

ACM UIST 2022 Notes

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Haiqing Xu <your-name> [Feel free to request editing privilege :)]

Collaborators, feel free to add your name to the list; let's organize papers in different categories and paste 1~3 best pictures to represent the key ideas

UIST Official Site: <https://uist.acm.org/uist2022/>

Teaser:  [UIST 2022 Teaser](#)

Program: <https://programs.sigchi.org/uist/2022>

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Discord: <https://discord.com/channels/734723053036109904/>

Paper Statistics: 98 submissions + 2 TOCHI / 372, 26.3% vs. 25.9%, 69 PC

Past Notes: (Public)  [Public] CHI 2022 Trip Report ([go/chi22-doc](#))

(Internal) [go/uist21-doc](#), [go/uist19-summary](#), [go/chi19-doc](#), [go/siggraph-2019-trip-report](#), [go/ieee-vr-2019-trip-report](#)

Keynotes

Opening: [Ted Chiang](#) - Thoughts on Being a Cyborg

Keywords:

computer interfaces, computer graphics, different languages, computer human interaction, human computer interaction, handheld computer, cognitive technologies, computer programming languages, modern technology, direct brain interfaces, personal computer, laptop computer, computer text, desktop computer, external brain, brain implants, different time, new cognitive technology

Full text: https://lu8iaqkext.feishu.cn/minutes/obcnhf37fa3arif76vf83786?from=from_copylink



Learning from past

- Imperial Earth: 1960s -> imagine text / graphics on the screen -> calculator + clocks
- Snow Crash by Neal Stephenson: 1992 -> Google Earth; recording speech using visual symbols
- [From Reading in the Brain](#), Stanislas Dehaene, 2010 -> will character evolve in the future?

Humans naturally pick up speech (like birds sing), writing is artificially taught

- written language was iterated to make reading quicker (spacing, lower/upper case, etc)
- there are less ambiguities in written language. Different phrases can sound very similar.
 - e.g., How to wreck a nice beach vs. How to recognize speech

Rhyme and meter helped to memorize phrases, as one could anticipate how the next line should sound like. Since the introduction of written language, rhyme and meter became optional/decorative.

Why are we writing a presentation beforehand that is delivered orally?

- Writing helps you organize your thoughts -> cognitive technology, technology for thinking

Does it make us a cyborg? It extends our abilities.

- Eyeglasses fix a biological deficit.
- Neurolink implants -> motor-impairments -> Elon musk -> more productive -> skeptical -> advantage over biological abilities?

Externalizing thoughts in writing can extend but also limit us. What happens when we don't have access to our devices anymore?

- Our body works great as a biological adapter to use and manipulate physical objects. What would it take to invasively extend the abilities through augmentation? And will it make things much better?

Math and programming languages are tools for thinking within a specific domain.

Computer text -> computer graphics -> What's next?

speech -> (*we gained the concept of words, rhyme and meter lose their utility*) -> the written word -> (*what linguistic features might we gain?, what else loses its utility?*) -> ?

What is the next step beyond written language itself? What is the next cognitive technology that is better than writing?

- discovery that are neurons that detect shapes. Could there be symbols, especially for displays?

Is technology dehumanizing? Cyborg, humans part of a cog.

What technology is humanizing? Would the presenter have told their stories, when they grew up in an environment where there is no written language? Storytelling is more about the performance. Ted is glad he has access to written language.

- Technology will give us new ways to be human.
- Writing was around for a long time, but it takes centuries until it is dominant; someone could easily propose a new symbolic input, but shifts have to occur incrementally: low-case, punctuations - no one would understand them if introduced all at once.

David's own thoughts:

- Alphabet and language are encoding that a sufficient number of people have agreed on. These are maybe minimal as pens and typewriters are only that much expressive. With access to generative art and media online, can we extend language with more expensive pictograms on-the-spot? Emojis are already helping add emotional nuances to written language (e.g. make understanding sarcasm more easily. etc.). These may help convey thoughts more efficiently. But what could help us think better? E.g. mind maps, diagrams / flowchart? What about other non-linear types of storytelling? Is hypertext/web that? But it's somewhat slow. Could AR glasses make hypertext more instant? Make it feel more like an extension of ourselves rather than a tool I use asynchronously? Can we share that mind map/hypertext with other people more efficiently for easier "thought transplantation"? Can we represent verbs and adjectives visually as edges/connections in mind maps, and nodes as objects/subjects/concepts? More visually expressing concepts and relationships of ideas to another... Can a mind map be expressive as a picture? Understanding things at one glance, rather than "reading" the mind map.

Ruofei's own thoughts:

- At one time, there would be a minimum language required for people to understand each other, whereas real-time visuals, graphics, and ad hoc, automatic communication assists people to build trust and resolve ambiguities.
- One of the main reasons speech is still preferred than language is that it attracts multi-modal attention and leverages multiple parts of brain: sound, visual, language, gestures, body language, micro expressions; which emphasize memories and help people build trust.
 - This is also why Tiktok, Dalle-2, Imagen is popular by adding additional dimensions to language alone.

- Immersion aids recall.

Vision Talk: [Barbara Tversky](#)



Space, cognition, and action.
Gestures are actions; can they help action understanding?

Vision Talk: [Jaime Teevan](#)

<https://www.microsoft.com/en-us/research/publication/microsoft-new-future-of-work-report-2022/>



Closing: [Marissa Mayer](#)

AMA Session by Lining Yao on "Doing antidisciplinary research"

Keywords:

thing right, engineering design, right way, different things, designer way, junior researchers, team right, different ways, Right nature physics, physical materials, disciplinary research, right doctors, right lifestyles, perfect right, field engineering material science, Matrix engineering things, different backgrounds designer

Text version link: https://lu8iaqkext.feishu.cn/minutes/obcng72tvmn4ixw392p9rkgr?from=from_copylink

Technical Programs

Virtual Reality / Augmented Reality

Sensory

Integrating Real-World Distractions into Virtual Reality

<https://programs.sigchi.org/uist/2022/program/content/85035>



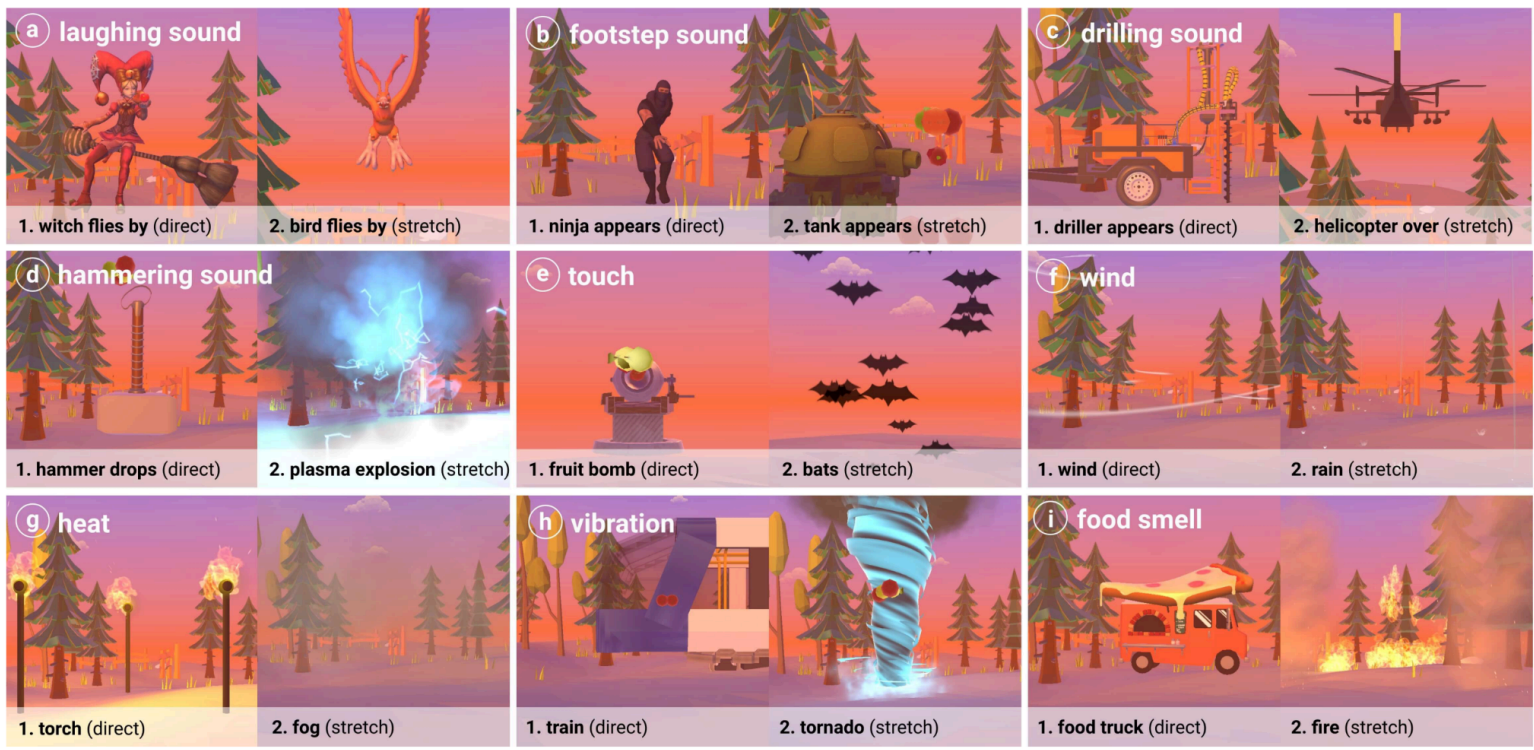
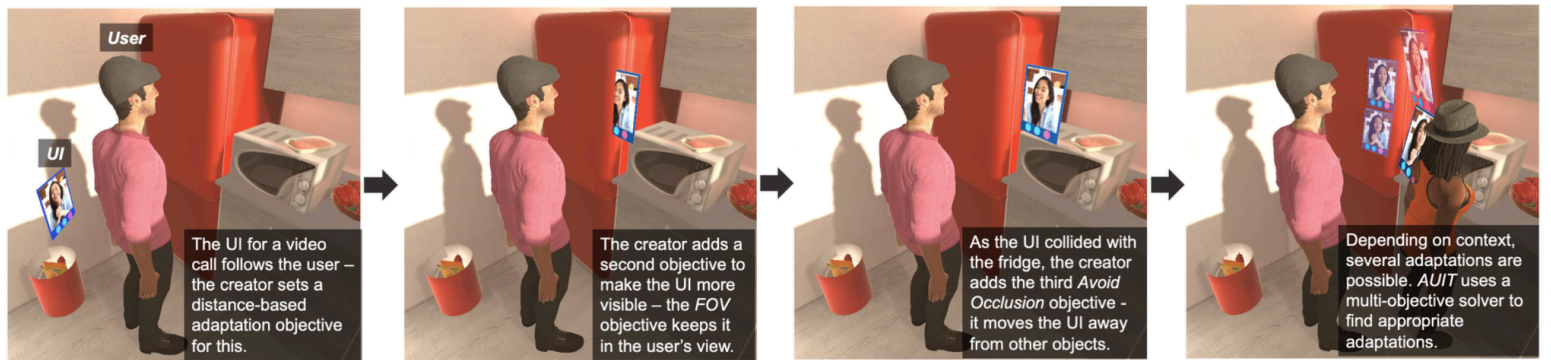


Figure 7: Study #1 mapping design used in custom fruit ninja game. It involves four sound stimuli: (a) laughing sound, (b) footstep sound, (c) drilling sound, (d) hammering sound, and five multimodal stimuli: (e) touch, (f) wind, (g) heat, (h) vibration and (i) food smell. For each distraction, we designed both a *direct* and *stretch* mapping that attempted to integrate this distraction into VR.

Layout

AUIT – the Adaptive User Interfaces Toolkit for Designing XR Applications

[pdf](https://programs.sigchi.org/uist/2022/program/content/85060)
<https://programs.sigchi.org/uist/2022/program/content/85060>



See-through

RealityLens: A User Interface for Blending Customized Physical World View into Virtual Reality

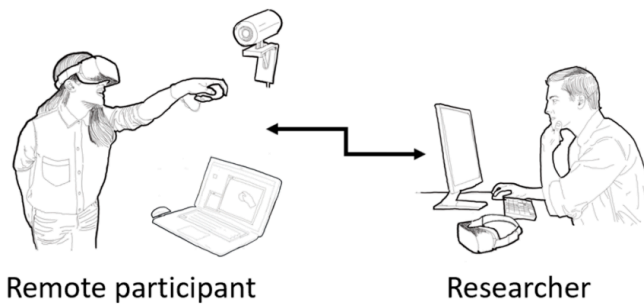
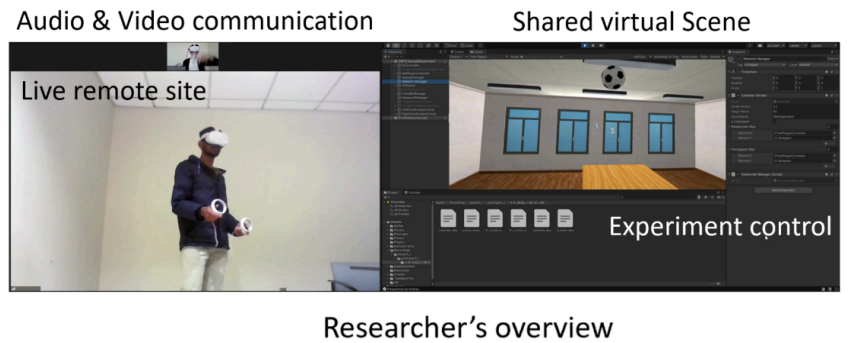
<https://programs.sigchi.org/uist/2022/program/content/85028>



Multi-player

RemoteLab: Virtual Reality Remote study Tool Kit

<https://programs.sigchi.org/uist/2022/program/content/84991>



PassengXR: A Low Cost Platform for Any-Car, Multi-User, Motion-Based Passenger XR Experiences

<https://programs.sigchi.org/uist/2022/index/content/84970>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545657>





Figure 4: Illustration showcasing the *Matched Virtual and Physical Movement* application (top), where the movement of the virtual spaceship (bottom) reference frame matches the movement of the real car the passenger is inside.



Figure 5: The *Movement-Locked Content for Productivity* application, where a single user interacts with web-based word processor, pdf and video content locked to the reference frame of the virtual vehicle they are sat inside. A digitised city route updates around the vehicle based on the real location.

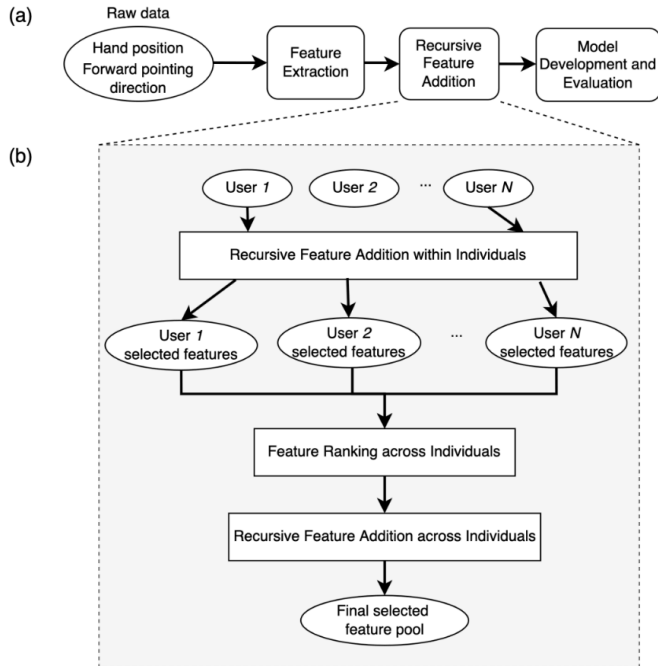
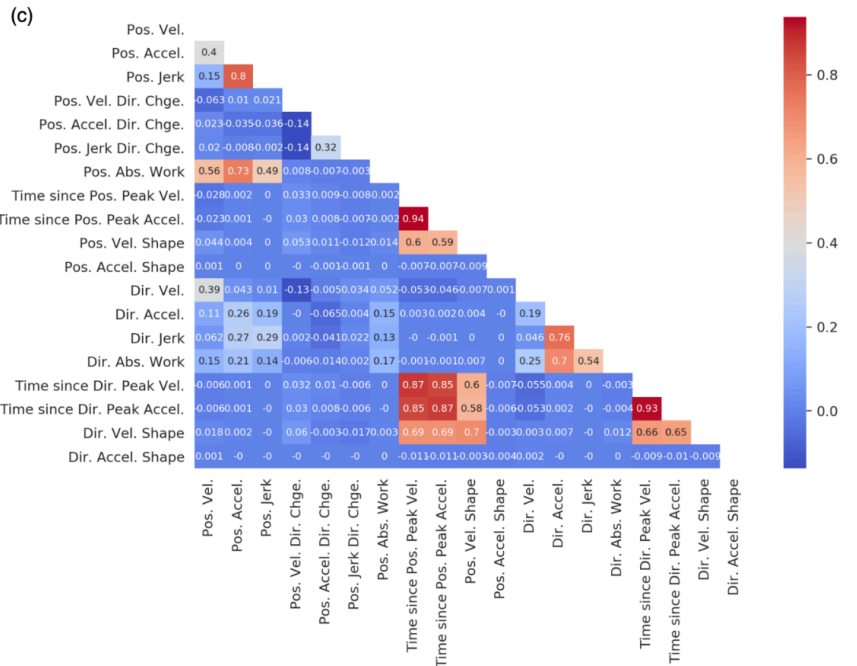
Gestures

RIDS: Implicit Detection of a Selection Gesture Using Hand Motion Dynamics During Freehand Pointing in Virtual Reality

<https://programs.sigchi.org/uist/2022/program/content/84993>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545701>

Feature Name	Description	Mathematical Formula
Pos. Vel.	hand position velocity v	$v = \frac{\sqrt{(x_1-x_0)^2+(y_1-y_0)^2+(z_1-z_0)^2}}{\Delta t}$, where $\Delta t = t_1 - t_0$
Pos. Accel.	hand position acceleration a	$a = \frac{v_1-v_0}{\Delta t}$
Pos. Jerk	hand position jerk j	$j = \frac{a_1-a_0}{\Delta t}$
Pos. Vel. Dir. Chge.	velocity direction change $\Delta\alpha$	$\Delta v = \frac{\arccos[(\vec{p}_1 \cdot \vec{p}_0)/(\vec{p}_1 \vec{p}_0)]}{\Delta t}$
Pos. Accel. Dir. Chge.	acceleration direction change Δa	$\Delta a = \frac{\arccos[(\vec{v}_1 \cdot \vec{v}_0)/(\vec{v}_1 \vec{v}_0)]}{\Delta t}$
Pos. Jerk Dir. Chge.	jerk direction change Δj	$\Delta j = \frac{\arccos[(\vec{a}_1 \cdot \vec{a}_0)/(\vec{a}_1 \vec{a}_0)]}{\Delta t}$
Pos. Abs. Work	absolute work of hand position	$w = a * \vec{p}_1 - \vec{p}_0$, $\vec{p}_t$ is the position vector at time t
Time since Pos. Peak Vel.	time since peak hand position velocity t_{v_p} , reset the start time to 0 after each pinch selection event	$t_{v_p} = \begin{cases} 0 & v \leq v_p \\ t - t_{v_p} & v_p \leq v \end{cases}$, v_p is the rolling peak velocity
Time since Pos. Peak Accel.	time since peak hand position acceleration t_{a_p} , reset the start time to 0 after each pinch selection event	$t_{a_p} = \begin{cases} 0 & a \leq a_p \\ t - t_{a_p} & a_p \leq a \end{cases}$, a_p is the rolling peak acceleration
Pos. Vel. Shape	position velocity shape vs	$vs = \frac{v_p}{v_m}$, v_p, v_m is the rolling peak and mean velocity
Pos. Accel. Shape	position acceleration shape as	$as = \frac{a_p}{a_m}$, a_p, a_m is the rolling peak and mean acceleration
Dir. Vel.	hand pointing direction velocity v	$v = \frac{\arccos[(\vec{d}_1 \cdot \vec{d}_0)/(\vec{d}_1 \vec{d}_0)]}{\Delta t}$, $\vec{d}_t$ is pointing direction vector
Dir. Accel.	hand pointing direction acceleration a	$a = \frac{v_1-v_0}{\Delta t}$
Dir. Jerk	hand pointing direction jerk j	$j = \frac{a_1-a_0}{\Delta t}$
Dir. Abs. Work	pointing direction absolute work	$w = a * \vec{p}_1 - \vec{p}_0$, $\vec{p}_t$ is the position vector at time t
Time since Dir. Peak Vel.	time since peak velocity of pointing direction t_{v_p} , reset the start time to 0 after each pinch selection event	$t_{v_p} = \begin{cases} 0 & v \leq v_p \\ t - t_{v_p} & v_p \leq v \end{cases}$, v_p is the rolling peak velocity
Time since Dir. Peak Accel.	time since peak acceleration of pointing direction t_{a_p} , reset the start time to 0 after each pinch selection event	$t_{a_p} = \begin{cases} 0 & a \leq a_p \\ t - t_{a_p} & a_p \leq a \end{cases}$, a_p is the rolling peak acceleration
Dir. Vel. Shape	pointing direction velocity shape vs	$vs = \frac{v_p}{v_m}$, v_p, v_m is the rolling peak and mean velocity
Dir. Accel. Shape	pointing direction acceleration shape as	$as = \frac{a_p}{a_m}$, a_p, a_m is the rolling peak and mean acceleration



Freehand pointing sensing

- vision-based tracking: cumbersome for lightweight devices, occlusion problems
- wrist-based sensing: more suited for AR glasses

Pinch gesture

RIDS: Make gesture detection agnostic to the sensing method. Detect motion preceding the pinch gesture
Use hand motion dynamics. Use wrist-based IMU and hand motion to detect the pinch gesture

Pointing behavior

There is a ballistic phase (high velocity) and a correction phase (low velocity) (Reference: Designing 3d selection techniques using ballistic and corrective movements)

ARnnotate: An Augmented Reality Interface for Collecting Custom Dataset of 3D Hand-Object Interaction Pose Estimation

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545663>

<https://programs.sigchi.org/uist/2022/program/content/85058>

Enable novice end-users to collect 3D hand-object pose estimation datasets ad-hoc and on-site with the help of AR.

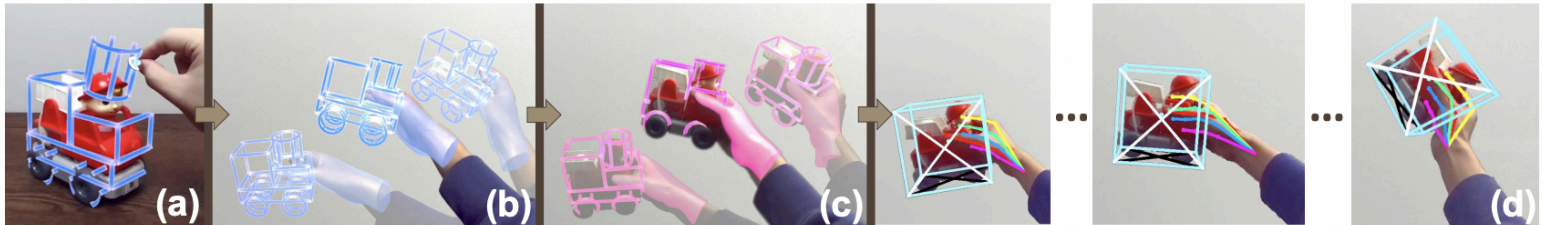


Figure 1: Overview of the ARnnotate workflow. (a) A user creates a *bounding contour* as the virtual representation of a target physical object in AR. (b) The user manipulates the *bounding contour* with a preferred gesture, while ARnnotate keeps recording the 3D poses of both the *bounding contour* and hand obtained by a hand-tracking-capable AR-HMD as the dataset labels. (c) ARnnotate replays the record as an *interaction clip* in AR. The user grabs the physical object using the same gesture and manipulates it while ensuring both the hand and object are accurately aligned with the counterparts of the *interaction clip*. ARnnotate captures the user's first-person view as the dataset images and temporally pairs them with the corresponding labels via back-end processing. (d) The custom dataset created by ARnnotate.

Gaze

DEEP: 3D Gaze Pointing in Virtual Reality Leveraging Eyelid Movement

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545673>

<https://programs.sigchi.org/uist/2022/program/content/84993>

AAE: Aperture Angle of Eyelids

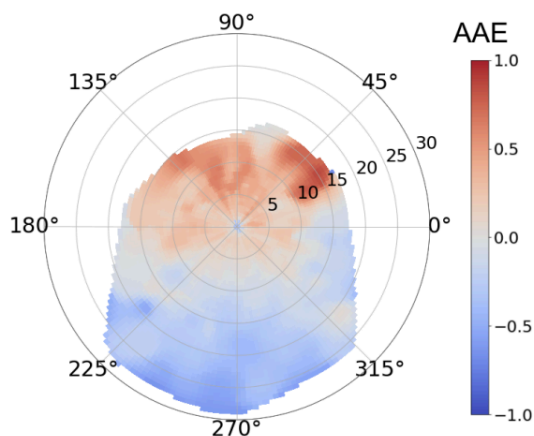
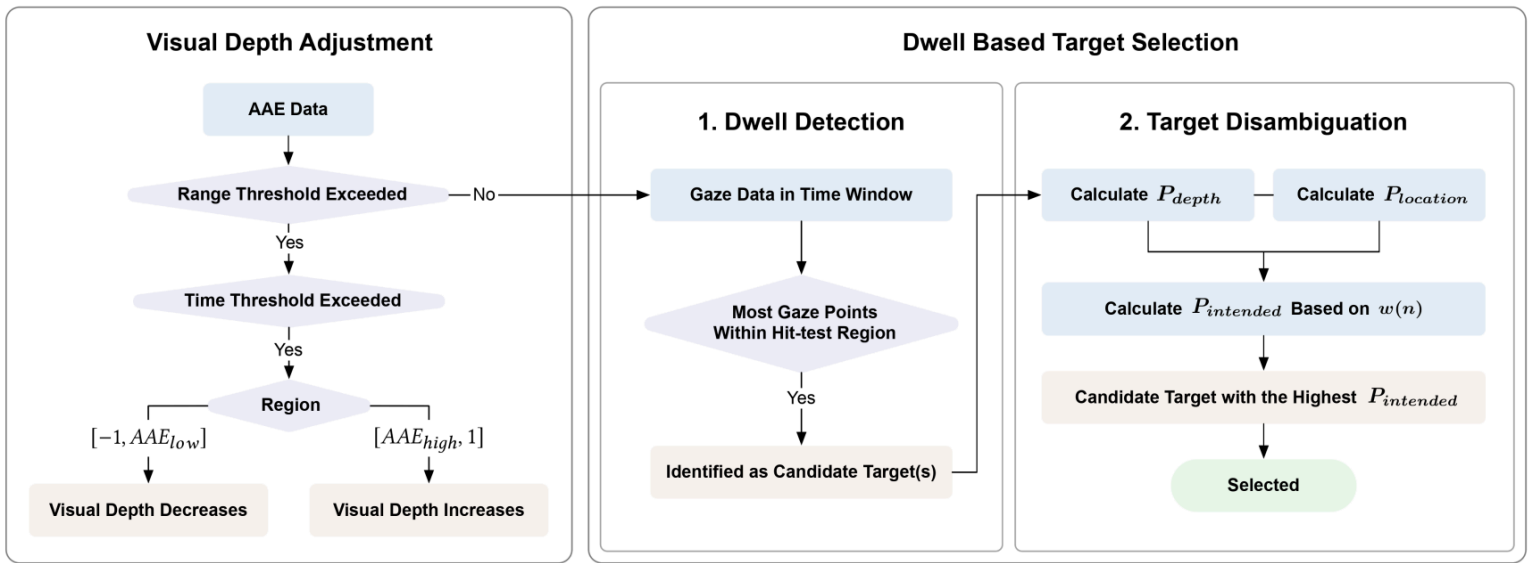


Figure 4: AAE value at different gaze locations.



Probabilistic gaze-point decoder

$$P_{intended}(k) = w(n) \times P_{depth}(k) + [1 - w(n)] \times P_{location}(k). \quad (1)$$

$$P_{depth}(k) = (d_{max} - d_k) / \sum_{i=1}^n (d_{max} - d_i)$$

What is users' gaze dwelling precision?



Detecting Input Recognition Errors and User Errors Using Gaze Dynamics in Virtual Reality

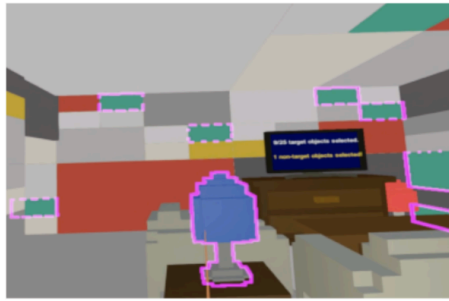
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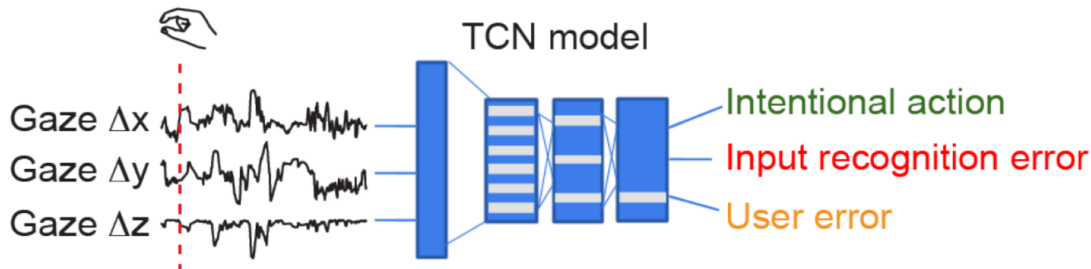
Tile Search task



Room Search task



Dice Game task



Detecting Input Recognition Errors and User Errors using Gaze Dynamics in Virtual Reality

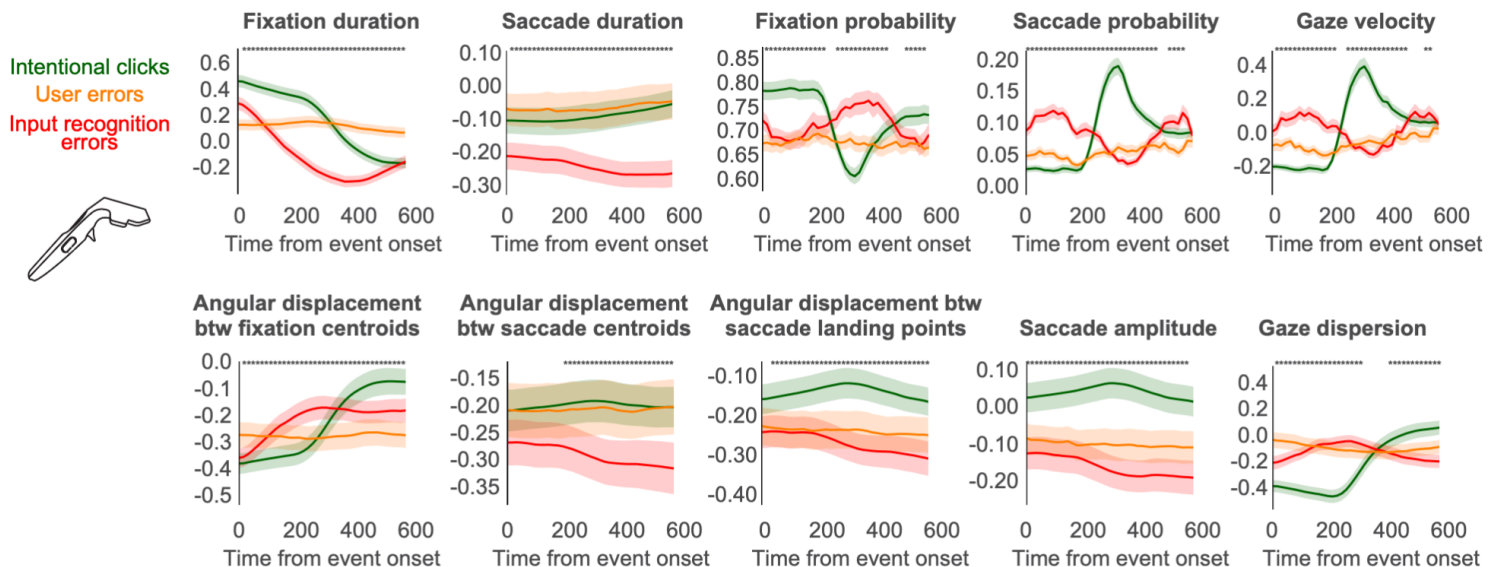
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<https://dl.acm.org/doi/pdf/10.1145/3526113.3545628>

Types of Errors to detect:

- Intentional Clicks
- User Errors
- Input Recognition error

Tile Search task



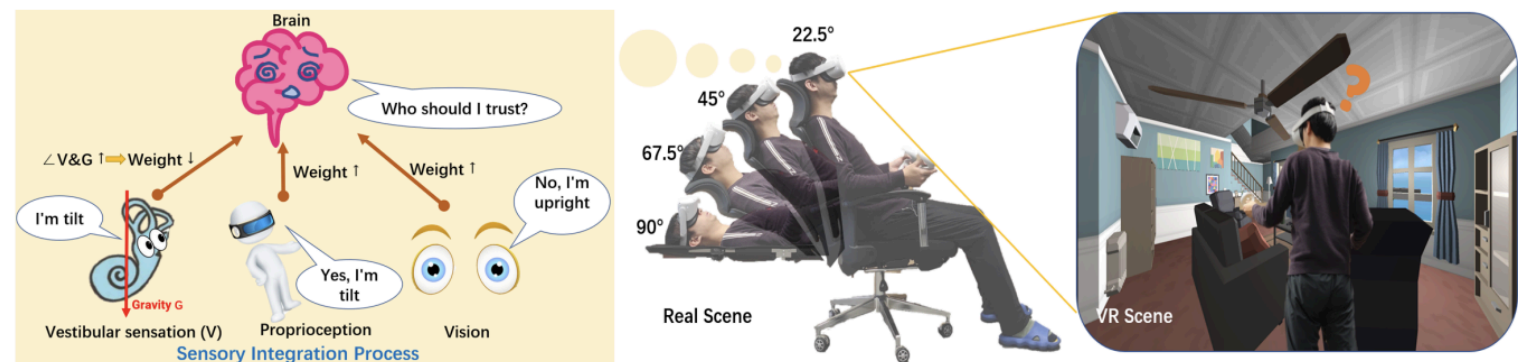
Takeaway: Gaze features patterns can be used as a metric

Can gaze behavior be used to classify input event types? Yes → TCN Model
Relative generalizability across three different VR settings.

Perception

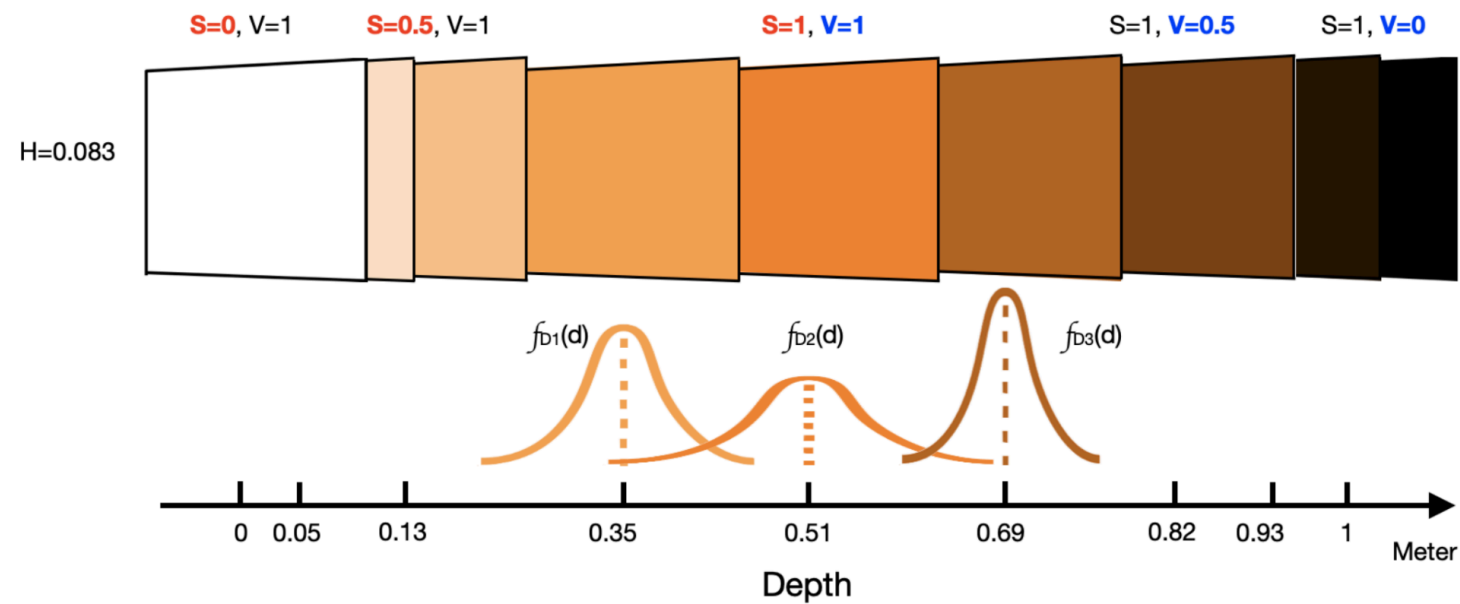
Exploring Sensory Conflict Effect Due to Upright Redirection While Using VR in Reclining & Lying Positions

<https://programs.sigchi.org/uist/2022/program/content/84985>
<https://dl.acm.org/doi/pdf/10.1145/3526113.3545692>



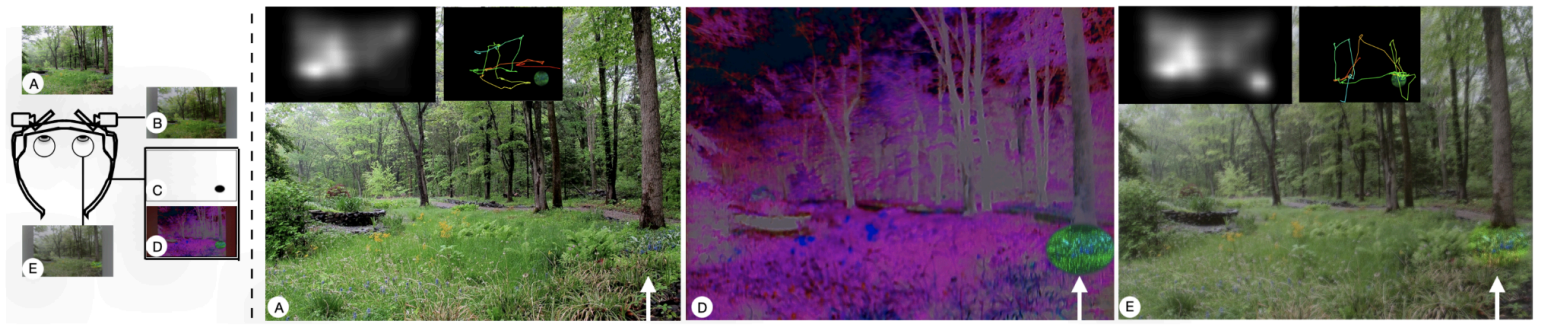
Color-to-Depth Mappings as Depth Cues in Virtual Reality

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545646>
<https://programs.sigchi.org/uist/2022/index/content/85049>



Look over there! Investigating Saliency Modulation for Visual Guidance with Augmented Reality Glasses

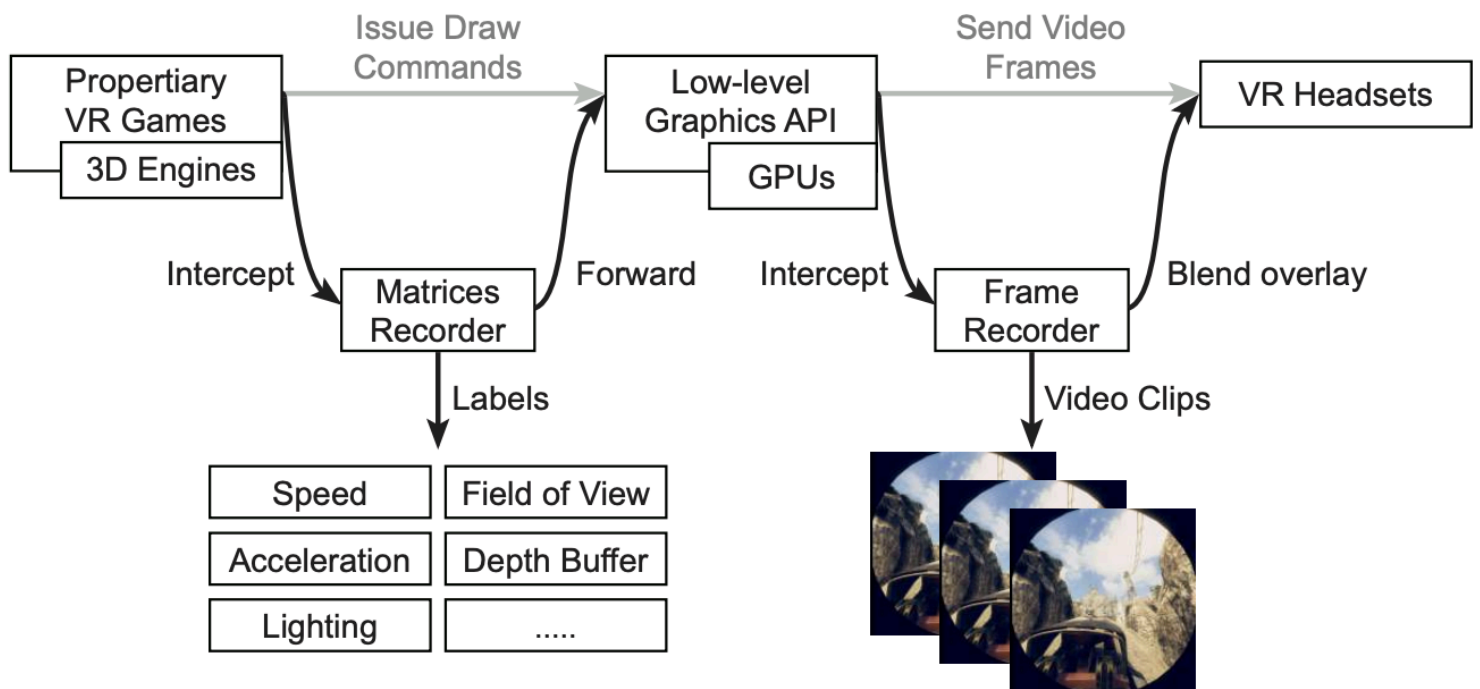
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VRhook: A Data Collection Tool for VR Motion Sickness Research

<https://programs.sigchi.org/uist/2022/program/content/85059>

<https://dl.acm.org/doi/10.1145/3526113.3545656>

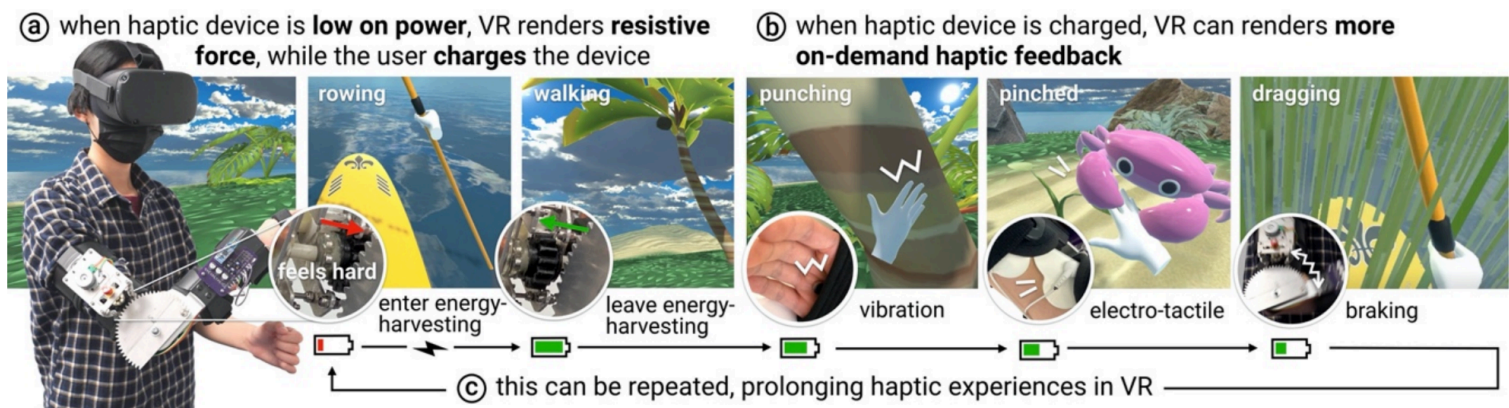


Haptics

Prolonging VR Haptic Experiences by Harvesting Kinetic Energy from the User

<https://programs.sigchi.org/uist/2022/program/content/85033>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545635>



Robotics

Mimic: In-Situ Recording and Re-Use of Demonstrations to Support Robot Teleoperation

<https://dl.acm.org/doi/10.1145/3526113.3545639>

<https://programs.sigchi.org/uist/2022/program/content/84990>

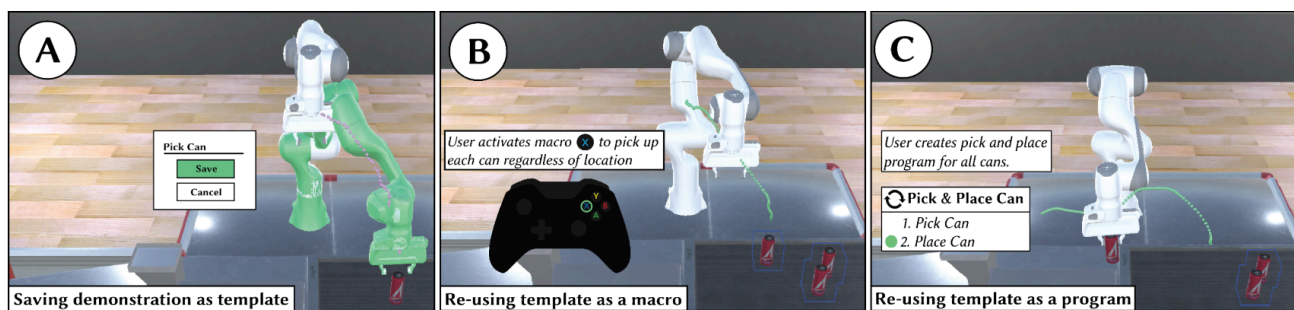
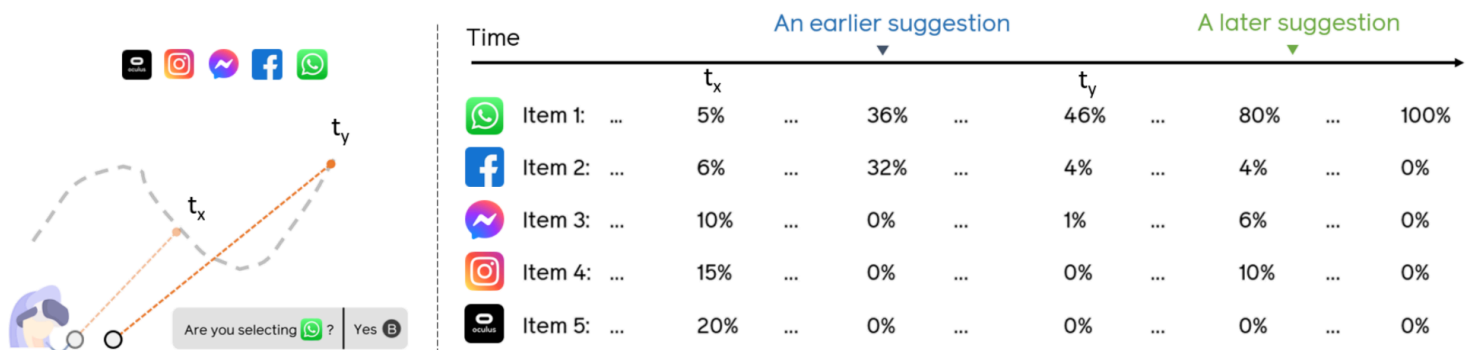


Figure 1: Mimic is a system that allows robot users to record arbitrary robot trajectory demonstrations and (A) save them as templates. Later, they can re-use templates for remotely teleoperating the robot to perform manipulation tasks through: (B) macros, parametrized templates activated by buttons, and (C) programs, sequences of parametrized templates that operate autonomously.

Optimization

Optimizing the Timing of Intelligent Suggestion in Virtual Reality

<https://programs.sigchi.org/uist/2022/program/content/85040>



Useful for:

- effortful input

- selecting far-away objects

Target prediction models

Challenge: “When” to suggest a target? (trade-off between time saving and accuracy)

Cost-benefit quantification (step 1)

gain = benefit*correct probability - cost*incorrect probability

benefits, costs:

1. potential time savings, time delay (due to distraction)
2. potential usage of a suggestion, non usage

Gain threshold determination (step 2)

How to determine the gain threshold?

2 approaches:

1. optimal thresholding (OT)
2. reinforcement learning (RL)

Authoring

MechARspace: An Authoring System Enabling Bidirectional Binding of Augmented Reality with Toys in Real-time

<https://programs.sigchi.org/uist/2022/index/content/85012>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545668>

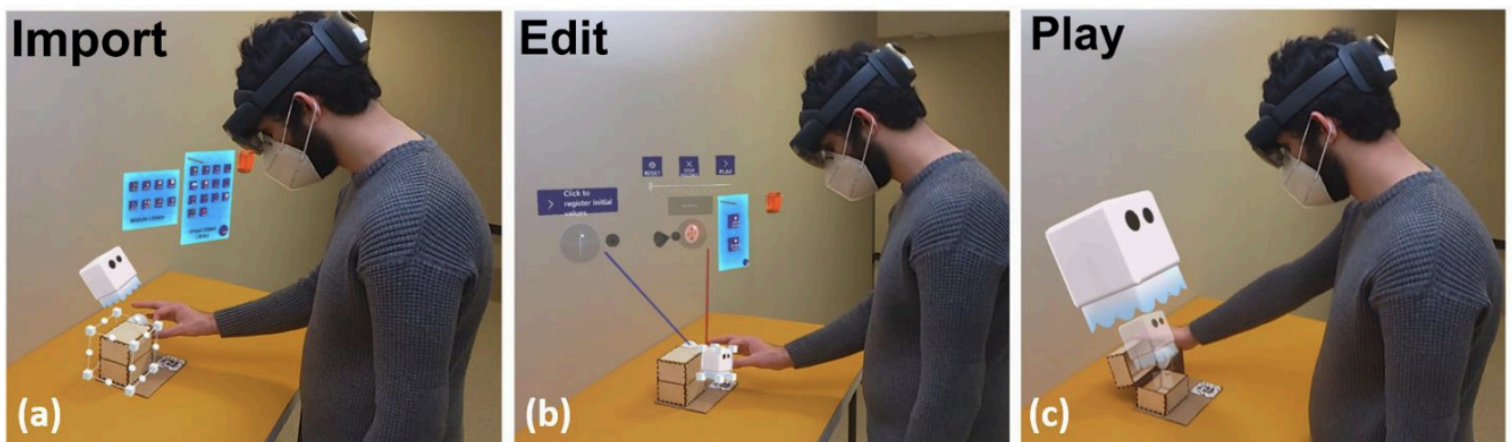


Figure 1: An overview of MechARspace workflow. (a) A user starts with a chest (physical toy) which contains a rotation module (part of our IoT toolkit). The chest, with its module, is imported into the AR scene by the user defining a bounding box around it. **(b)** The user authors the interaction between the virtual ghost and the rotation module of the physical chest through demonstration and input-output visual programming. The ghost pops out of the chest with respect to the angle the user sets for the rotation module. **(c)** The user plays with his authored AR-enhanced toy.

Sketch

Sketched Reality: Sketching Bi-Directional Interactions Between Virtual and Physical Worlds with AR and Actuated Tangible UI

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545626>



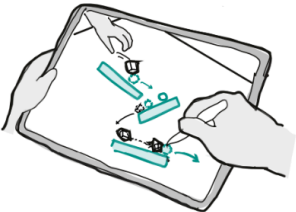
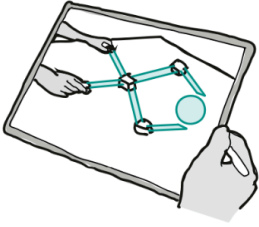
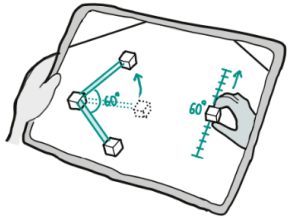
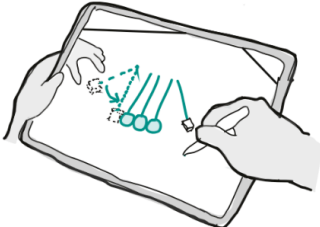
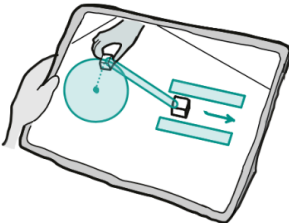
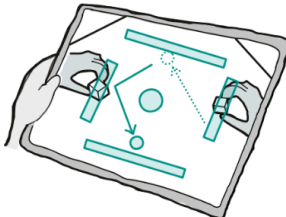
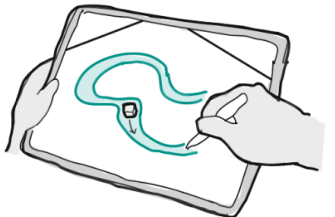
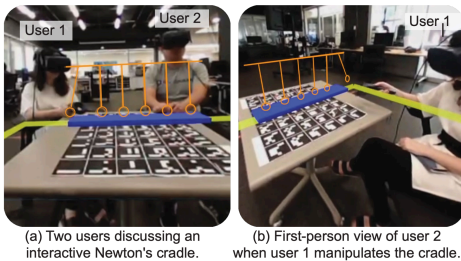
Physics Education	Explorable Mechanism	Tangible Gaming	In-situ Programming
 Rube Goldberg Machine	 Scissors Grab	 Pinball Game	 In-situ Actuated TUI
 Newton's Cradle	 Mechanical Piston	 Hockey Game	 Programming Motion by Sketching

Figure 9: Application Sketches: Sketches highlighting the capability of Sketched Reality through Physical Education (left), Explorable Mechanism (middle left), Tangible Gaming (middle right), In-situ Programming (right).

Design Space:

- Boundary Constraint, Geometric Constraint, Applied Force, Dynamic Collision
- Physical -> Virtual, Virtual to Physical

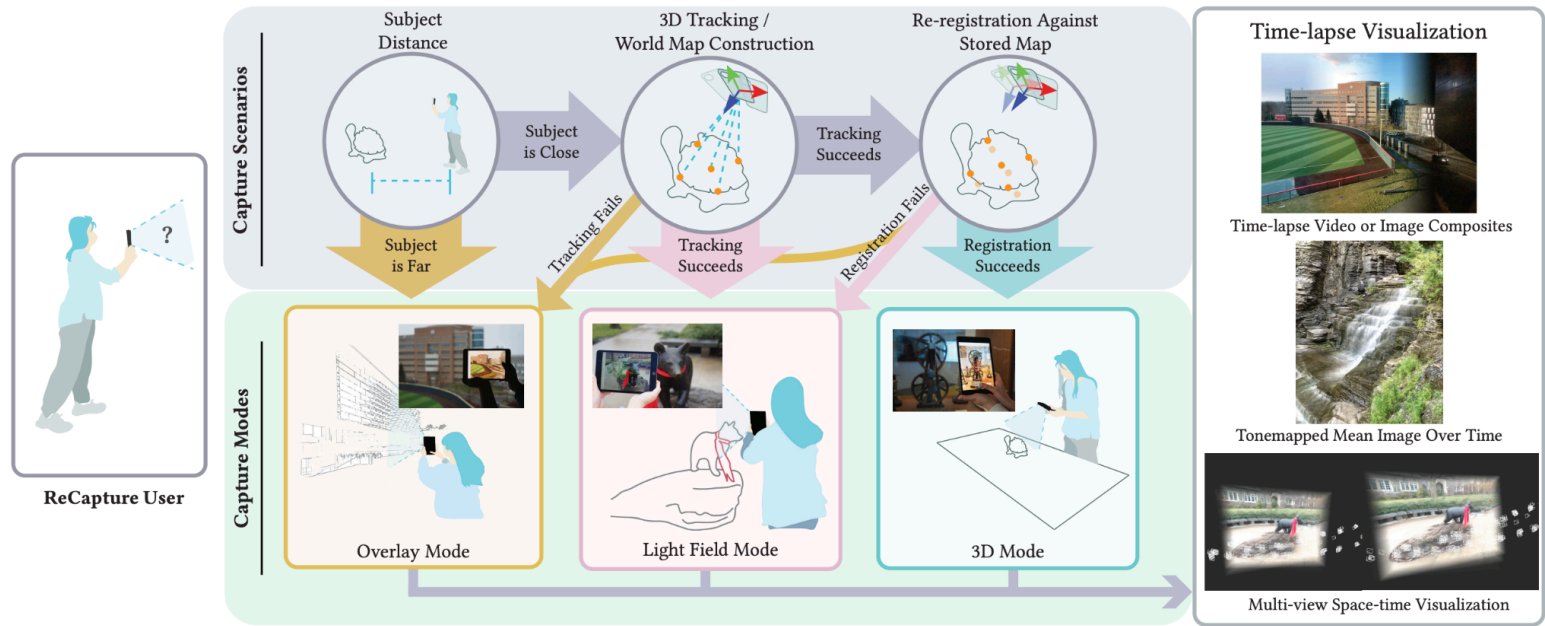
Reminds me of our [CollaboVR](#) + [ChalkTalk](#):



Photography

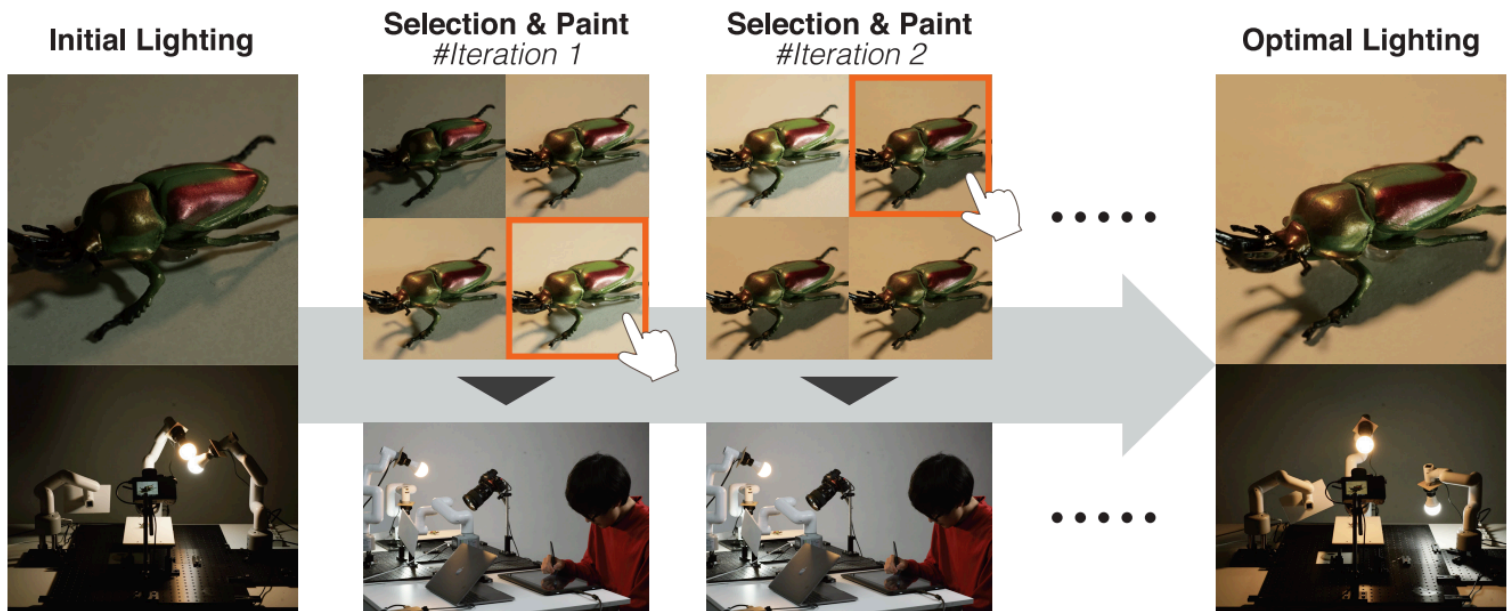
ReCapture: AR-Guided Time-lapse Photography

<https://programs.sigchi.org/uist/2022/program/content/85032>
<https://dl.acm.org/doi/pdf/10.1145/3526113.3545641>



Photographic Lighting Design with Photographer-in-the-Loop Bayesian Optimization

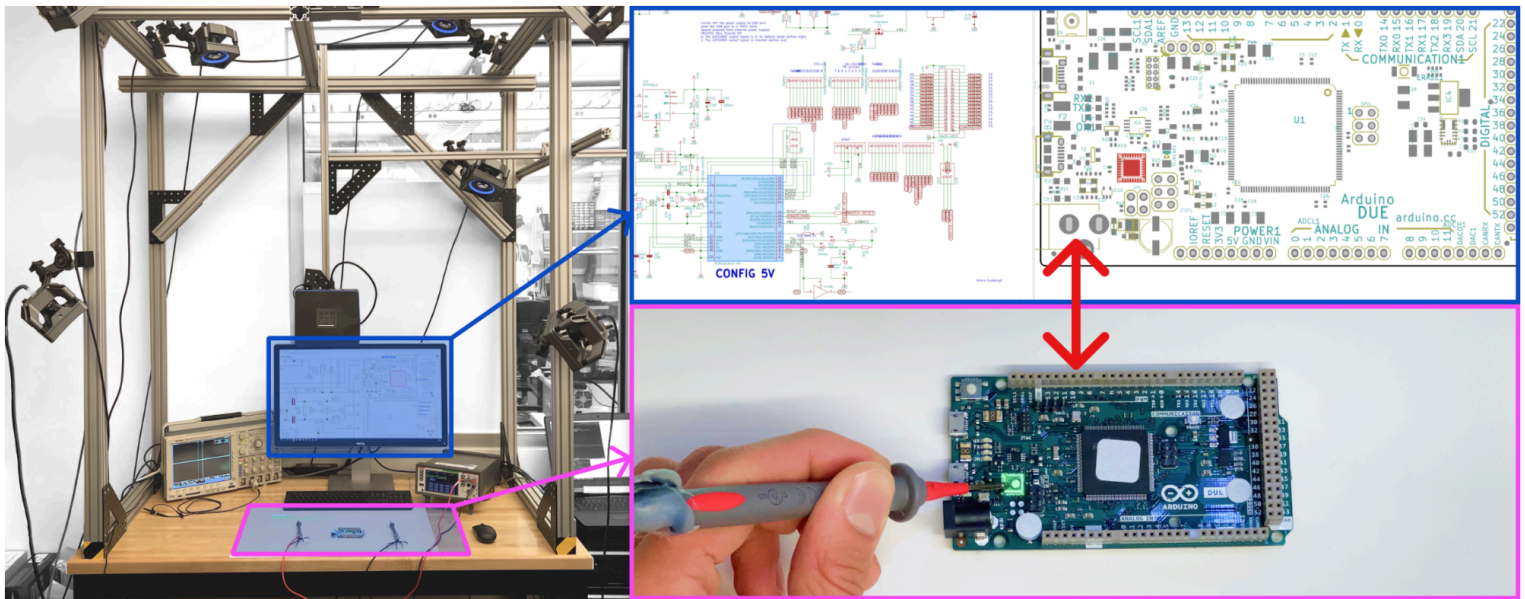
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<https://programs.sigchi.org/uist/2022/program/content/84977>



Debugging

ARDW: An Augmented Reality Workbench for Printed Circuit Board Debugging

<https://programs.sigchi.org/uist/2022/program/content/85029>



Latency:

ToolKit:

AUIT – the Adaptive User Interfaces Toolkit for Designing XR Applications

Propose five design goals

- Support a range of adaptation behavior
- Allowing combining multiple adaptation in one adaption (solvers_
- Real time context collection and interpretation

- Adaptation triggers
- A variety of property transitions

Optimizing the Timing of Intelligent Suggestion in Virtual Reality

Avatars

Eye Tracking

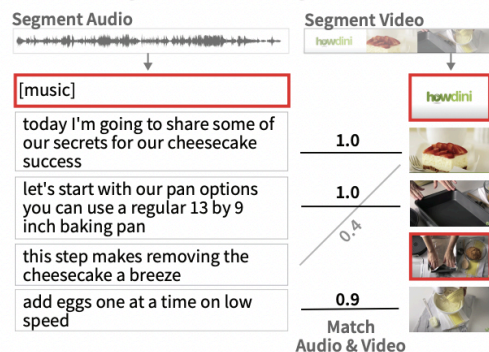
Speech

Accessibility

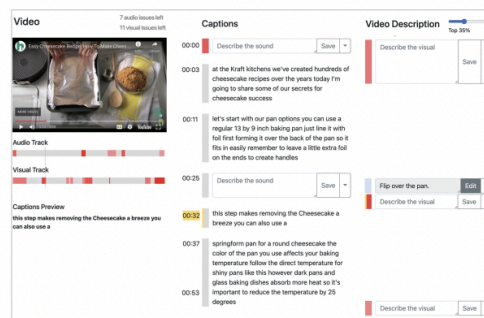
CrossA11y: Identifying Video Accessibility Issues via Cross-modal Grounding (Best Paper Award)

<https://programs.sigchi.org/uist/2022/program/content/85006>

A. Identify Accessibility Issues



B. Address Accessibility Issues



C. Play Accessible Video



CrossA11y:

- (1) Identifies accessibility issues by locating modality asymmetries (in red) between audio segments and video segments using cross-modal grounding.
- (2) Lets authors address accessibility issues using the CrossA11y interface to write captions and video descriptions
- (3) Creates a more accessible video from the authored descriptions.

Grounding pipeline:

- (1) Segmentation that segments the video into audio and visual segments.
- (2) Cross-modal Grounding that finds correspondences between visual and audio segments.

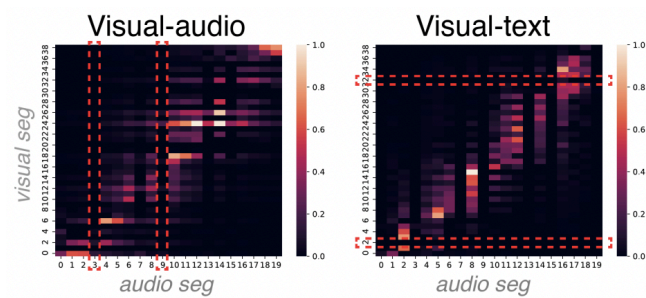


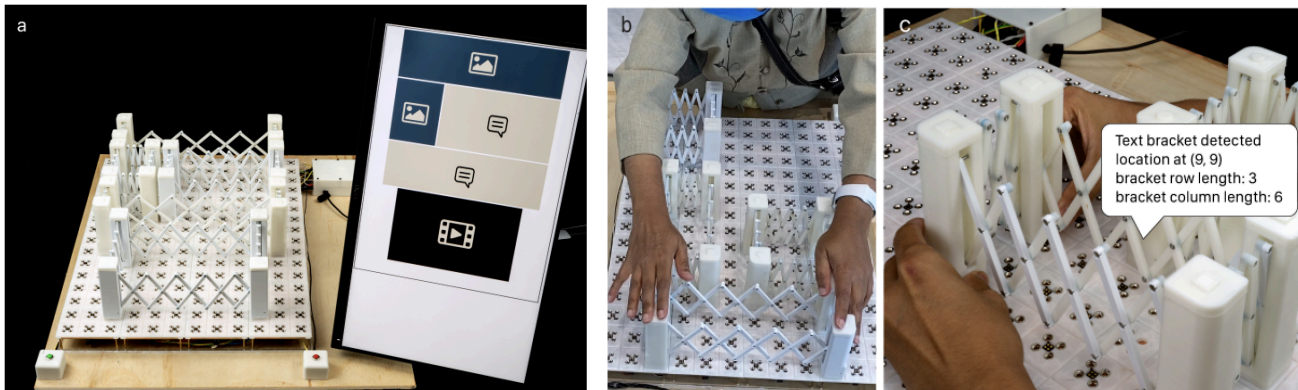
Figure 6: Example of visual to audio similarity matrix, and visual to text (transcript) similarity matrix. Red dotted lines highlight examples of asymmetric and potentially inaccessible segments.

- (3) Postprocessing that filters identified correspondences: remove commonly detected accessibility issues that do not need further description including: the presenter speaking to the camera, and silences.

TangibleGrid: Tangible Web Layout Design for Blind Users

<https://programs.sigchi.org/uist/2022/index/content/85030>

<https://dl.acm.org/doi/10.1145/3526113.3545627>



DHH / Sound

Tangible Interaction

Fabrication

Flaticulation: Laser Cutting Joints with Articulated Angles

<https://programs.sigchi.org/uist/2022/program/content/84979>

Mixels: Fabricating Interfaces using Programmable Magnetic Pixels

<https://programs.sigchi.org/uist/2022/program/content/84989>

AirLogic: Embedding Pneumatic Computation and I/O in 3D Models to Fabricate Electronics-Free Interactive Objects

<https://programs.sigchi.org/uist/2022/program/content/84969>

HingeCore: Laser-Cut Foamcore for Fast Assembly

<https://programs.sigchi.org/uist/2022/program/content/85020>

iWood: Makeable Vibration Sensor for Interactive Plywood

<https://programs.sigchi.org/uist/2022/program/content/84974>

Fibercuit: Prototyping High-Resolution Flexible and Kirigami Circuits with a Fiber Laser Engraver

<https://programs.sigchi.org/uist/2022/program/content/85019>



Best Demo Award (People's Choice)

UIST 2022

ACM User Interface Software and Technology

October 30-November 2, 2022

Bend, Oregon

Presented to

**Zeyu Yan, Anup Sathya, Sahra Yusuf,
Jyh-Ming Lien, and Huaishu Peng**

For

**"Fibercuit: Techniques to Prototype High-Resolution
Flexible and Kirigami Circuits with a Fiber Laser Engraver"**

Jun Nishida
Demo Co-Chair

Michael Wessely
Demo Co-Chair

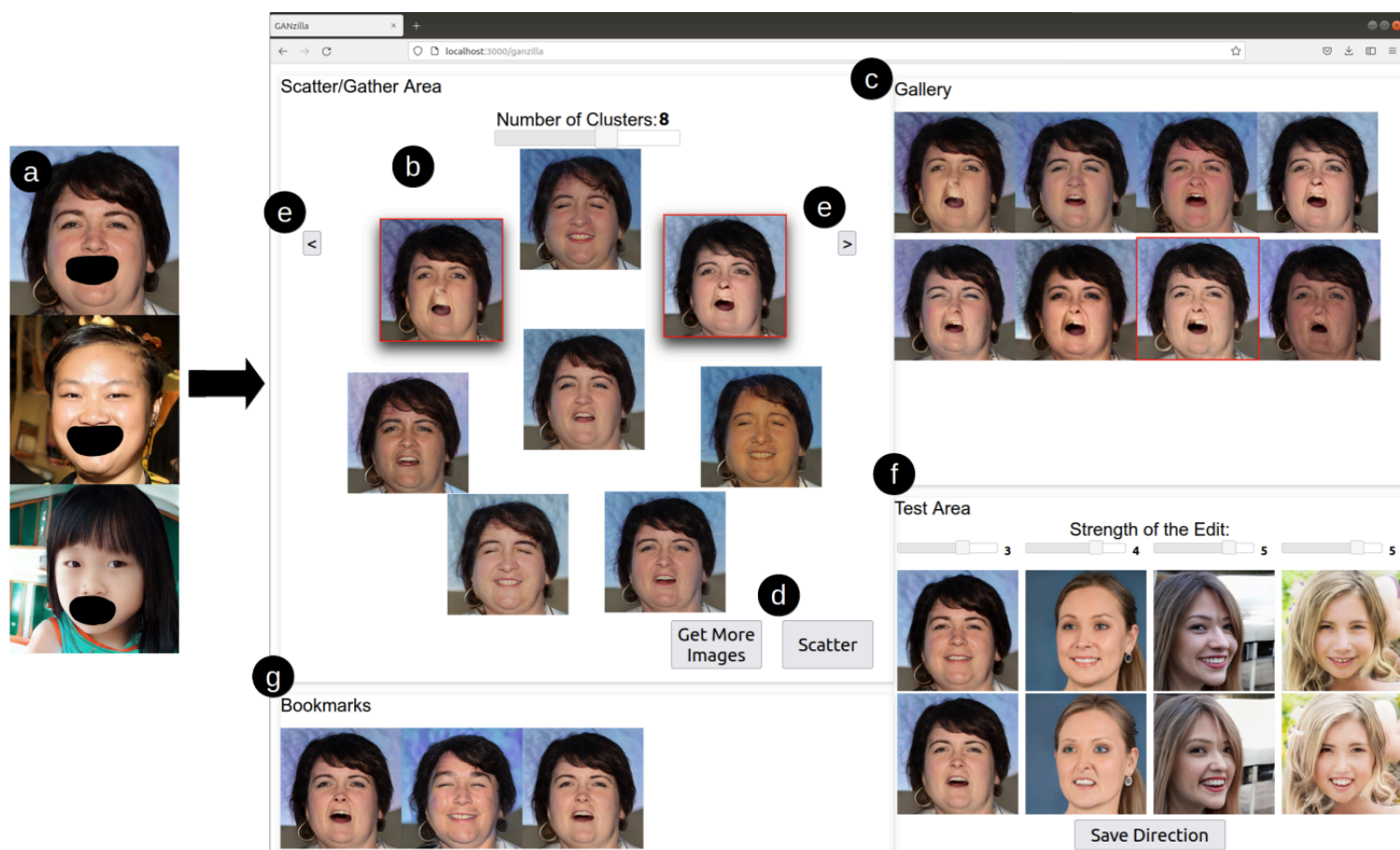
Mingrui "Ray" Zhang
Demo Co-Chair

Visualization / Storytelling

GANzilla: User-Driven Direction Discovery in Generative Adversarial Networks

<https://programs.sigchi.org/uist/2022/index/content/85004>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545638>



CodeToon: Story Ideation, Auto Comic Generation, and Structure Mapping for Code-Driven Storytelling

<https://programs.sigchi.org/uist/2022/program/content/84976>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545617>

Record Once, Post Everywhere: Automatic Shortening of Audio Stories for Social Media

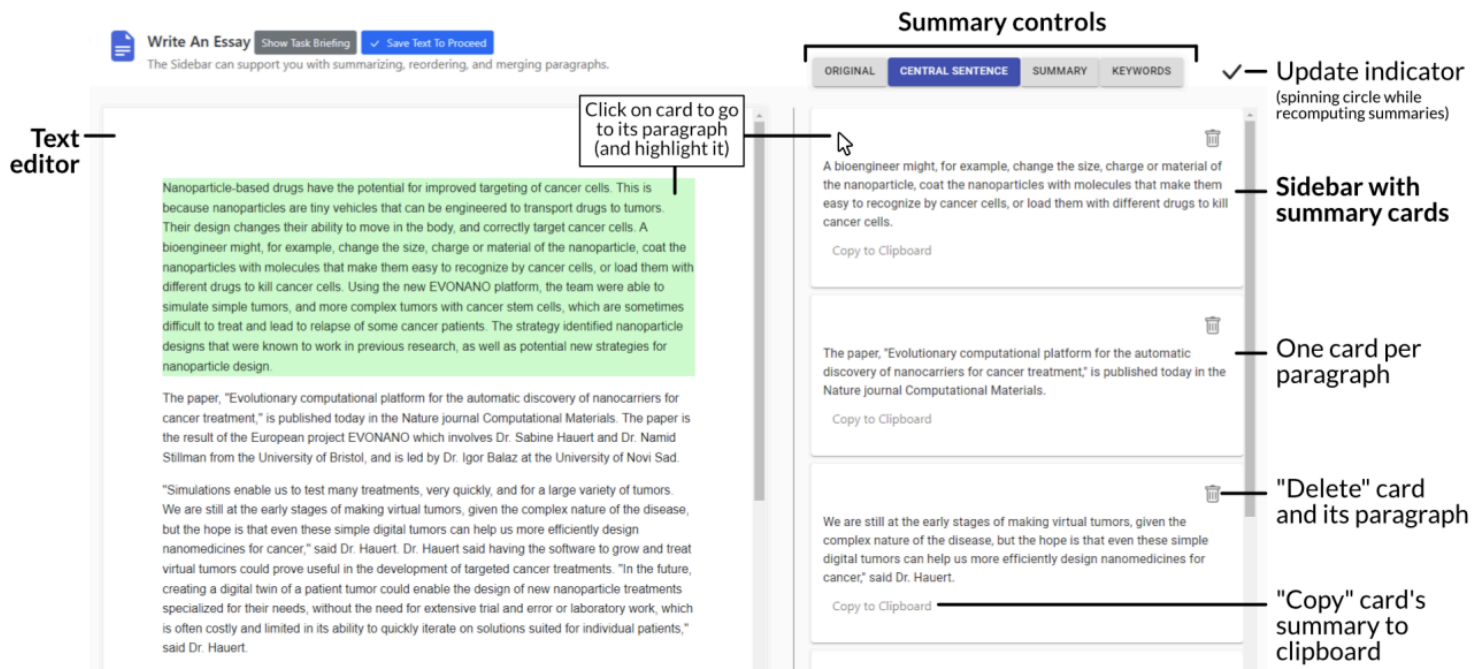
<https://programs.sigchi.org/uist/2022/program/content/85001>

<https://dl.acm.org/doi/10.1145/3526113.3545680>

RealityTalk: Real-time Speech-driven Augmented Presentation for AR Live Storytelling

<https://programs.sigchi.org/uist/2022/program/content/85010>

<https://dl.acm.org/doi/10.1145/3526113.3545702>

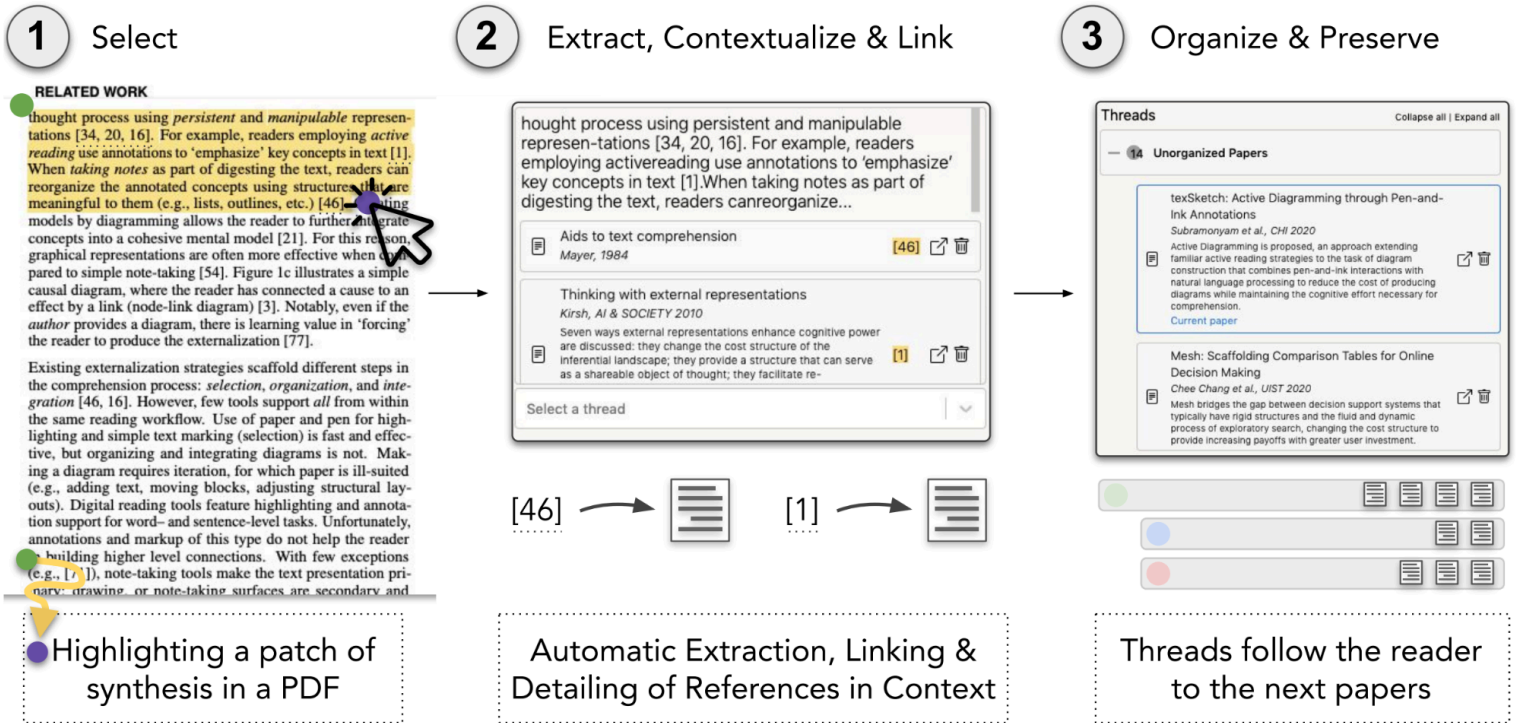


Threddy: An Interactive System for Personalized Thread-based Exploration and Organization of Scientific Literature

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545660>

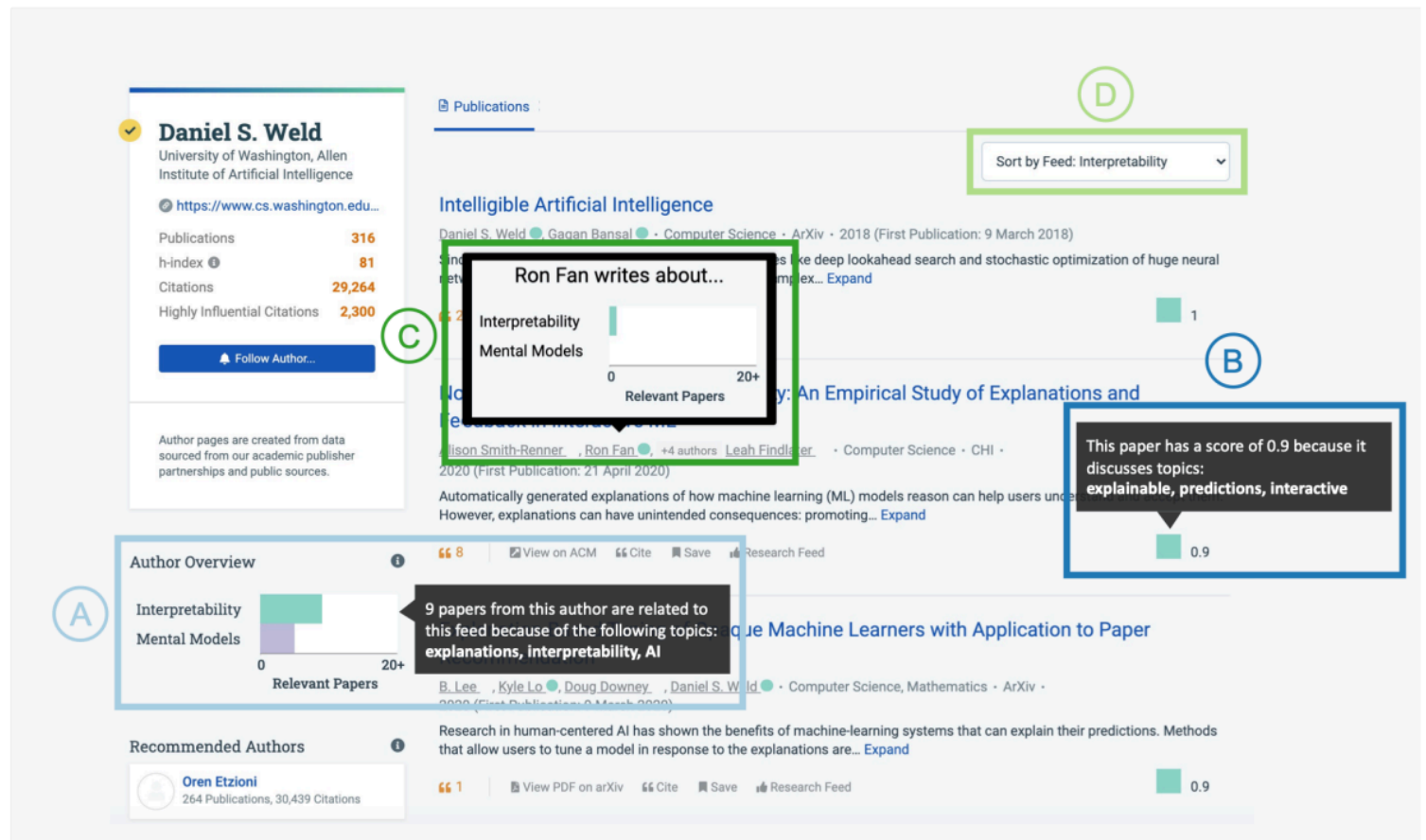
<https://programs.sigchi.org/uist/2022/program/content/85005>

Reviewing the literature to understand relevant threads of past work is a critical part of research and vehicle for learning. However, as the scientific literature grows the challenges for users to find and make sense of the many different threads of research grow as well. Previous work has helped scholars to find and group papers with citation information or textual similarity using standalone tools or overview visualizations. Instead, in this work we explore a tool integrated into users' reading process that helps them with leveraging authors' existing summarization of threads, typically in introduction or related work sections, in order to situate their own work's contributions. To explore this we developed a prototype that supports efficient extraction and organization of threads along with supporting evidence as scientists read research articles. The system then recommends further relevant articles based on user-created threads. We evaluate the system in a lab study and find that it helps scientists to follow and curate research threads without breaking out of their flow of reading, collect relevant papers and clips, and discover interesting new articles to further grow threads.



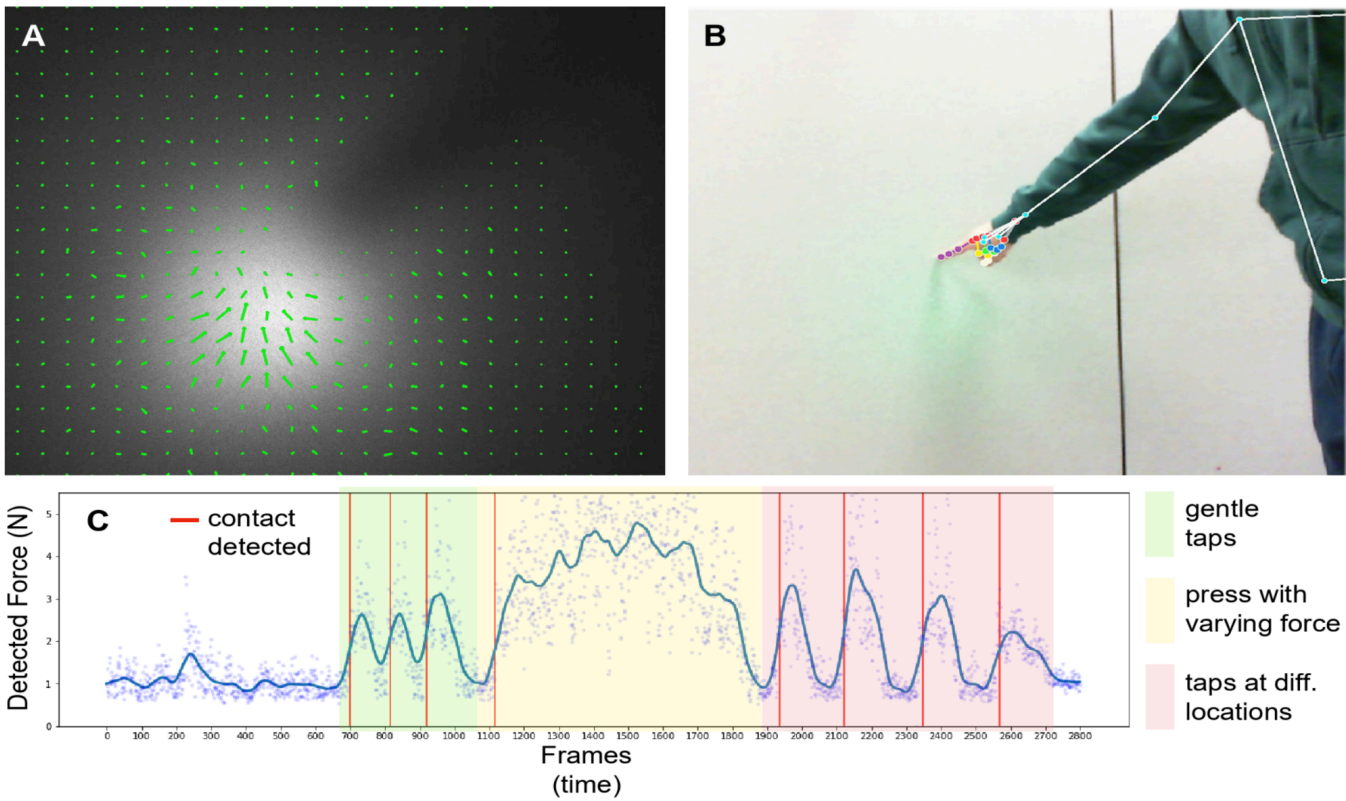
FeedLens: Polymorphic Lenses for Personalizing Exploratory Search over Knowledge Graphs

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545631>



Sensing

ForceSight: Non-Contact Force Sensing with Laser Speckle Imaging <https://dl.acm.org/doi/10.1145/3526113.3545622>



Flexel: A Modular Floor Interface for Room-Scale Tactile Sensing

<https://dl.acm.org/doi/10.1145/3526113.3545699>

<https://programs.sigchi.org/uist/2022/index/content/84987>

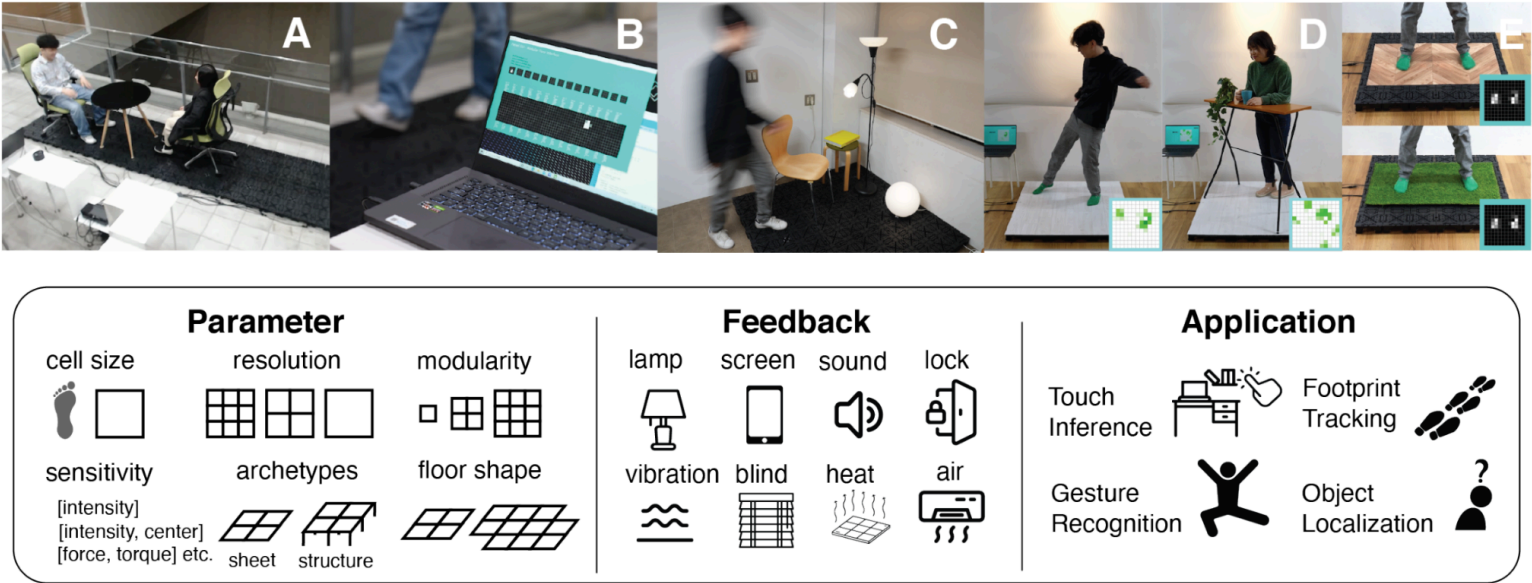
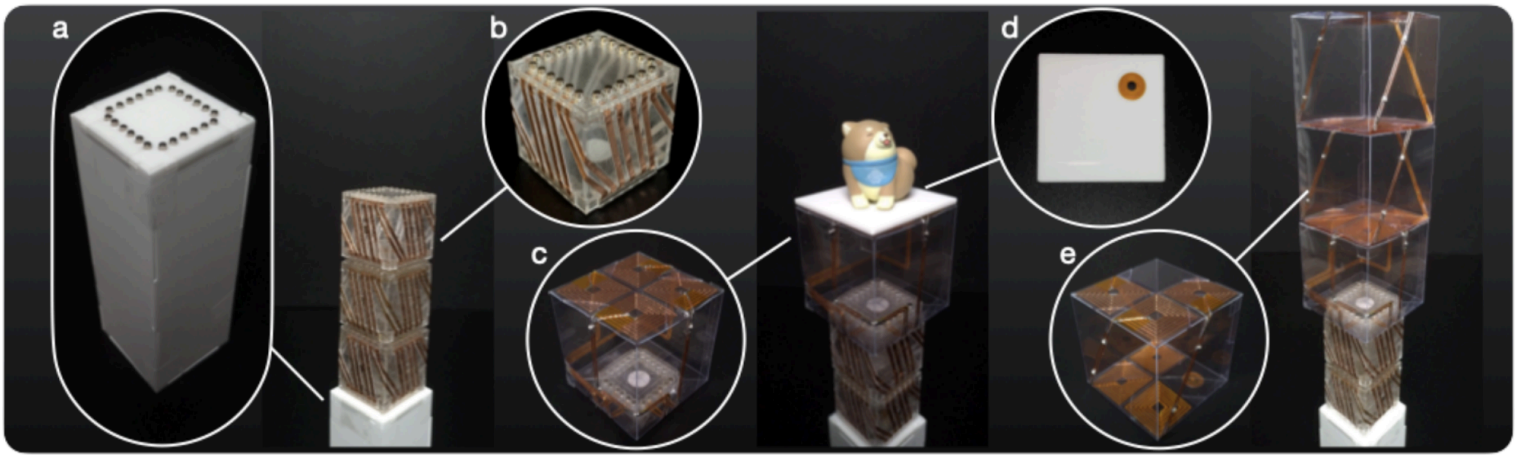


Figure 5: Design space of a modular floor interface. An interaction designer can (left) select module *parameters* according to the design guideline we proposed in this paper, (center) design the *feedbacks* for creating interaction loop, and (right) build *applications* with a set of sensing capabilities that includes touch, footprint, gesture, and object.

NFCStack: Identifiable Physical Building Blocks that Support Concurrent Construction and Frictionless Interaction

<https://programs.sigchi.org/uist/2022/index/content/85017>

<https://dl.acm.org/doi/10.1145/3526113.3545658>



Gesture-aware Interactive Machine Teaching with In-situ Object Annotations

<https://programs.sigchi.org/uist/2022/index/content/85000>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545648>



Figure 1: (a): The teaching interface of our vision-based Interactive Machine Teaching system, LookHere. LookHere provides a segmentation mask (an object highlight) on the object guided by users' deictic gestures in real time during teaching. This segmentation mask is used for model training as additional information for training classifiers. (b): Users' deictic gestures guides in-situ object annotations. (c): Example images in our *HuTics* dataset that enables the implementation of LookHere. *HuTics* includes 2040 labeled images that capture how 170 people use deictic gestures to present an object.

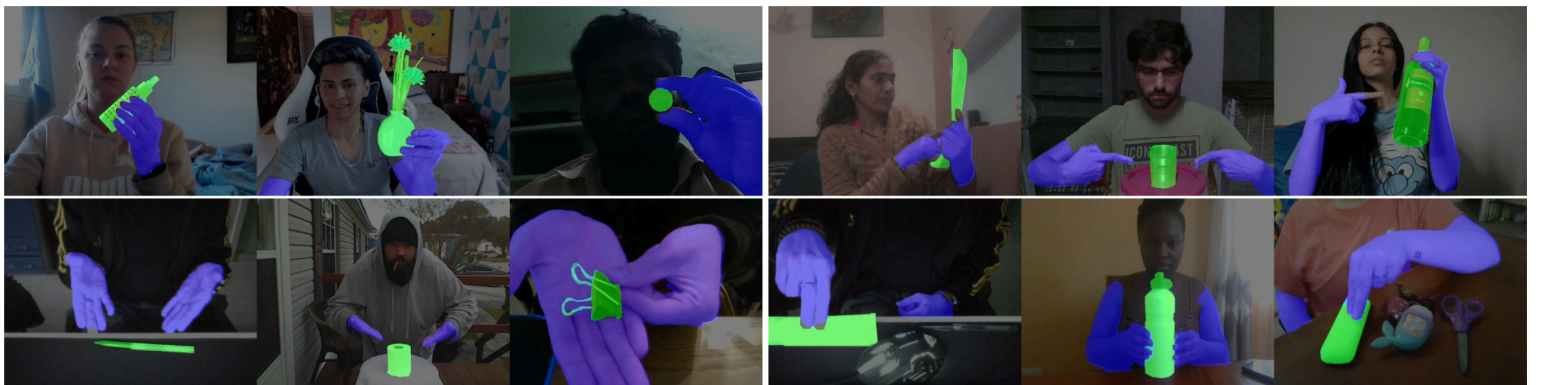
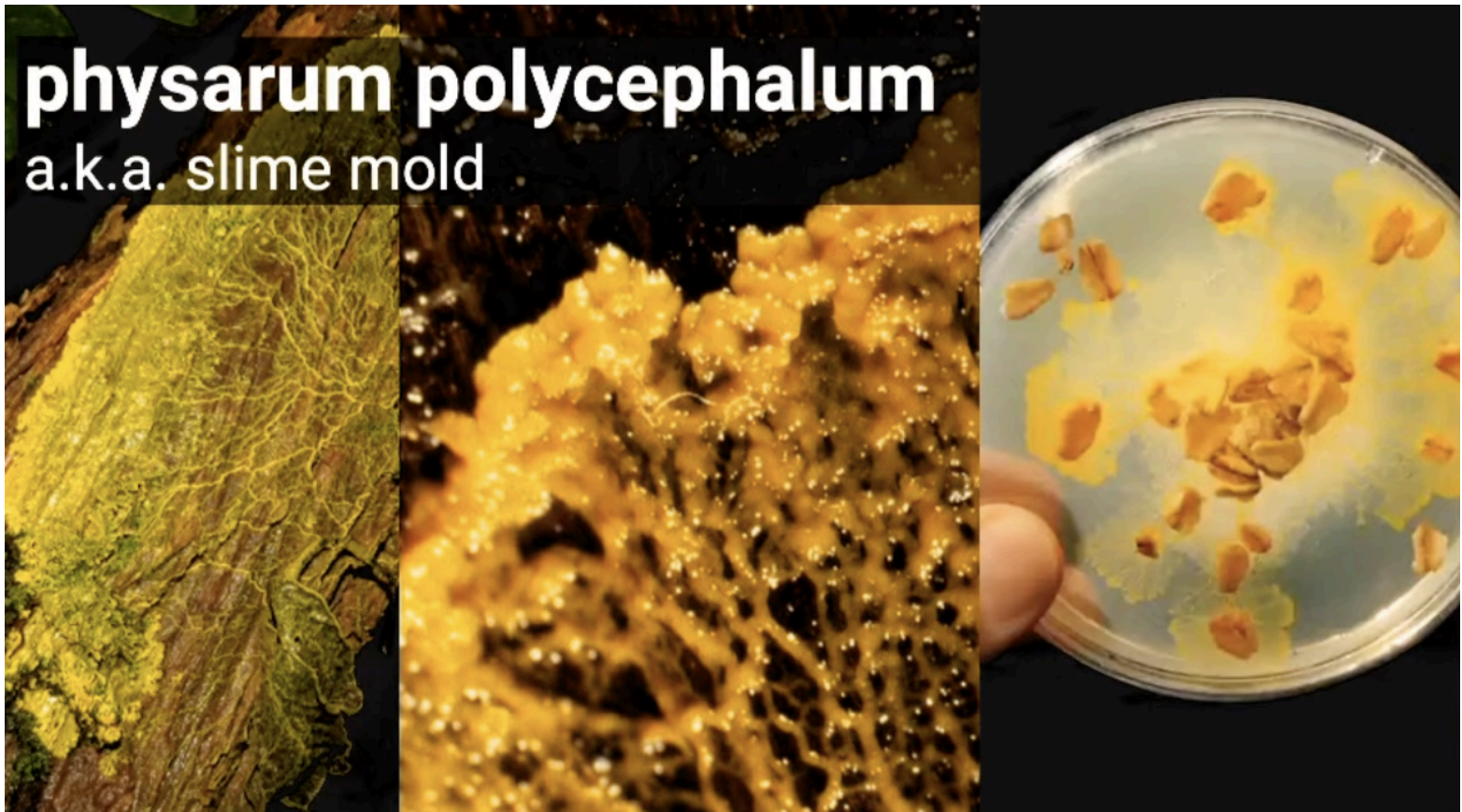
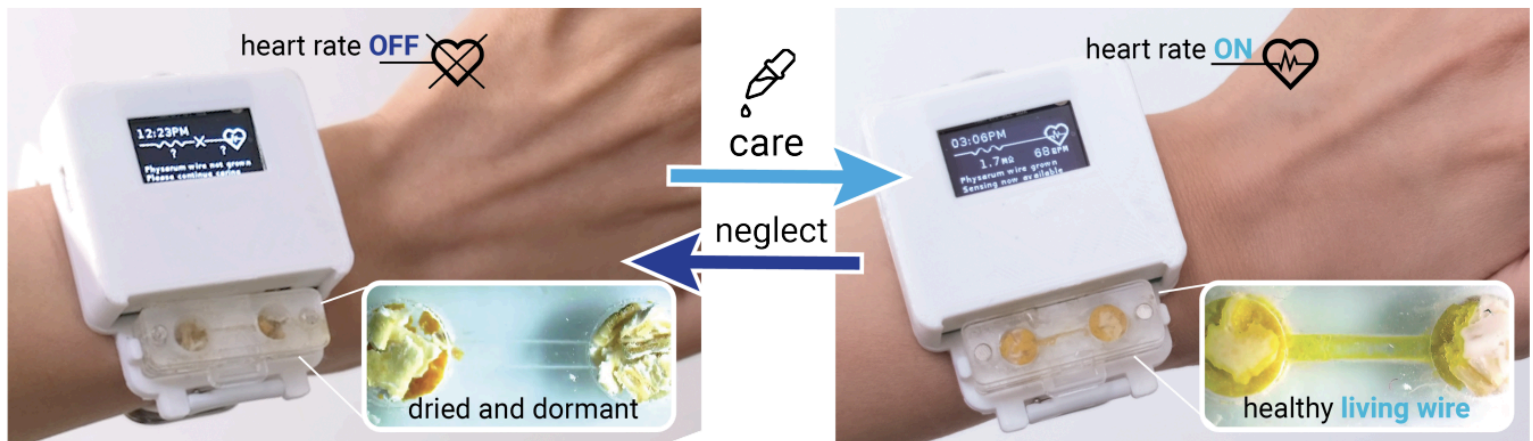


Figure 6: Example images in *HuTics* dataset. *HuTics* covers four kinds of deictic gestures to objects: exhibiting (top-left), pointing (top-right), presenting (bottom-left) and touching (bottom-right). The hands and objects of interest are highlighted in blue and green, respectively.



<https://programs.sigchi.org/uist/2022/index/content/85043>



WaddleWalls: Room-scale Interactive Partitioning System using a Swarm of Robotic Partitions

<https://programs.sigchi.org/uist/2022/index/content/84997>

<https://dl.acm.org/doi/pdf/10.1145/3526113.3545615>

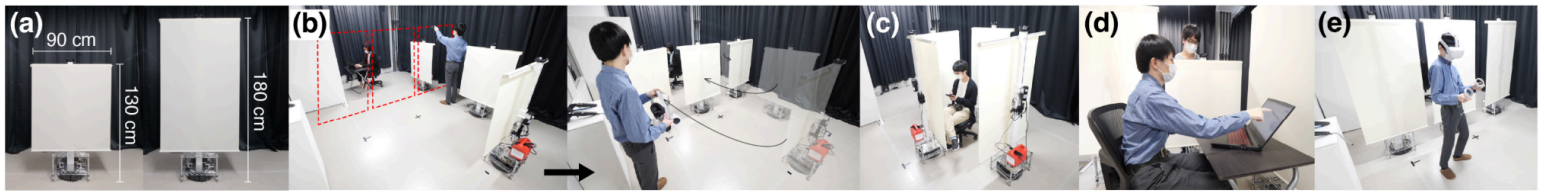
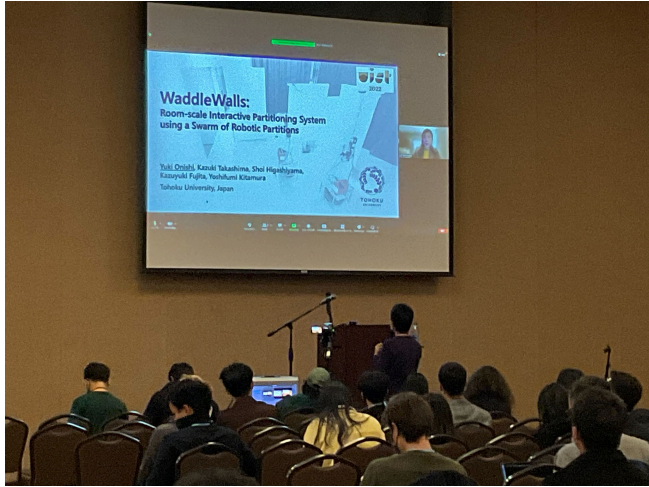


Figure 1: WaddleWalls enables configuration of various workspace layouts with novel vertically actuating robotic partitions. (a) The height-adjustable robotic partition stretching 1.3 m~1.8 m. (b) A swarm of robotic partitions are configured specified layout. WaddleWalls provides example scenarios like (c) building an ad hoc private spot, (d) adjusting partition height for ad hoc face-to-face communication, and (e) separating an entire workspace temporarily.



Programming Languages

Internet of Things

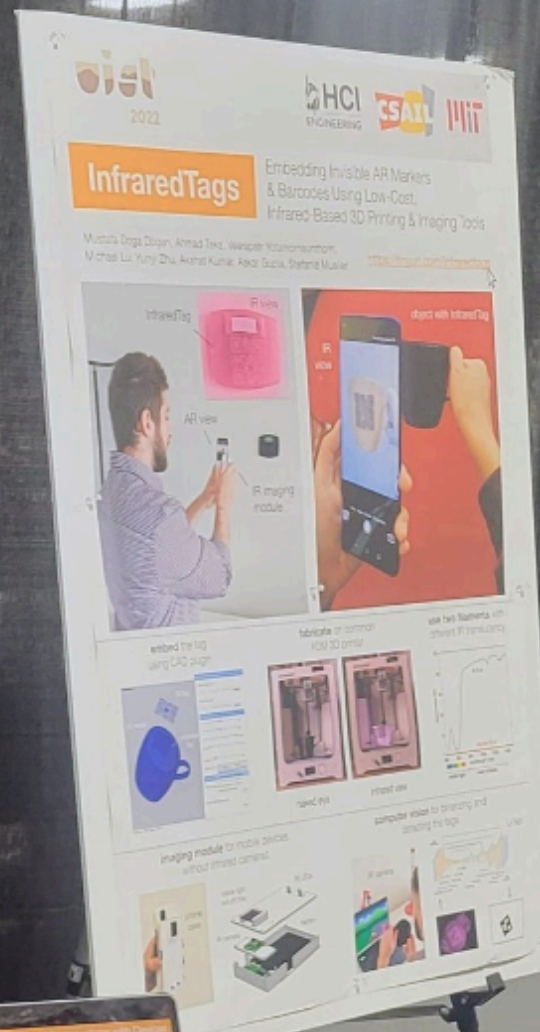
AI Fairness

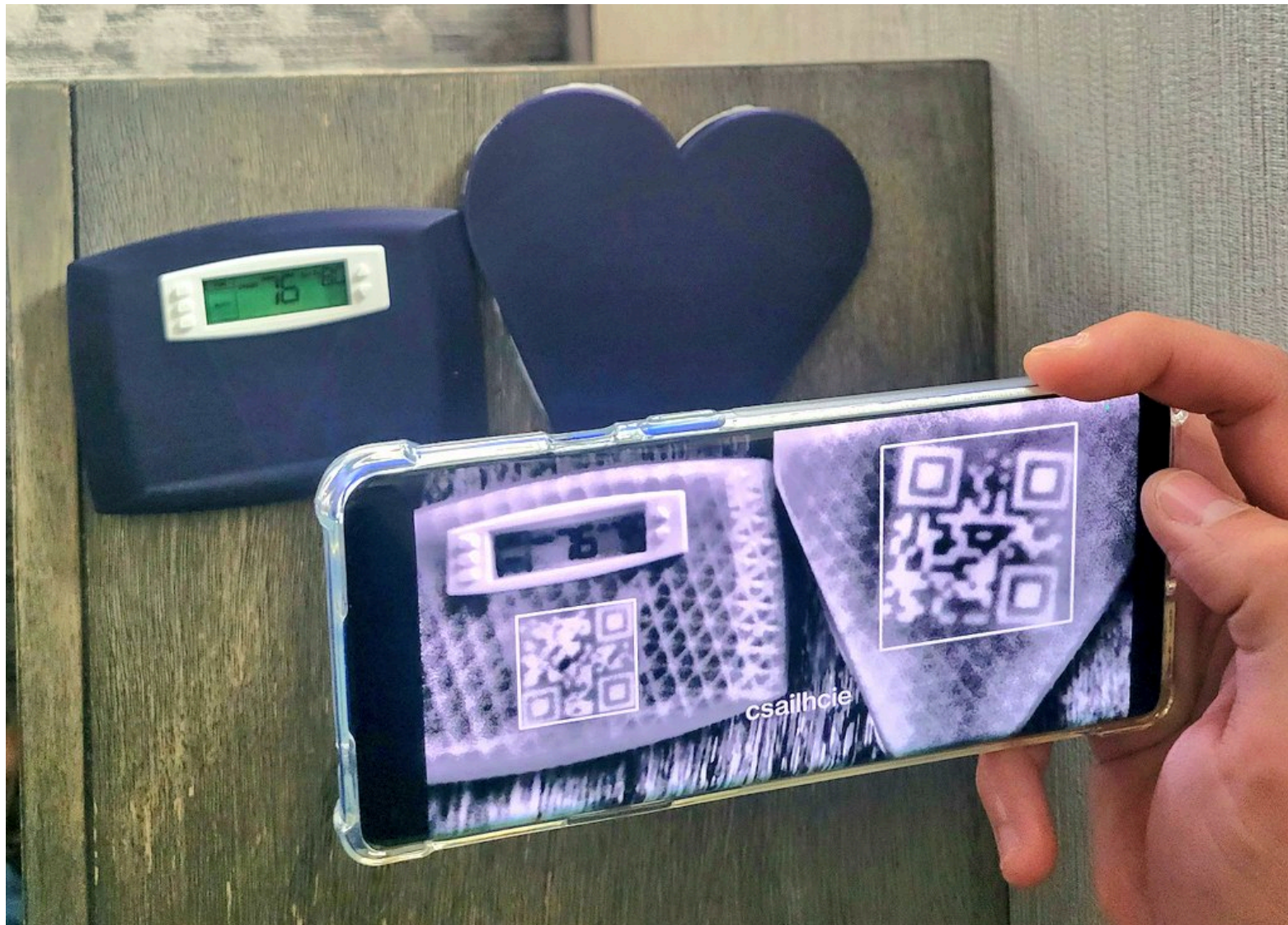
Demos



Sensing / Fabrication

ForceSight: Non-Contact Force Sensing with Laser Speckle Imaging <https://dl.acm.org/doi/10.1145/3526113.3545622> Booth 1032







Virtual / Augmented Reality



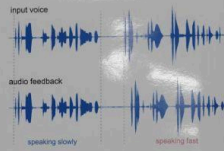


#1007

Shadowed Speech: an Audio Feedback System which Slows Down Speech Rate

Shadowed Speech: an Audio Feedback System which Slows Down Speech Rate

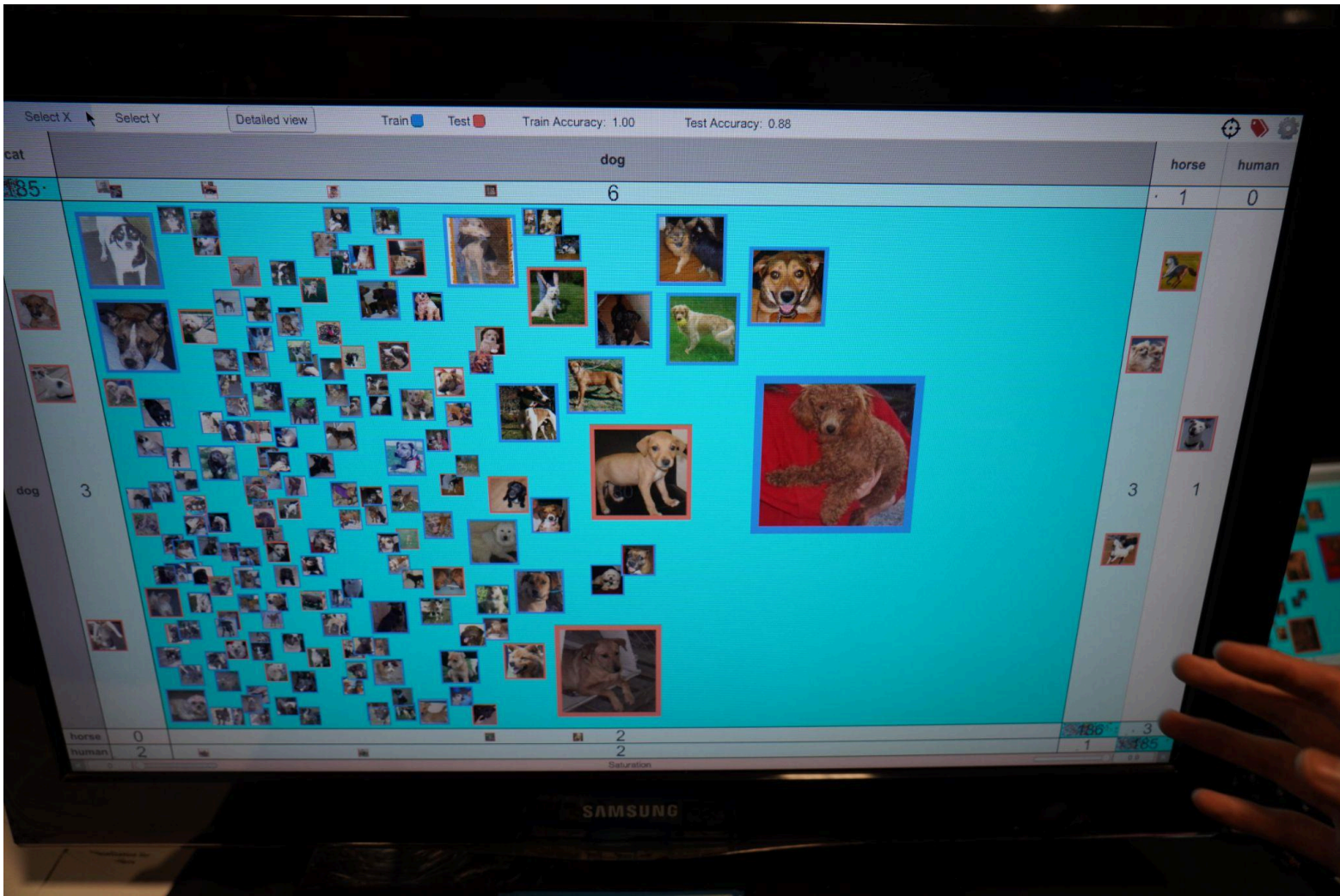
Mariko Chiba (mariko.chiba@acm.org),
Wataru Yamada, Keichi Ochiai

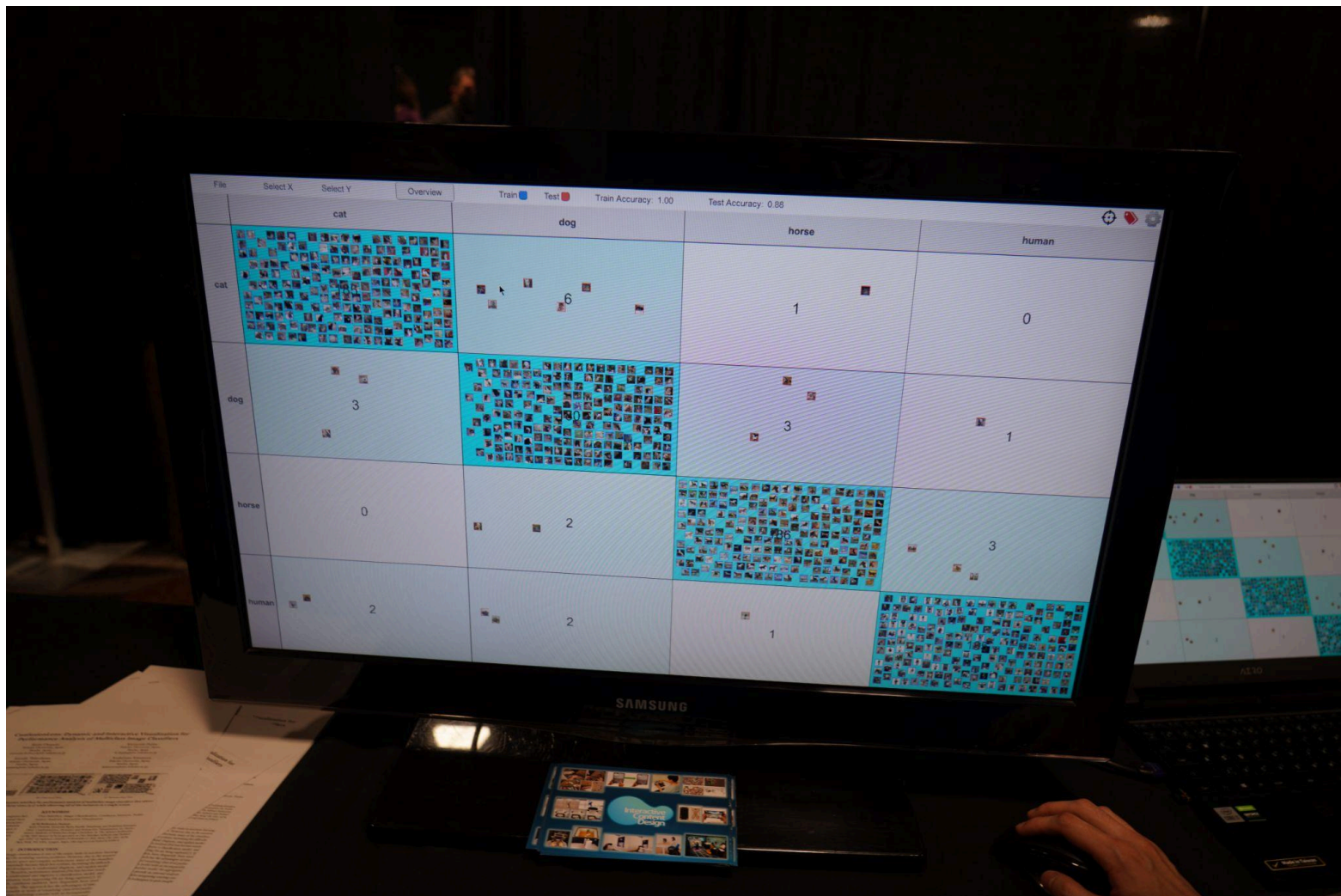


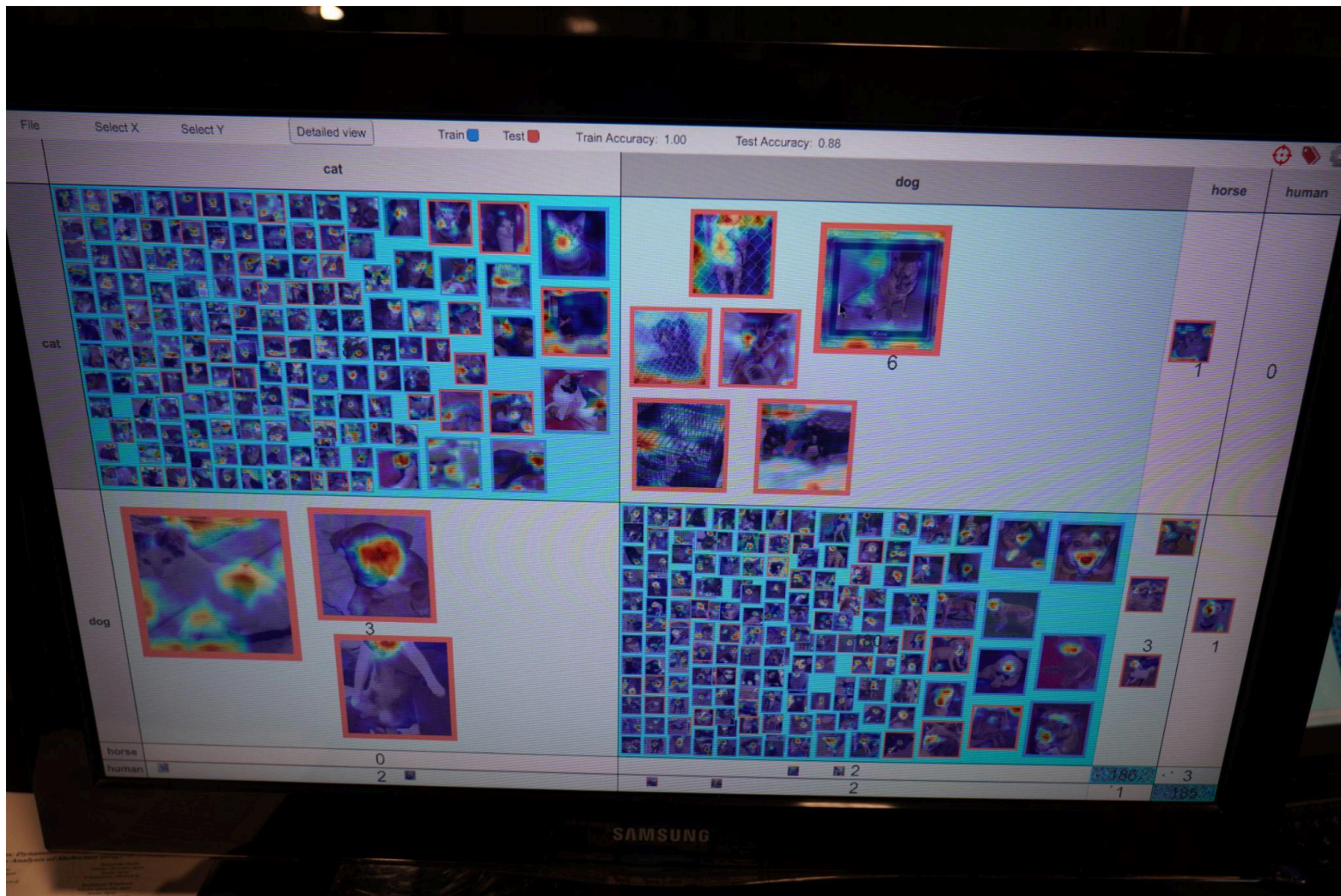
In oral communication, it is important to speak at a speed appropriate for the situation. However, we need a lot of training in order to control our speech rate as intended. This paper proposes a speech rate control system which enables the user to speak at a pace closer to the target rate using Delayed Auditory Feedback (DAF). We implement a prototype and confirm that the proposed system can slow down the speech rate when the user speaks too fast without giving any instructions to the speaker on how to respond to the audio feedback.

Reference: Chiba M. et al., "Shadowed Speech: an Audio Feedback System which Slows Down Speech Rate," Adjunct Proc. UIST '22.

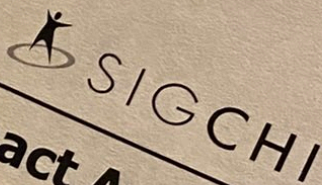
Visualization







Lasting Impact



Lasting Impact Award

UIST 2022

ACM User Interface Software and Technology
October 30-November 2, 2022

Presented to

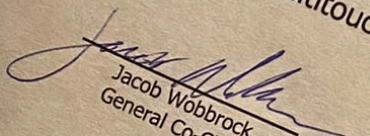
Bend, Oregon

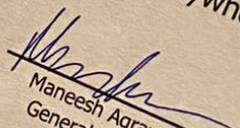
**Chris Harrison, Hrvoje Benko,
Andrew D. Wilson**

For

OmniTouch:

Wearable Multitouch Interaction Everywhere


Jacob Wobbrock
General Co-Chair


Maneesh Agrawala
General Co-Chair



uist
2022

bend on, usa | oct 29 - nov







SIC Honorable Mention (Jury)

UIST 2022

ACM User Interface Software and Technology

October 30-November 2, 2022

Bend, Oregon

Presented to

Mehrad Faridan and Marcus Friedel

For

**"Ultrabots: Large-Area Mid-Air Haptics for VR with
Robotically Actuated Ultrasound Transducers"**

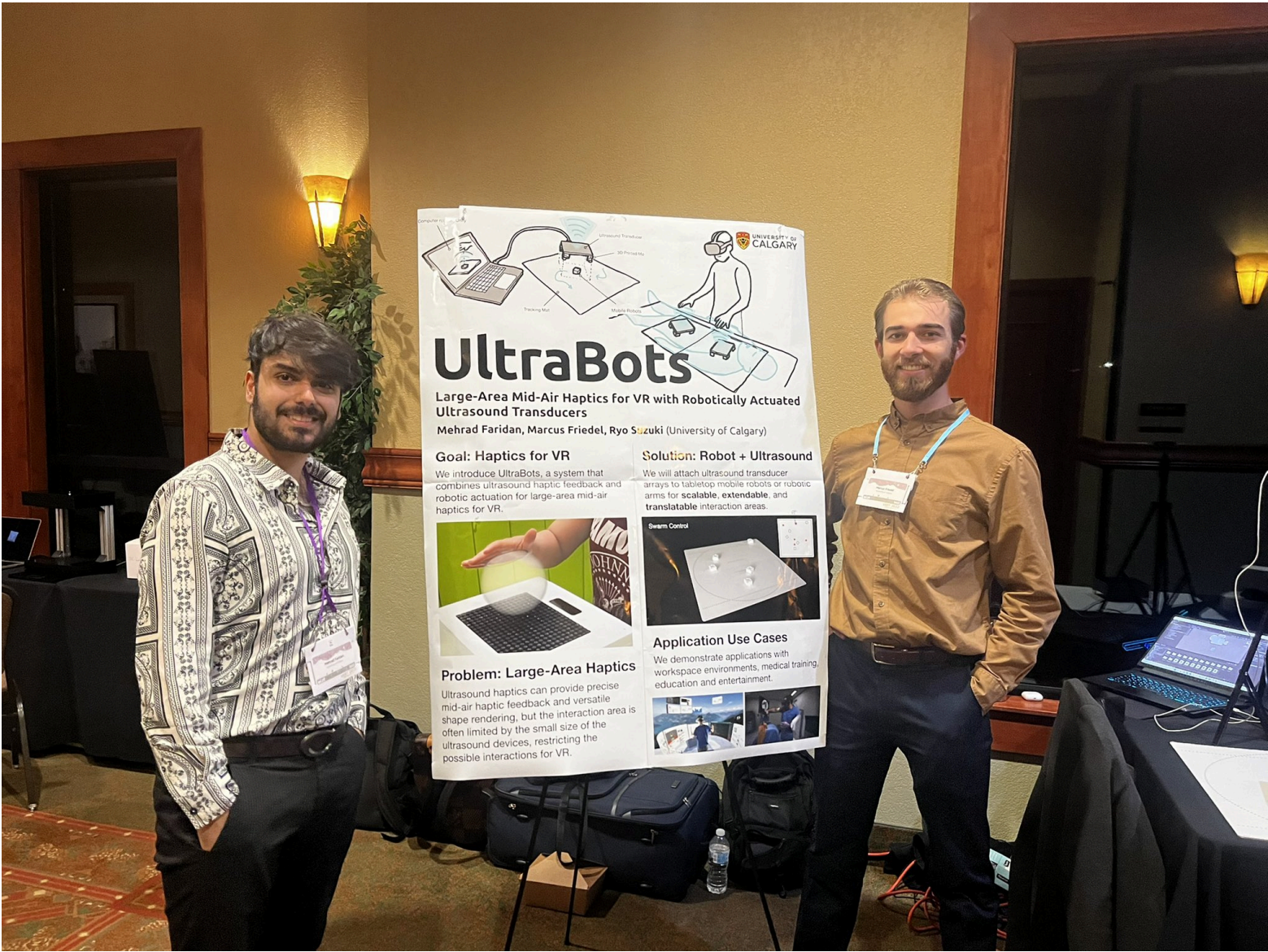
Thijs Roumen
SIC Co-Chair

Ryo Suzuki
SIC Co-Chair

Posters







Student Innovation Award – Jury Awards



Jury Best SIC:
Top-Levi: Multi-User Interactive Systems Using Acoustic Levitation

Jiwan Kim and Hyunjae Gil (UNIST Korea)

Jury Honorable Mentions:

ShadowAstro: Levitating Constellation Silhouette for Spatial Exploration and Learning
Jialong Li and Chenfeng Gao (University of Chicago)

Ultrabots: Large-Area Mid-Air Haptics for VR with Robotically Actuated Ultrasound Transducers
Mehrad Faridan and Marcus Friedel (University of Calgary)

Wemoji

Towards Designing Complementary Communication Systems in Augmented Reality

Joanne Leong¹, Olivia Soong², Cathy Mengying Fang¹,
Benny J. Tang¹, Rajee Vash³, Petrie Maek⁴
¹MIT Media Lab, ²MIT CSAIL, ³Google Research, ⁴Connecticut College

Overview

Wemoji is a mobile AR app and complementary communication system to enhance same-time, same-place social interactions. Through an iterative design exploration, we outline important design factors and share a set of insights from initial testing to inform future design iterations.



Wemoji is built based on Connected Lenses in Lens Studio. It supports bi-directional exchanges. Users can **emote** and trigger AR effects next to them for self-expression, or **react** by sending effects to others, adding dimension and volume to social exchanges.



Design Factors

Interaction & Agency

AR Effects can be triggered mutually or automatically. This can affect people's cognitive load and sense of agency.

Content Type

Many types of information can be presented in AR, depending on the desired use case. These include emotions, opinions, and information.

Directionality & Spatiality

3D space can be used to give additional context to expressions, and also differentiate sender and recipient.

Design Reflections

- Balance visibility and distraction
- Go beyond standard body gestures
- Use 3D effects to amplify immersion
- Discover ways to express emotional valence
- Aggregate information for larger groups
- Preserve eye contact with HBDs

ICEBOAT: An Interactive User Behavior Analysis Tool for Automotive User Interfaces

Patrick Ebel, Kim Güler, Christoph Ungenheimer, Andreas Vogelwang

Background

- Large number of tasks
- High complexity of the main functions and the sub-functions
- High number of interactions
- High number of sub-functions
- High number of sub-functions
- High number of sub-functions

Methodology

Initial interaction studies with design experts to collect requirements and design principles. Subsequent iterative design process.

ICEBOAT

Based on large interaction studies and design principles. Enables users to explore their own interaction with the UI. Allows a detailed comparison of different levels of interaction performance and design principles.

Research Plan

- Conduct user studies
- Evaluate usability
- Performance
- Usability
- Design principles







MoonBuddy: A Voice-based Augmented Reality User Interface That Supports Astronauts During Extravehicular Activities

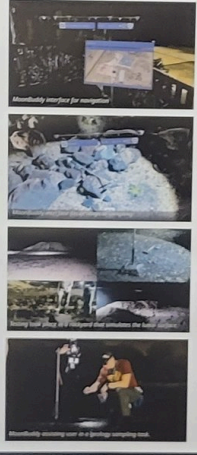
Angelica Bonilla Fominaya, Rong Kang (Ron) Chew, Matthew Komac, Jeremia Lo, Alexandra Siabakis, Ningling (Anita) Sun, Yuni (Joyce) Zhang, David Lindbauer

Motivation

- Upcoming NASA Artemis missions will feature Extravehicular activities (EVAs) for lunar surface exploration.
- EVAs depend on constant communication with the Mission Control Center (MCC) to provide mission-critical information on tasks, status, and emergency procedures.
- Current EVA systems are not as safe and efficient for lunar surface exploration and geological sampling.

MoonBuddy is a voice-based AR interface that supports astronauts in EVAs. It reduces cognitive load and improves communication, navigation, and emergency response. It is hands-free and provides a more reliable and safe EVA experience.

MoonBuddy is a NASA Johnson Space Center project. It is a simple voice-based AR interface that supports astronauts in EVAs. It is a simple voice-based AR interface that supports astronauts in EVAs.





dextrEMS

increasing dexterity in electrical muscle stimulation by combining it with brakes

romain nith, shan-yuan teng, pengyu li, yujie tao, pedro lopes

ACM UIST 2021

what is dextrEMS?

DextrEMS is a haptic device designed to improve the dexterity of electrical muscle stimulation (EMS).

By combining EMS with brakes, which allow us to solve two main problems with EMS: (1) independent actuation—when a single finger is actuated via EMS, it also causes unwanted movements in other fingers; and (2) lack of precision—EMS cannot stop a finger at an angle without oscillations, which originate from the fact that to stop a finger, EMS needs to continuously contract the opposing muscle.

how our brake works

Our brake mechanism includes one ratchet per MCP and PIP joint on all four fingers, which allows us to stop the finger precisely, without the oscillations observed in typical EMS control loops.

more applications

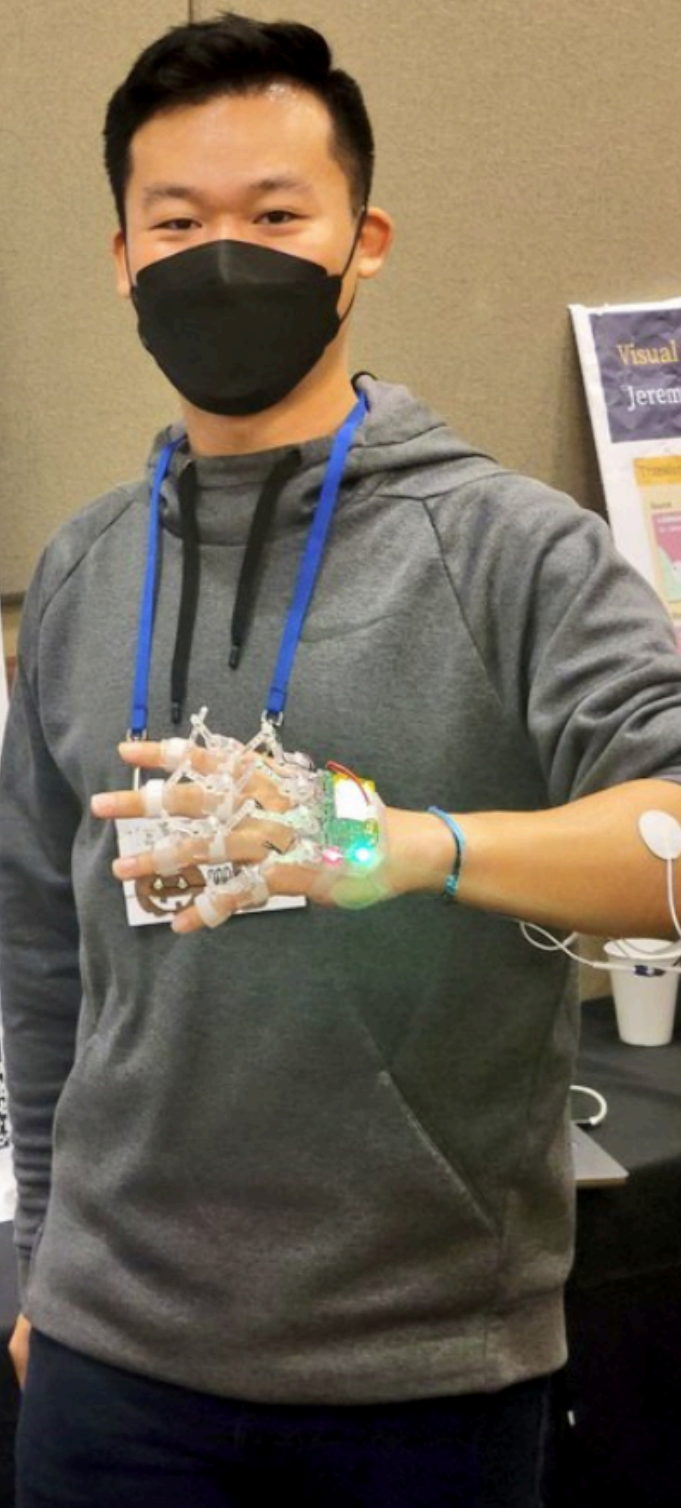
Our VR piano guiding application independently actuates and locks each finger to achieve the pose of a minor third.

DextrEMS achieves an unprecedented dexterity, enabling applications not possible with existing EMS-based interactive devices.

(a) We demonstrate a haptic finger spelling application, that actuates the user's fingers to pose the "K" sign (in American sign language, from which dextrEMS can only render a very small subset); (b) the quality of the same pose via EMS alone suffers from oscillations and unwanted movements.

learn more at lab.plopes.org/#dextrEMS

THE UNIVERSITY OF CHICAGO

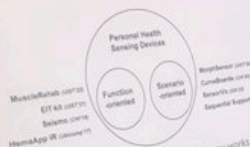




Design and Fabricate Personal Health Sensing Devices

Junyi Zhu, HCI Engineering Group - MIT, CSAIL

Research Overview



With the development of low-cost electronics, rapid prototyping techniques, as well as widely available mobile devices (e.g., mobile phones, smart watches), users are able to develop their own low-cost interactive functional applications, often on top of existing device platforms, in a stand-alone devices. However, the built-in devices, both function-prototyping and fabrication-wise, are still high.

In this doctoral symposium, I present my works on designing and fabricating personal health sensing devices with rapid function prototyping techniques and novel sensing technologies. Through these projects and ongoing future research, I am working towards my vision that everyone can design and fabricate highly-customized health sensing devices based on their form and desired functions.

Function-oriented Personal Health Sensing Devices



Scenario-oriented Personal Health Sensing Devices



Authors: Junyi Zhu, MIT CSAIL, HCI Engineering Group, MIT CSAIL

HandMorph

a passive exoskeleton that miniaturizes grasp

Jun Nishida | Soichiro Matsuda | Hiroshi Matsui | Shan-Yuan Teng
Ziwei Liu | Kenji Suzuki | Pedro Lopes
best paper award UIST 2020

in your hand
We designed an exoskeleton, which we call HandMorph, that approximates the exoskeleton of a hand with a smaller grasping range. It has mechanical links to transmit motion from the wearer's fingers to a smaller set of fingers with five anatomically correct joints. The result is that HandMorph miniaturizes a wearer's grasping range while providing haptic feedback.

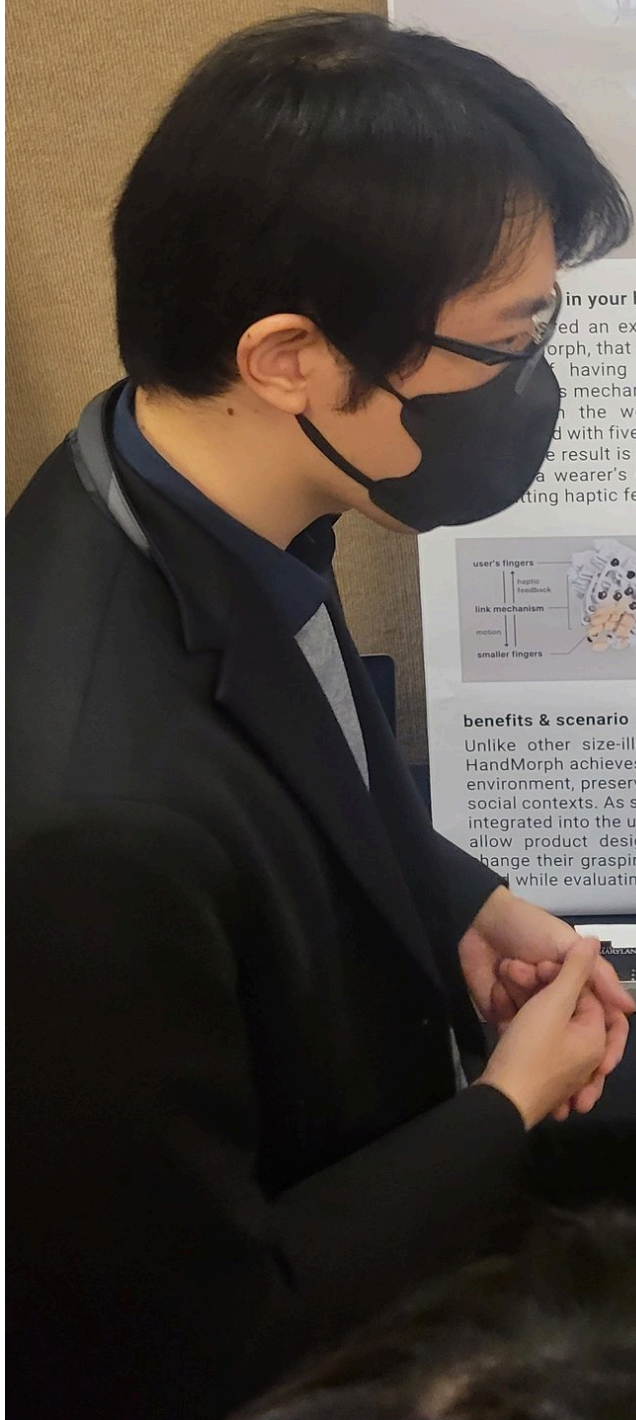
providing embodied knowledge
We found that participants perceived objects as larger when wearing HandMorph. We also assessed how HandMorph can support design process.

benefits & scenario
Unlike other size-illusions based on VR, HandMorph achieves this in the users' real environment, preserving their physical and social contexts. As such, our device can be integrated into the user's workflow, e.g., to allow product designers to momentarily change their grasping range into that of a child while evaluating a toy prototype.

Join my new lab!
Jun will join the University of Maryland, College Park as an Assistant Professor in 2023/01. He is looking forward to chatting with you during this conference!

learn more at lab.pl

THE UNIVERSITY OF CHICAGO



Arthur Caetano Misha Sra
caetano@ucsb.edu sra@ucsb.edu

UC SANTA BARBARA
Computer Science Department
Perceptual Engineering Lab

Motivation

Placing virtual content in target physical environments unknown during development is challenging. To accomplish this, developers apply strategies such as:

- **Manual placement** with AR markers or computer vision tracking.
 - **Automated placement** enabled by author-defined constraints
 - **Procedural content generation**
- Although effective, they require human effort or specialized virtual assets. ARfy does not require end-user intervention or asset annotation by AR authors.

Algorithm

ARfy operates on point-cloud data extracted from the physical scene and the surface of the virtual scene. It calculates an aligning 3D transformation using the classic ICP algorithm and heuristics for the AR setting.

1. **Translation:** XYZ centroid and lowest y-coordinate alignment
2. **Rotation:** discrete search along the y axis
3. **Scale:** constraining virtual scene to the physical scene bounding box

ARfy minimizes the mean square distance between pairs of closest points between scenes, resulting in a satisfactory alignment of virtual and physical surfaces.

Evaluation

We demonstrated the capabilities of ARfy computing alignments between a scene from Unity Gamelift and the validation tool of ARKit Scenes, both publicly available. The best-performing scene shows the feasibility of our approach. The worst-performing scenes helped us to identify that environments with **reflective surfaces**, **multiple floors**, and **occluded areas** are more challenging to ARfy.



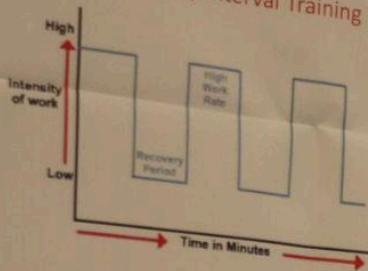
Bodyweight Exercise based Exergame to Induce High Intensity Interval Training

Seokwoo Song, Doil Kwon
Samsung Research, Seoul, Samsung Electronics

Samsung Research

INTRODUCTION

High Intensity Interval Training



HIIT is effective exercise consisting of intermittent vigorous activity and short rest.

HIIT-based Machine Exergames



Single Input Type (ex., cycling, running, and rowing [1,2,3])

Research Contribution

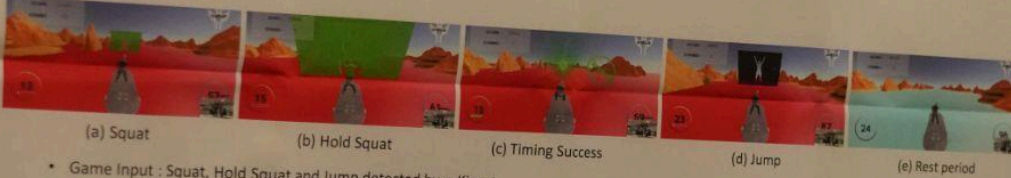


Various Input Type

We propose a Bodyweight Exercise based HIIT exergame.

SYSTEM DESIGN

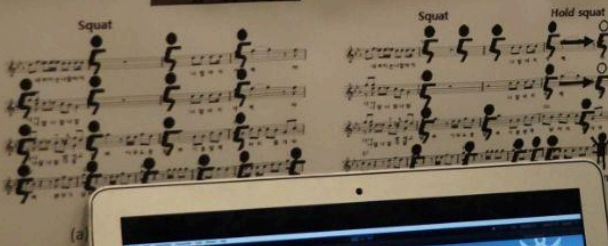
Game Screenshots



- Game Input : Squat, Hold Squat and Jump detected by a Kinect
- Game Score : (1) Movement timing (2) Posture accuracy

EVALUTATION

Youtube-like Video V.S. Exergame



RESULT

Enjoyment

Questions	Video	Exergame
1 The activity was fun to do	3.6 (1.4)	5.8 (0.8)
2 I enjoyed doing the activity very much	3.9 (1.9)	5.8 (2.0)
3 While I was doing the activity, I was thinking about how much I enjoyed it	3.7 (3.0)	5.6 (2.5)

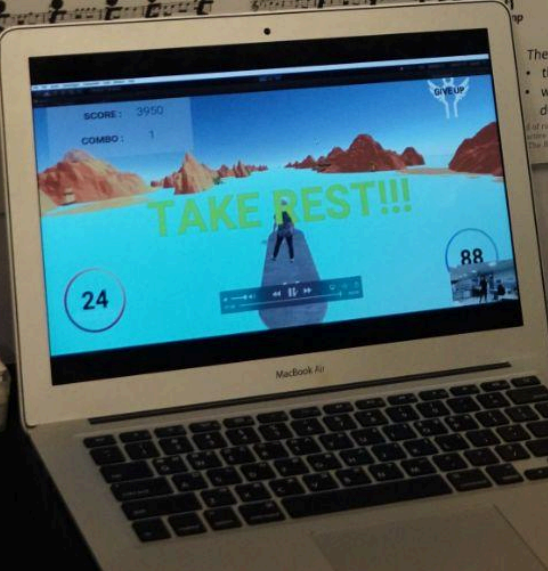
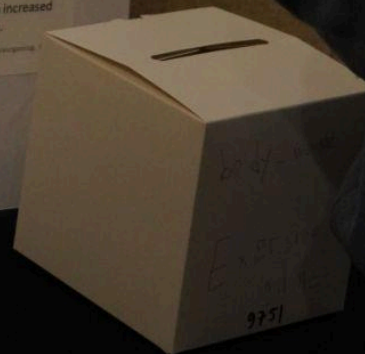
Means (and variance) of the questionnaire for the experiments. 1 (not at all) to 7 (very true)

Squat posture accuracy

UserID	Video	Exergame
1	10%	82.5%
2	47.9%	71.7%
3	6.5%	28%
4	1.9%	10.7%
5	60%	71.4%
6	5.8%	57.6%
7	7.3%	6.4%
8	9.4%	44%
9	0%	6.2%
10	0%	28.8%

The ratio of incorrect squat posture

- The initial study (n=10) showed
- the exergame had a significant effect on enjoyment,
 - while the ratio of incorrect posture (ex., squat) also increased due to participants' concentration on the exergame.

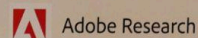


iMarker: Instant and True-to-scale AR with Invisible Markers

Chang Xiao

Ryan A. Rossi

Eunyee Koh



Principle Overview



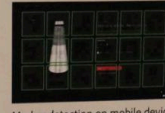
Website Content



What human can see



What camera can see



Marker detection on mobile device



AR Rendering

Motivation

Online shopping experiences have been largely enhanced by Augmented Reality (AR) techniques. Current AR solutions are usually based on marker-less scene reconstruction, which requires the user to use their mobile device to scan the environment for a few seconds. The quality of scene reconstruction will determine the quality of virtual objects rendered in AR. Besides, current AR solutions usually cannot render the size of the object correctly.



Repeated Scan



Incorrect Size

Our proposed system can instantly render AR objects at its true scale.

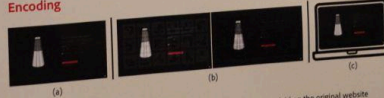
Method

We utilize the difference between human vision and camera vision:

- Human vision can recognize change up to 30fps,
- Camera on mobile devices can detect 240fps,
- Computer monitor usually can display content at least 60Hz.

When monitor is refresh two images at a high frame rate, our human eyes cannot see the changes but the camera can.

Encoding

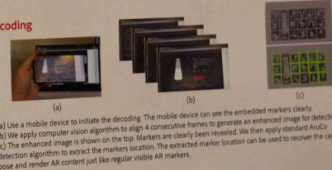


(a) Input is the original website content.
(b) We generate two pairs of images with opposite color of markers that overlaid on the original website.
(c) When the two images in (b) alternatively displayed on a monitor that refresh at 60Hz, human will observe the monitor same as the original website content. However, a camera with 120fps or higher can see the frame is changing between the two images in (b).

The two images in (b) can be computed by the following formula:

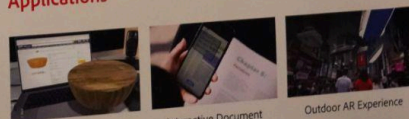
$$I_1 = I_0 \cdot a + a_1, I_2 = I_0 - a + a_1$$

Decoding



(a) Use a mobile device to initiate the decoding. The mobile device can see the embedded markers clearly.
(b) We apply computer vision algorithm to align 4 consecutive frames to generate an enhanced image for detection.
(c) The enhanced image is shown on the top. Markers are clearly been revealed. We then apply standard ArUco detection algorithm to extract the markers location. The extracted marker location can be used to recover the camera pose and render AR content just like regular visible AR markers.

Applications



Online Shopping

Interactive Document

Outdoor AR Experience

Contact

Chang Xiao (cxiao@adobe.com)

MoonBuddy: A Voice-based Augmented Reality User Interface That Supports Astronauts During Extravehicular Activities

Angelica Bonilla Fominaya, Rong Kang (Ron) Chew, Matthew Komar, Jeremia Lo, Alexandra Slabakis, Ningjing (Anita) Sun, Yunyi (Joyce) Zhang, David Lindlbauer

Motivation

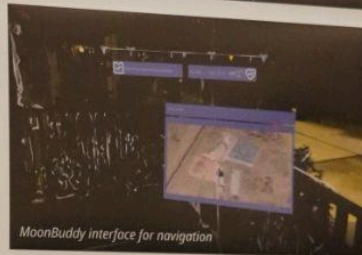
- Upcoming **NASA Artemis missions** will feature **Extravehicular activities (EVAs)** for lunar surface exploration.
- **EVAs** depend on constant communication with the Mission Control Center (MCC) to **provide mission-critical information** on tasks, navigation, and emergency procedures.
- EVA systems must be as **safe and efficient** for successful exploration and geological sampling.

MoonBuddy

- **Augmented Reality (AR)** and **voice-based interaction** to assist astronauts in EVAs.
- MoonBuddy should reduce cognitive load & increase efficient task completion.
- Specialized interfaces for communication, navigation, and documentation.
- Voice-based assistant enables hands-free interaction.
- Shader-based surface highlight enable safe navigation.

Evaluation

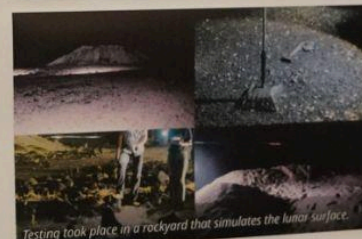
- Preliminary evaluation at **NASA Johnson Space Center** in a simulated lunar landscape.
- Evaluation tasks included navigation, geological sample collection, and search & rescue.
- Participants appreciated the simple **voice commands**, the guided nature of MoonBuddy, and the **surface edge detection** feature that helped them avoid hazards during navigation.



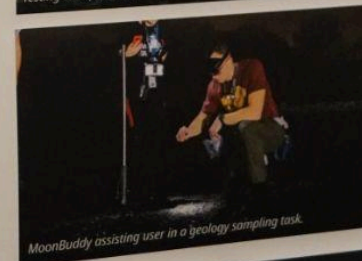
MoonBuddy interface for navigation



MoonBuddy interface for geological sampling



Testing took place in a rocky yard that simulates the lunar surface.



MoonBuddy assisting user in a geology sampling task.

MOON
BUDDY

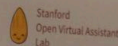
Carnegie
Mellon
University



Human-
Computer
Interaction
Institute

HomeView

Automatically Building Smart Home Digital Twins With Augmented Reality Headsets
Zhuoyue Lyu, Jackie (Junrui) Yang, Monica S. Lam, James A. Landay



Stanford ENGINEERING
Computer Science

<https://jya.ng/homeview>



Problem

Digital twins are dynamic representations of physical systems, which have demonstrated great capabilities in the industrial setting.

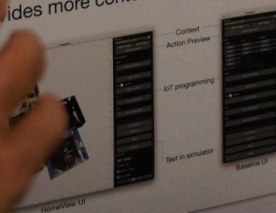
However, building digital twins traditionally have to be manually built by professionals who understand the relationship between sensor data and 3D models. The cost makes it prohibitive for home settings and limited to specific commercial applications.

Evaluation

We evaluate HomeView with a home simulator, where virtual cameras replace the AR headsets.

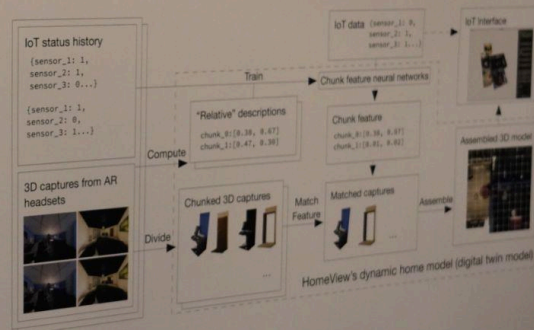
The first evaluation shows that HomeView has better visual fidelity than a baseline retrieve-from-history method.

The second evaluation shows users prefer UI build with HomeView as a baseline UI without visual information.



Solution: Auto build digital twins from AR cameras and IoT data

HomeView takes colored point clouds from the AR as well as the corresponding IoT data as inputs, divides the point clouds into chunks, and learns to associate the IoT status with the chunks. In this way, HomeView can assemble new point clouds for any given IoT status.



Applications

1. HomeView is useful when the tenants are not the same as the operator who helps them set up their IoTs (assisted living). Its ability to simulate historical situations allows the operator to have the context and feel situated when they program the automation.
2. HomeView's dynamic model works nicely building-information model (BIM). Building managers can better understand the tenants' needs and program the building to reduce energy costs while not compromising the tenants' experience.

1. User Problem: "How do I search & browse products that will fit and look good in my space?"

- In e-commerce, the typical user flow involves first choosing a product from a catalog, navigating to each product page for product details, and gauging if the product will physically and aesthetically fit in the desired space.
- Browsing this way can be time consuming and overwhelming for large catalogs. Additionally, there is no guarantee the product will physically fit in the user's space which might lead to more returns.

2. Solution: Search with Space - Visualize the catalog in a user's space in near-real time

Search with Space enables the user to invert the process by starting with their spatial parameters as an input. This approach allows the user to quickly sift through large catalogs to identify products that will physically fit, and also visualize the products at real-world scale in their space. Search with Space is implemented as a mobile prototype, which guides the user to capture photos of their space using augmented reality (AR).

2a. AR-guided capture of user's space from preset angles



Fig. 2a. AR-guided capture of user's space from preset angles

2b. Catalog search using the AR information to find and visualize matches in the user's space

- Products that will fit in the user space are shortlisted based on the dimensions chosen for the gray model in the AR guided capture process.
- Corresponding images of the shortlisted products are processed to create "photo-realistic" stickers (Fig. 3), which are then composited onto the user's photos at physically accurate scale (Fig. 3).



Fig. 3. Generation of photo-realistic stickers from product images: (a) A starting image of a product is labeled with its (b) short angle, followed by (c) background removal to make it transparent, and (d) addition of shadows to create a photo-realistic sticker used for the corresponding scene described above.



Fig. 4. Gallery page showing comparison

2c. Gallery page with all catalog matches is rendered in near-time in the user's space

- The short angle of the product and the user photos are matched for consistency.
- Products are shown at physically accurate scale to enable effective side-by-side comparison of various options (Fig. 4).



Conclusion

Search with Space is a novel, interactive approach to browse large catalogs. It enables users to input information about their space as a search parameter with AR to then find all corresponding product matches. These matches are visualized at physically accurate scale in the user's space to enable seamless comparison of various options and confident decision making.

¹ Co-first authors, equal contributions ² Corresponding author, nivedha@wayfair.com

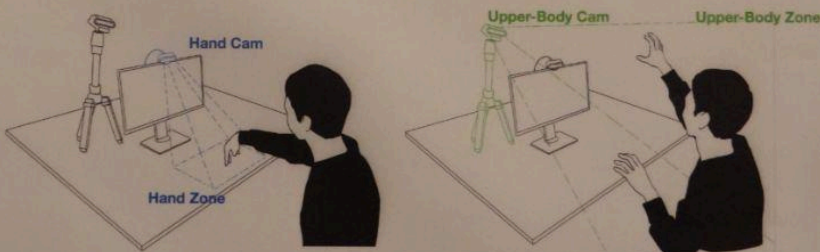
Puppeteer

Manipulating Human Avatar Actions
with Intuitive Hand Gestures and
Upper-Body Postures

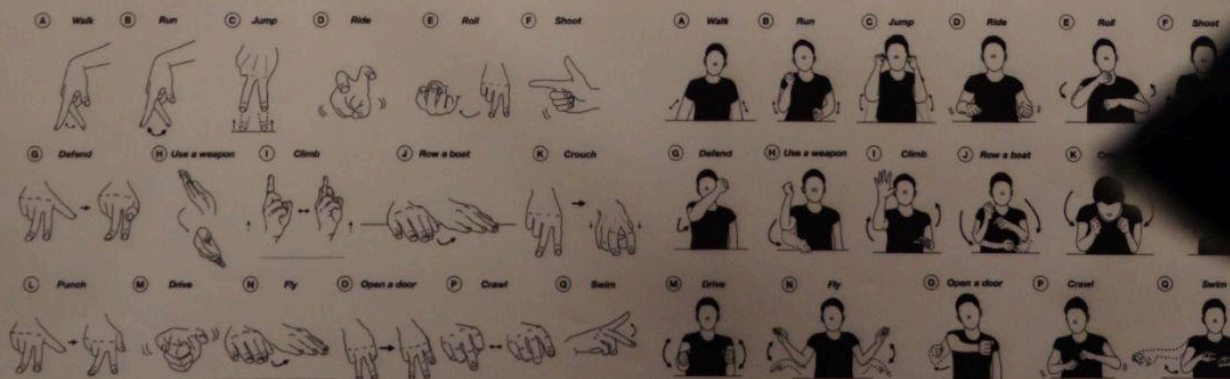
Ching-Wen Hung
Ruei-Che Chang
Hong-Sheng Chen
Chung-Han Liang
Liwei Chan
Bing-Yu Chen



We present Puppeteer, an input prototype system that allows users directly control their avatars through intuitive hand gestures and upper-body postures. The system consists of two cameras mounted on a screen and a tripod to detect gestures/postures separately.



We explored how users preferred the two manipulations and invited them to define 17 hand gestures and 17 upper-body postures. Finally, we proposed possible applications to demonstrate this new input interaction.



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Patrick Ebel, Kim Gülle, Christoph Lingenfelder, Andreas Vogelsang

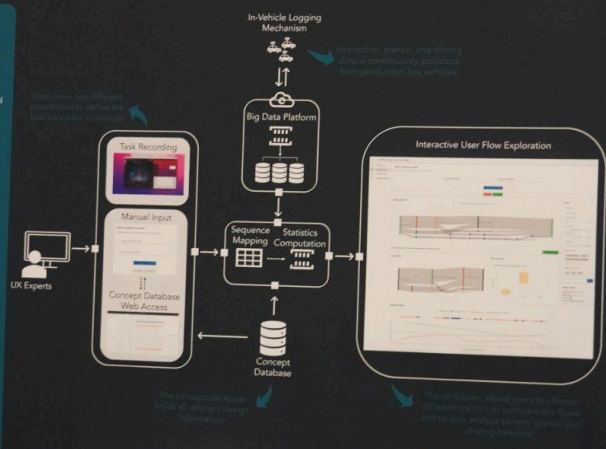
Learn more about
my research

- Large center stack touchscreens are the main interface between driver and In-Vehicle Information Systems (IVIS)
- Touchscreen interactions while driving are safety critical
- UX experts are in need of data-driven assistance in the design process of IVISs

- ## Methodology
- Initial Interview studies with domain expert to collect requirements
 - Subsequent co-design process

- Based on large naturalistic driving data
- Enables users to explore how drivers interact with IVISs
- Allows a detailed comparison of different flows based on performance, usability

- Introduce additional visualizations and filters
- Perform an extensive usability evaluation
- Integrate the tool in the product design process



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ICEBOAT
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VLOGS: Virtual Laboratory Observation Tool for Monitoring a Group of Students

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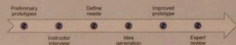


Abstract

Virtual laboratories (VLs) enable students to conduct lab experiments in the virtual world using Virtual Reality (VR) technology, providing benefits in areas such as availability, safety as well as scalability. While there are existing platforms that provide VLs with rich content as well as research works on promoting effective learning in VLs such as [1], less attention has been paid on VLs from a teaching perspective. Students usually learn and practice in VL sessions with limited help from the instructors. Instructors, on the other hand, could only receive limited information on the performance of the students and could not provide timely feedback to facilitate students' learning. In this work, we present a prototype virtual laboratory monitoring tool, created using a design thinking approach, for addressing teaching needs when conducting a virtual laboratory session simultaneously for multiple students, similar to that in a physical lab environment.

Design Process

A design thinking approach originated from the Hasso-Plattner Institute of Design at Stanford University [2] is adopted to design the VL observation tool on the unconfined compression test in the field of civil engineering. The framework consists of six stages as depicted below: 1) Creation of preliminary prototypes as feedback instruments; 2) Interviewing subject instructors; 3) Define monitoring and grading needs; 4) Idea generation for meeting the needs; 5) Creating the improved prototype; 6) Invite domain experts to review the tool. The design process is iterative and can involve different user groups (e.g. students and lab technicians) to cover more user needs in the next iterations.



Preliminary Prototypes

The Grid-based design (top-left) and the Progress-based design (top-right) for monitoring VLs with multiple students. The Queue-based design (bottom) for grading students in VLs.

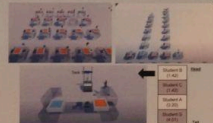


Figure 1: Three preliminary prototypes created as feedback instruments.

Improved Prototype

The improved prototype can allow the instructor to monitor multiple students simultaneously in a virtual laboratory session like that in a physical lab environment.



Figure 2: VLOGS Virtual Laboratory Observation tool for monitoring a Group of Students.

Monitoring and Grading requirements in VLs

Monitoring

Requirements	Proposed Solution
Observing with different level of details	A picture in picture view (Figure 3a)
Addition class/student-based information	Color-coded progress (Figure 2)
Instructor-student communication channel	Real-time annotation (Figure 3b)
Monitoring scope adjustment	Students by task

Grading

Requirements	Proposed Solution
Monitoring for measurement tasks	Color-coded progress (Figure 2)
Grading for complex tasks	Real-time annotation (Figure 3b)
Grading of a grading policy on different	Students by task

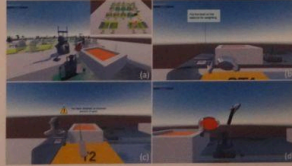


Figure 3: Features addressing monitoring and grading requirements.

Reference

- [1] Santawat Thanyadit, Pannya Purnpongson, Thammaph Pumsomboon, and Ting-Chuen Pong. 2022. AR-LINE: Enhancing Asynchronous Shared Space Demonstrations with Spatial-Temporal Assistance Tools for Effective Learning in Immersive Virtual Laboratories. *Proc. ACM Hum.-Comput. Interact.* 6, CSCW1, Article 136 (Apr 2022), 23 pages. <https://doi.org/10.1145/3512862>
- [2] Hasso Plattner Institute of Design at Stanford University. 2010. An Introduction to Design Thinking PROCESS GUIDE. Retrieved July 19, 2022 from <https://web.stanford.edu/msharna/MichaelSharnaNew100654.pdf>











Misc Googlers representations



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