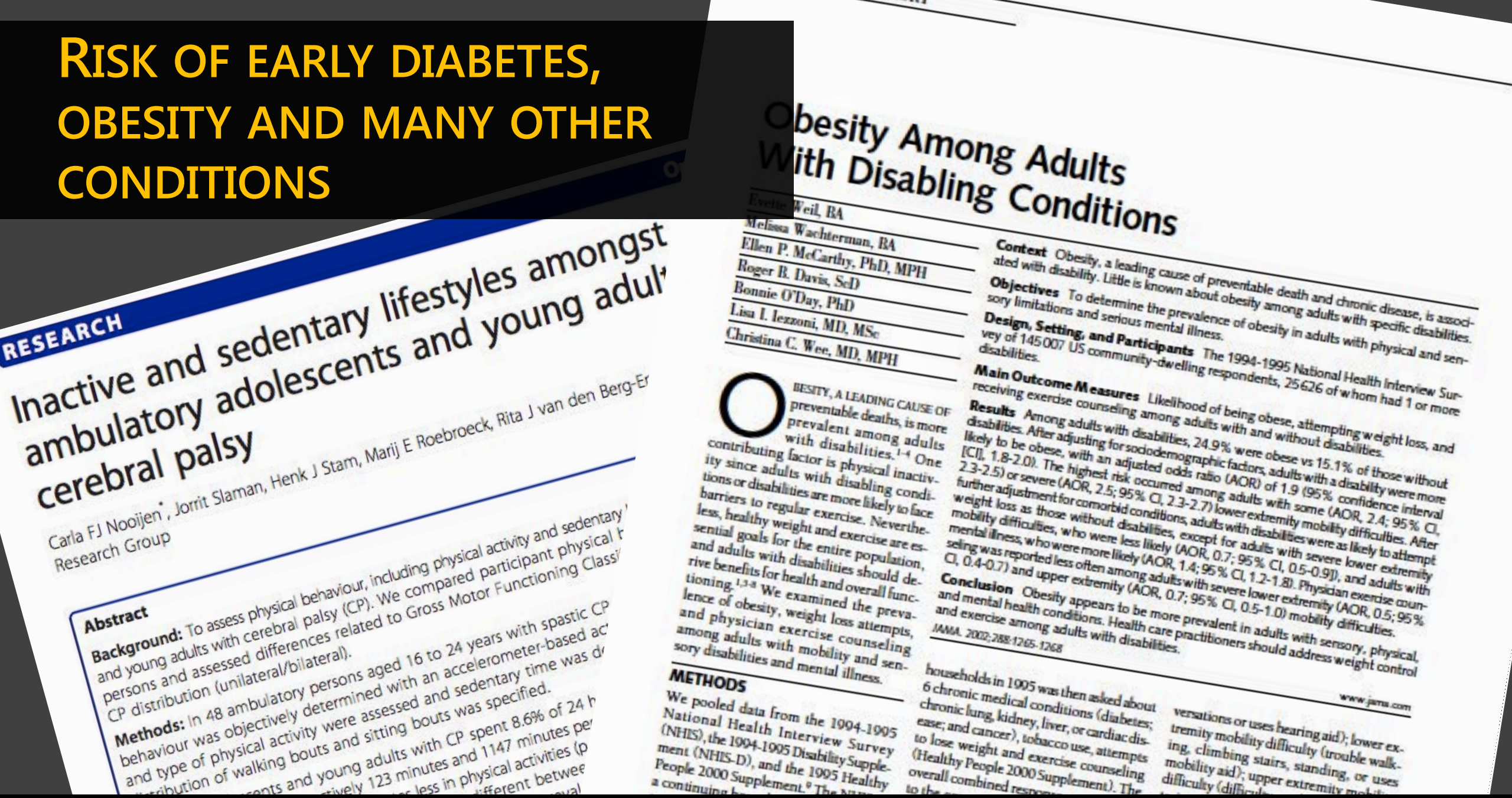
Floors climbed

Hours you've walked/run

Calories you've burnt

But there are 15 million people who find performing these activities difficult or impossible

RISK OF EARLY DIABETES, OBESITY AND MANY OTHER CONDITIONS



RESEARCH

Inactive and sedentary lifestyles amongst ambulatory adolescents and young adul

cerebral palsy

Carla FJ Nooijen*, Jorrit Slaman, Henk J Stam, Marij E Roebroeck, Rita J van den Berg-Er

Research Group

Abstract

Background: To assess physical behaviour, including physical activity and sedentary and young adults with cerebral palsy (CP). We compared participant physical persons and assessed differences related to Gross Motor Functioning Class CP distribution (unilateral/bilateral).

Methods: In 48 ambulatory persons aged 16 to 24 years with spastic CP behaviour was objectively determined with an accelerometer-based ac and type of physical activity were assessed and sedentary time was d tribution of walking bouts and sitting bouts was specified.

ents and young adults with CP spent 8.6% of 24 h ively 123 minutes and 1147 minutes pe less in physical activities (p ifferent betwee

Obesity Among Adults With Disabling Conditions

Evette Weil, BA
Melissa Wachterman, BA
Ellen P. McCarthy, PhD, MPH
Roger B. Davis, ScD
Bonnie O'Day, PhD
Lisa I. Iezzoni, MD, MSc
Christina C. Wee, MD, MPH

Context Obesity, a leading cause of preventable death and chronic disease, is associated with disability. Little is known about obesity among adults with specific disabilities.

Objectives To determine the prevalence of obesity in adults with physical and sensory limitations and serious mental illness.

Design, Setting, and Participants The 1994-1995 National Health Interview Survey of 145 007 US community-dwelling respondents, 25 626 of whom had 1 or more disabilities.

Main Outcome Measures Likelihood of being obese, attempting weight loss, and receiving exercise counseling among adults with and without disabilities.

Results Among adults with disabilities, 24.9% were obese vs 15.1% of those without disabilities. After adjusting for sociodemographic factors, adults with a disability were more likely to be obese, with an adjusted odds ratio (AOR) of 1.9 (95% confidence interval [CI], 1.8-2.0). The highest risk occurred among adults with some (AOR, 2.4; 95% CI, 2.3-2.5) or severe (AOR, 2.5; 95% CI, 2.3-2.7) lower extremity mobility difficulties. After further adjustment for comorbid conditions, adults with disabilities were as likely to attempt weight loss as those without disabilities, except for adults with severe lower extremity mobility difficulties, who were less likely (AOR, 0.7; 95% CI, 0.5-0.9)), and adults with mental illness, who were more likely (AOR, 1.4; 95% CI, 1.2-1.8). Physician exercise counseling was reported less often among adults with severe lower extremity (AOR, 0.5; 95% CI, 0.4-0.7) and upper extremity (AOR, 0.7; 95% CI, 0.5-1.0) mobility difficulties.

Conclusion Obesity appears to be more prevalent in adults with sensory, physical, and mental health conditions. Health care practitioners should address weight control and exercise among adults with disabilities.

JAMA. 2002;288:1265-1268

www.jama.com

OBESITY, A LEADING CAUSE OF preventable deaths, is more prevalent among adults with disabilities.[1-4] One contributing factor is physical inactivity since adults with disabling conditions or disabilities are more likely to face barriers to regular exercise. Nevertheless, healthy weight and exercise are essential goals for the entire population, and adults with disabilities should derive benefits for health and overall functioning.[1,3-8] We examined the prevalence of obesity, weight loss attempts, and physician exercise counseling among adults with mobility and sensory disabilities and mental illness.

METHODS

We pooled data from the 1994-1995 National Health Interview Survey (NHIS), the 1994-1995 Disability Supplement (NHIS-D), and the 1995 Healthy People 2000 Supplement.[9] The

households in 1995 was then asked about 6 chronic medical conditions (diabetes; chronic lung, kidney, liver, or cardiac disease; and cancer), tobacco use, attempts to lose weight and exercise counseling (Healthy People 2000 Supplement). The overall combined respo

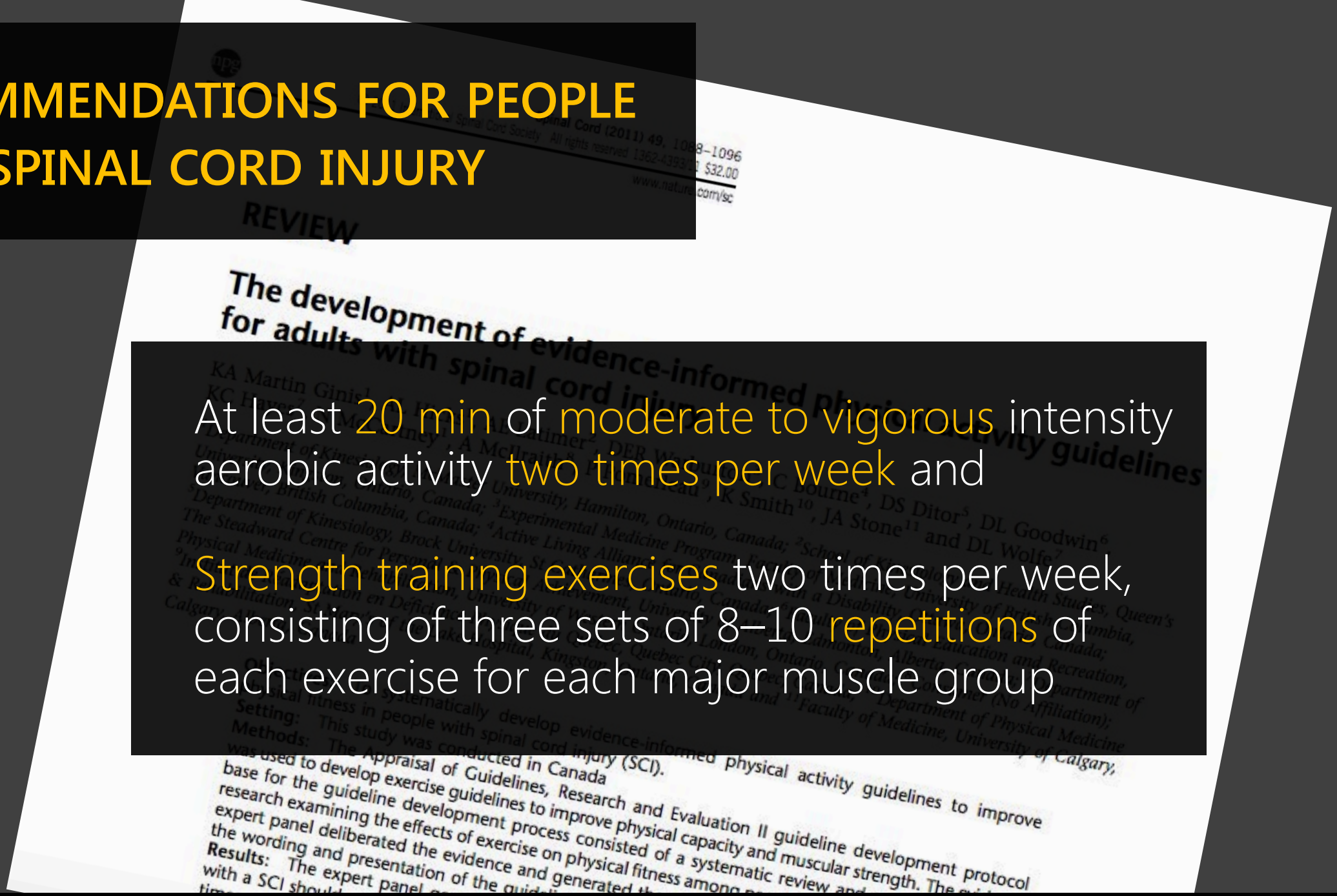
versations or uses hearing aid); lower extremity mobility difficulty (trouble walking, climbing stairs, standing, or uses mobility aid); upper extremity

Evette Weil. 2002. Obesity Among Adults With Disabling Conditions. *JAMA*, Carla FJ Nooijen et a.l 2014. Inactive and Sedentary Lifestyles Amongst Ambulatory Adolescents and Young Adults with Cerebral Palsy. Journal of NeuroEngineering and Rehabilitation.

Recommendations for people with spinal cord injury

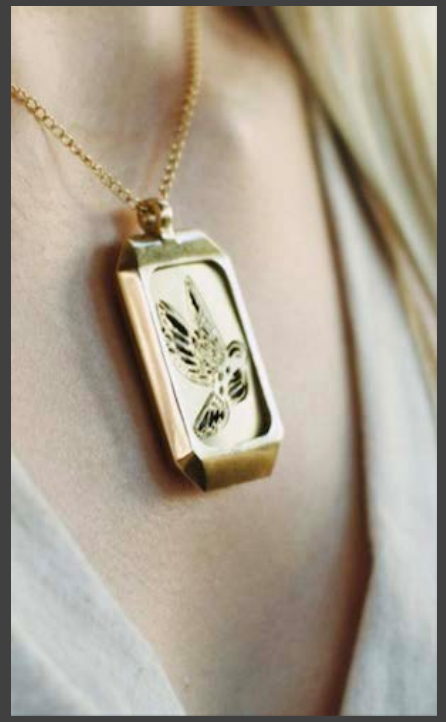
At least 20 min of moderate to vigorous intensity aerobic activity two times per week and

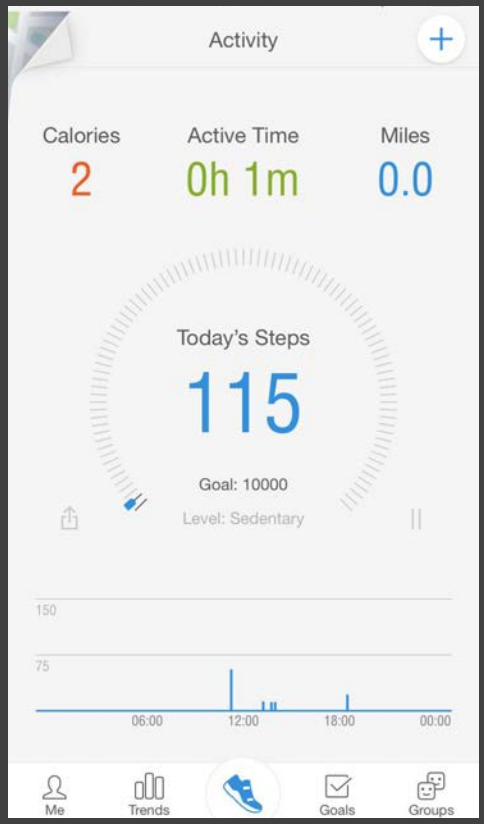
Strength training exercises two times per week, consisting of three sets of 8–10 repetitions of each exercise for each major muscle group

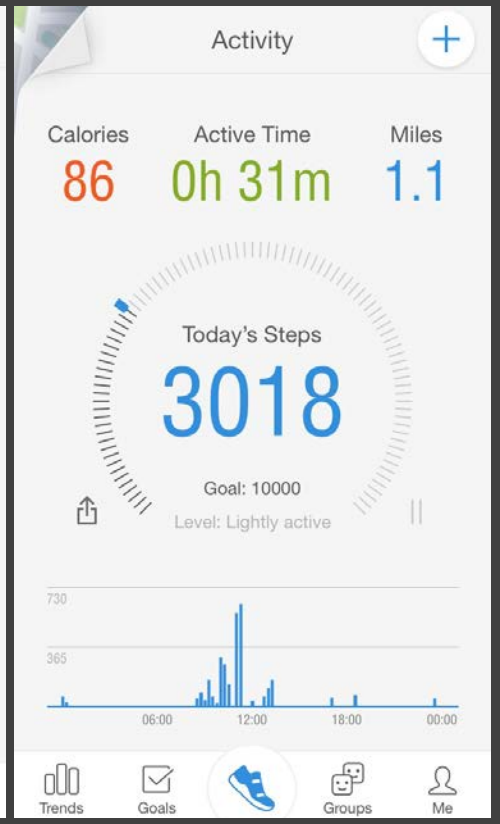


KA Martin Ginis et al. 2011. The development of evidence-informed physical activity guidelines for adults with spinal cord injury. SCI

Benefits of Activity Trackers

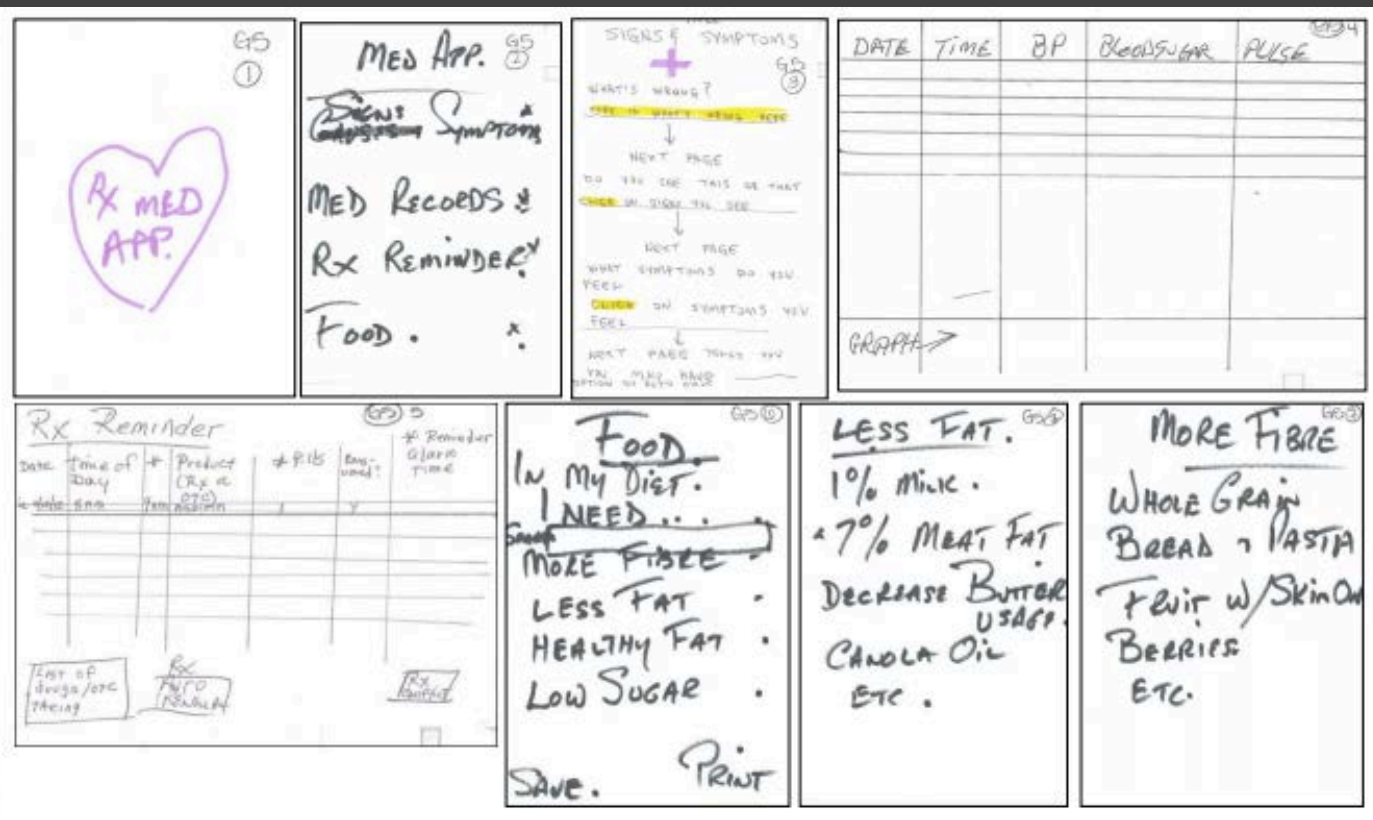






Images of activity tracking technologies used in studies the web.

Exergaming (exercise + games) Rehabilitation Technology

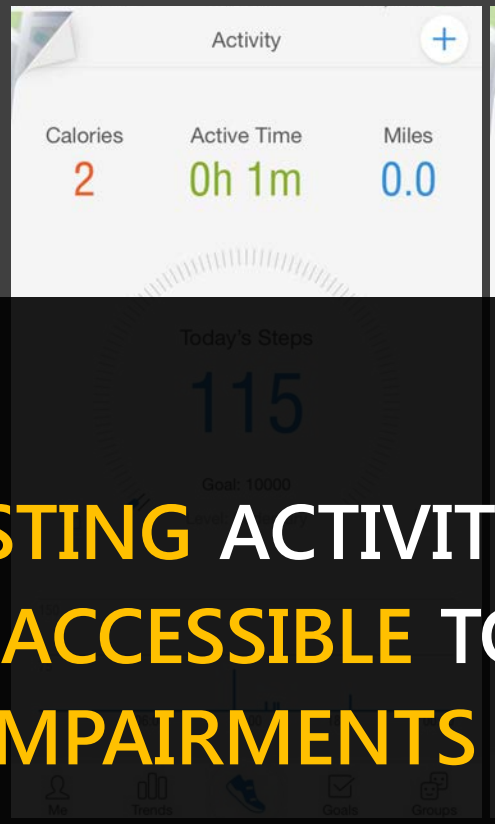


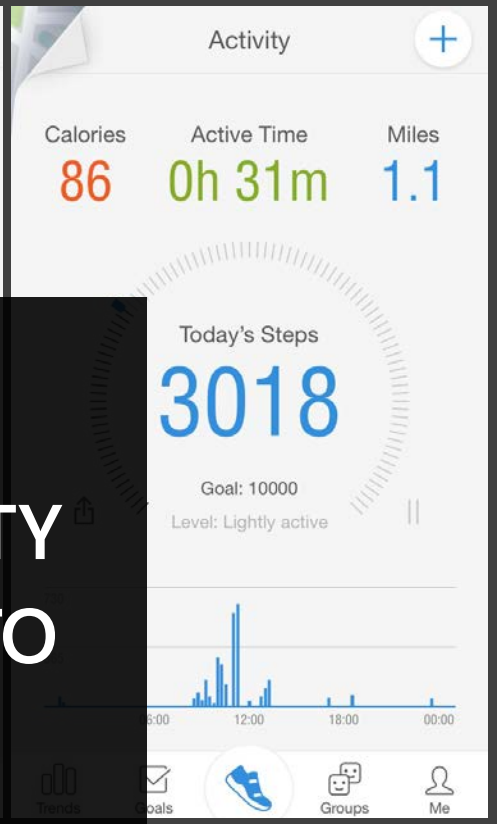
Kathrin M. Gerling et al. 2013. **KINECT^{wheels}: wheelchair-accessible motion-based game interaction. CHI EA'13.** Jennifer L. Davidson et al. **What health topics older adults want to track: a participatory design study**. ASSETS '13.

Perceptions of Existing Wearables

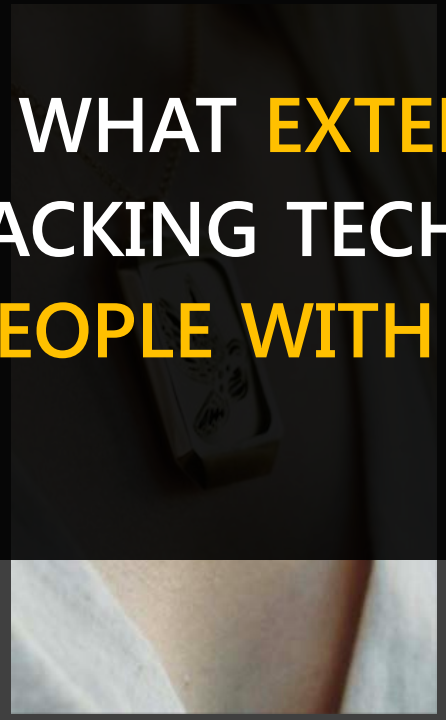
Patrick Carrington et al. 2015. “But, I don’t take steps”: Examining the Inaccessibility of Fitness Trackers for Wheelchair Athletes. ASSETS ‘15.

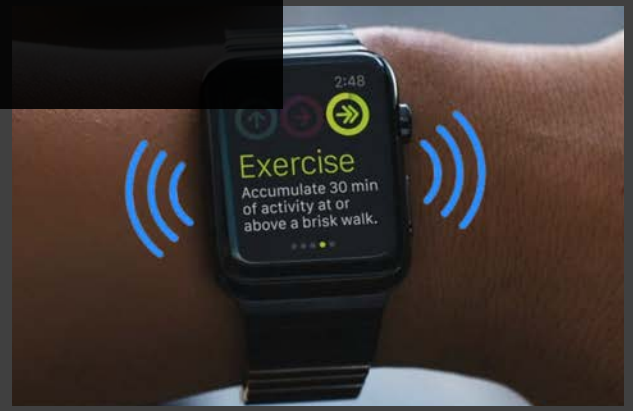
HENCE ...





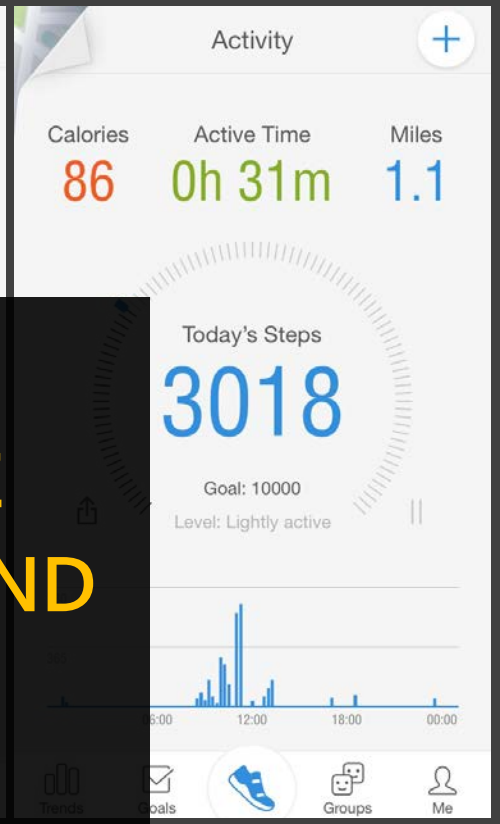
TO WHAT EXTENT ARE EXISTING ACTIVITY TRACKING TECHNOLOGIES ACCESSIBLE TO PEOPLE WITH MOBILITY IMPAIRMENTS

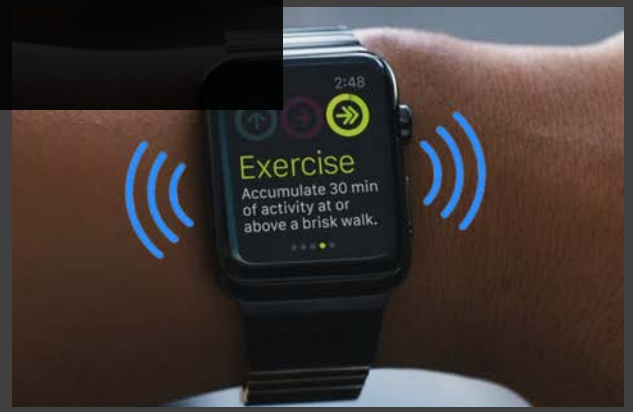




Meethu Malu et al. 2016. Toward an Accessible Health and Fitness Tracking for People with Mobility Impairments. Pervasive Health.

AND HOW CAN WE BUILD ACCESSIBLE TECHNOLOGY TO HELP TRACK HEALTH AND FITNESS RELATED ACTIVITIES OF THIS GROUP?





Meethu Malu et al. 2016. Toward an Accessible Health and Fitness Tracking for People with Mobility Impairments. Pervasive Health.

In depth approach
In Lab and on the Field

Semi-structured interview
Assessment of two wearables
Participatory design

A week long field study

In depth approach
In Lab and on the Field

Semi-structured interview
Assessment of two wearables
Participatory design

6 power
4 manual

1 cane

1 walker

2 participants were using no assistive aid that day

In depth approach
In Lab and on the Field

Semi-structured interview
Assessment of two wearables
Participatory design

6 power
4 manual

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In depth approach
In Lab and on the Field

Semi-structured interview
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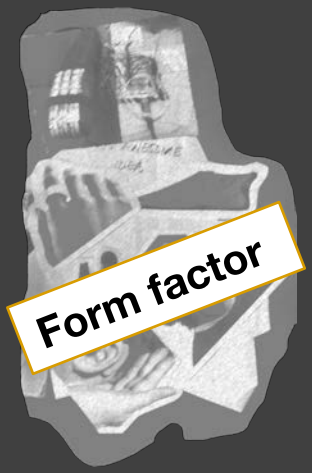
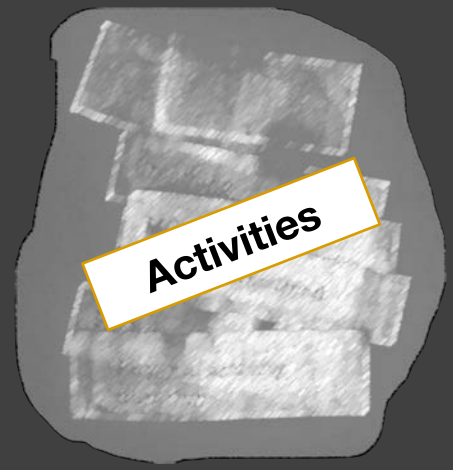
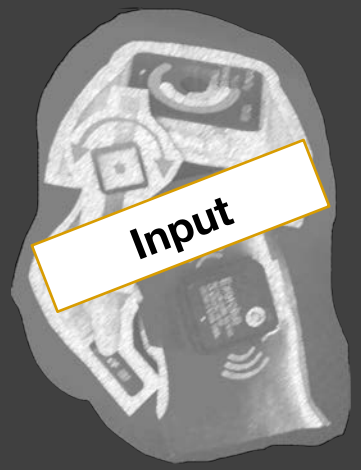






In depth approach
In Lab and on the Field

A week long field study

3 power
3 manual

1 cane

1 participant was using no assistive aid that day

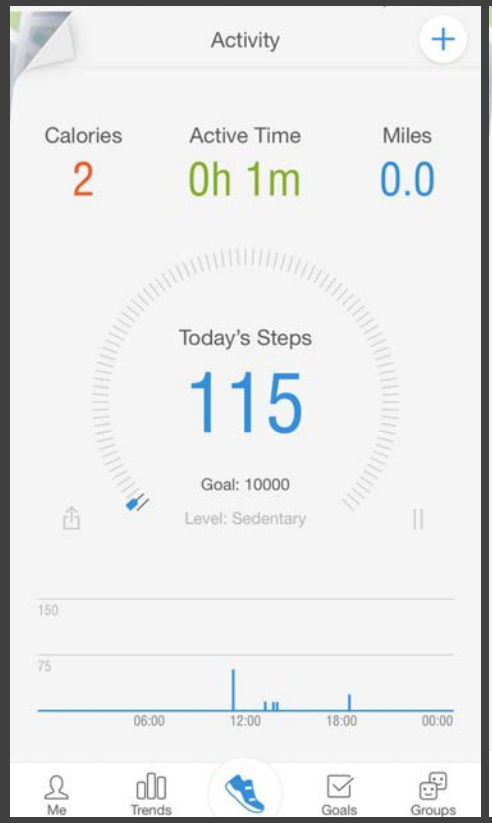
In depth approach
In Lab and on the Field

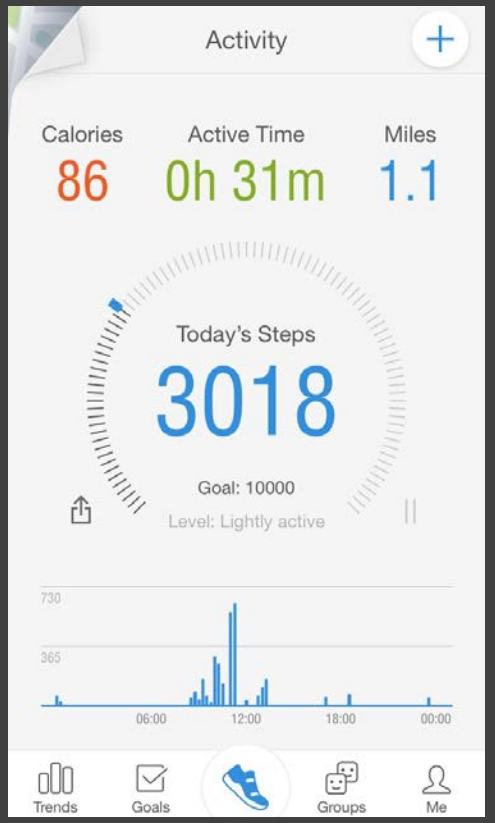
A week long field study

3 power
3 manual

1 cane

1 participant was using no assistive aid that day





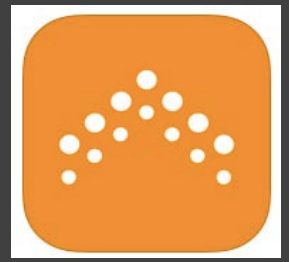
Findings
Existing technology use

1. Participants interest in tracking their health and fitness related activities was evident from current use


Fooducate


LooseIt


Runkeeper

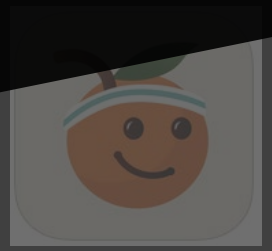

Pact

MeetMobile: Swim

Findings
Existing technology use

1. Participants interpreted tracking their health and fitness related activities was evident from current use

! Inaccuracy, Manual Input, Tracking irrelevant targets, Form Factor


Fooducate


LooseIt


Runkeeper


Pact

MeetMobile: Swim

Findings
Varying mobility impairments

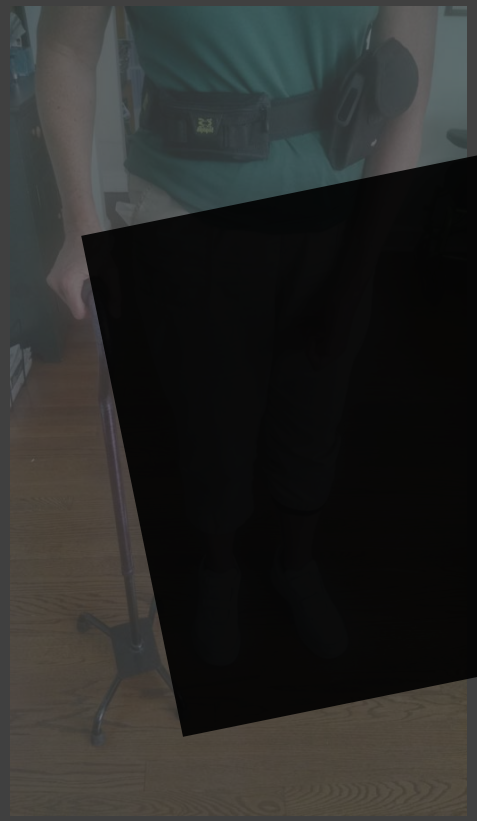
P5: "*my normal walking pace is so slow that they don't consider me moving*"

Findings
Varying mobility impairments

P5: "*my normal walking pace is so slow that they don't consider me moving*"

P14: "*because I walk with more movement than other people it believes I'm exercising when I'm only walking*"

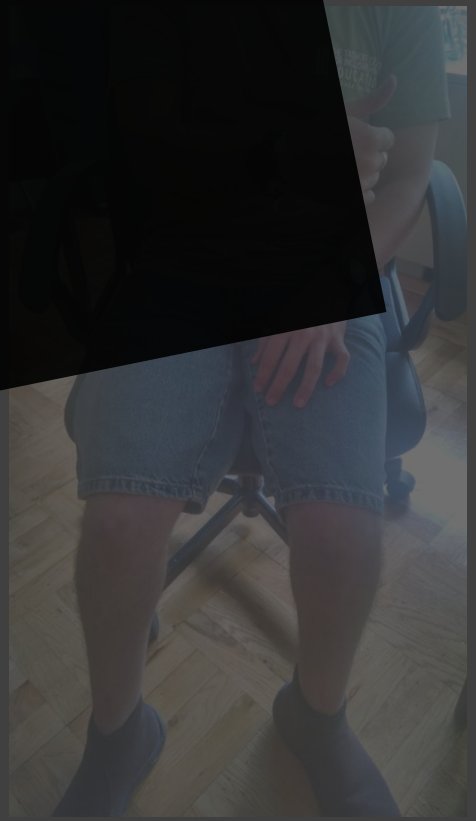
Findings
Varying mobility impairments



P5: "*my normal walking pace is so slow that they don't consider me*

! Need for personalization

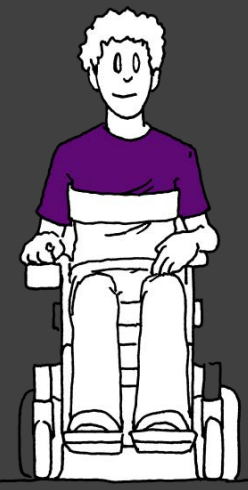
P14: "*because I walk with more movement than other people it believes I'm exercising when I'm only walking*"



Future Work

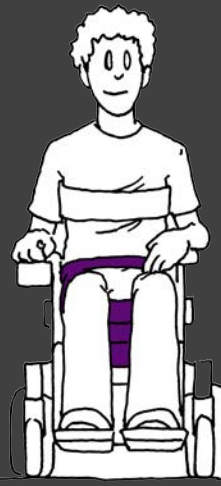
1. Accessible Form Factor

On Clothing



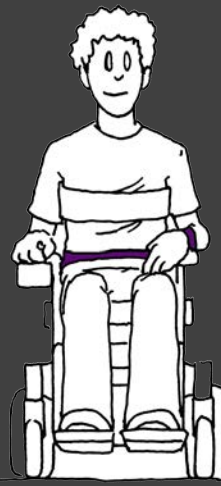
Collar or sleeve
(7 participants)

On Wheelchair



Seatbelt, pouch cushion
(4 participants)

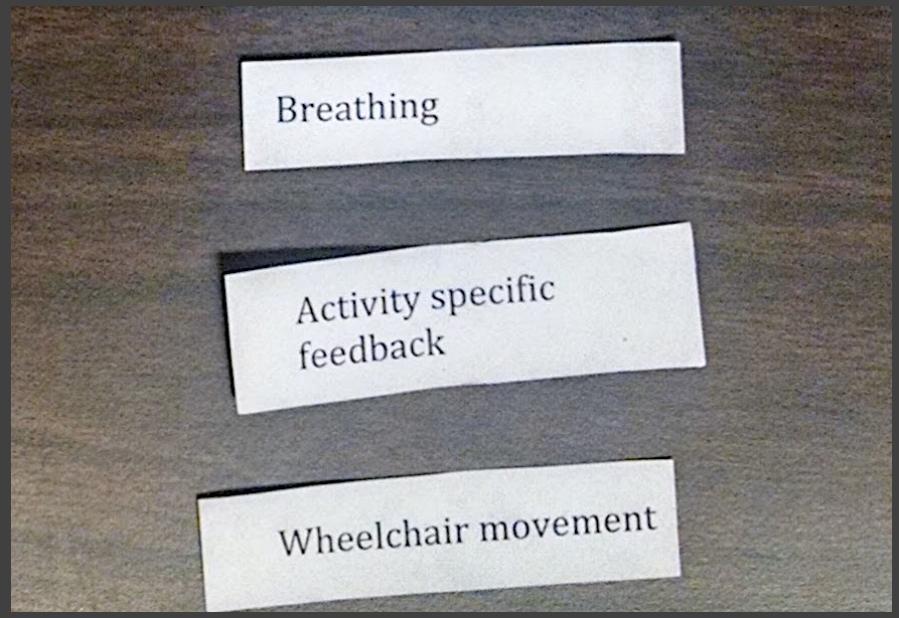
On Body



Waist strap, wrist
(3 participants)

Future Work

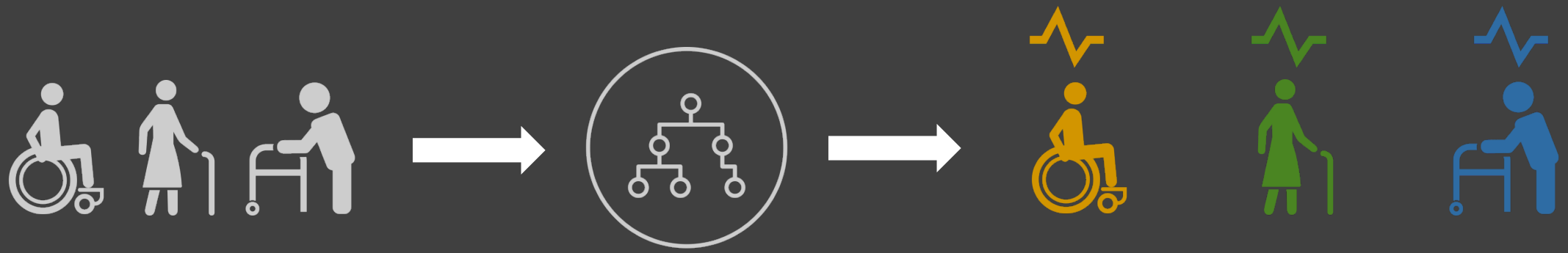
2. Relevant Tracking



1. Accessible Form Factor

Future Work

3. Personalized Tracking



1. Accessible Form Factor
2. Relevant Tracking

Future Work

4. Inclusive Sharing

P5 says, "If I was in a stroke support group that might be the kinda place I would... Other people I would share it with. Well, I think sharing with other people in the same situation is, well, probably can't say always but almost always beneficial 'cause you all have the same struggles."

1. Accessible Form Factor
2. Relevant Tracking
3. Personalized Algorithms

Toward Accessible Health and Fitness Tracking for People with Mobility Impairments

UMD Diversity in Computing Summit | November 7, 2016

Presenter: Meethu Malu

makeability lab

inclusive design lab

HCIL Human Computer Interaction Laboratory

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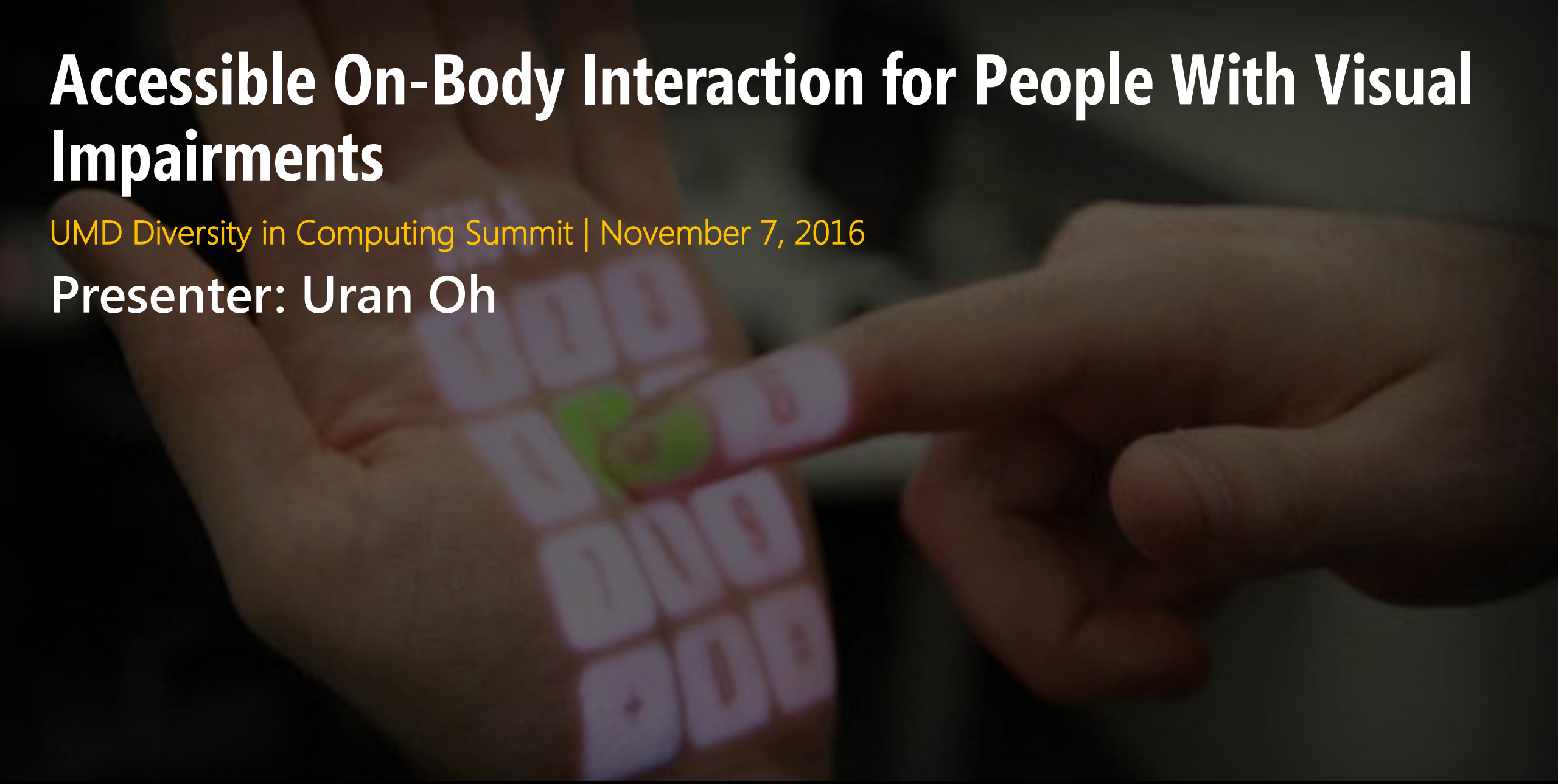
UNIVERSITY OF MARYLAND

Accessible On-Body Interaction for People With Visual Impairments

UMD Diversity in Computing Summit | November 7, 2016

Presenter: Uran Oh



inclusive design lab

HCIL Human Computer Interaction Laboratory

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There are **285 million** people with visual impairments worldwide–including **39 million** who are blind.

Accessibility Issues Exist for Visual Tasks

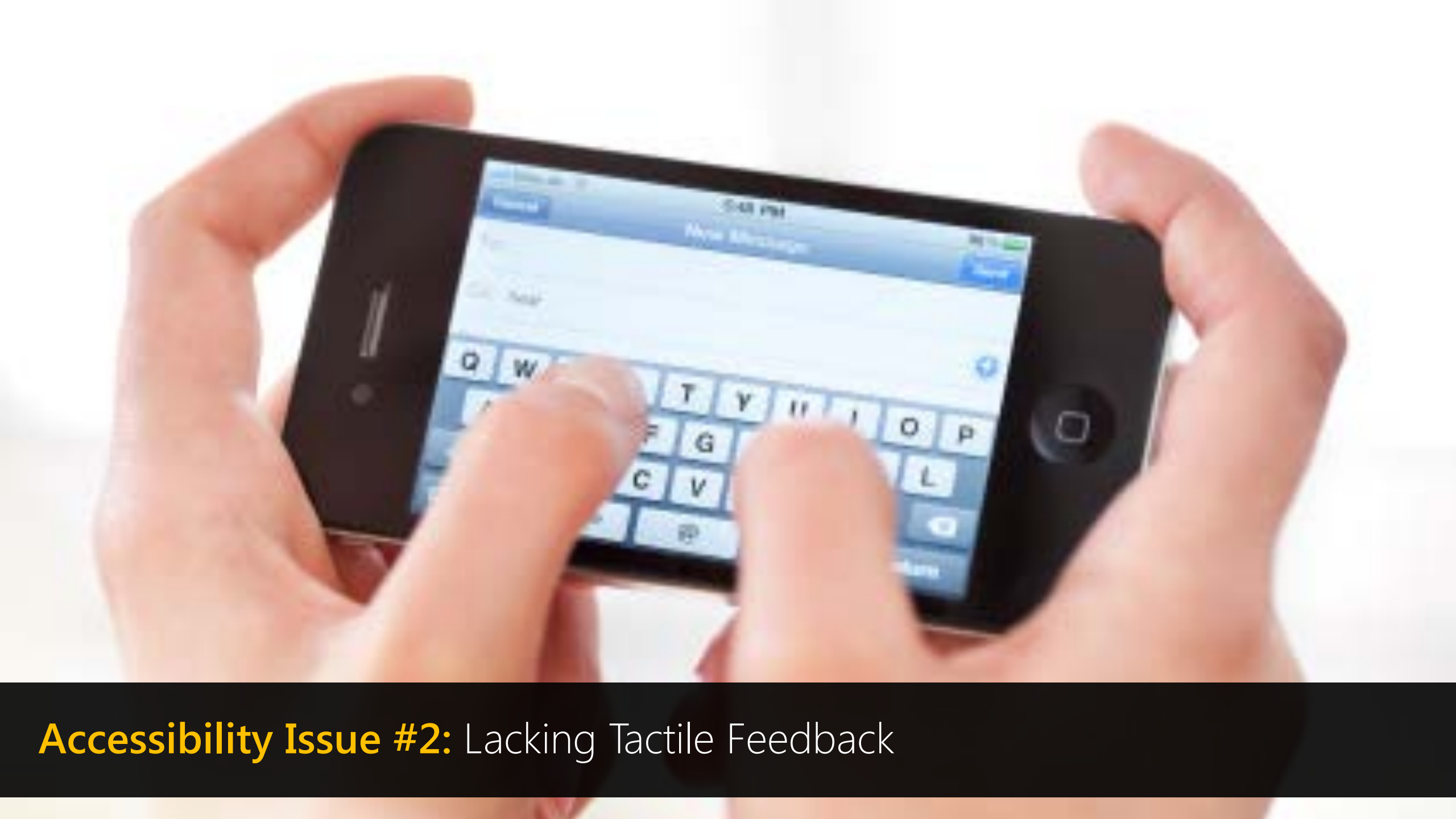
According to a report (August, 2014) from World Health Organization (WHO)

Increased Independence and Safety With Mobile Devices

Smartphone Accessibility

Accessibility Issue #1: High Visual Dependency

An Example of App Navigation On an iOS Device



Accessibility Issue #2: Lacking Tactile Feedback

Accessibility Issue #2: Lacking Tactile Feedback

Accessibility Issue #3: Not As Accessible in Mobile Context


What if they can use **their own body** instead of **a mobile phone with a touchscreen**?
Chris Harrison

Potential Benefits of On-Body Interaction

Extra Tactile Feedback

Potential Benefits of On-Body Interaction

Extra Proprioceptive Feedback

Potential Benefits of On-Body Interaction

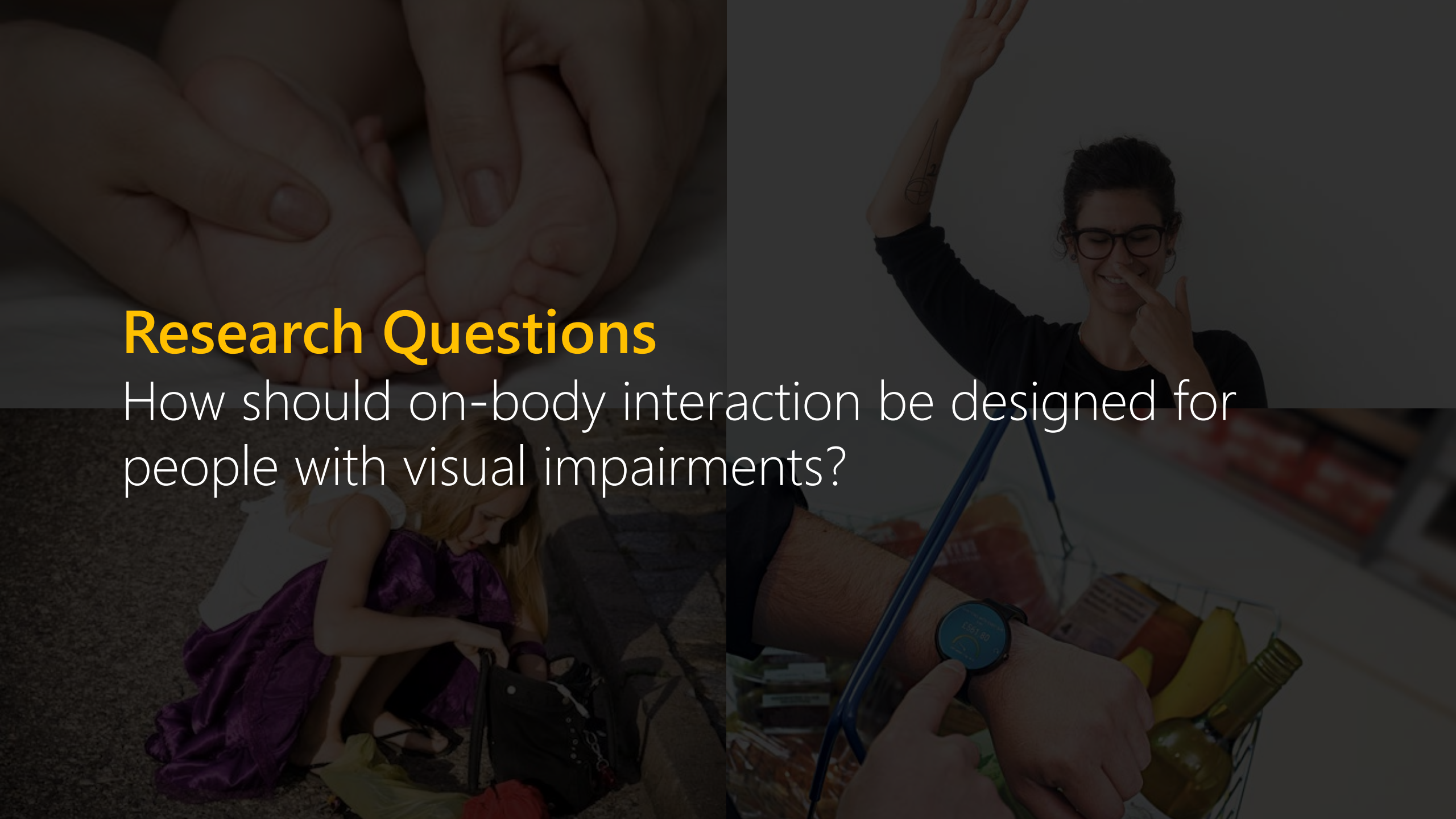
No Device Retrieval

Potential Benefits of On-Body Interaction

Hands-Free Interaction



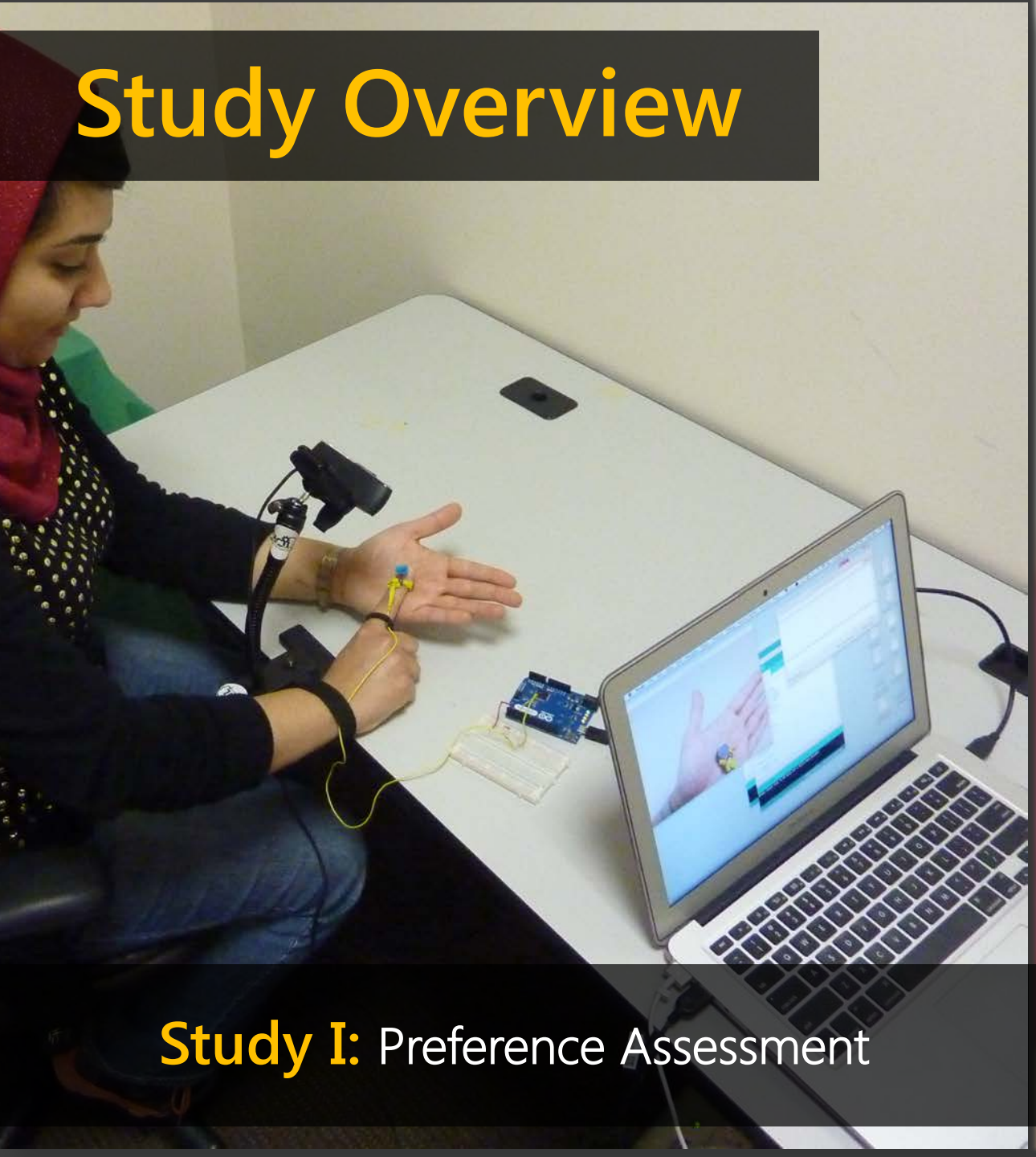

[!] No thorough investigation of on-body interaction in accessibility contexts



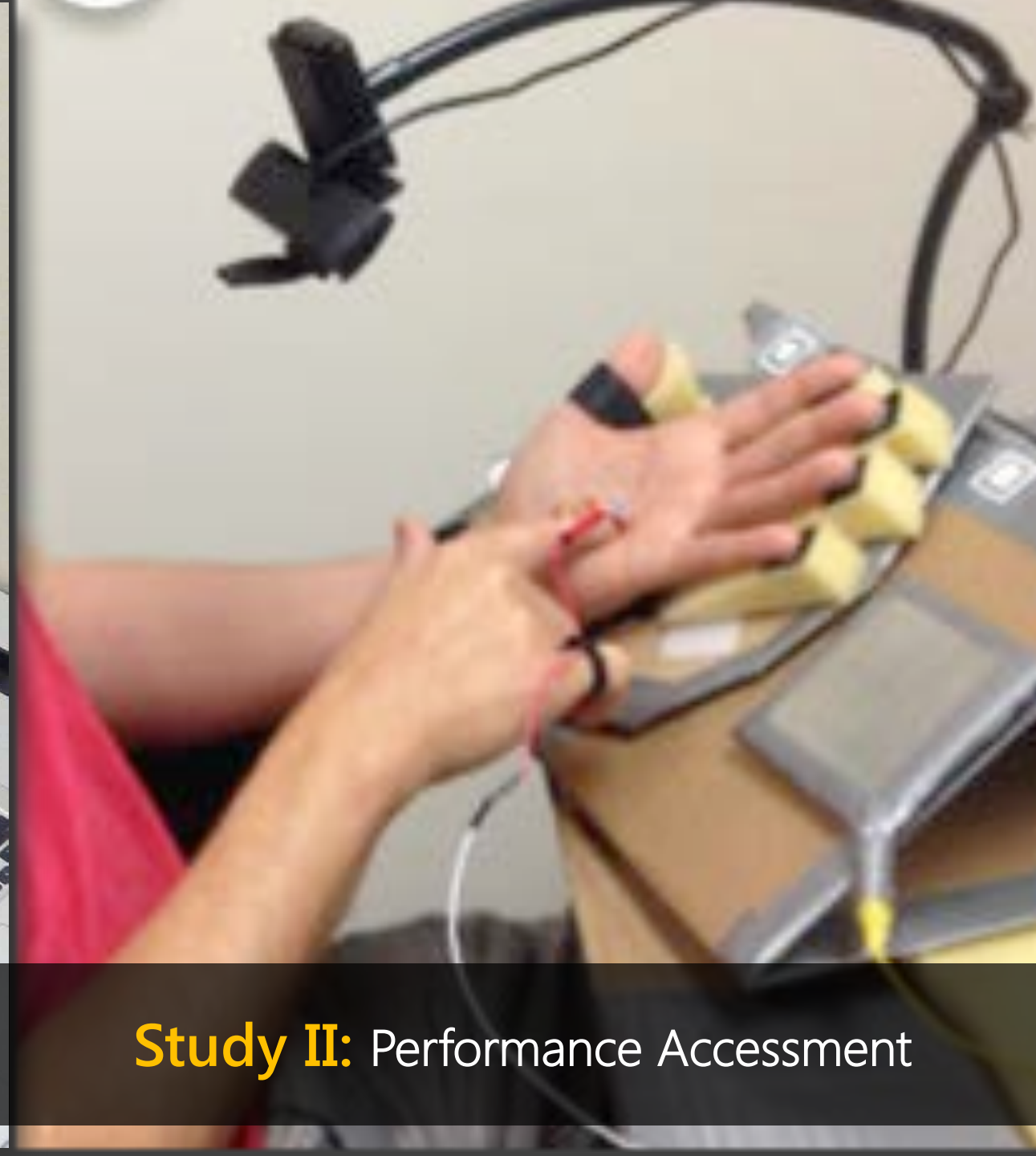
Research Questions

How should on-body interaction be designed for people with visual impairments?

Study Overview

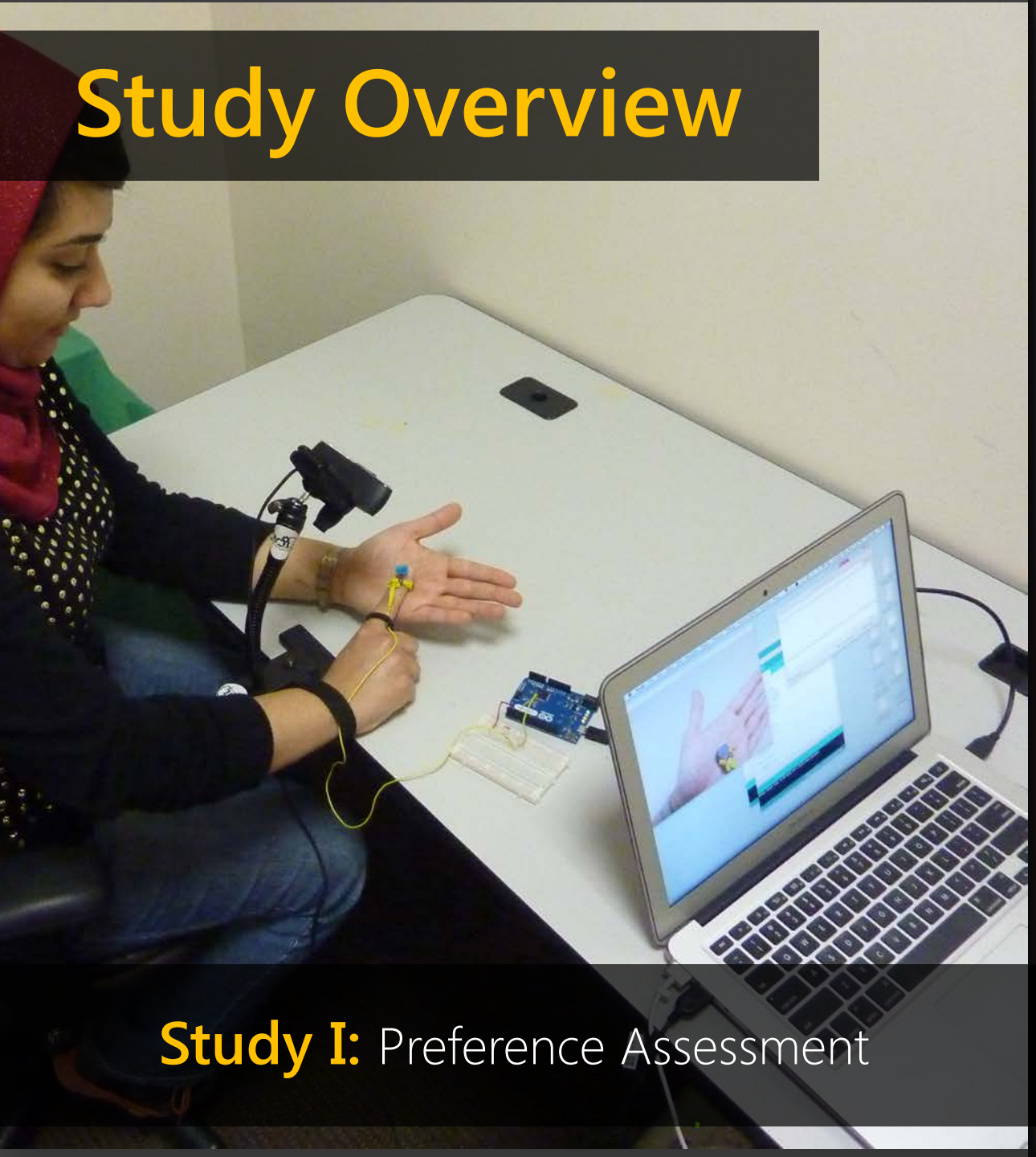


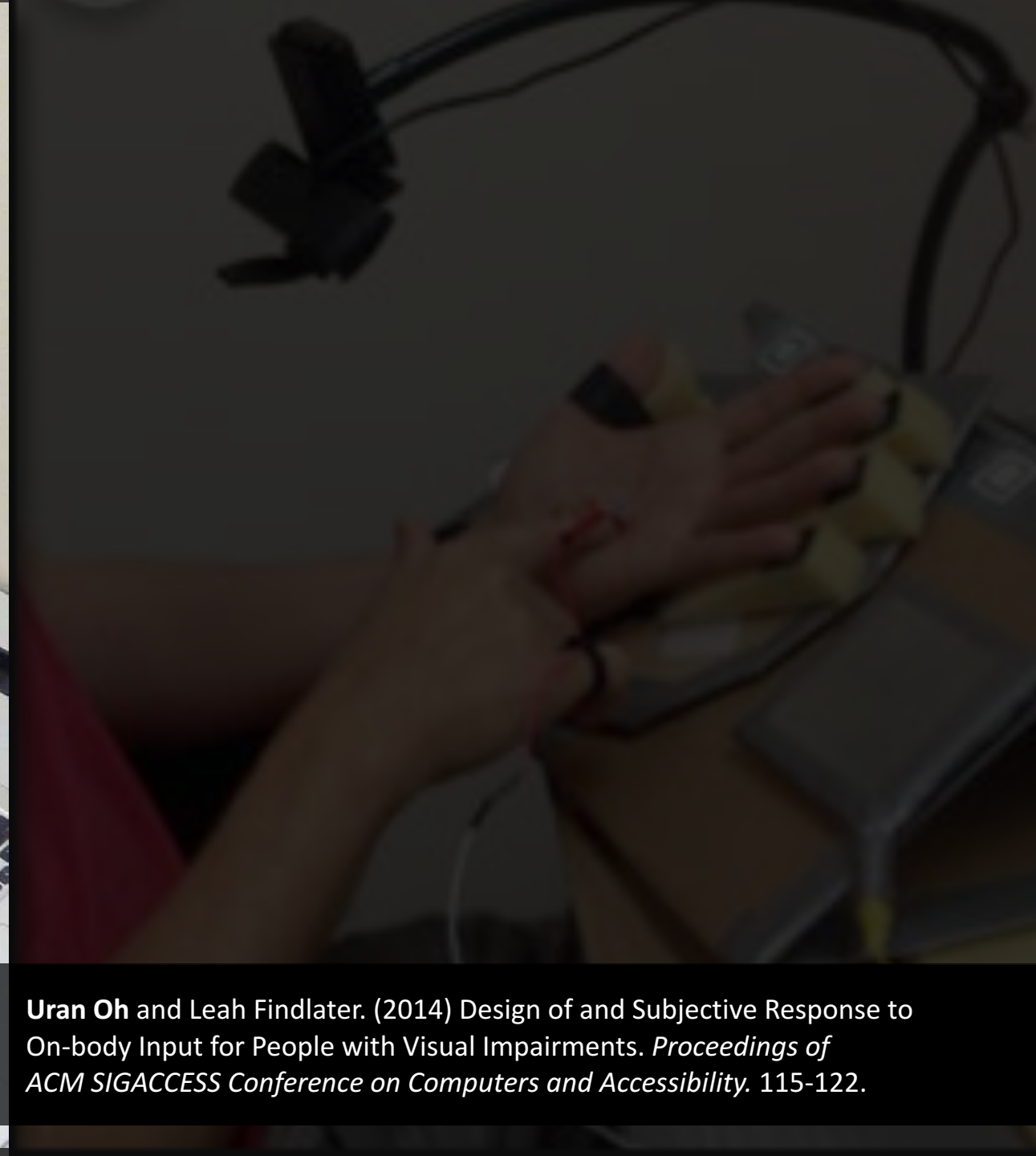
Study I: Preference Assessment



Study II: Performance Accessment

Study Overview





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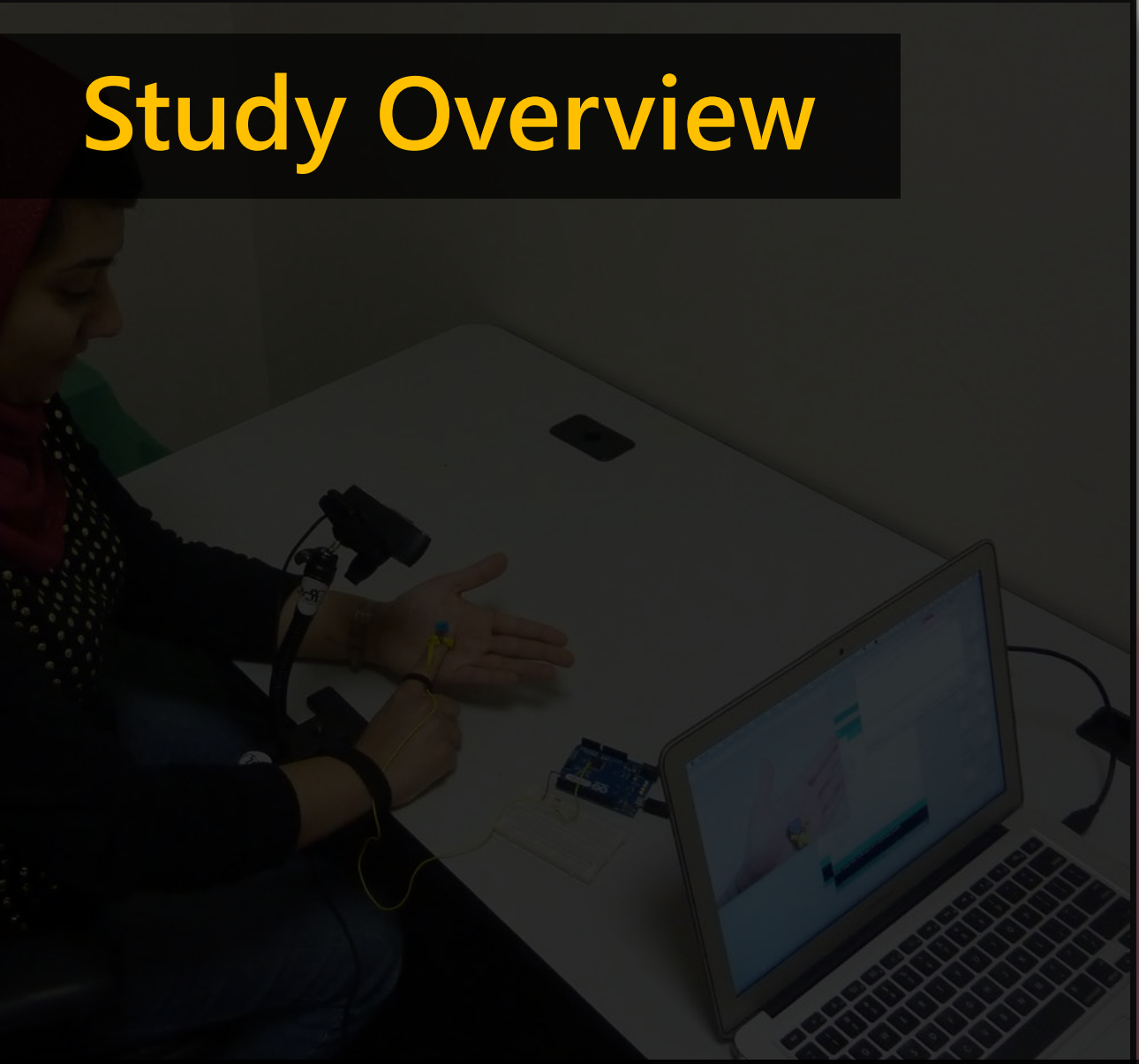
Uran Oh and Leah Findlater. (2014) Design of and Subjective Response to On-body Input for People with Visual Impairments. *Proceedings of ACM SIGACCESS Conference on Computers and Accessibility.* 115-122.

Study Overview



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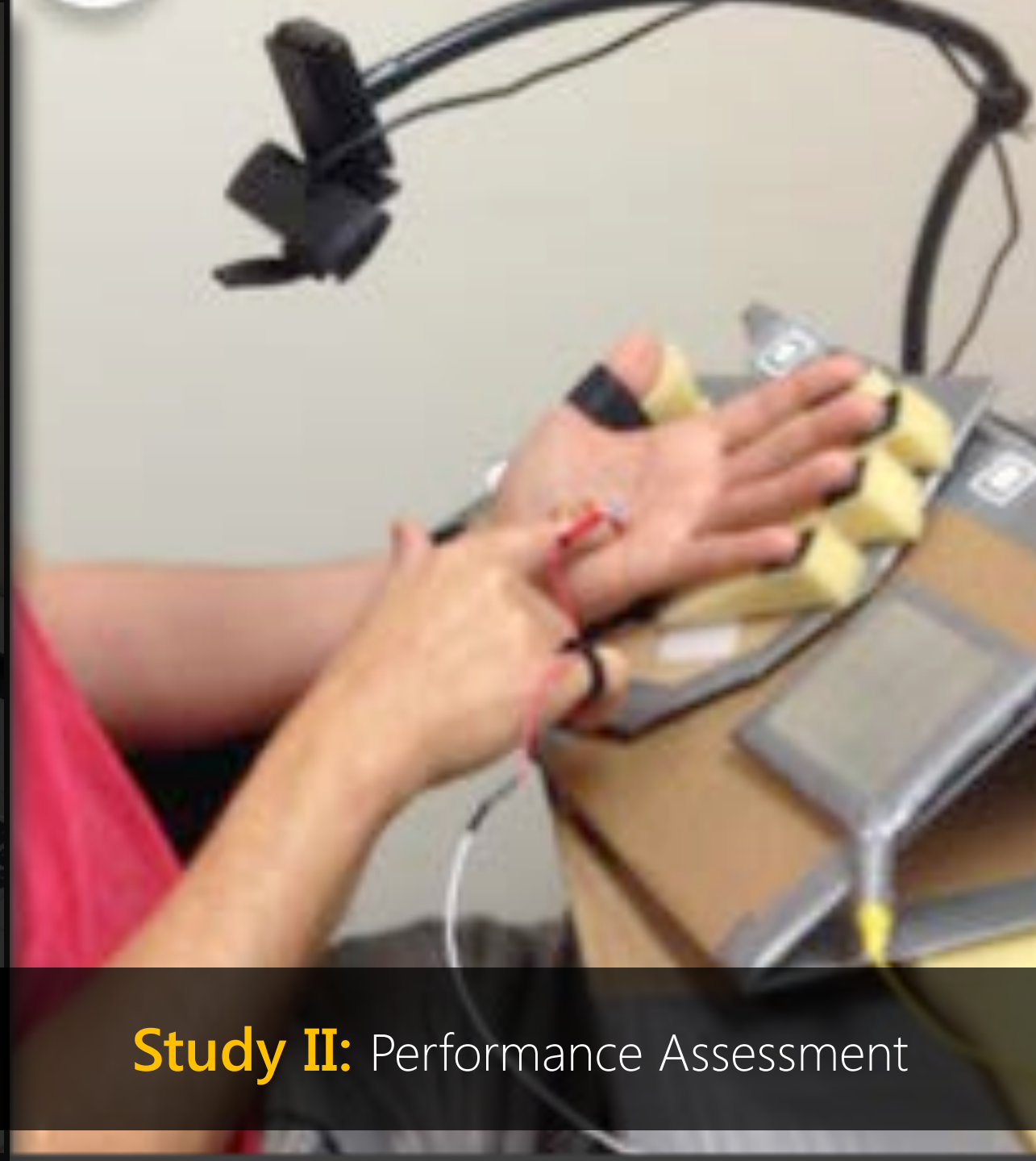
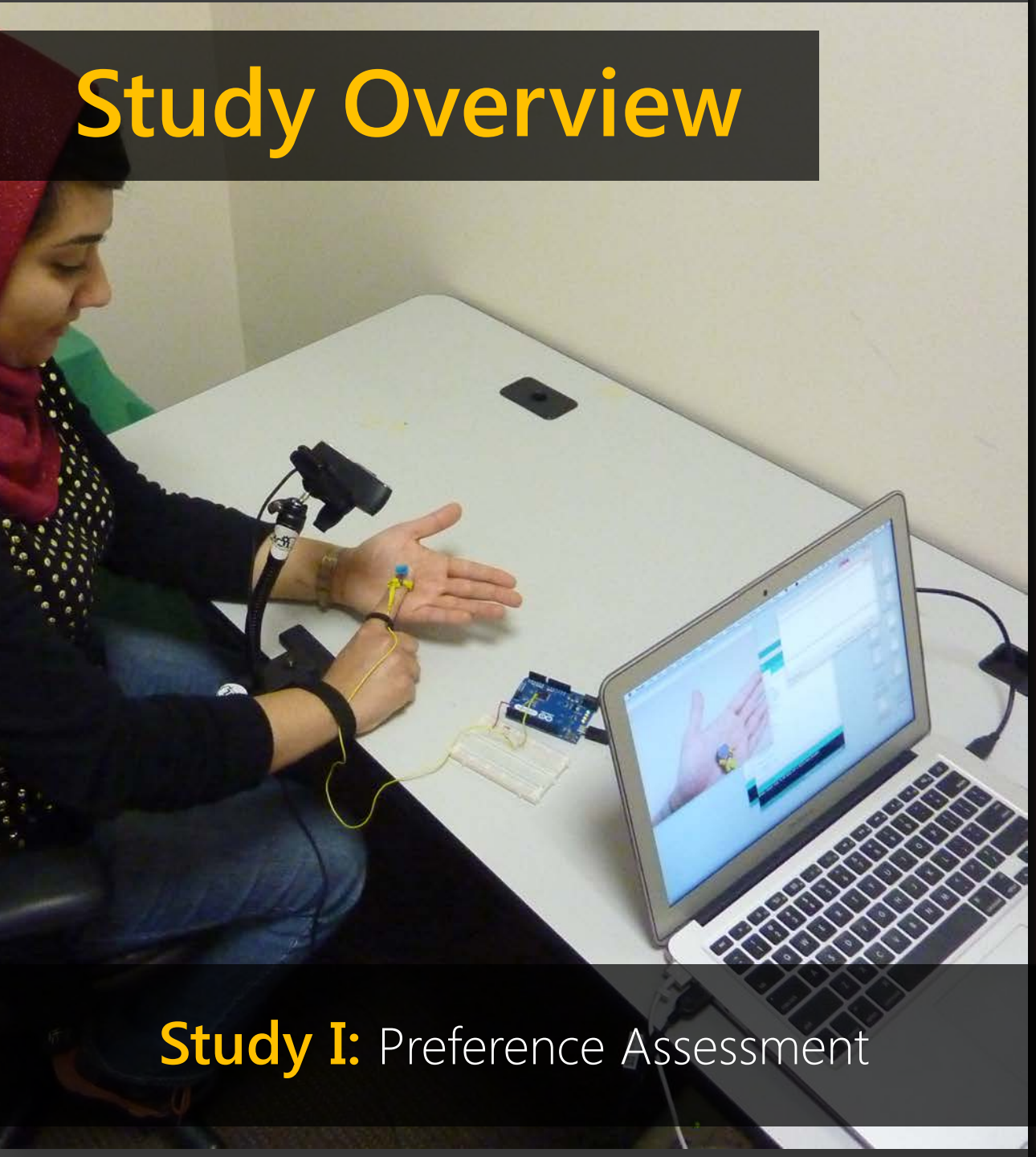
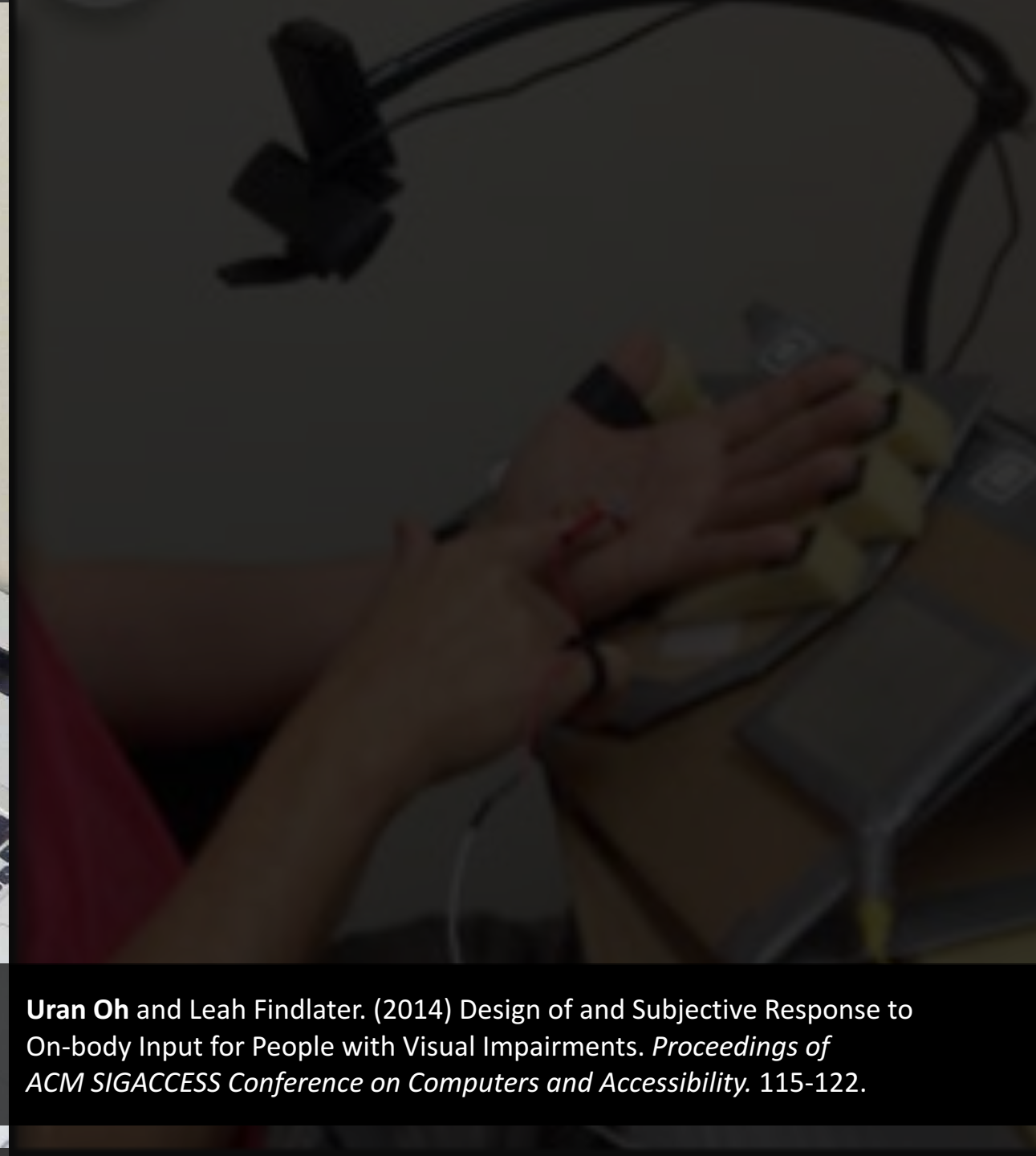
ACM Transactions on Accessible Computing (TACCESS), Vol. 7, No. 4, Article 14.



Study II: Performance Assessment

Study Overview





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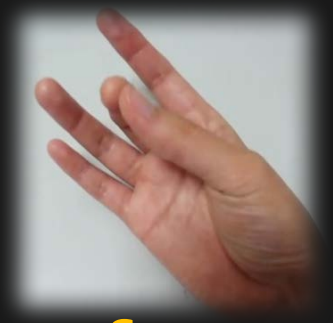
Task 1: On-Body Location Preference



Same hand

Other hand -palm

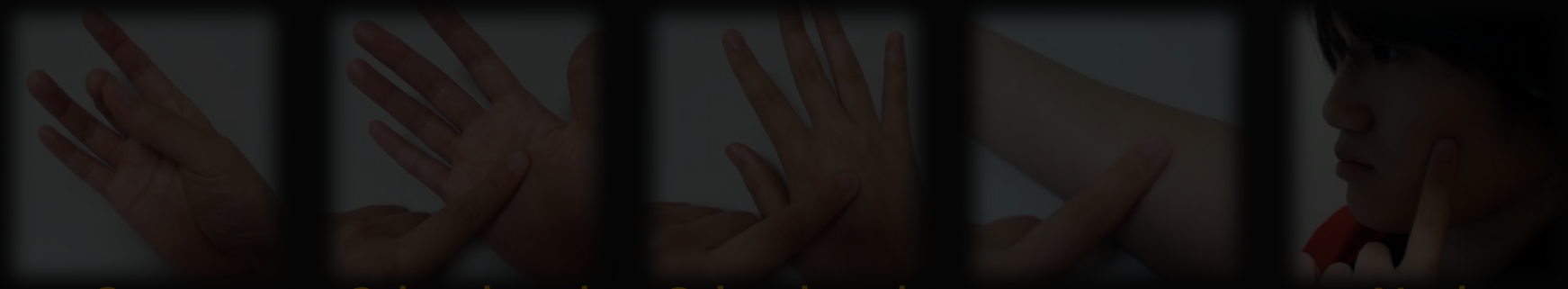
Other hand -back

Forearm

Neck & Face

Study I: Needs and Preferences (12 VI participants)

Task 1: On-Body Location Preference



Same hand | Other hand -palm | Other hand -back | Forearm | Neck & Face

Task 2: Phone vs. Hand, One vs. Two hands

Phone, one handed | Phone, two handed | Hand, two handed | Hand, two handed

Study I: Needs and Preferences (12 VI participants)

Study I: Findings for Task 1

On-Body Input Location Preference:

Same hand

Other hand -palm

Most preferred

Other hand -back

Forearm

Neck & Face

Study I: Findings for Task 1

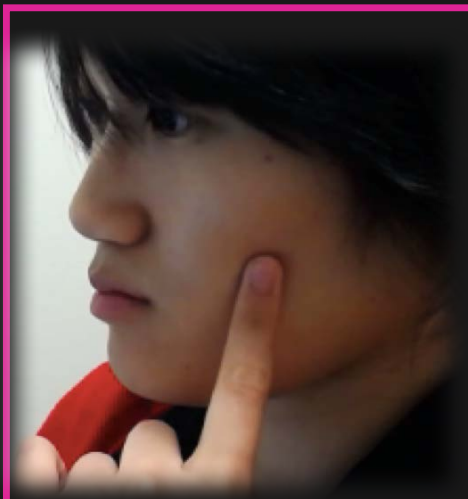
On-Body Input Location Preference:

Same hand

Other hand -palm

Other hand -back

Forearm



Neck & Face

Least preferred

Study I: Findings for Task 2

Trade-Offs Between Phone versus Hand:

Phone,
two handed

Hand,
two handed

Phone,
one handed

Hand,
two handed

Study I: Findings for Task 2

Trade-Offs Between Phone versus Hand:

Phone,
two handed

Preferred with
two hands

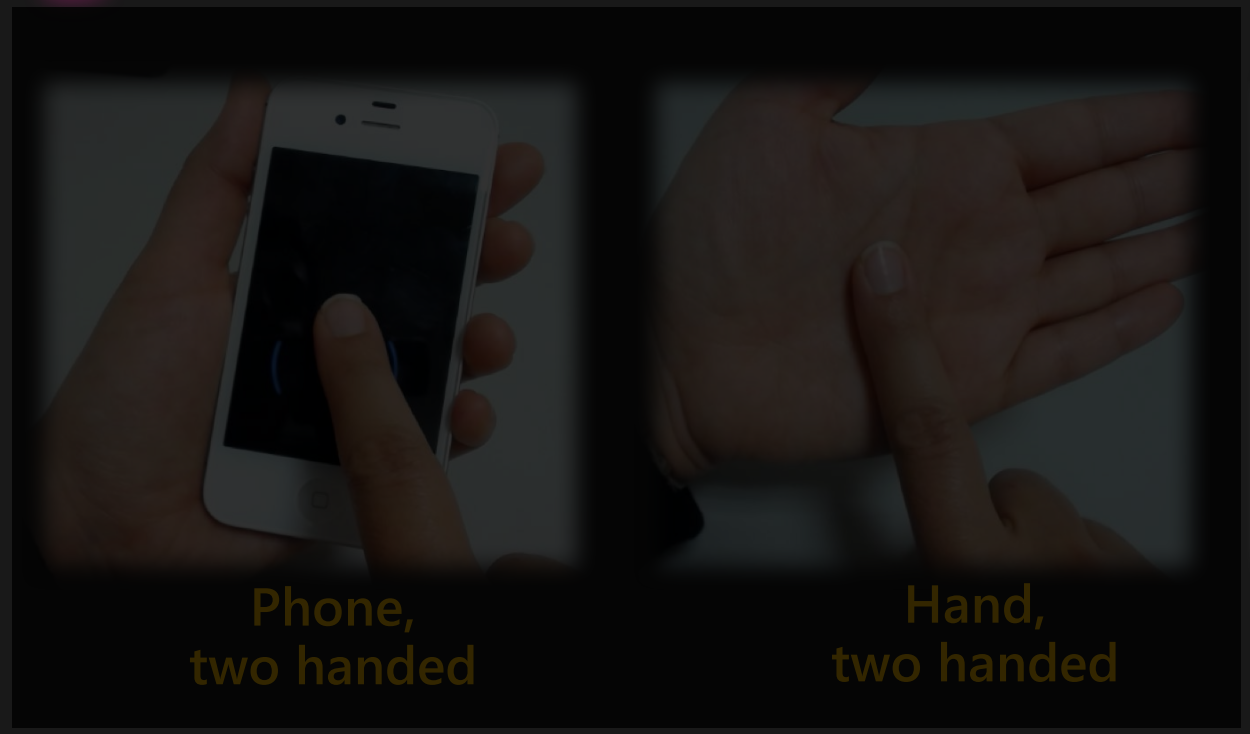
Hand,
two handed

Phone,
one handed

Hand,
two handed

Study I: Findings for Task 2

Trade-Offs Between Phone versus Hand:



Phone, two handed

Hand, two handed

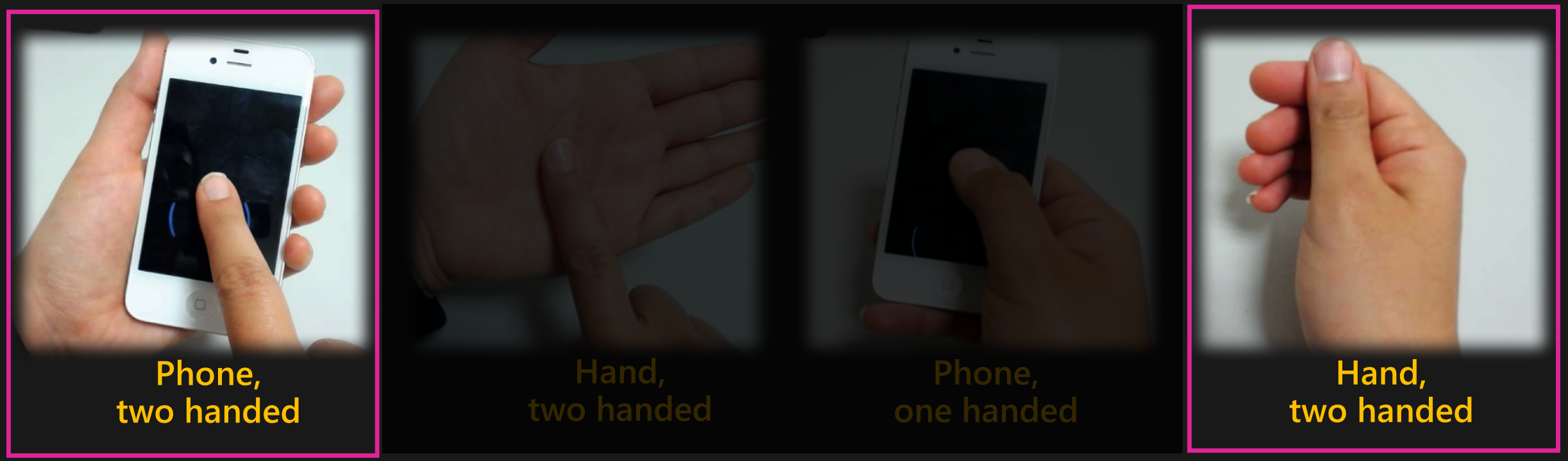
Phone, one handed

Hand, two handed

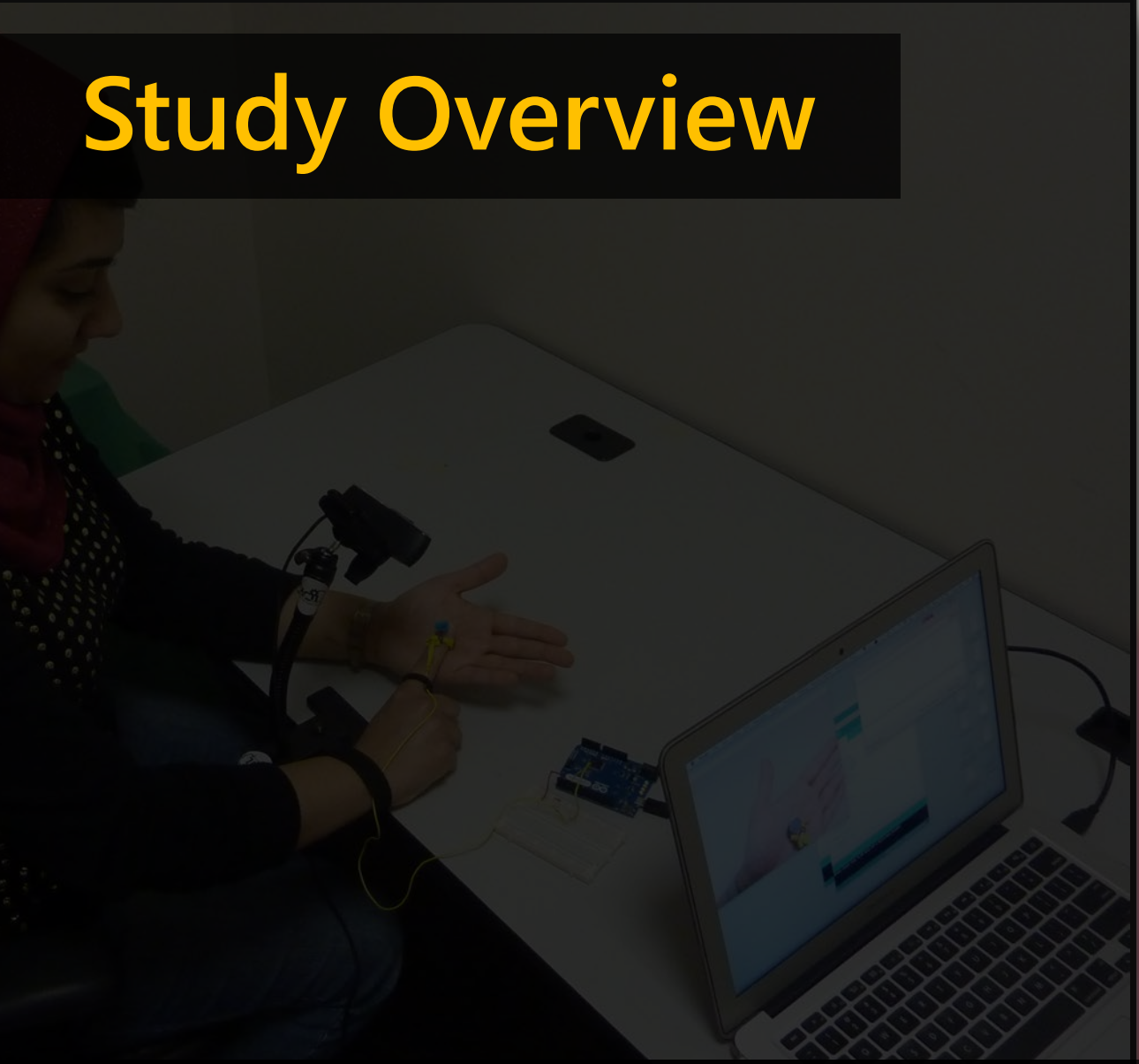
Preferred with one hand

Study I: Findings for Task 2

Trade-Offs Between Phone versus Hand:



Study Overview



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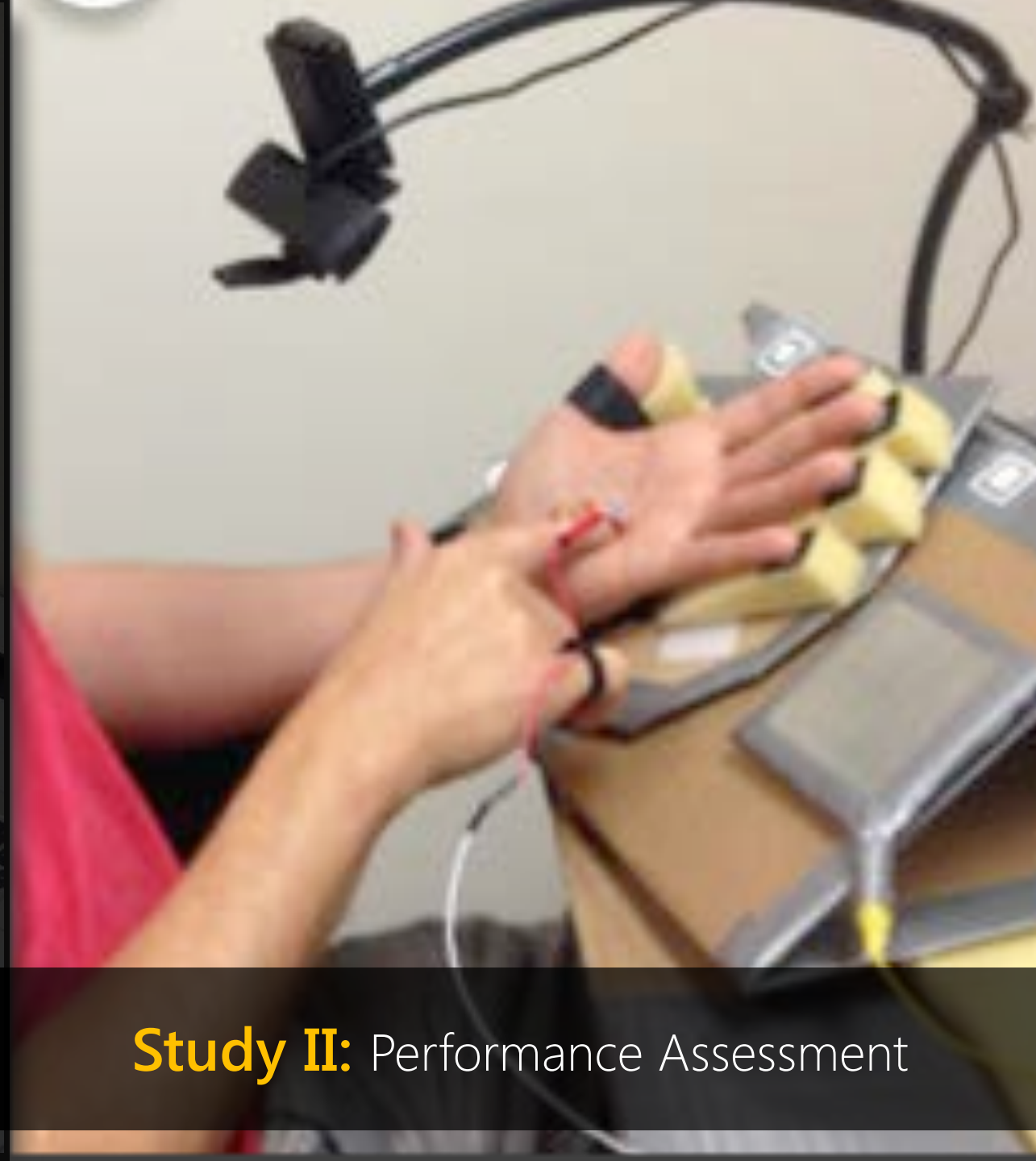
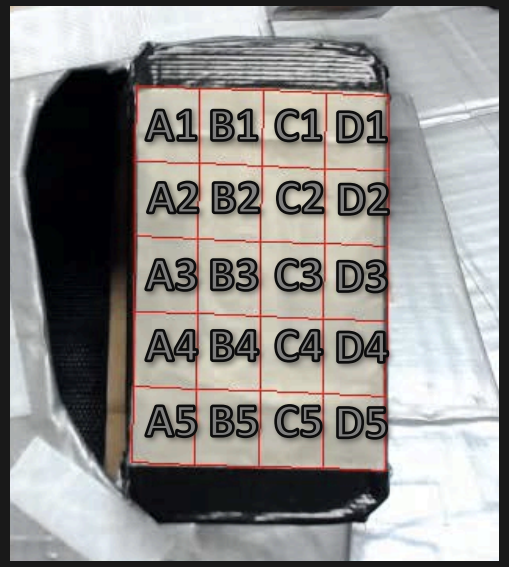


Study II: Performance Assessment

Task 1: Target Pointing

"Find a target as quickly and accurately as possible"

Two interfaces: Phone vs. Hand



Study II: Performance Comparisons (11 blind participants)

Task 1: Target Pointing

"Find a target as quickly and accurately as possible"

Two interfaces: Phone vs. Hand

Task 2: Shape Drawing

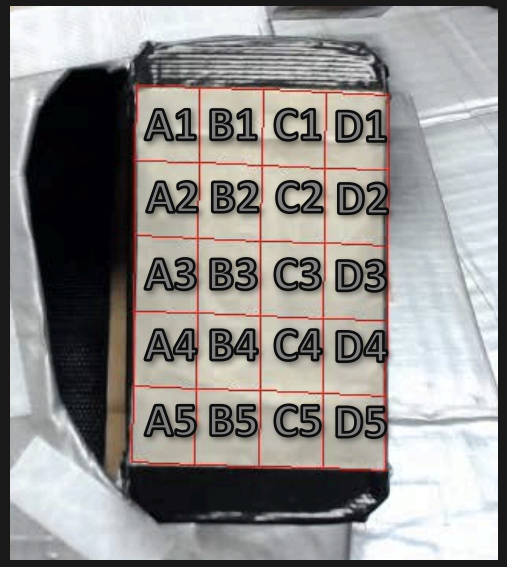
"Draw a shape as consistently and accurately as possible"

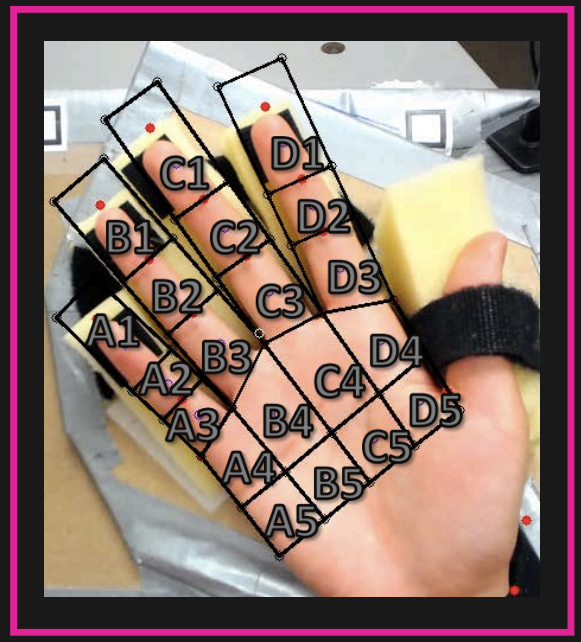
Two interfaces: Phone vs. Hand

Study II: Performance Comparisons (11 blind participants)

Study II Findings for Target Pointing Task

Speed Comparison for Target Pointing Task

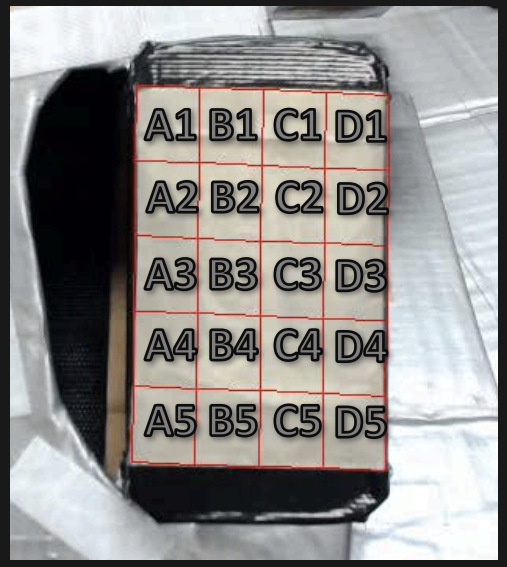


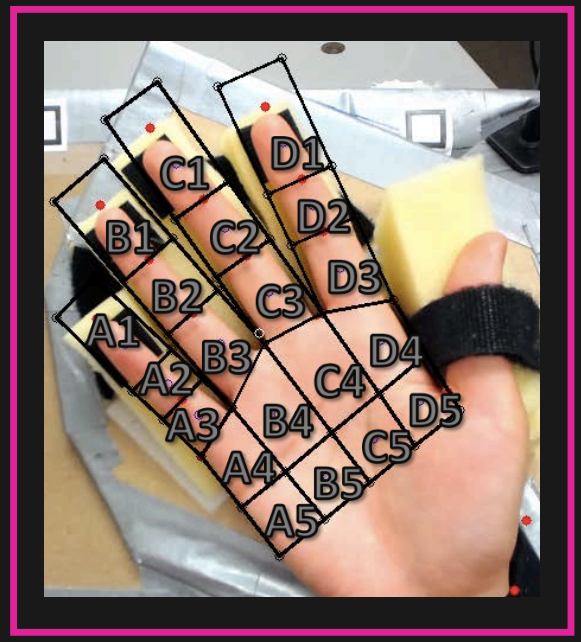


Faster

Study II Findings for Target Pointing Task

Accuracy Comparison for Target Pointing Task





More accurate

Study II Findings for Shape Drawing Task

Consistency Comparison for Shape Drawing Task

More consistent

Overall Design Implications

Avoiding neck and face areas as an input location

Overall Design Implications

Avoiding neck and face areas as an input location

Supporting one-handed interaction

Overall Design Implications

Avoiding neck and face areas as an input location

Supporting one-handed interaction

Using the hand as a default input location

A Follow-Up Project

Supporting on-body interaction for people with visual impairments through wearable technologies

The Ultimate Goal

Supporting activities of daily living for people with visual impairments through wearable technologies

Making Printed Text Accessible to People with Visual Impairments Using Finger-Mounted Cameras

UMD Diversity in Computing Summit | November 7, 2016

Presenter: Lee Stearns

makeability lab

inclusive design lab

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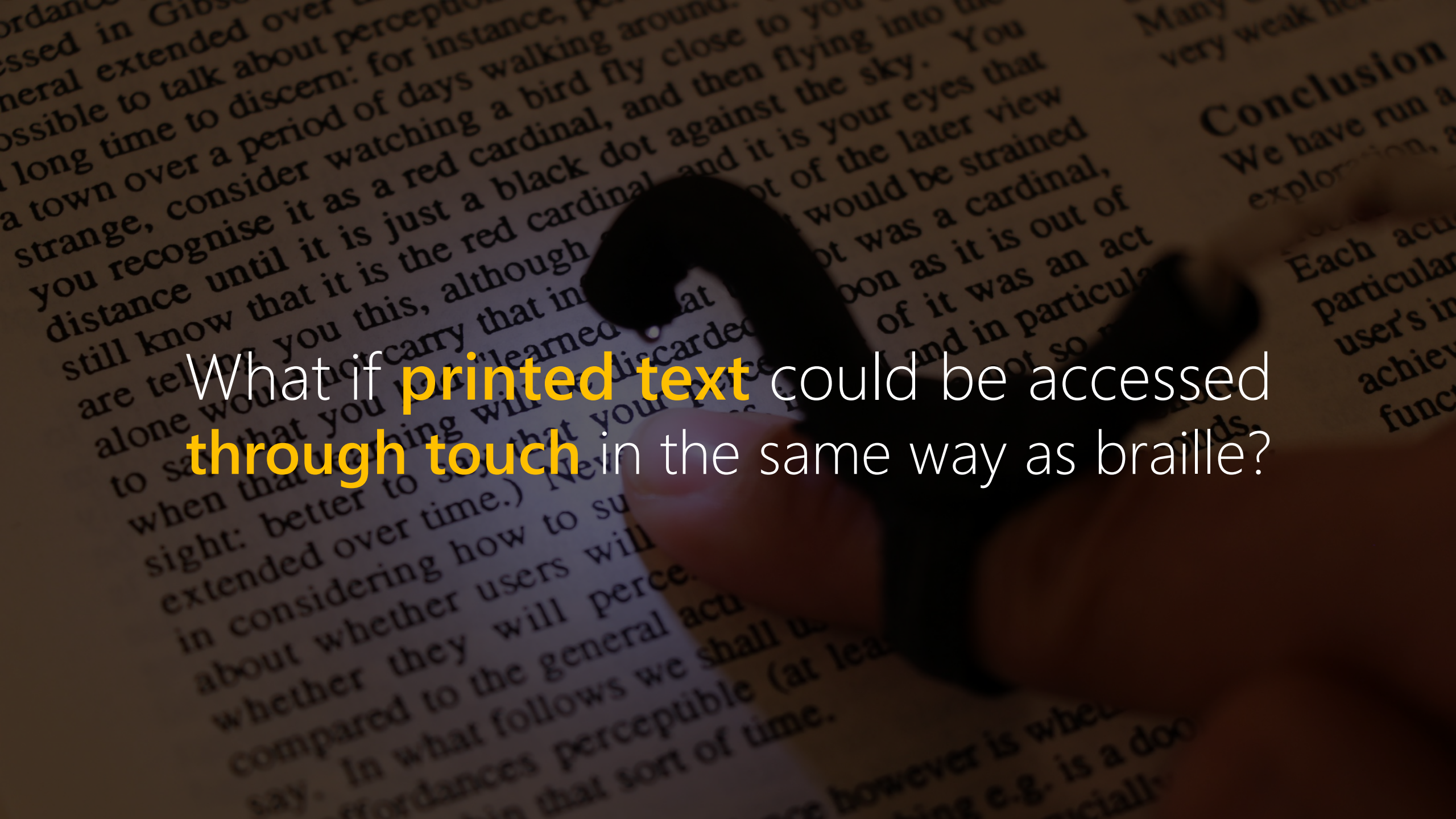
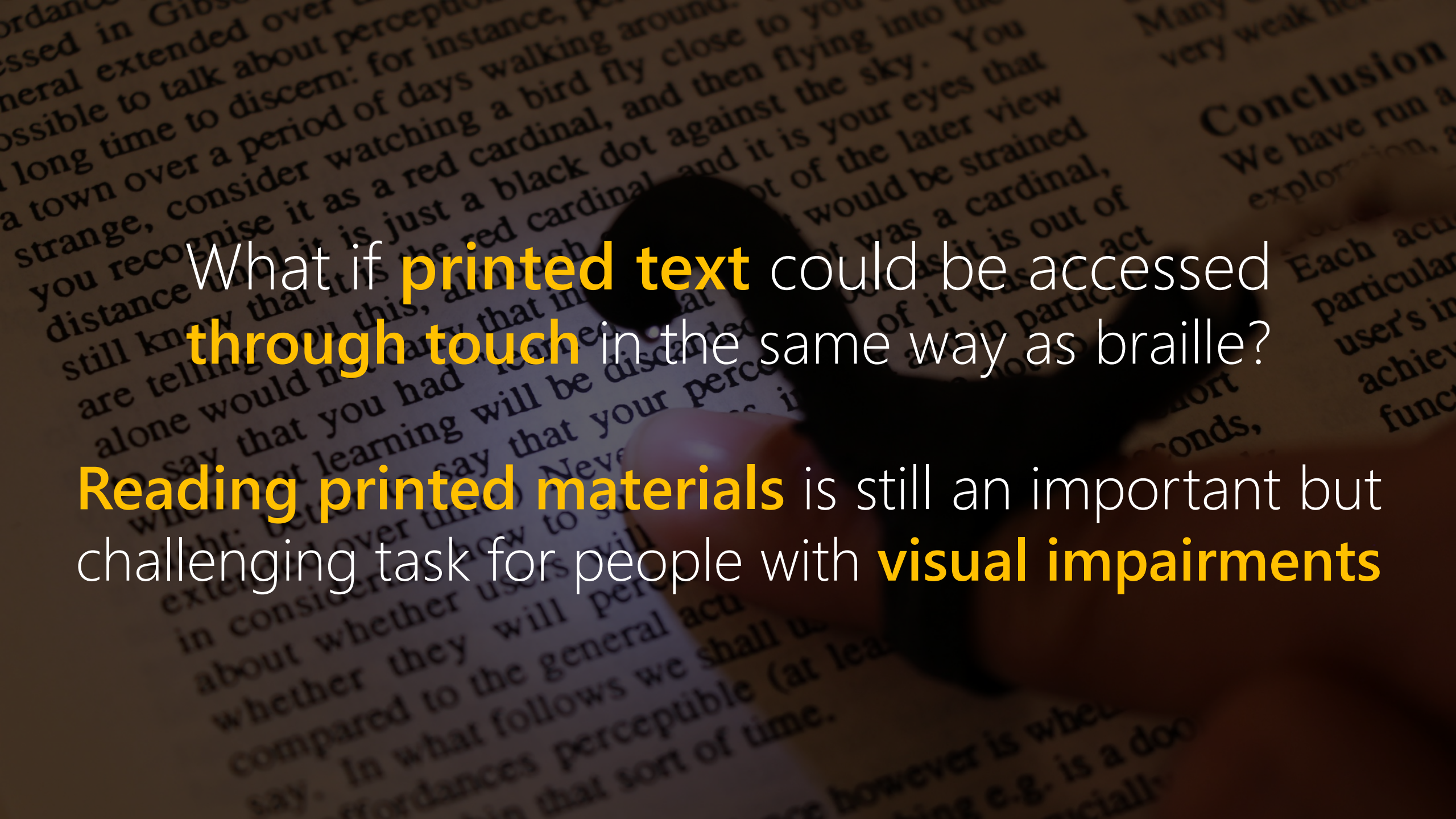
*Video Credit: YouTube—Ginny Owens—How I See It (Reading Braille)

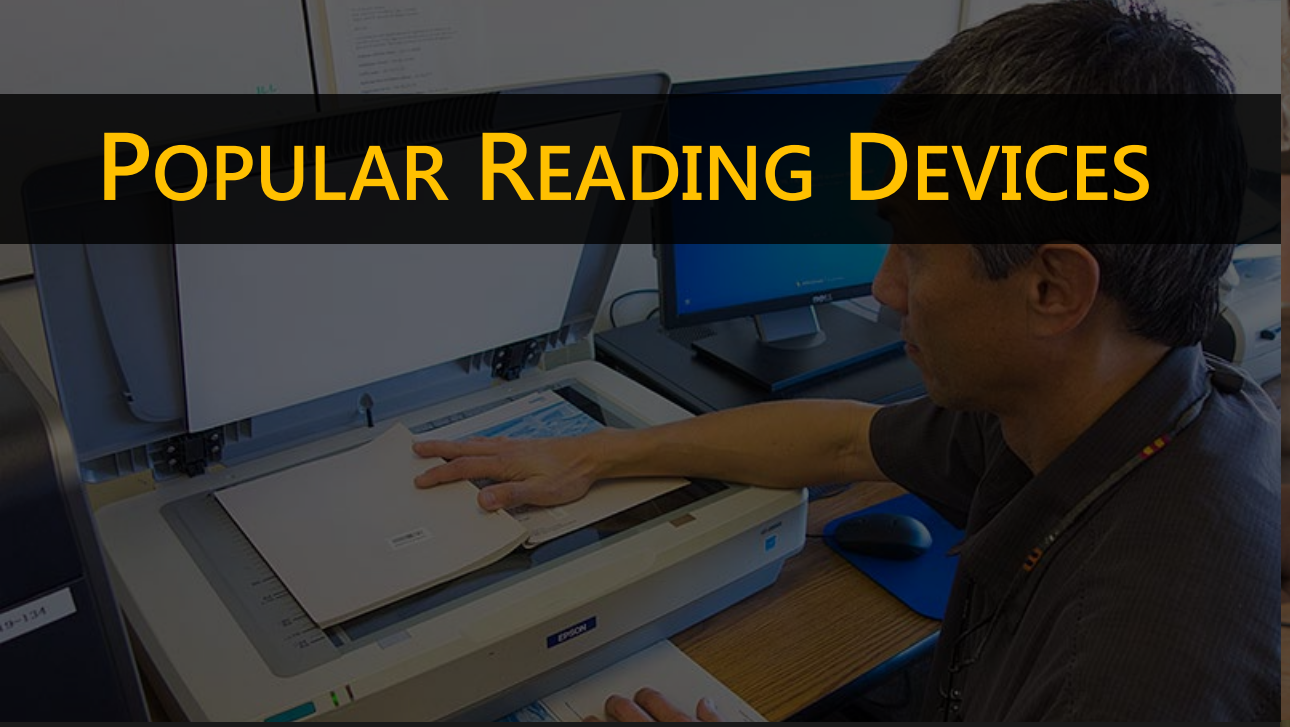

What if **printed text** could be accessed **through touch** in the same way as braille?



What if **printed text** could be accessed **through touch** in the same way as braille?

Reading printed materials is still an important but challenging task for people with **visual impairments**

Popular Reading Devices



Popular Reading Devices

Scanner | OCR | Screen Reader

Popular Reading Devices

Dedicated devices (*e.g.*, video magnifiers)

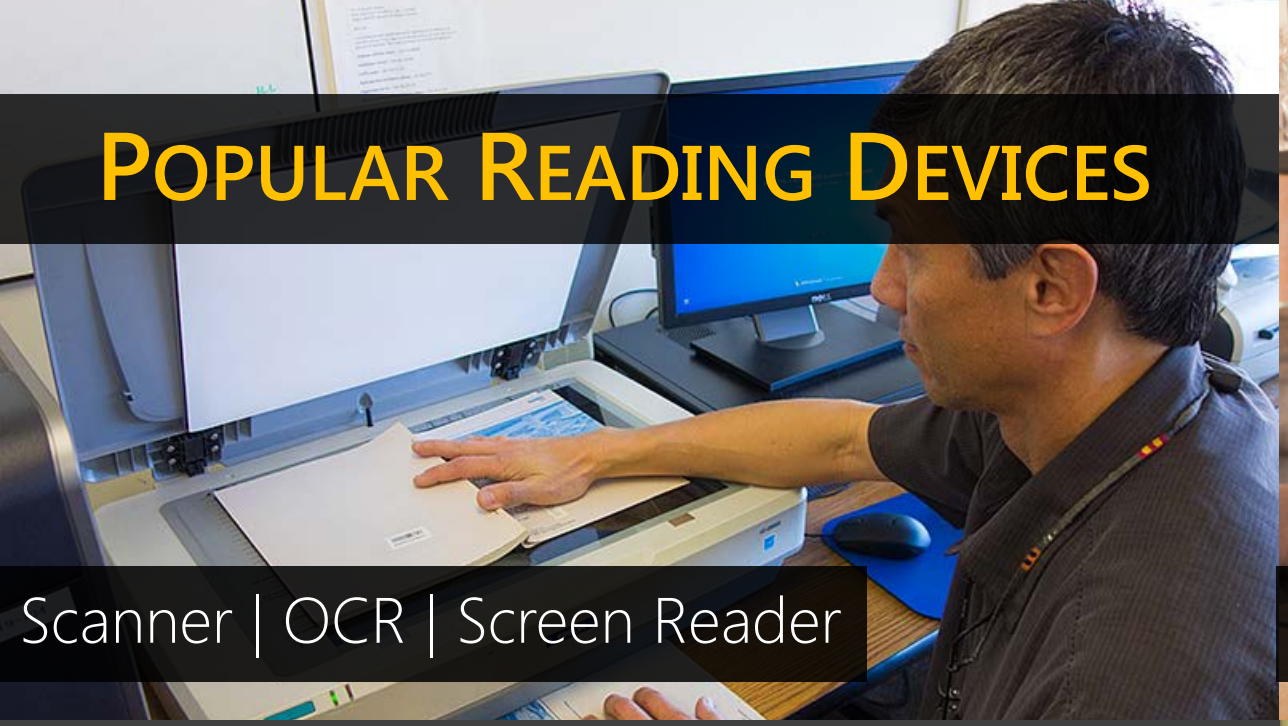
Popular Reading Devices

Smartphone apps (*e.g.,* KNFB Reader iOS)

Popular Reading Devices

Wearable Cameras (*e.g.*, OrCam)

Popular Reading Devices



Scanner | OCR | Screen Reader

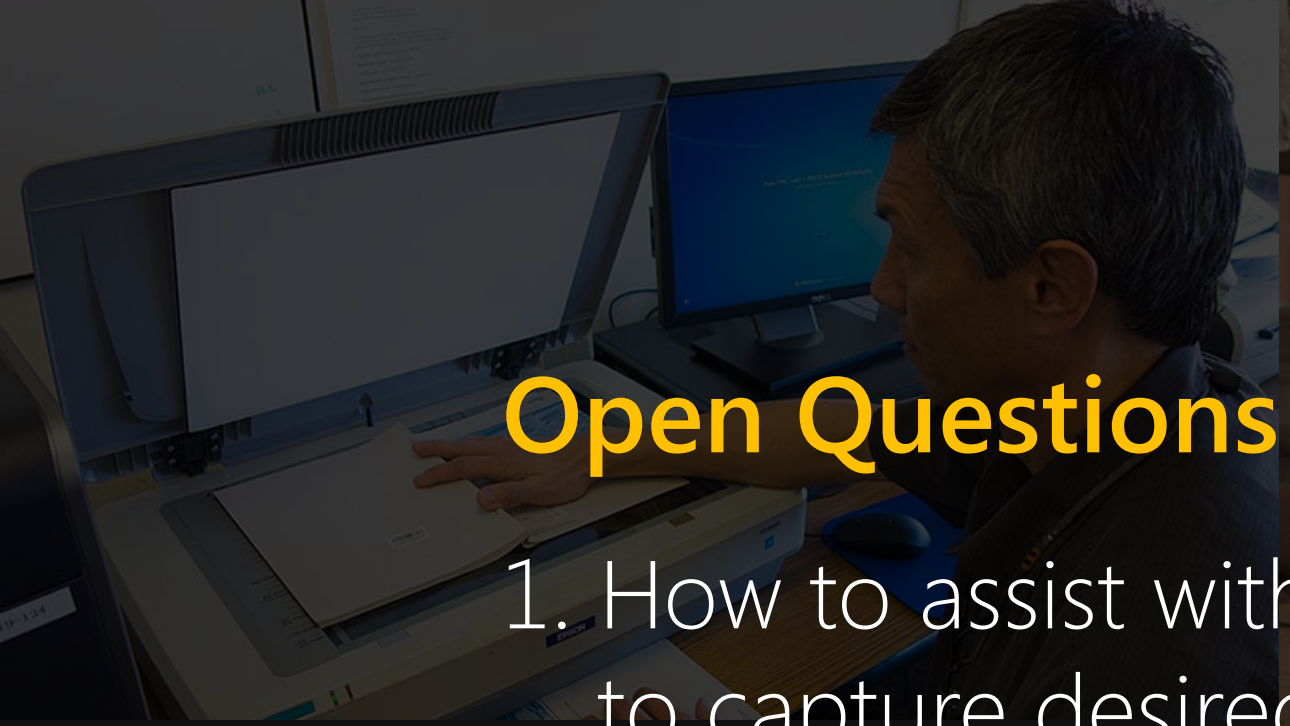
Dedicated Devices (*e.g.*, video magifiers)

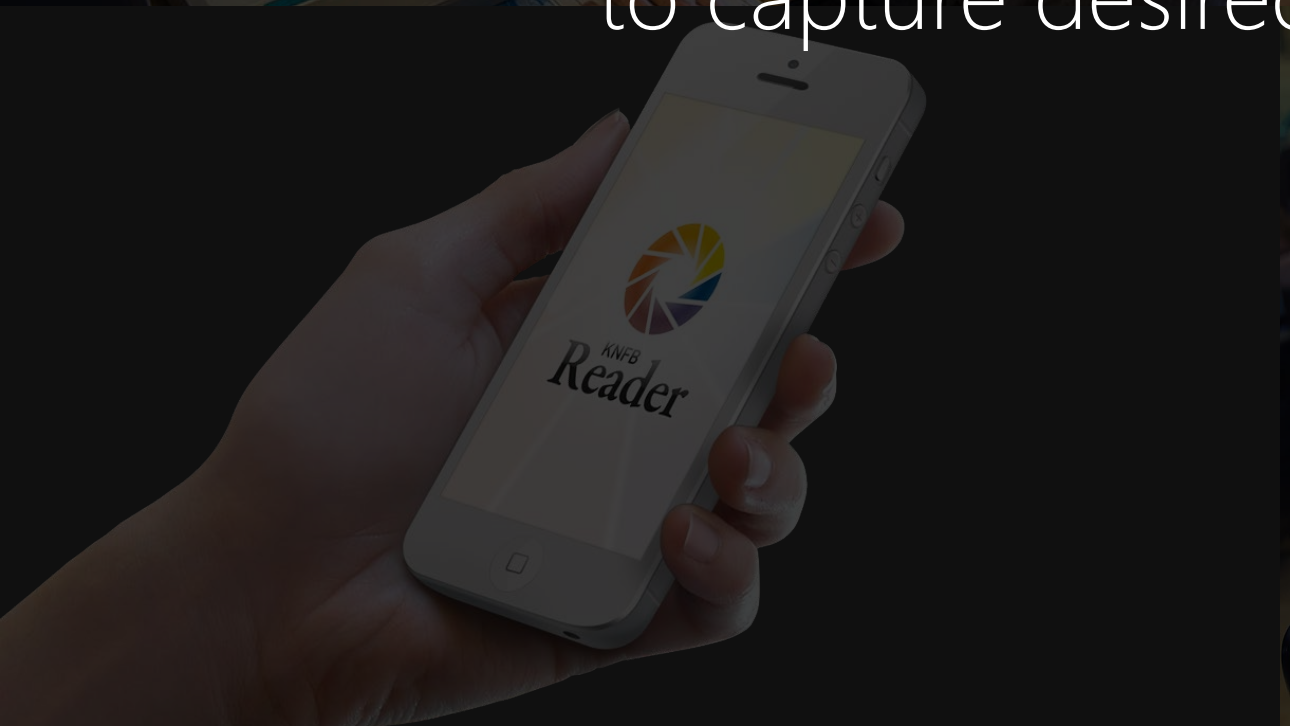
Smartphone Apps (*e.g.*, KNFB Reader iOS)

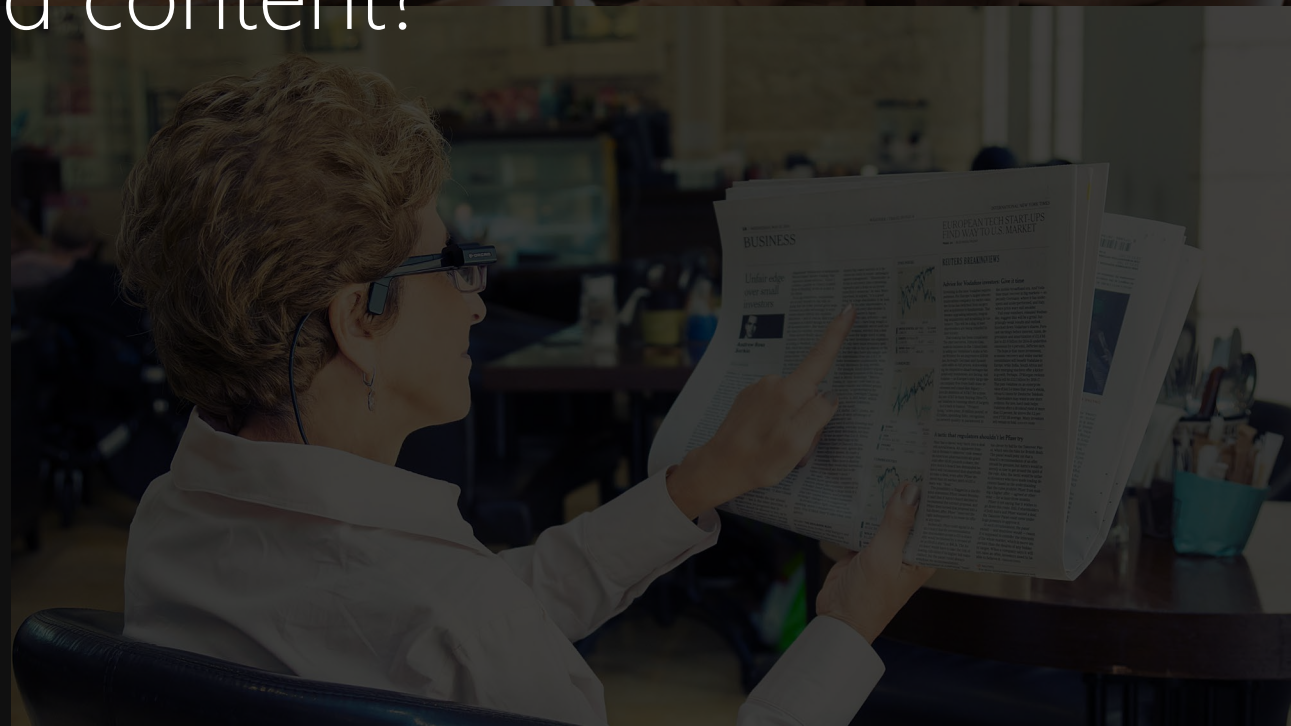
Wearable Cameras (*e.g.*, OrCam)

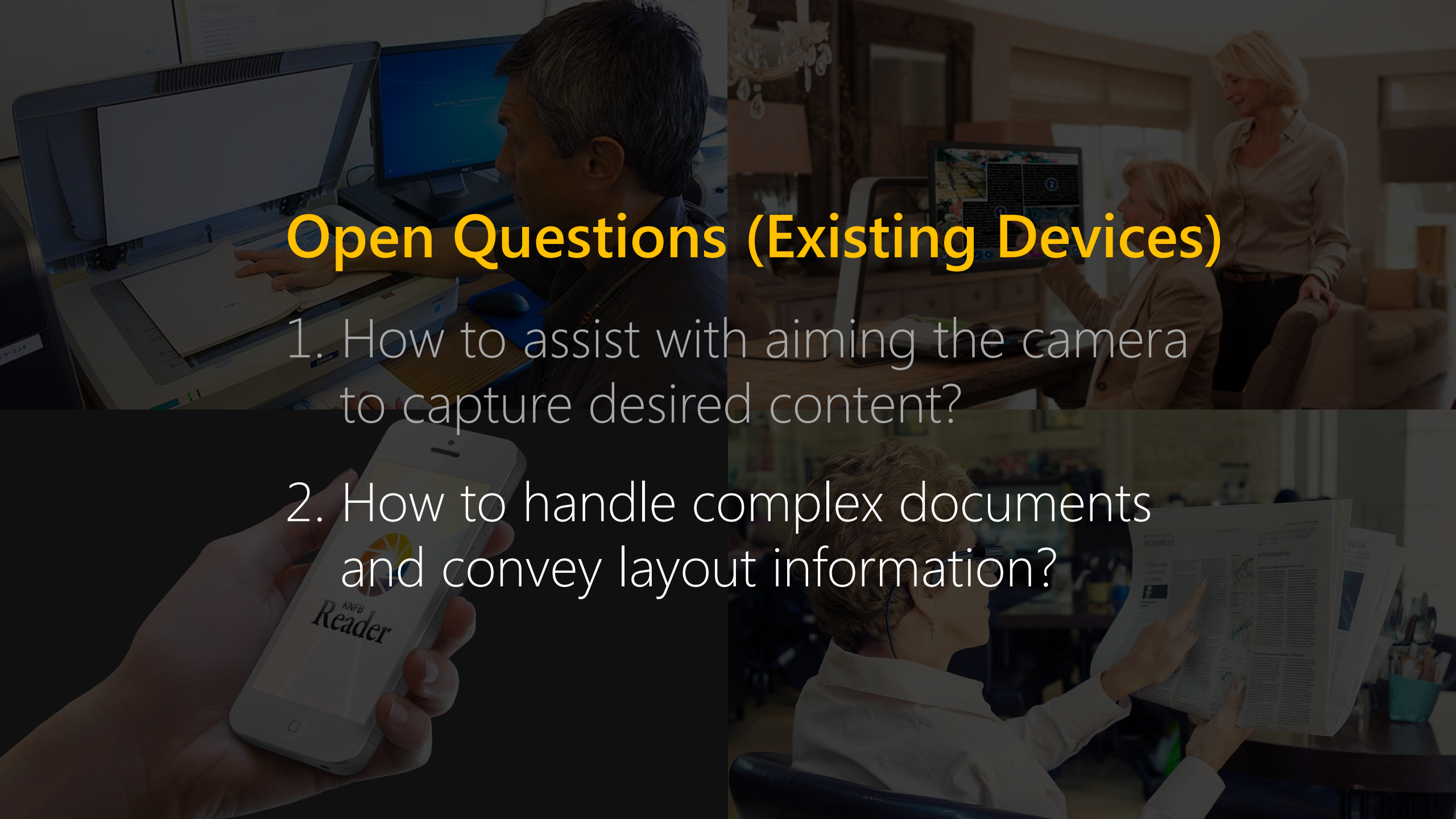
Open Questions (Existing Devices)

1. How to assist with aiming the camera to capture desired content?









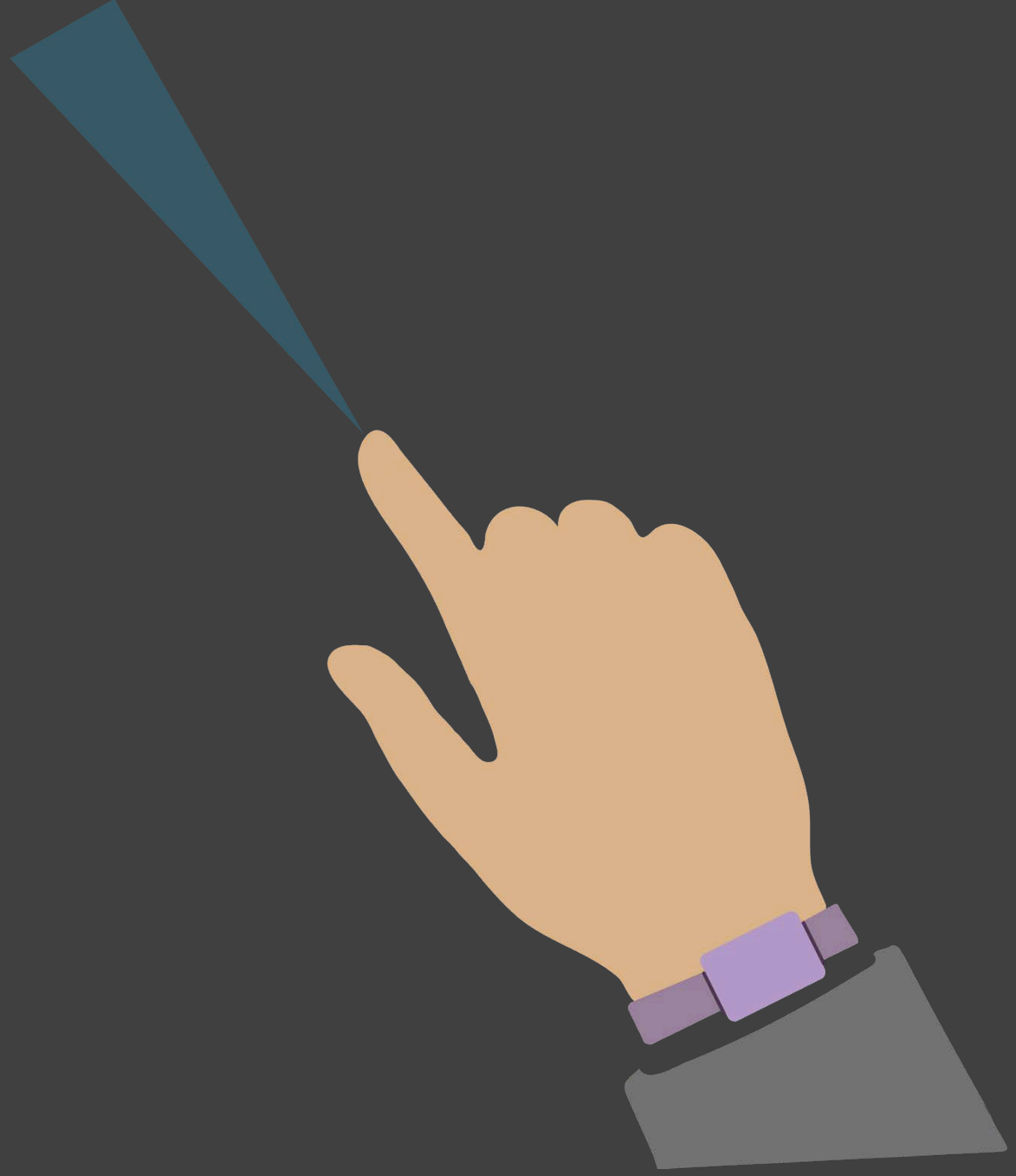
Open Questions (Existing Devices)

1. How to assist with aiming the camera to capture desired content?

2. How to handle complex documents and convey layout information?

HandSight

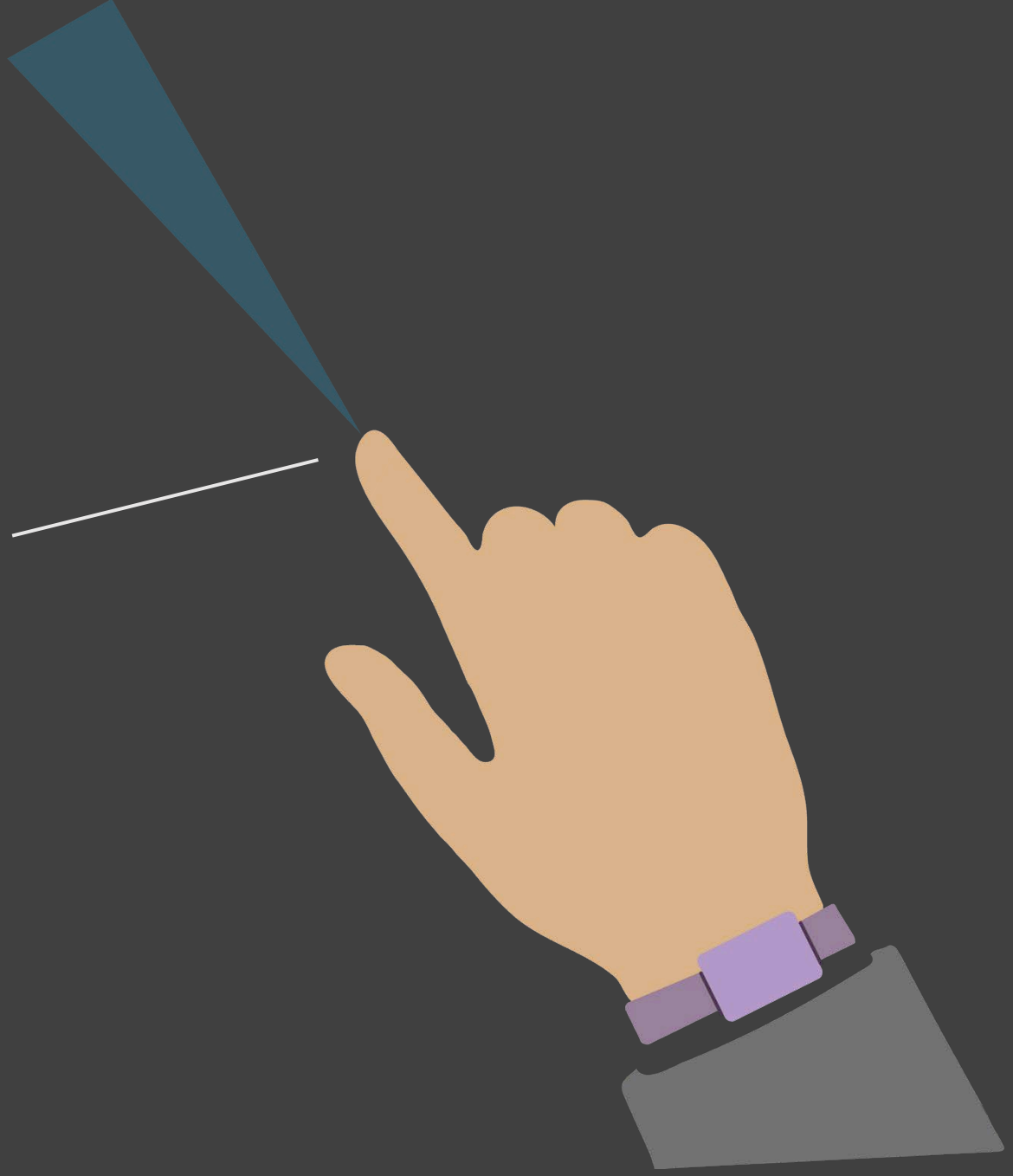
A vision-augmented touch system



HandSight

A vision-augmented touch system

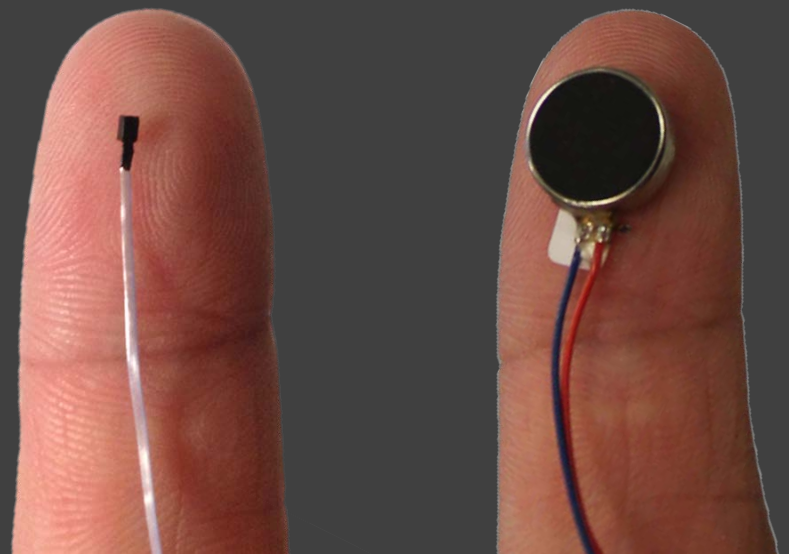
Tiny CMOS cameras,



HandSight

A vision-augmented touch system

Tiny CMOS cameras,
haptic vibration motors
mounted on the fingers



HandSight

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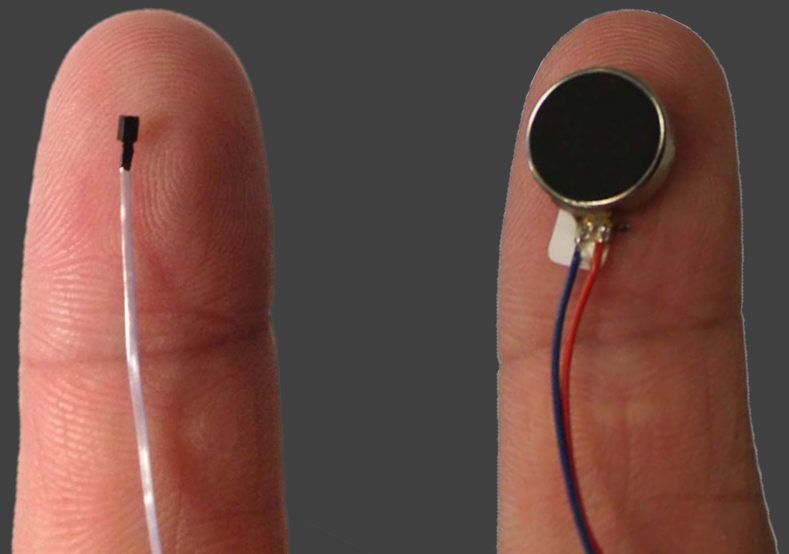

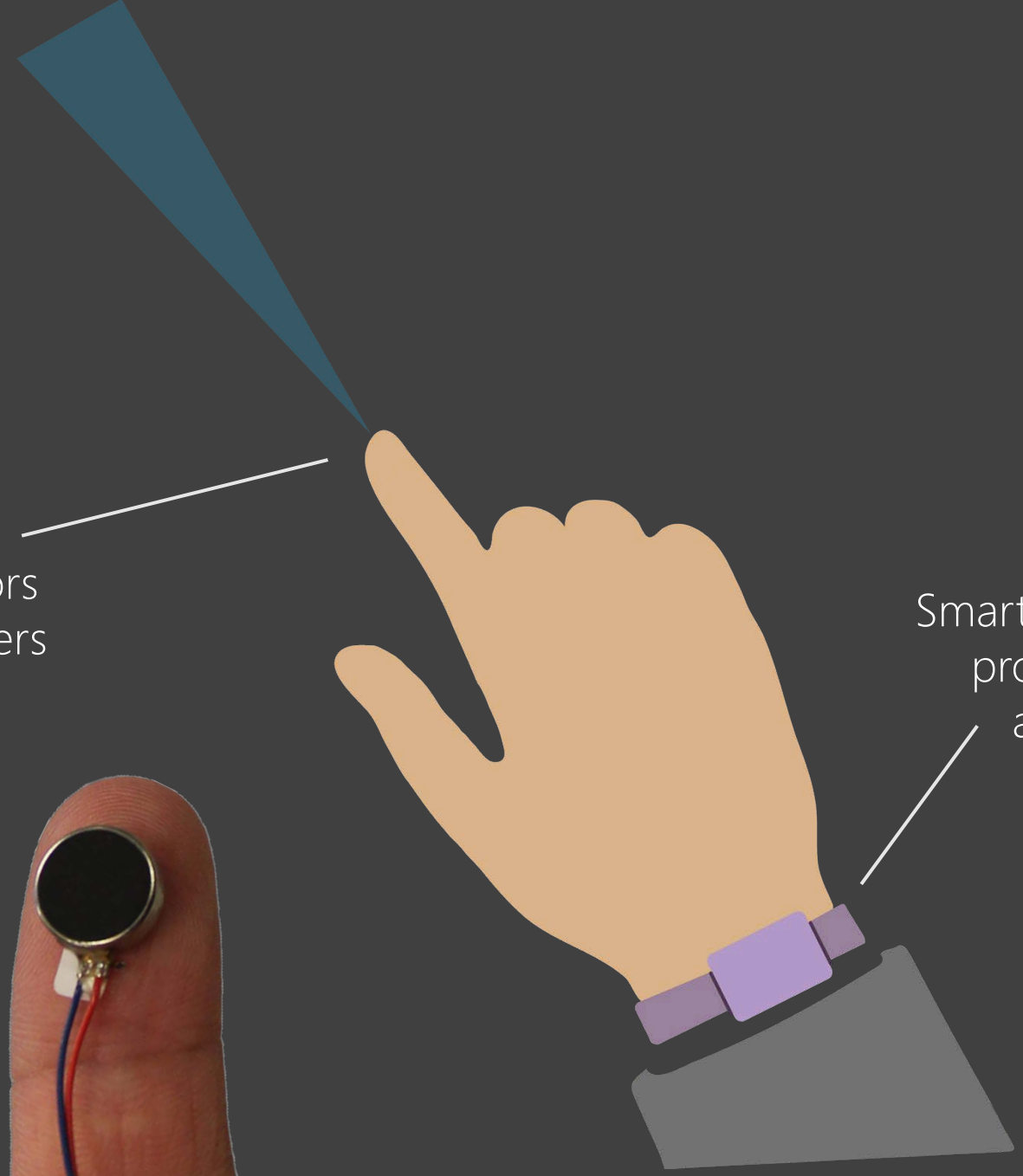

Smartwatch for power,
processing, speech
and audio output

Advantages of Finger-Based Reading

1. Does not require framing an overhead camera

Advantages of Finger-Based Reading

1. Does not require framing an overhead camera
2. Allows direct access to spatial information

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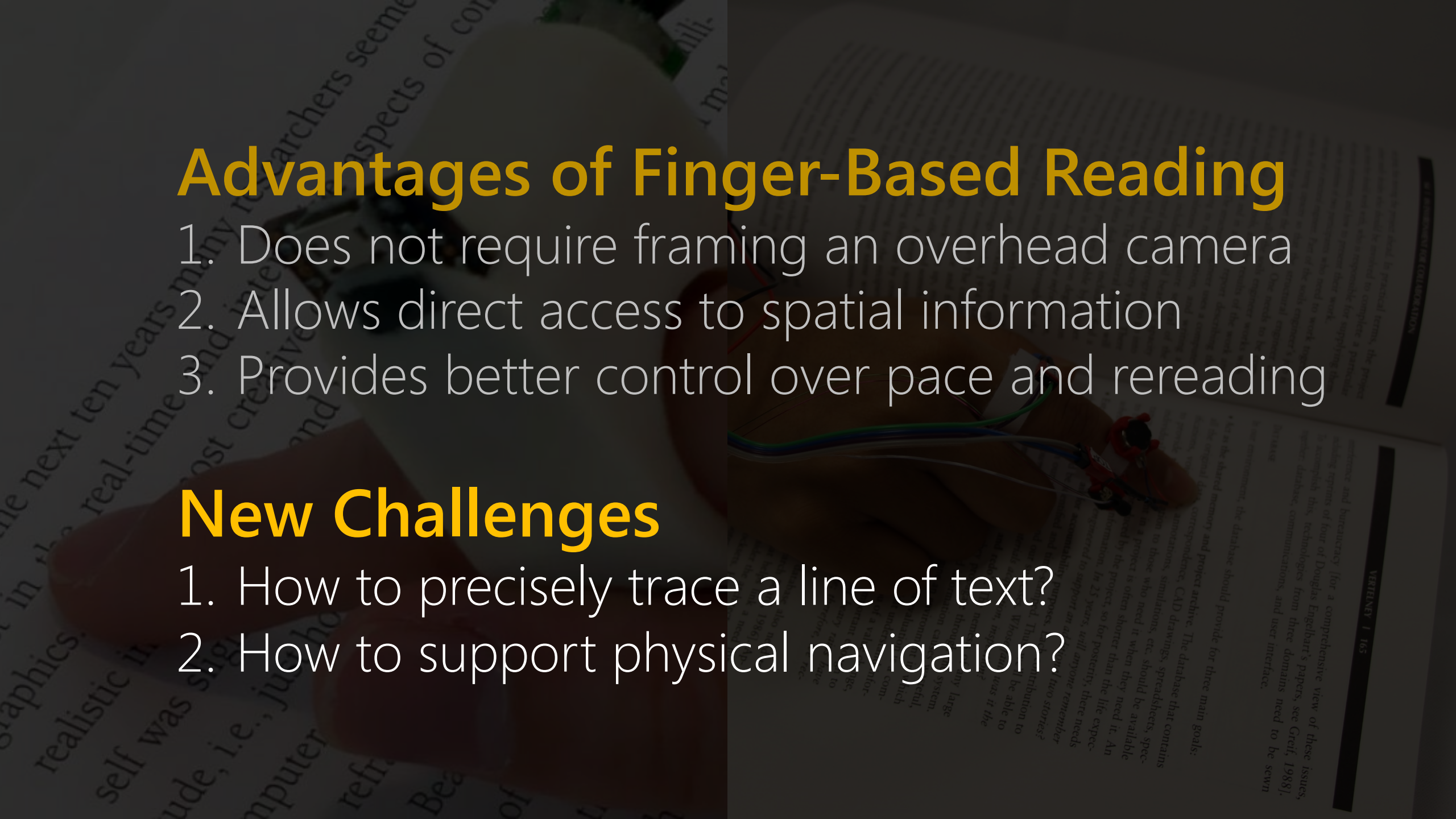


Advantages of Finger-Based Reading

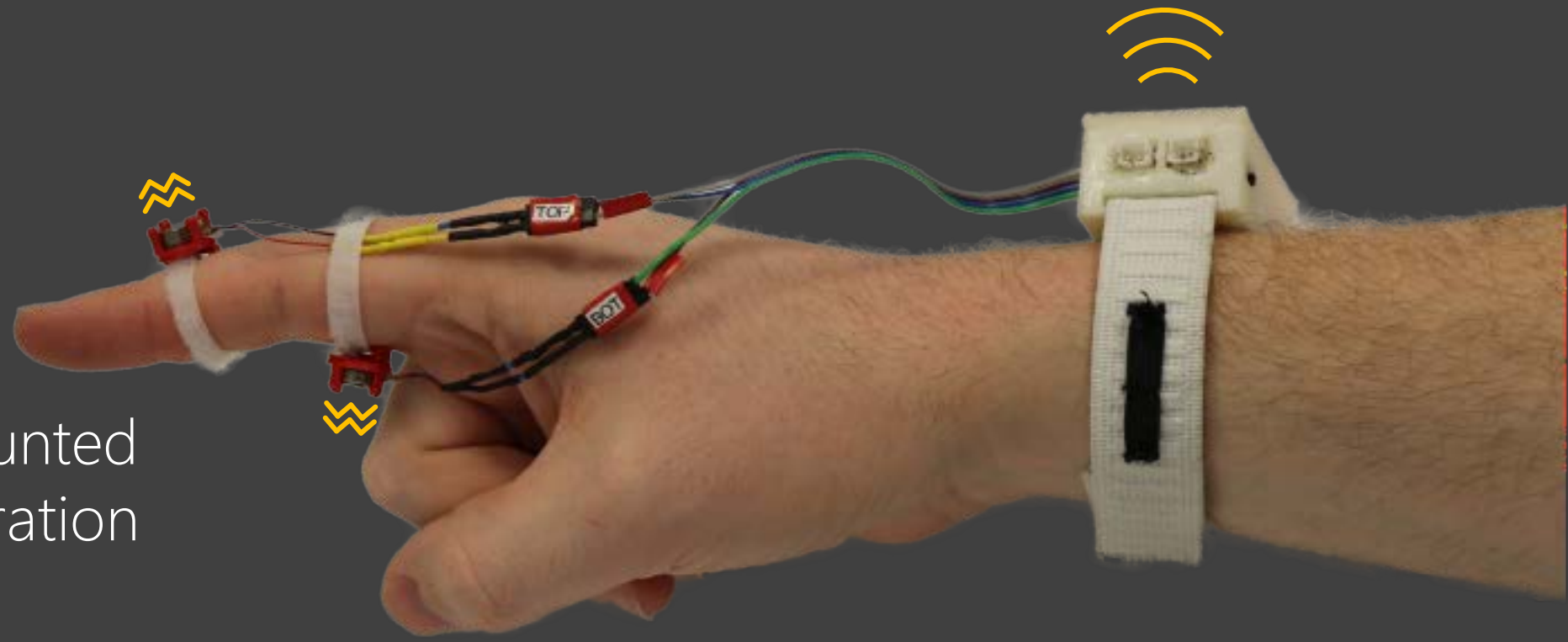
1. Does not require framing an overhead camera
2. Allows direct access to spatial information
3. Provides better control over pace and rereading

New Challenges

1. How to precisely trace a line of text?
2. How to support physical navigation?

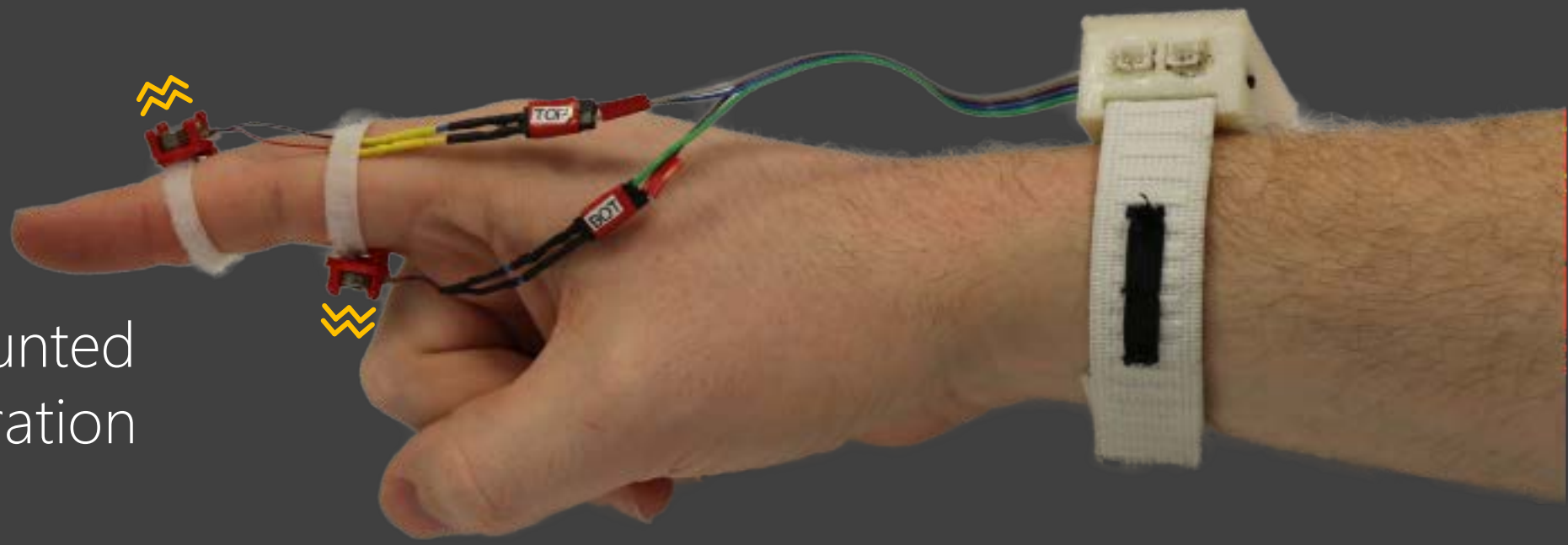
Comparing Two Types of Directional Finger Guidance

2. **Audio** via built-in or external speakers



1. Finger-mounted **haptic** vibration

Comparing Two Types of Directional Finger Guidance



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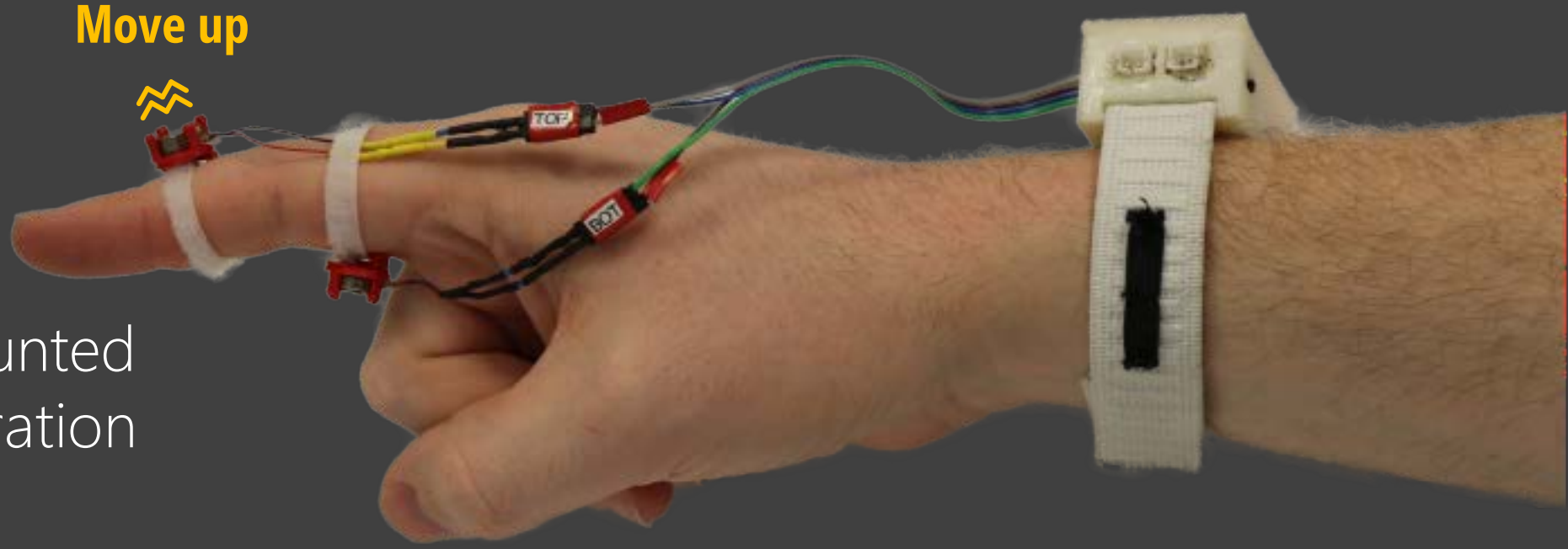

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Comparing Two Types of Directional Finger Guidance

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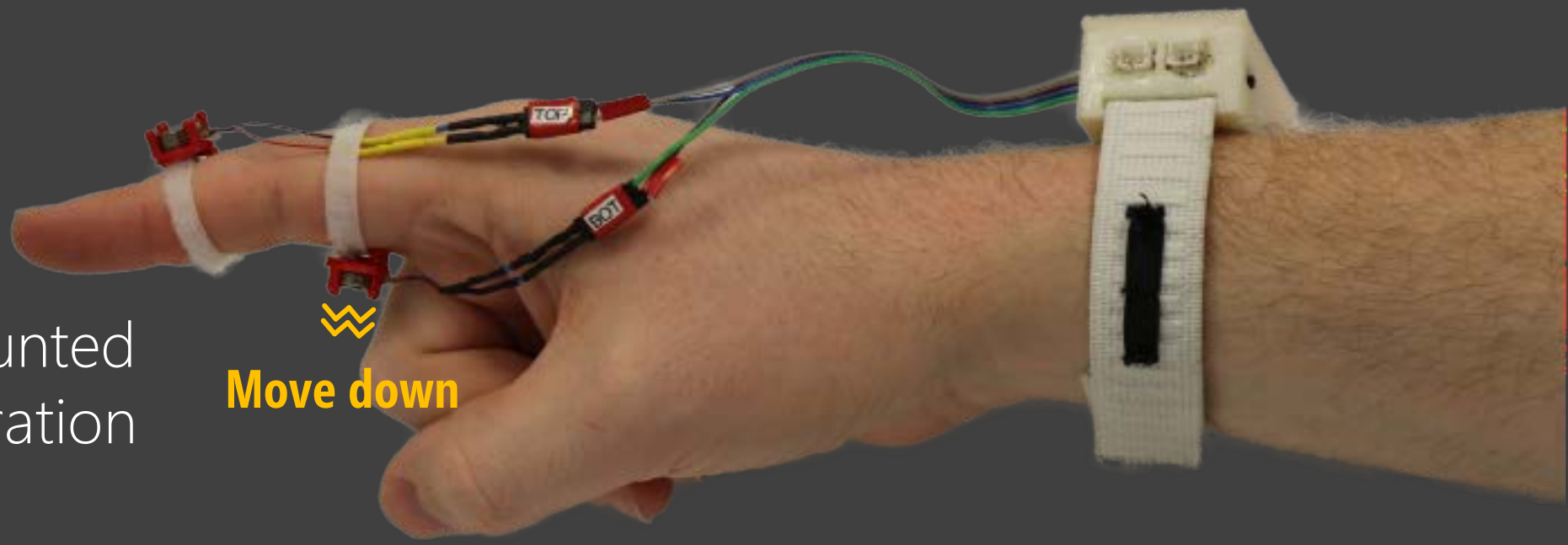

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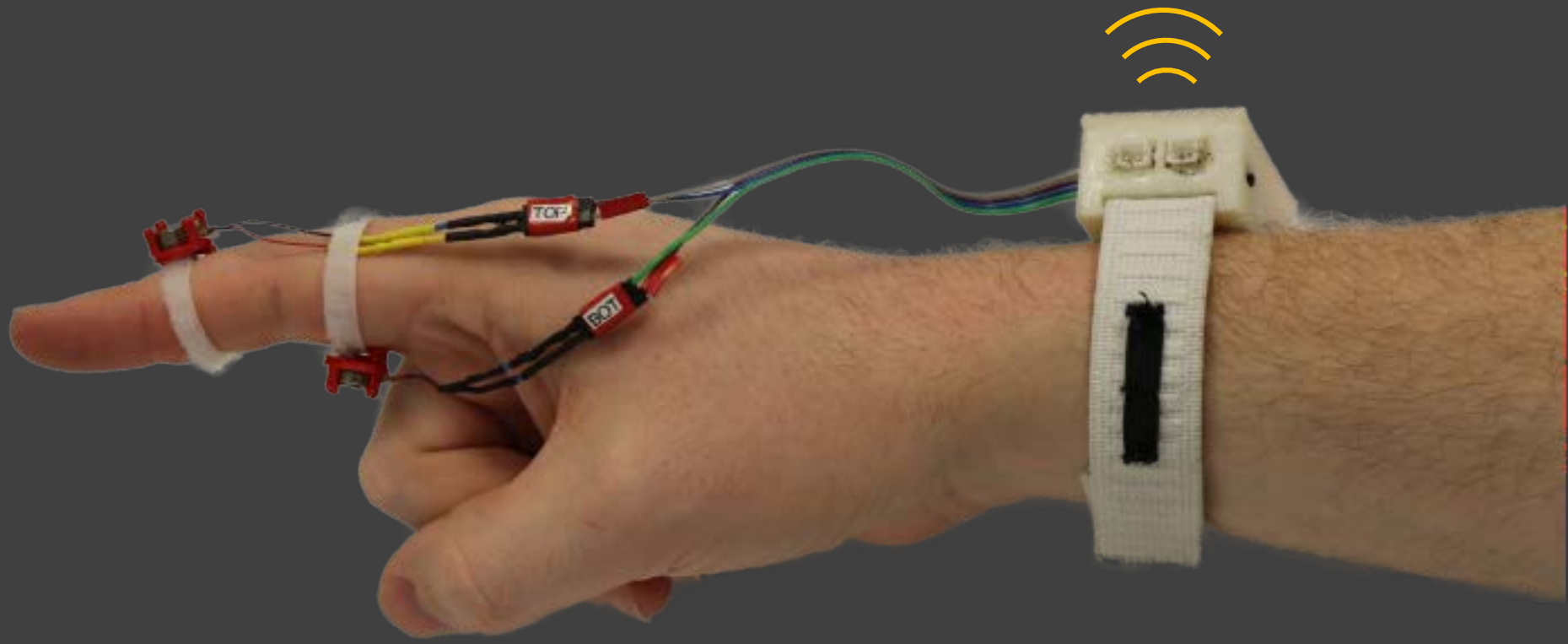
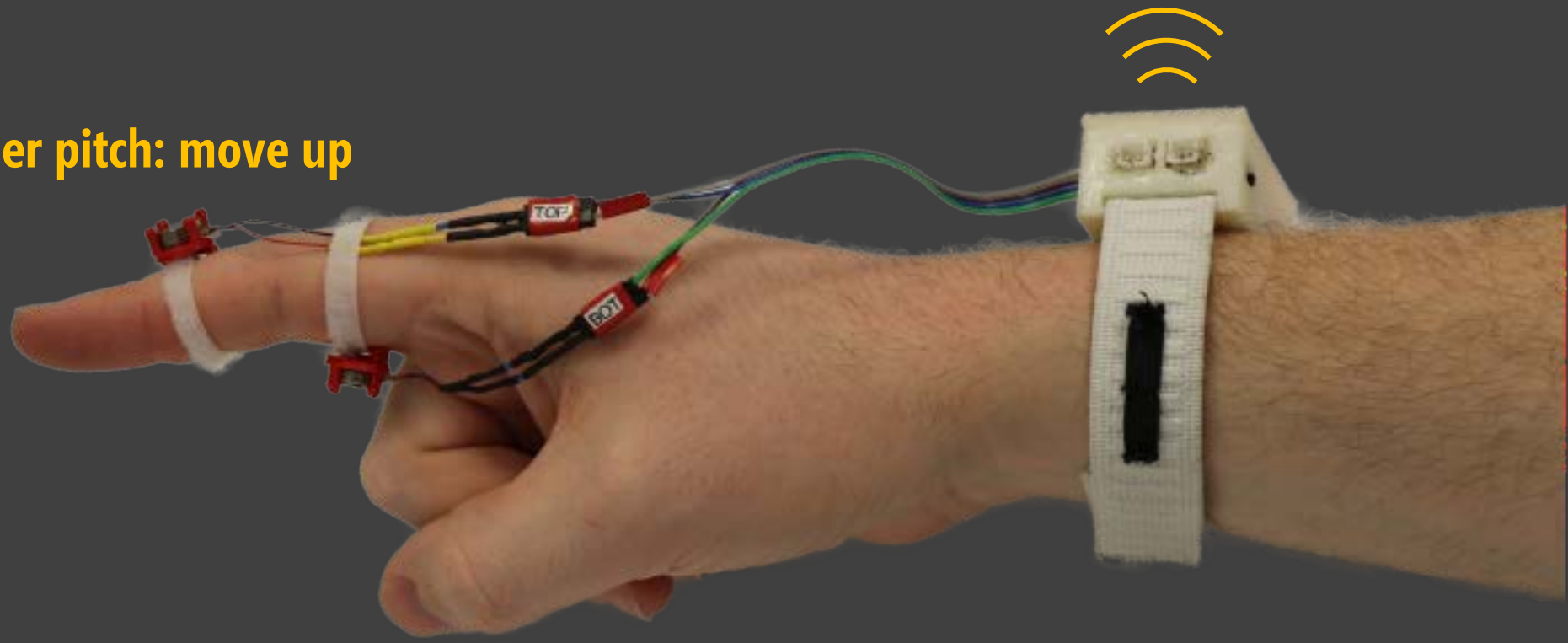


Comparing Two Types of Directional Finger Guidance

2. **Audio** via built-in or external speakers

Higher pitch: move up



Comparing Two Types of Directional Finger Guidance

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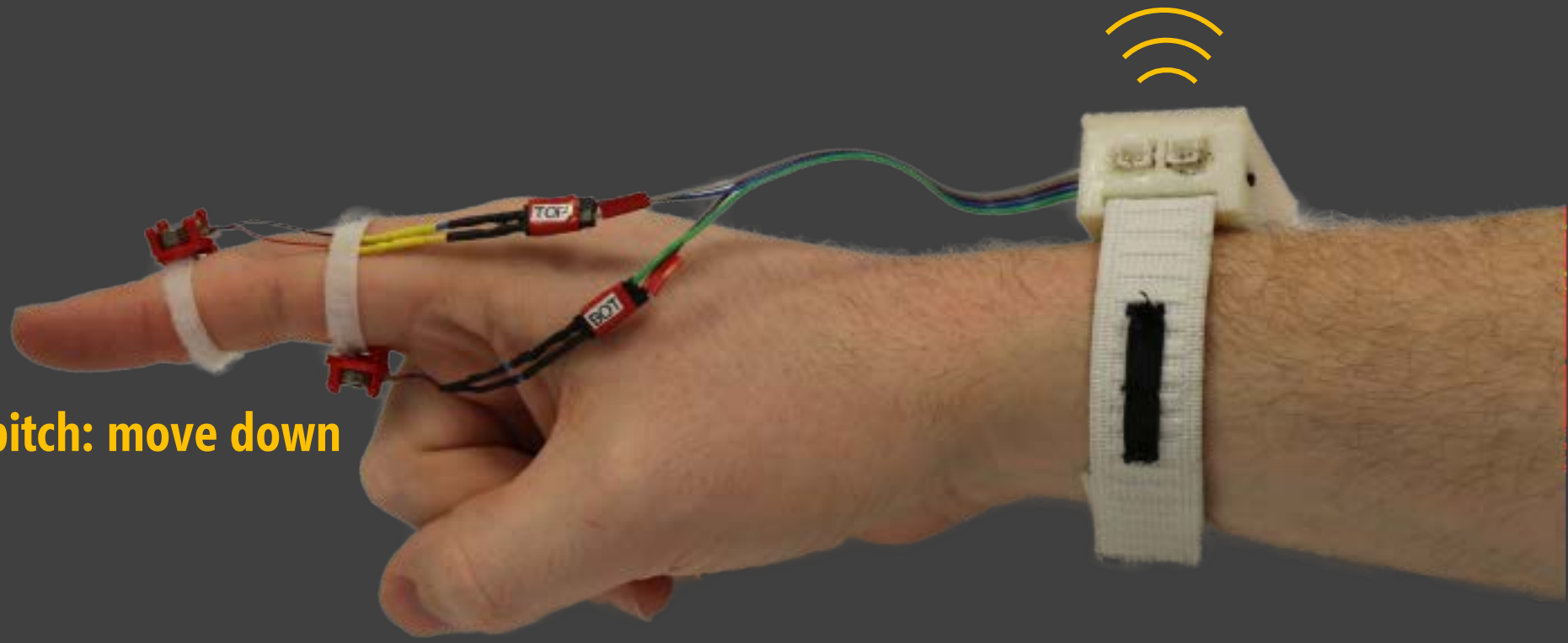
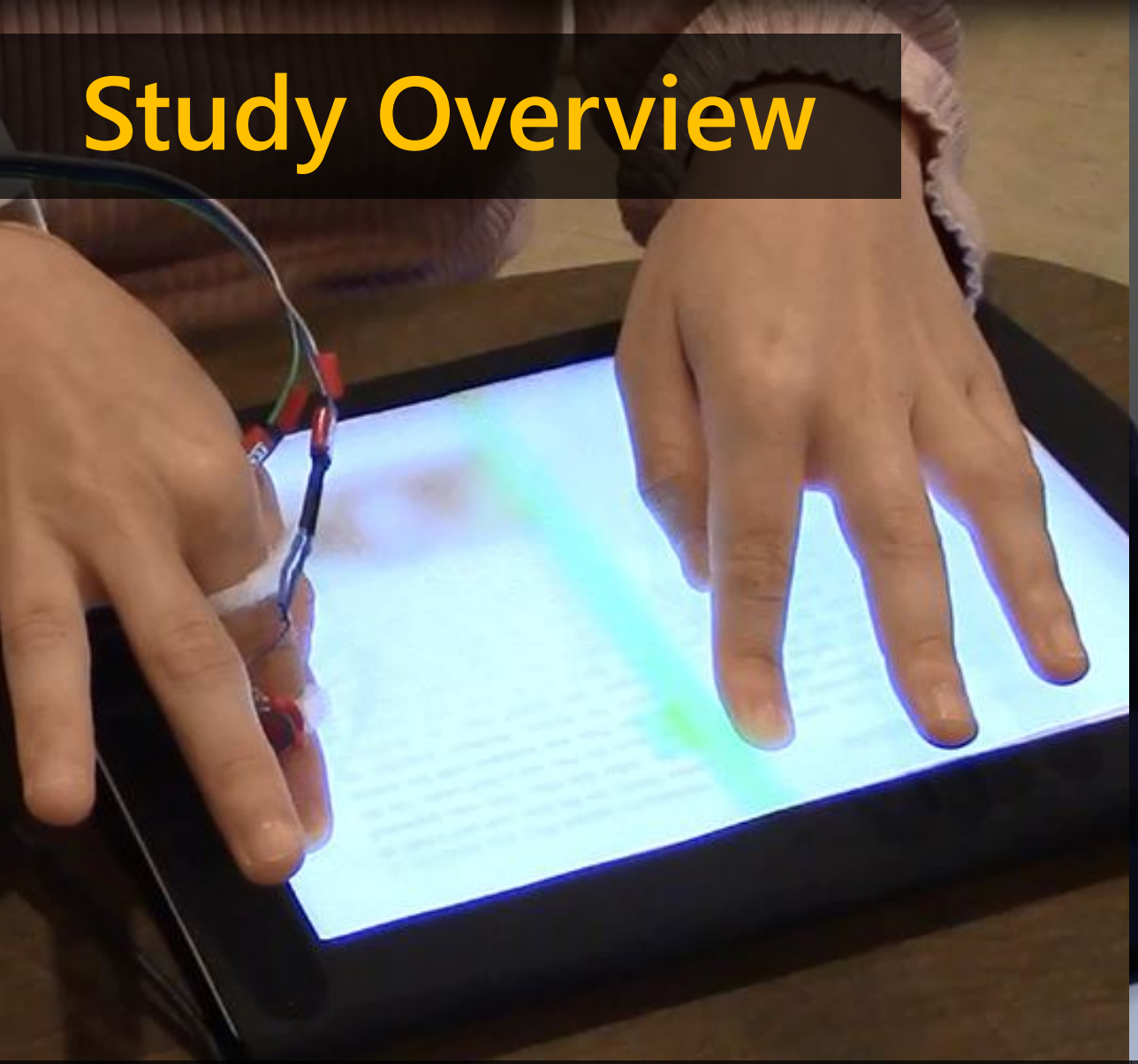


Lower pitch: move down

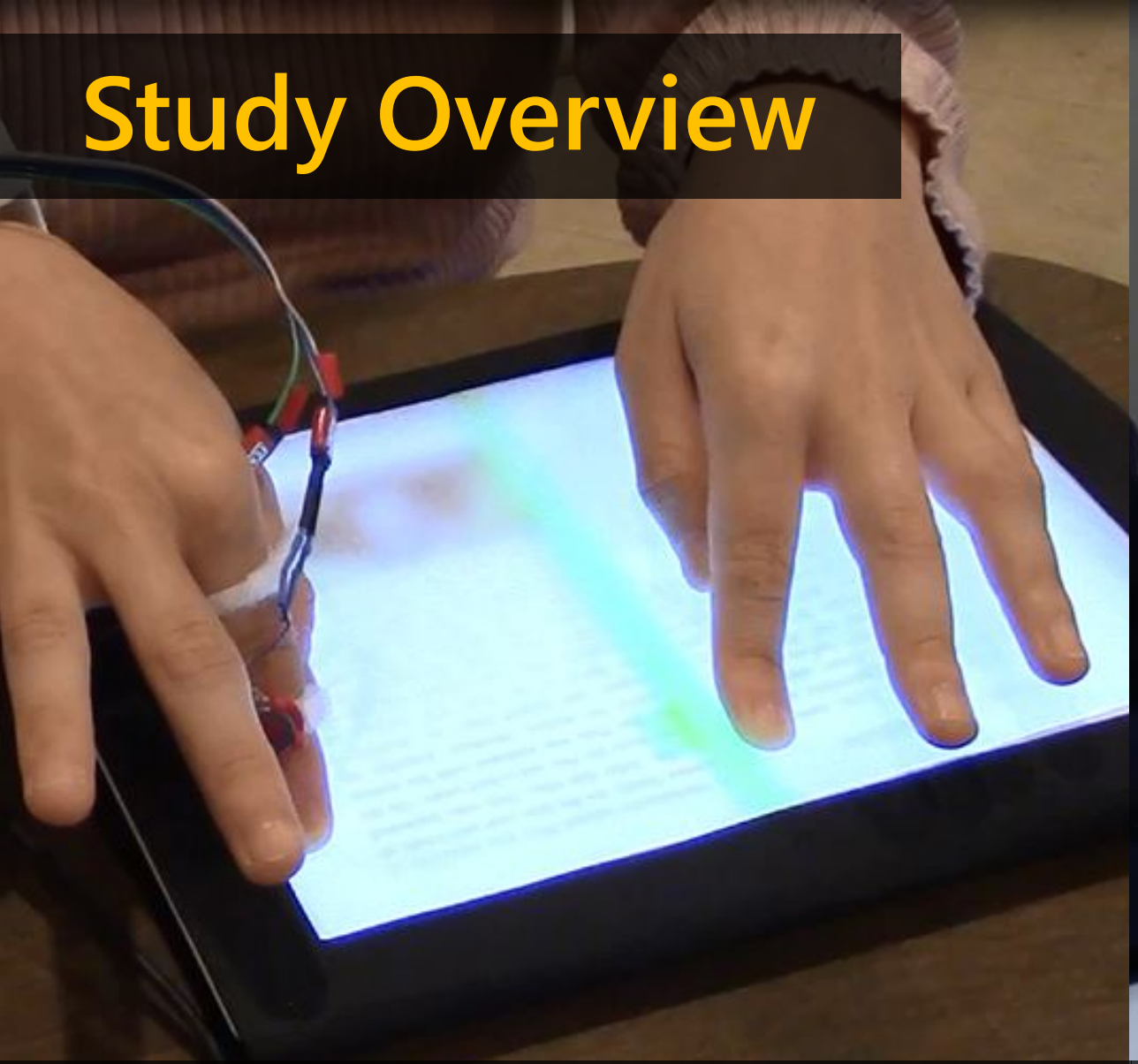
Study Overview



Study I: initial iPad study (19 participants)

Study II: physical prototype study (4 participants)

Study Overview



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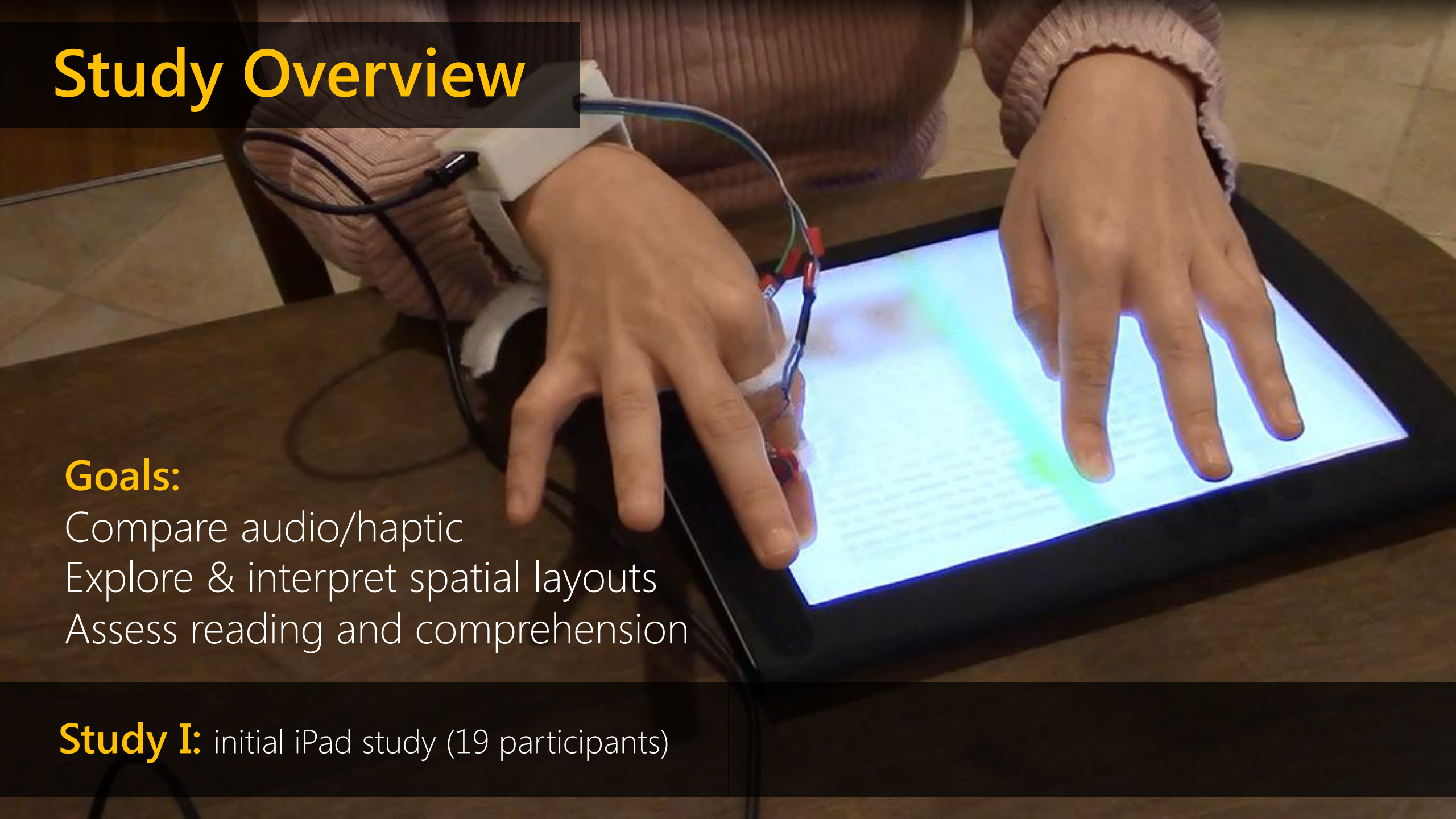


Goals:

Compare audio/haptic

Explore & interpret spatial layouts

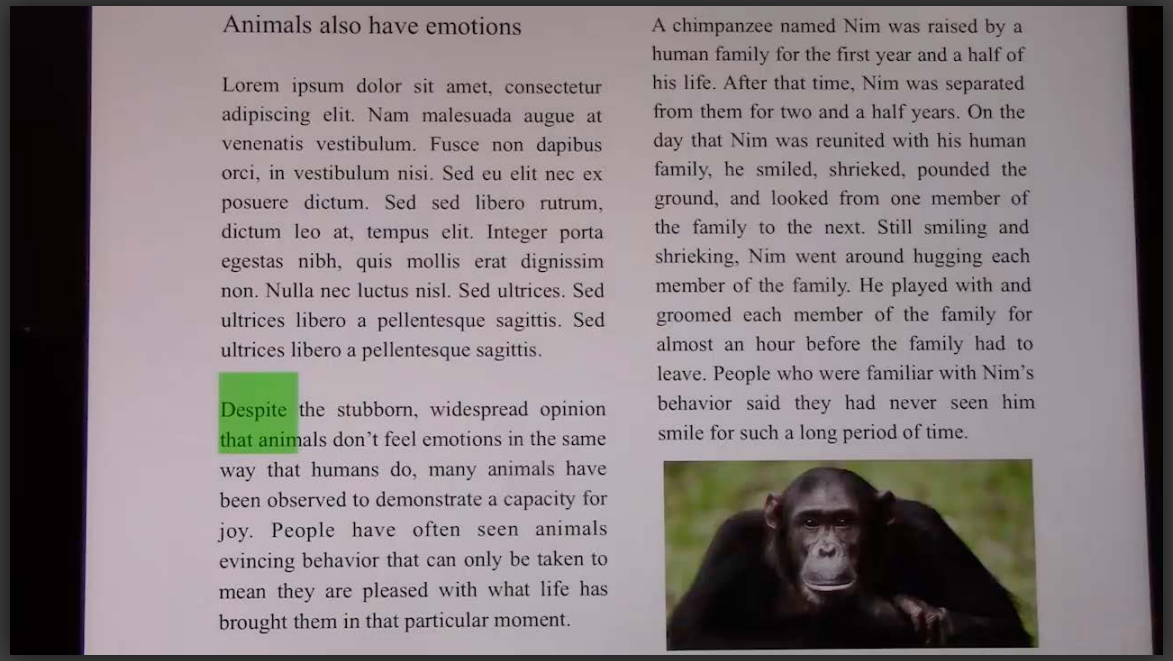
Assess reading and comprehension

Study I: initial iPad study (19 participants)

Study I

Used an iPad to focus on **user experience**, gather **finger trace** data

System Design: Exploration and Reading Modes



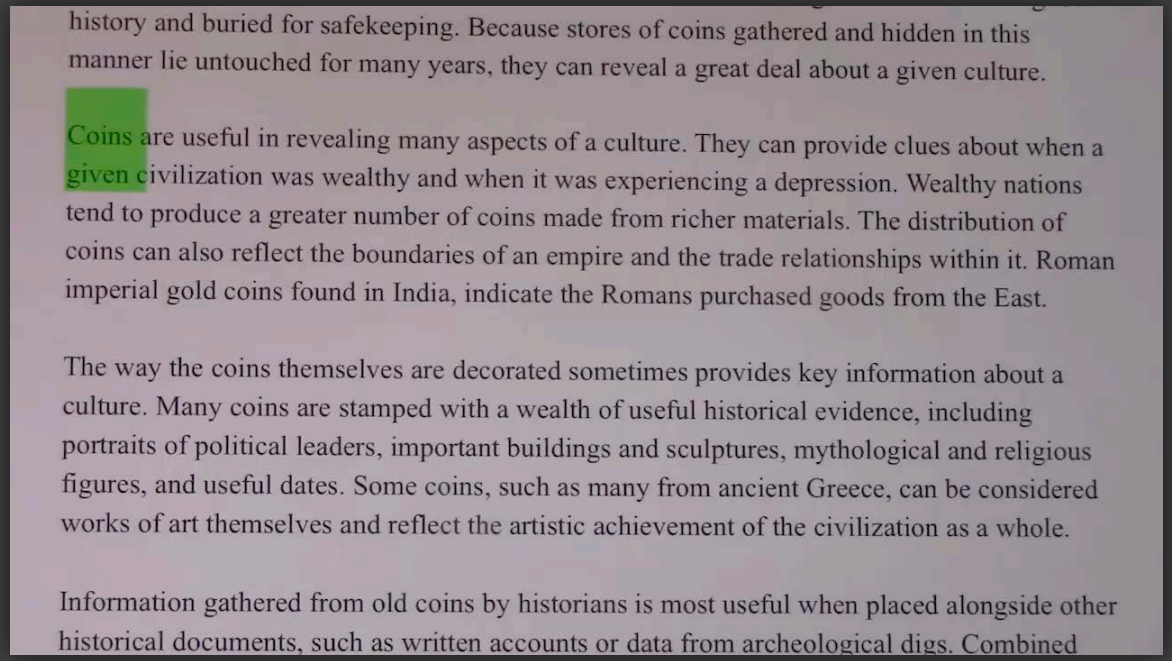
Animals also have emotions

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam malesuada augue at venenatis vestibulum. Fusce non dapibus orci, in vestibulum nisi. Sed eu elit nec ex posuere dictum. Sed sed libero rutrum, dictum leo at, tempus elit. Integer porta egestas nibh, quis mollis erat dignissim non. Nulla nec luctus nisl. Sed ultrices. Sed ultrices libero a pellentesque sagittis. Sed ultrices libero a pellentesque sagittis.

Despite the stubborn, widespread opinion that animals don't feel emotions in the same way that humans do, many animals have been observed to demonstrate a capacity for joy. People have often seen animals evincing behavior that can only be taken to mean they are pleased with what life has brought them in that particular moment.

A chimpanzee named Nim was raised by a human family for the first year and a half of his life. After that time, Nim was separated from them for two and a half years. On the day that Nim was reunited with his human family, he smiled, shrieked, pounded the ground, and looked from one member of the family to the next. Still smiling and shrieking, Nim went around hugging each member of the family. He played with and groomed each member of the family for almost an hour before the family had to leave. People who were familiar with Nim's behavior said they had never seen him smile for such a long period of time.

Exploration Mode



history and buried for safekeeping. Because stores of coins gathered and hidden in this manner lie untouched for many years, they can reveal a great deal about a given culture.

Coins are useful in revealing many aspects of a culture. They can provide clues about when a given civilization was wealthy and when it was experiencing a depression. Wealthy nations tend to produce a greater number of coins made from richer materials. The distribution of coins can also reflect the boundaries of an empire and the trade relationships within it. Roman imperial gold coins found in India, indicate the Romans purchased goods from the East.

The way the coins themselves are decorated sometimes provides key information about a culture. Many coins are stamped with a wealth of useful historical evidence, including portraits of political leaders, important buildings and sculptures, mythological and religious figures, and useful dates. Some coins, such as many from ancient Greece, can be considered works of art themselves and reflect the artistic achievement of the civilization as a whole.

Information gathered from old coins by historians is most useful when placed alongside other historical documents, such as written accounts or data from archeological digs. Combined

Reading Mode

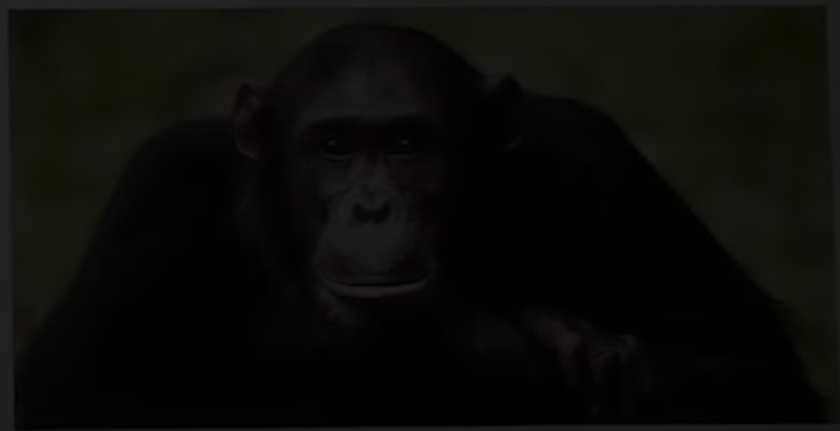
System Design: Exploration Mode

Continuous audio feedback to identify content beneath finger

Flute sound: text

Cello sound: picture

Silence: empty space



Animals also have emotions

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Silence: empty space

Flute sound: text

Cello sound: picture

System Design: Reading Mode

Right index finger to read, **left** to anchor start of line

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System Design: Reading Mode

Right index finger to read, **left** to anchor start of line

Two directional guidance conditions: **audio** or **haptic**

Used to stay on the line or find the start of the next line

Audio: pitch of continuous audio

Haptic: strength and position of vibration

System Design: Reading Mode

- **Right** index finger to read, **left** to anchor start of line
- Two directional guidance conditions: **audio** or **haptic**
  - Used to stay on the line or find the start of the next line
  - **Audio:** pitch of continuous audio
  - **Haptic:** strength and position of vibration
- Additional **audio cues** (same for both conditions)
  - Start/end of line or paragraph
  - Synthesized speech

history and buried for safekeeping. Be

manner lie untouched for many years,

Above the line: downward guidance
(low pitch or lower vibration motor)

this

ulture.

Coins are useful in revealing many aspects of a culture. They can provide clues about when a given civilization was wealthy and when it was experiencing a depression. Wealthy nations tend to produce a greater number of coins made from richer

coins

pire and the tra

imperial gold coins found in India, indicate the Romans purchased goods from the East.

Below the line: upward guidance
(high pitch or upper vibration motor)

Start/end of line or paragraph
(short but distinctive audio cues)

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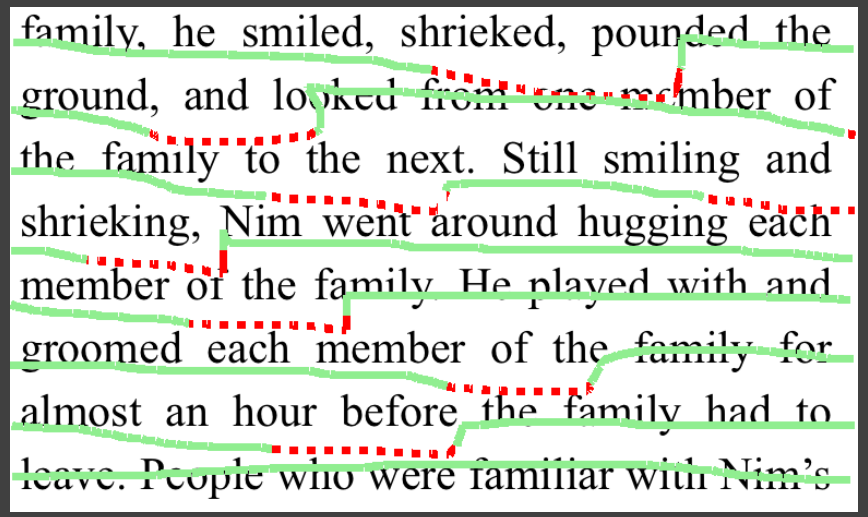
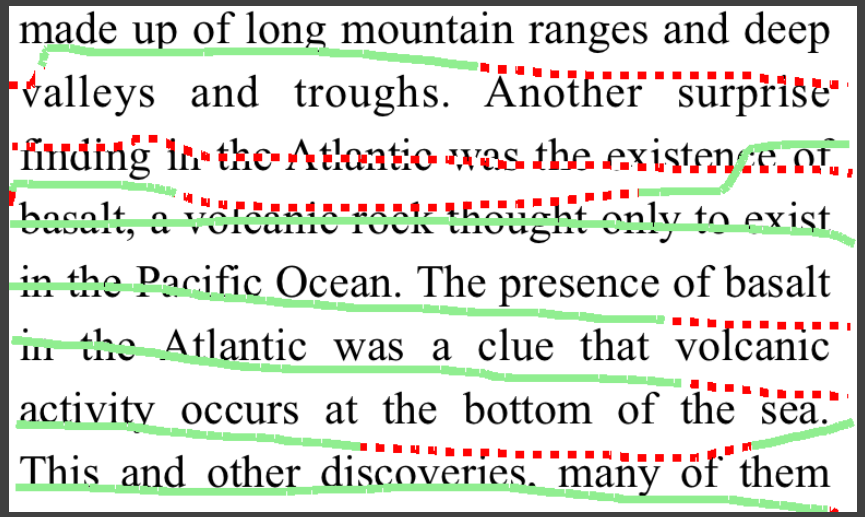
Study I Findings

Haptic vs. Audio: Quantitative Performance

audio



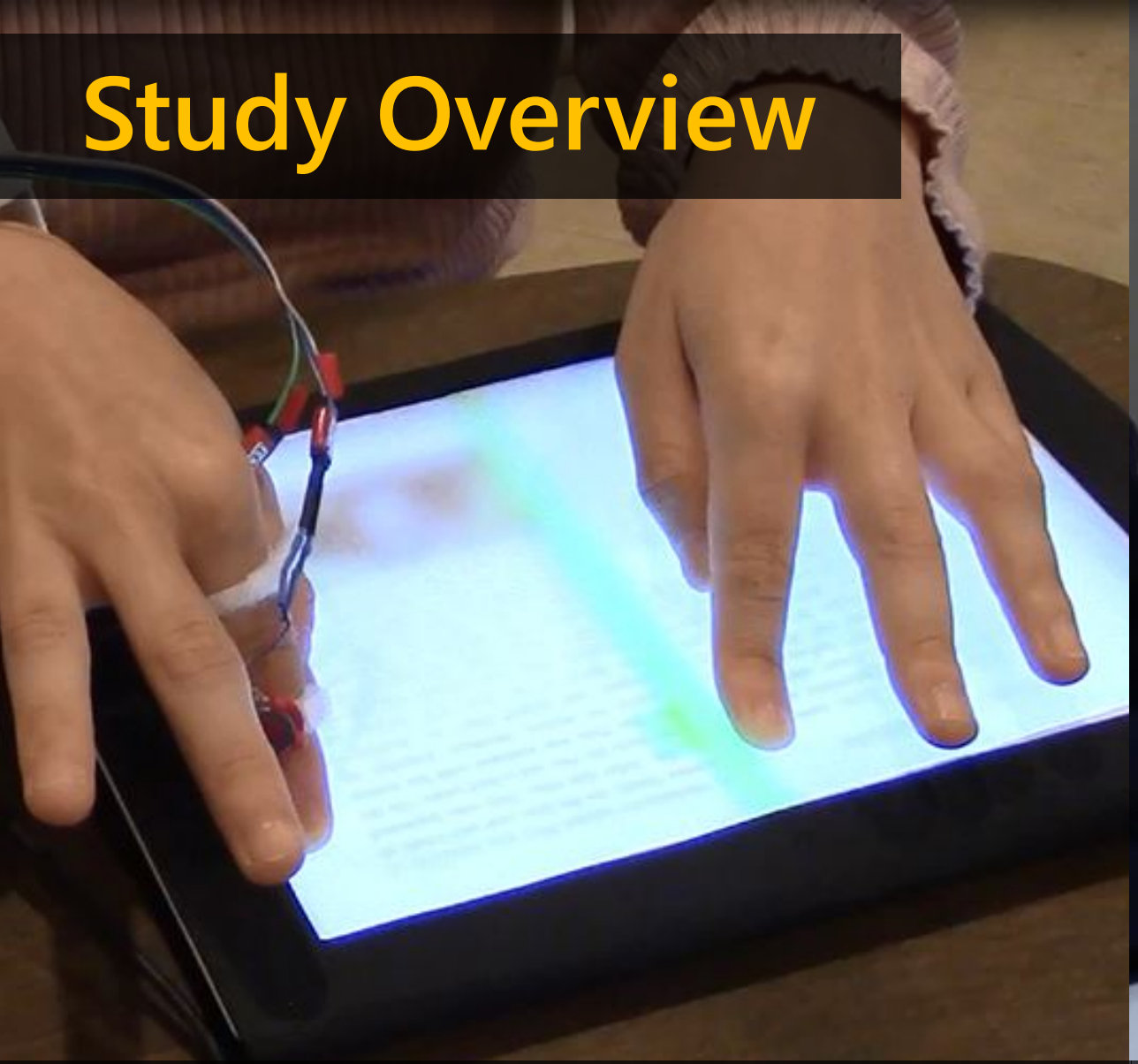
haptic



Example finger traces—**Dashed red lines** mark drift off of the line

Audio had better accuracy for some types of document (magazine style)

Study Overview



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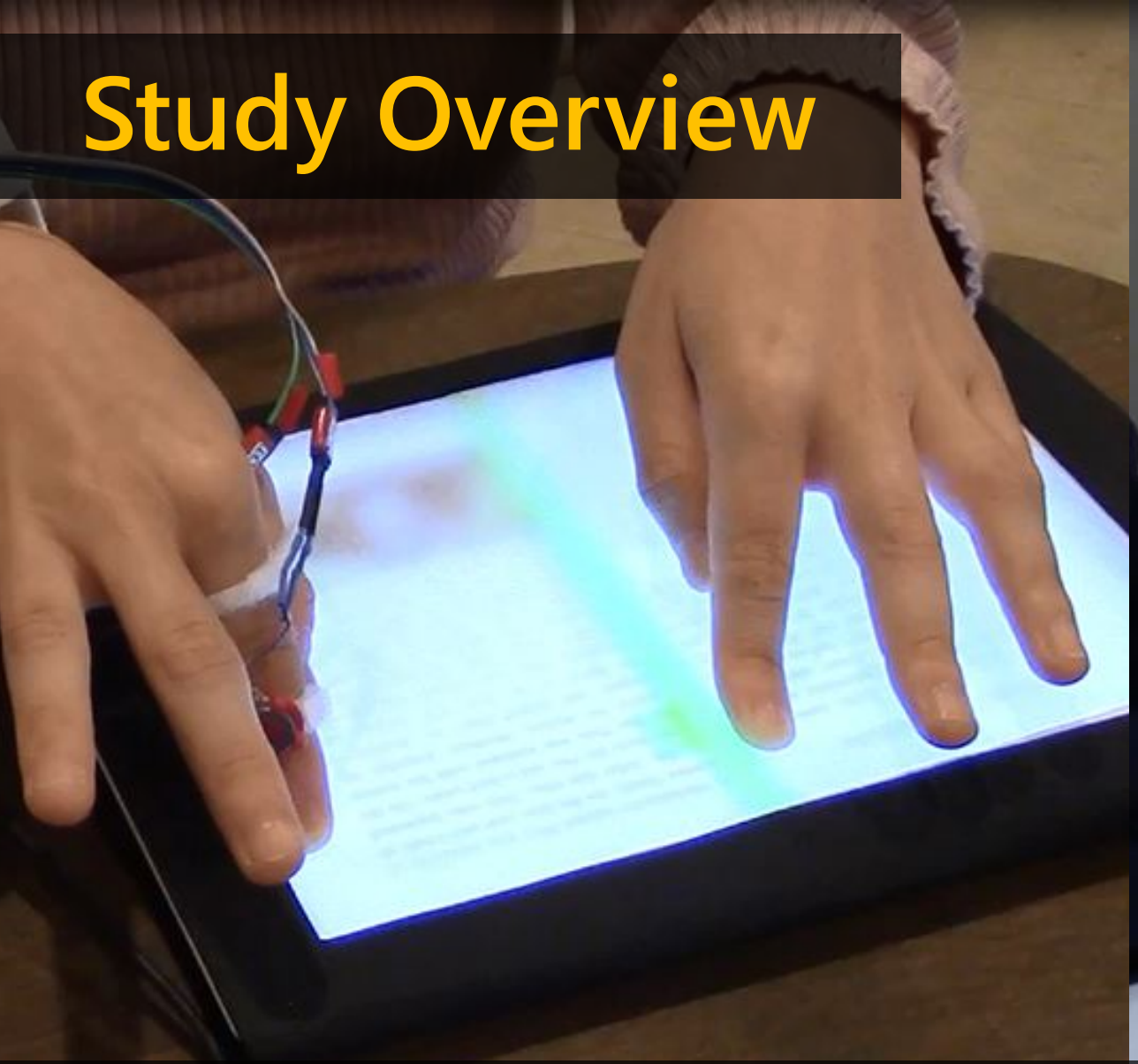


Study I: initial iPad study (19 participants)

Study II: physical prototype study (4 participants)

Study Overview

Goals:

Evaluate HandSight prototype

Gather subjective feedback

Compare with KNFB Reader iOS

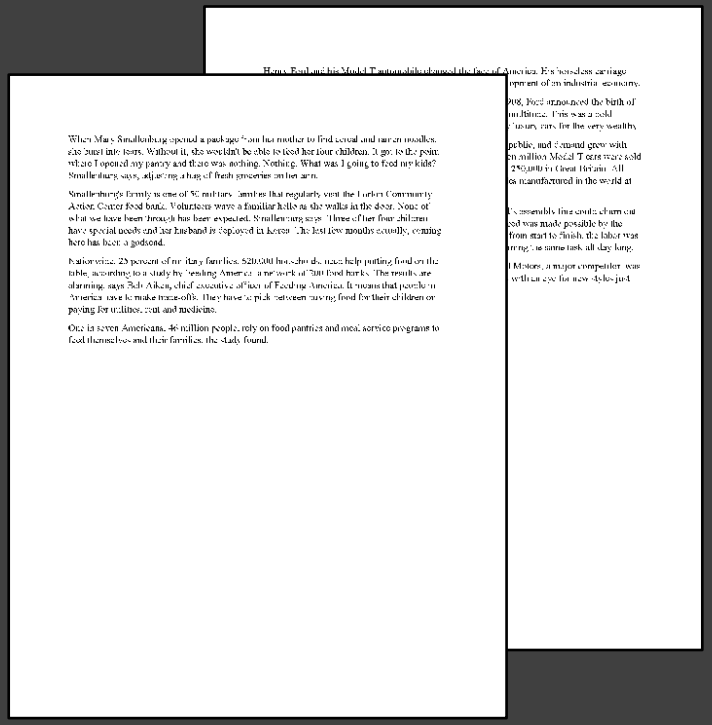
Study II: physical prototype study (4 participants)

Study II: HandSight Prototype System

Study II Method

HandSight:

Each participant used their preferred guidance from Study I to explore and read physical documents



When Mary Smallenburg opened a package from her mother to find cereal and macaroni noodles, she burst into tears. Without it, she wouldn't be able to feed her four children. It got to the point where I opened my pantry and there was nothing. Nothing. What was I going to feed my kids? Smallenburg says, adjusting a bag of fresh groceries on her arm.

Smallenburg's family is one of 50 visitors Tuesday that regularly visit the Harlem Community Action Center food bank. Volunteers wave a familiar hello as the walks in the door. None of what we have been through has been expected. Smallenburg says. Three of her four children have special needs and her husband is deployed in Korea. The last few months actually, coming here has been a godsend.

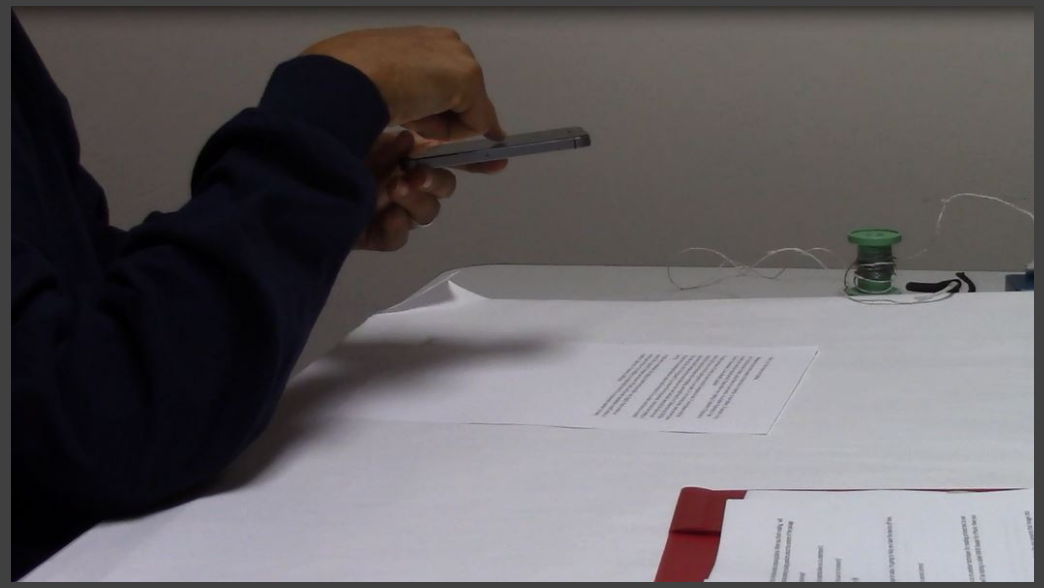
Nationwide, 25 percent of the many families, 820,000 households, need help putting food on the table, according to a study by Feeding America, a network of 200 food banks. The results are alarming, says Bob Aiken, chief executive officer of Feeding America. It means that people in America have to make trade-offs. They have to pick between buying food for their children or paying for utilities, rent and medicine.

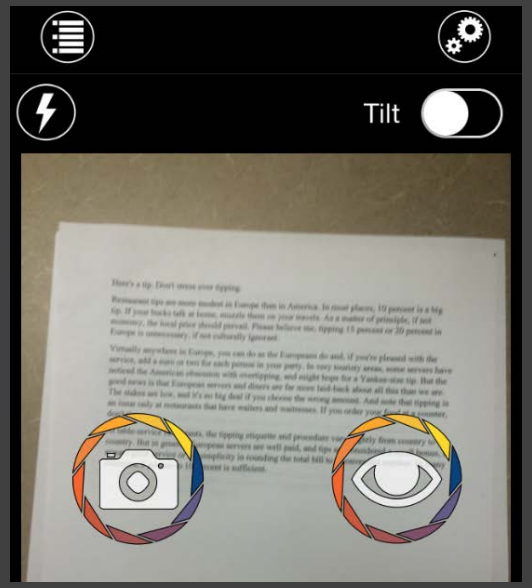
One in seven Americans, 46 million people, rely on food pantries and meal service programs to feed themselves and their families, the study found.

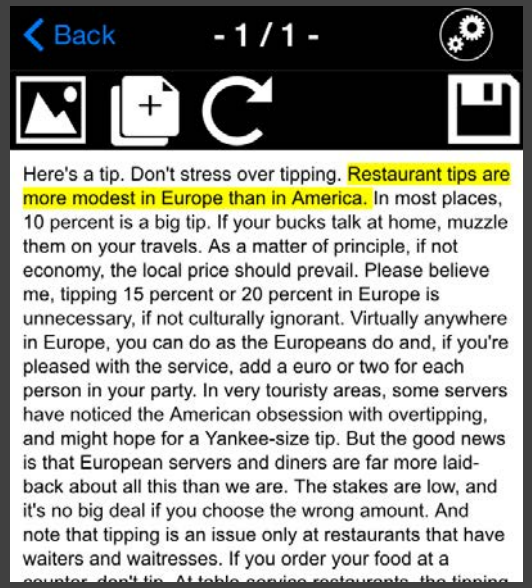
Study II Method

KNFB Reader iOS:

Photograph and read physical documents







Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	
Spatial layout information	

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	
Spatial layout information	
Direct control over reading	

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

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Spatial layout information	
Direct control over reading	
Reduced camera framing issues	

Implications

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Efficient text detection and recognition	

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

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Spatial layout information	
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Reduced camera framing issues	
Efficient text detection and recognition	

* We observed these in our studies

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	Cons
Spatial layout information	**Slower, requires increased concentration and physical dexterity**
Direct control over reading	
Reduced camera framing issues	
Efficient text detection and recognition	

* We observed these in our studies

Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	Cons
Spatial layout information	**Slower, requires increased concentration and physical dexterity**
Direct control over reading	* Consistent with previous research
Reduced camera framing issues	
Efficient text detection and recognition	
* We observed these in our studies	

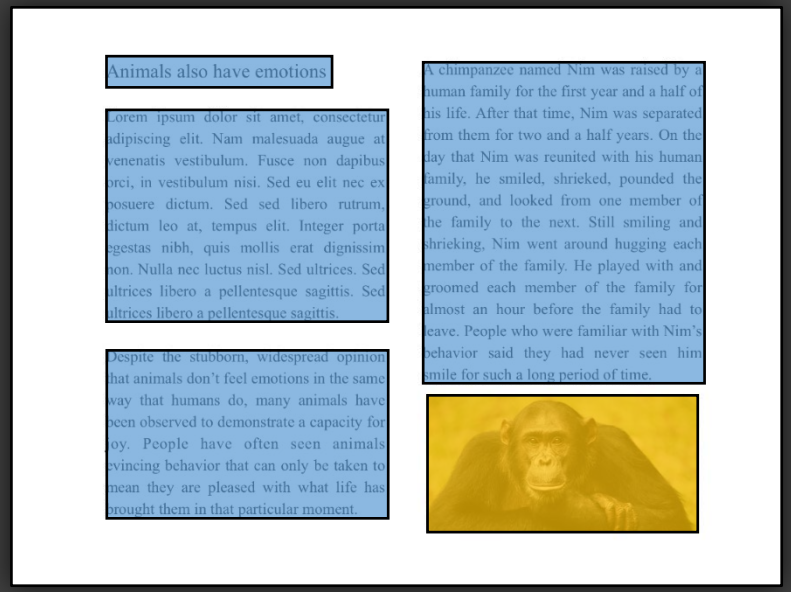
Implications

Advantages and Disadvantages of a Finger-Based Reading Approach

Pros	Cons
Spatial layout information	Slower, requires increased concentration and physical dexterity
Direct control over reading	* Consistent with Shilkrot *et al.* 2014, 2015
Reduced camera framing issues	**Importance of spatial layout information is unclear**
Efficient text detection and recognition	
* We observed these in our studies	

Future Work

Study usefulness of spatial layout information in everyday use



(*e.g.*, newspapers, menus, maps, graphs)

Future Work

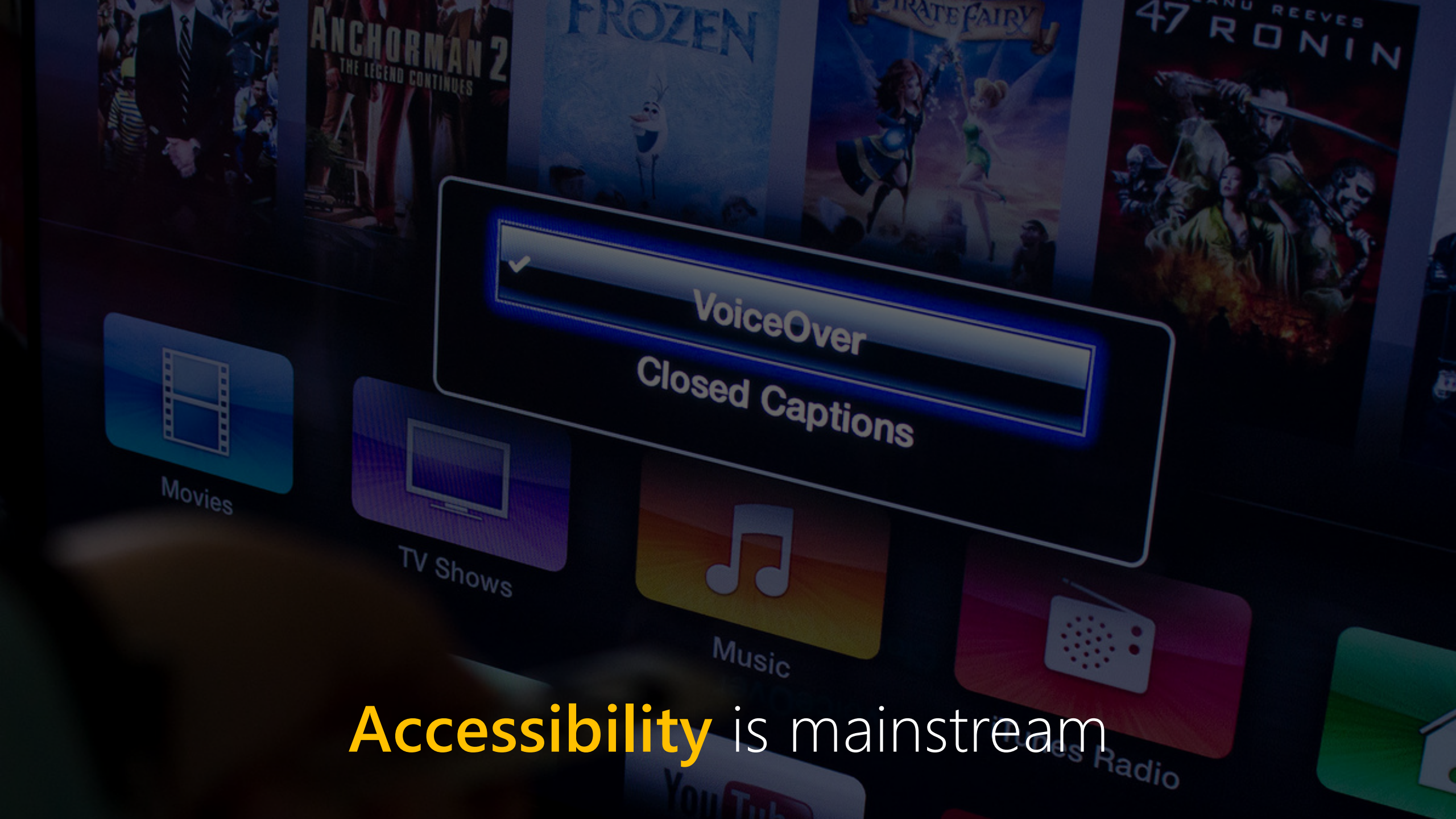
Study usefulness of spatial layout information

Explore possibilities for camera placement

HandSight

a vision augmented touch system

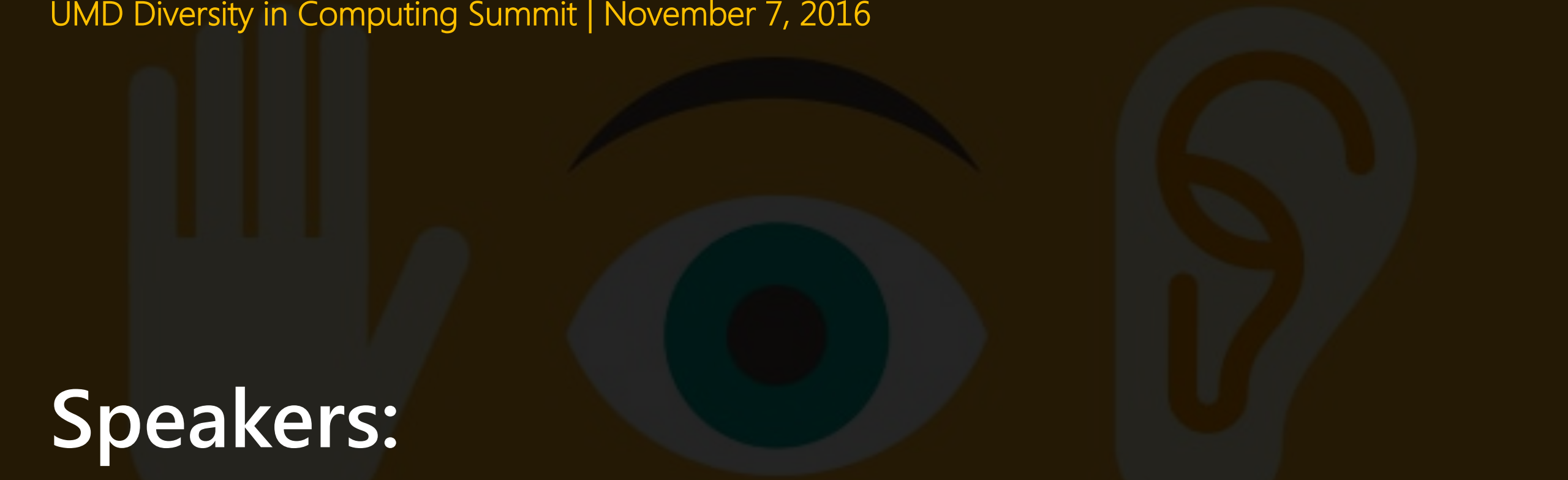

Accessibility is an important part of **diversity**



Accessibility is mainstream

Interactive Computational Tools for Accessibility

UMD Diversity in Computing Summit | November 7, 2016



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makeability lab

inclusive design lab

HCIL Human Computer Interaction Laboratory

COMPUTER SCIENCE UNIVERSITY OF MARYLAND

UNIVERSITY OF MARYLAND