

Augmenting Humans

From Physiology to Shared Experiences

Designing feedback loops in the age of AI

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Human-Centered Information Systems · TU Clausthal

kaikunze.de



AI Does More of the Work

What happens to the person?



Thinking

319 knowledge workers: more trust in GenAI, less critical thinking.

Motivation

N = 3,562: better work with GenAI, less motivation once back on their own.

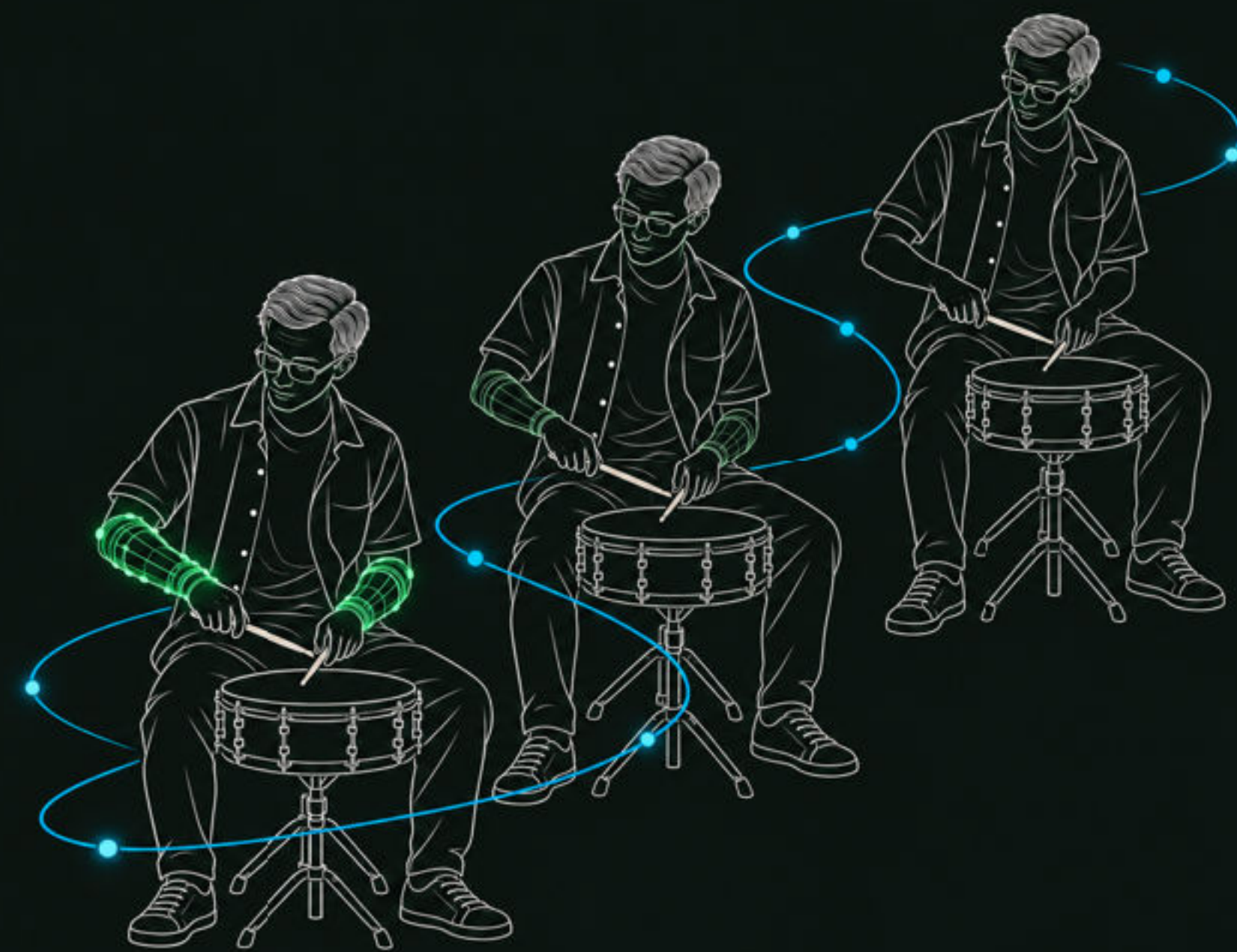
Ownership

n = 30 + 96: people did not feel they owned AI-written text, yet signed it.

Lee et al., CHI 2025 · Wu et al., Scientific Reports 15:15105, 2025 · Draxler, ..., Schmidt, Buschek, Welsch, ACM TOCHI 2023

We Design the Loops/Helixes/Coupling/Resonance ...

AI takes on the task; the feedback loop is ours to design



Agency

The system senses how I engage. It still feels like me doing it.

Skill

Which skills do I need? Which should I develop myself?

Experience

Meaningful moments with others, and ways to share them.

Engelbart, Augmenting Human Intellect, SRI 1962 · Ryan & Deci, American Psychologist 55(1), 2000

Augmenting Humans

Overview



Personal background

Wearable computing since 2000



Activity recognition

Computers learning what we do



System development

Glasses and sensors people wear all day



Augmented

Agency · Skill · Experience



My Background



Professor (2026)

Human-Centered Information Systems, TU Clausthal

Professor (2018)

Graduate School of Media Design, Keio University

Research Assistant Professor (2012)

Osaka Prefecture University

Visiting Researcher at MIT Media Lab

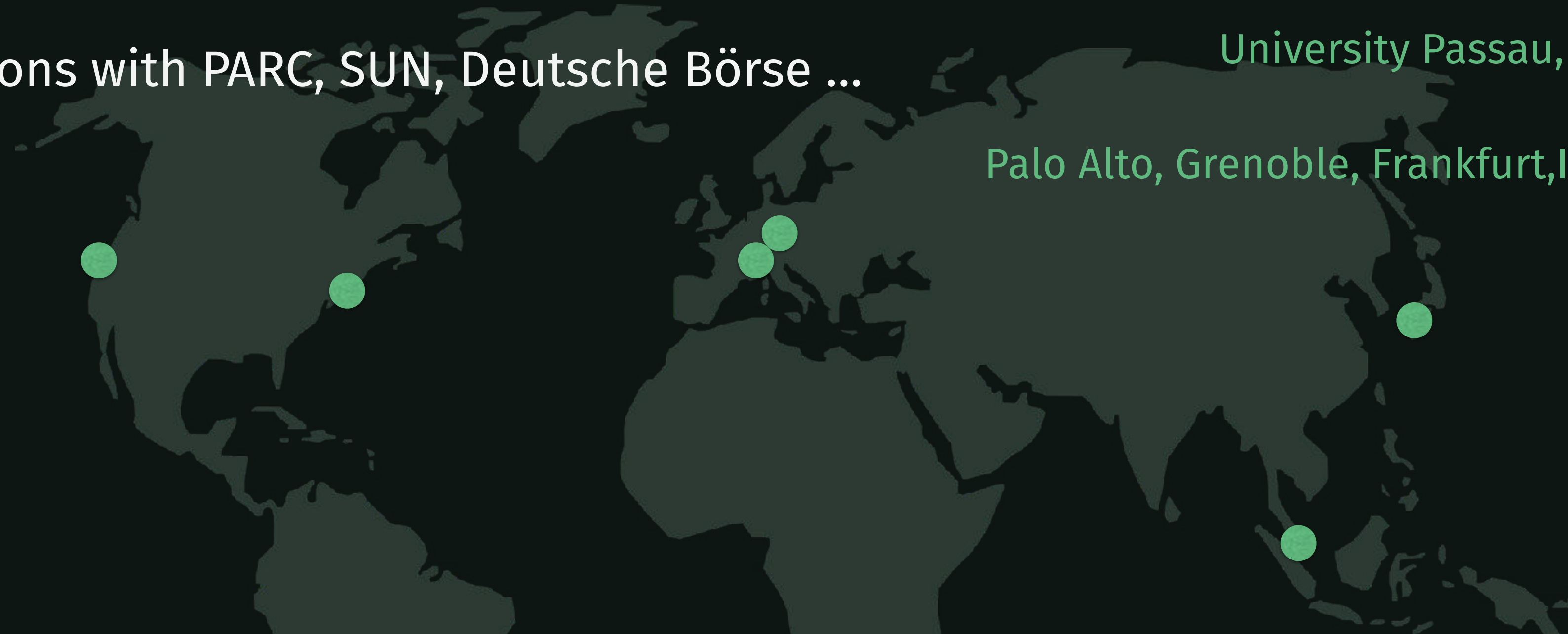
MIT, Cambridge, USA

PhD in Ubiquitous/Wearable Computing (2011)

University Passau, Germany

Collaborations with PARC, SUN, Deutsche Börse ...

Palo Alto, Grenoble, Frankfurt, Innsbruck





Our group at TU Clausthal

Still with us
in Yokohama (Keio)



Mingyang Xu



Danyang Peng



Kanyu Chen



Activity Recognition



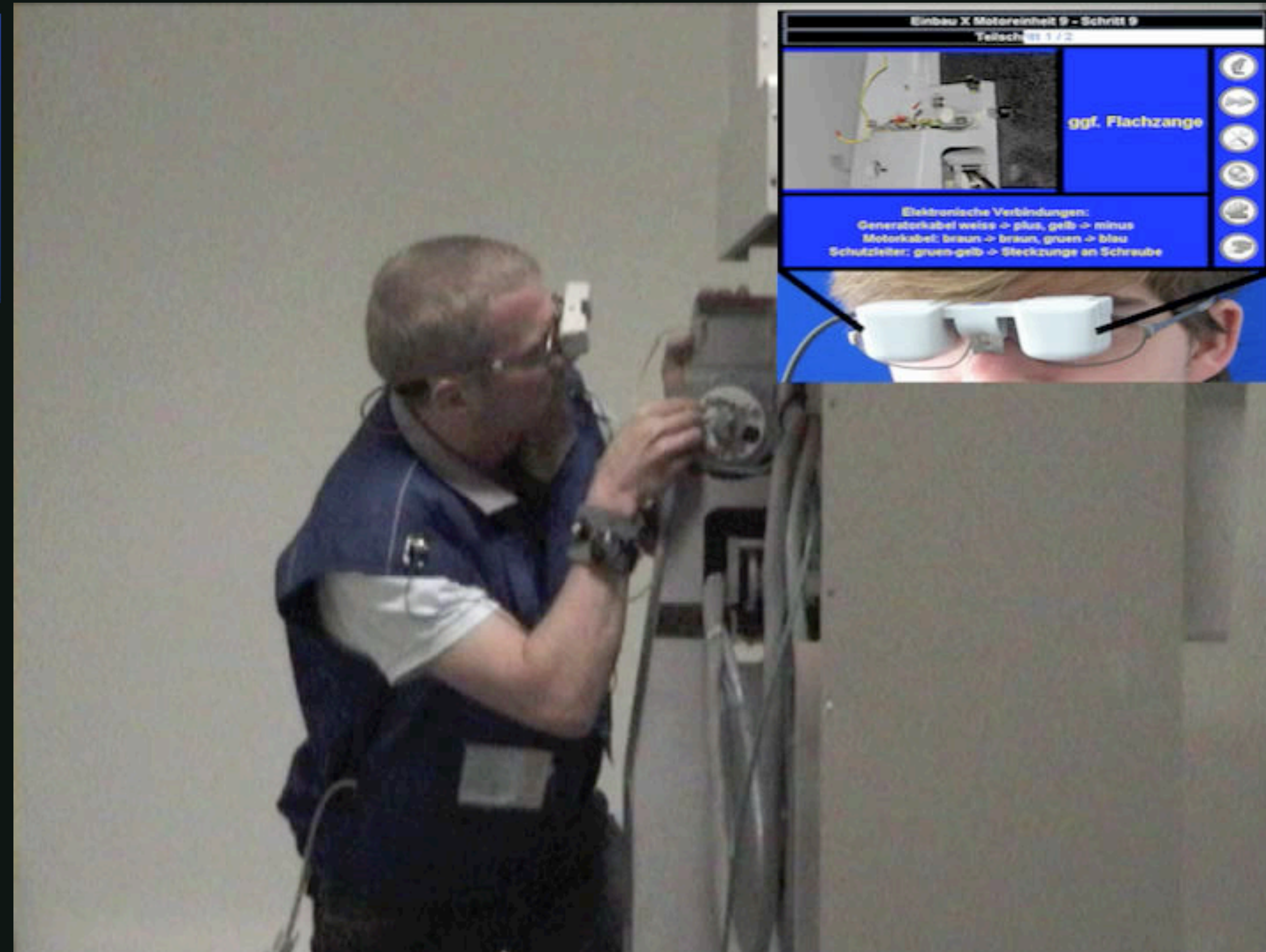
2000: Worn All Day, Already a Loop





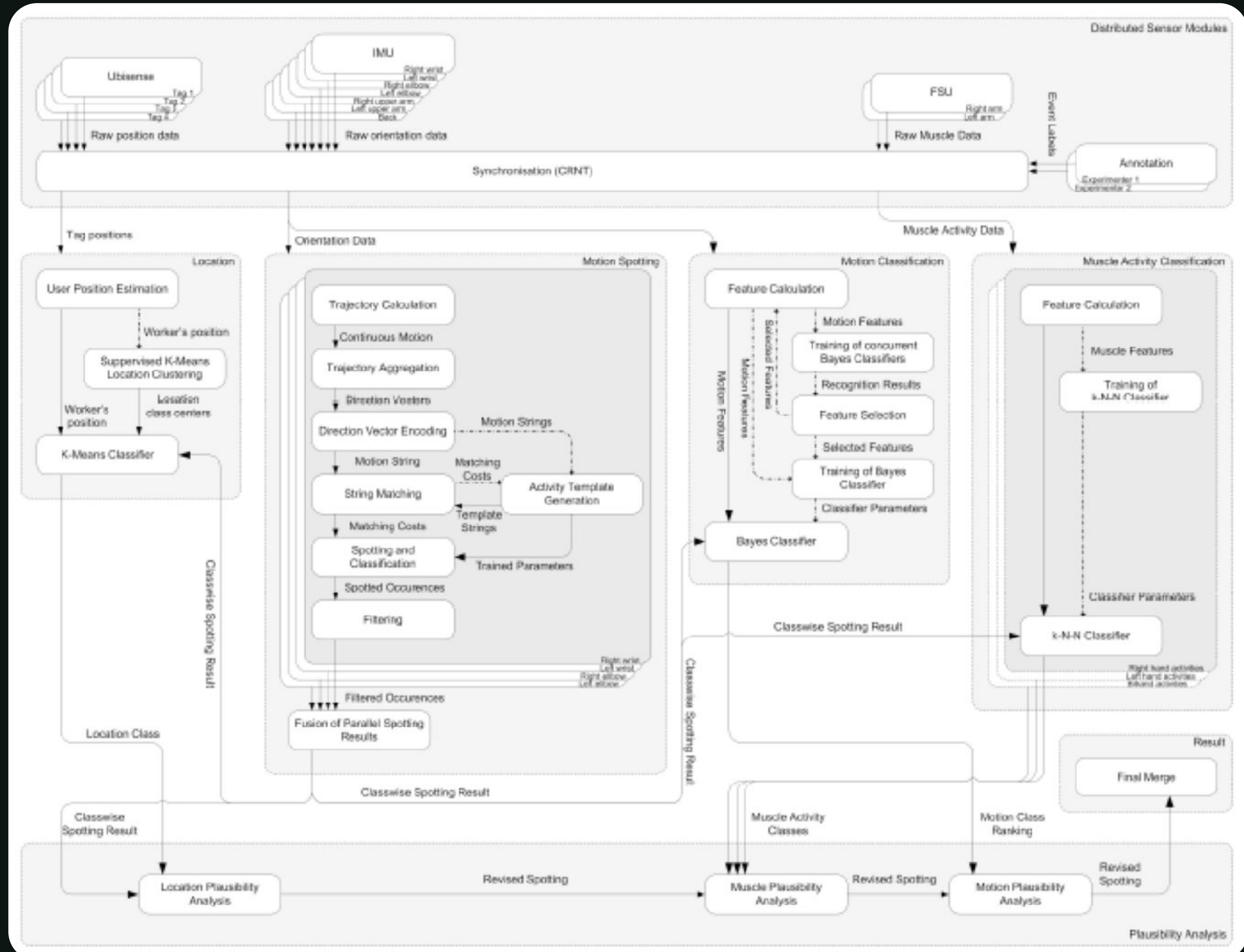
2007: The System Tells You the Next Step

Maintenance Scenario, Collaboration with University Bremen and Zeiss.



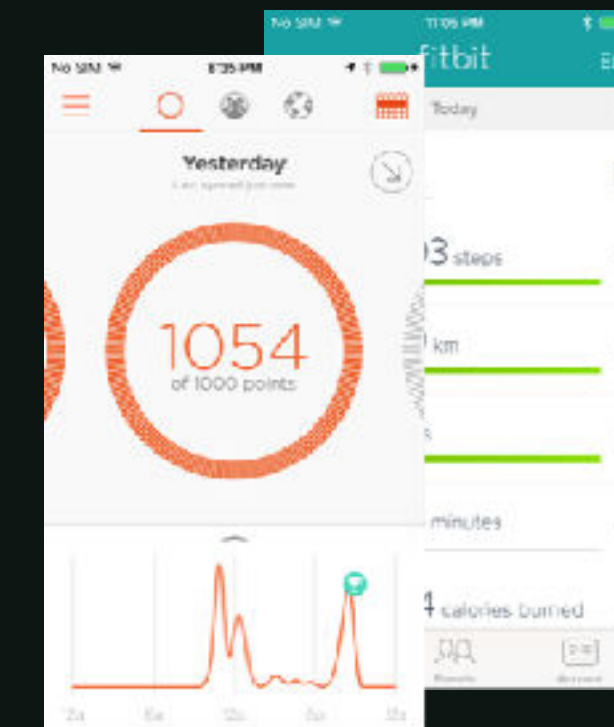
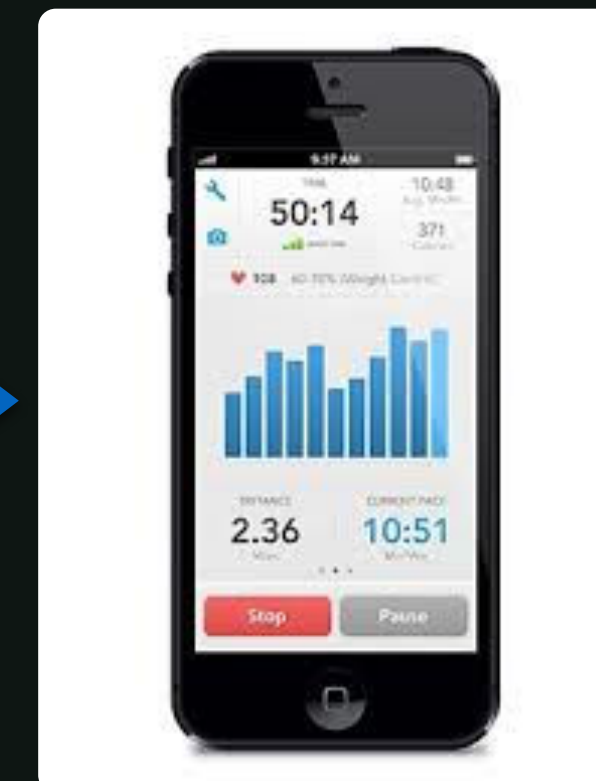
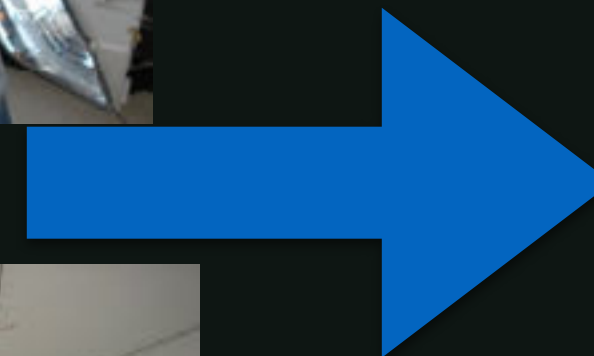
Kunze, Kai, et al. "Does context matter?-a quantitative evaluation in a real world maintenance scenario." Pervasive Computing: 7th International Conference, 2009.







Where You Wear It Changes What You See



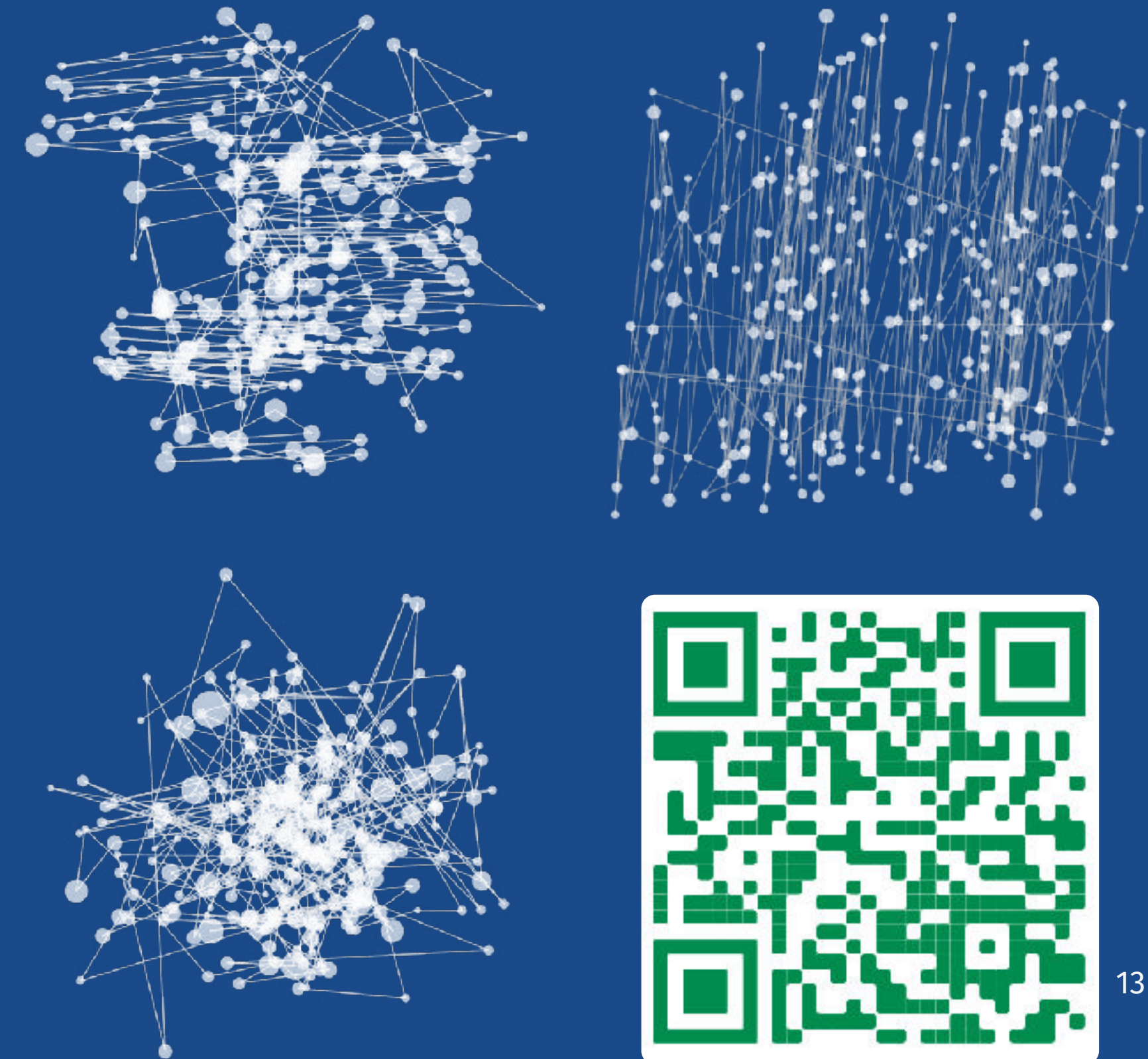


From Eye Movements Alone: What You Are Reading



Where to start?

Ubiquitous learning activity:
reading

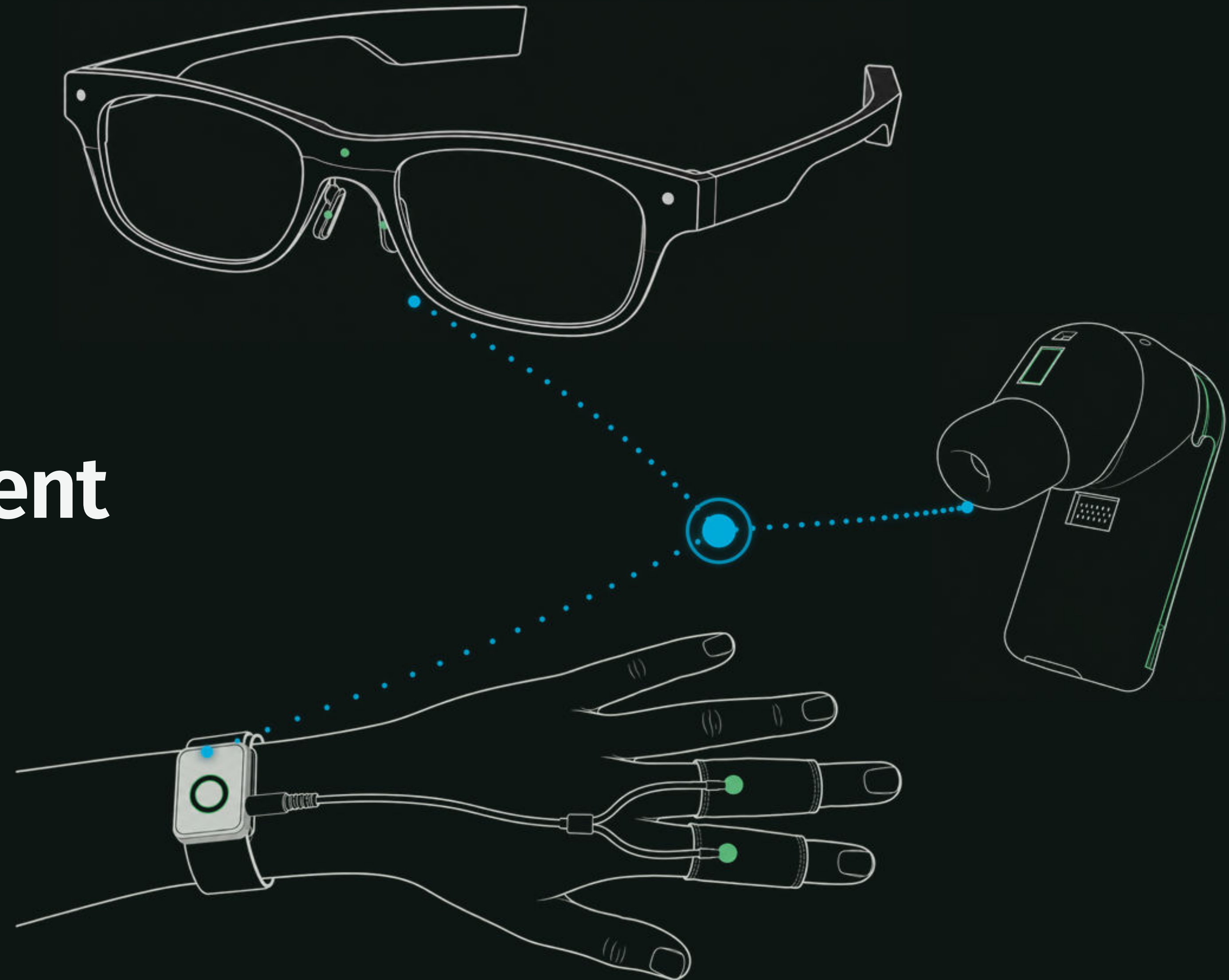


Kai Kunze, Yuzuko Utsumi, Yuki Shiga, Koichi Kise, and Andreas Bulling. 2013. I know what you are reading: recognition of document types using mobile eye tracking. ISWC '13



System Development

J!NS MEME and more





Is this how our brains work when we interact with the world?



Cognitive Activity Tracking in Everyday Life





Glasses People Actually Wear All Day

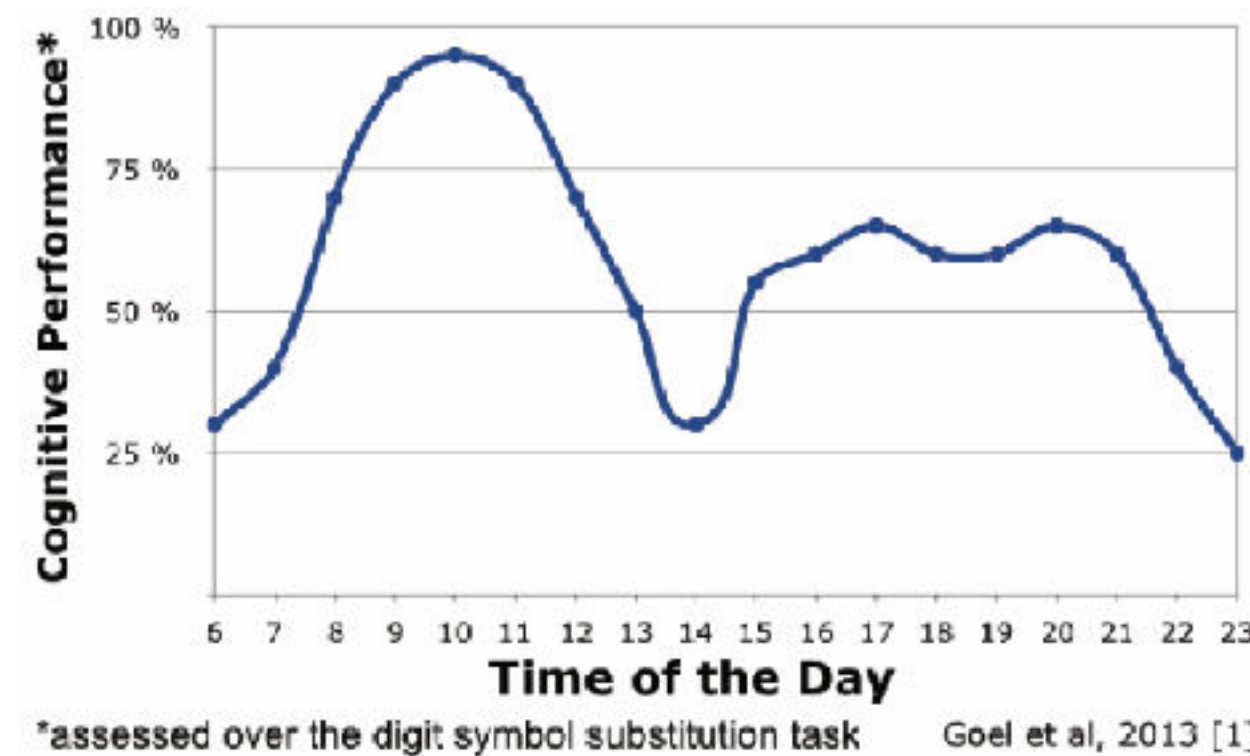
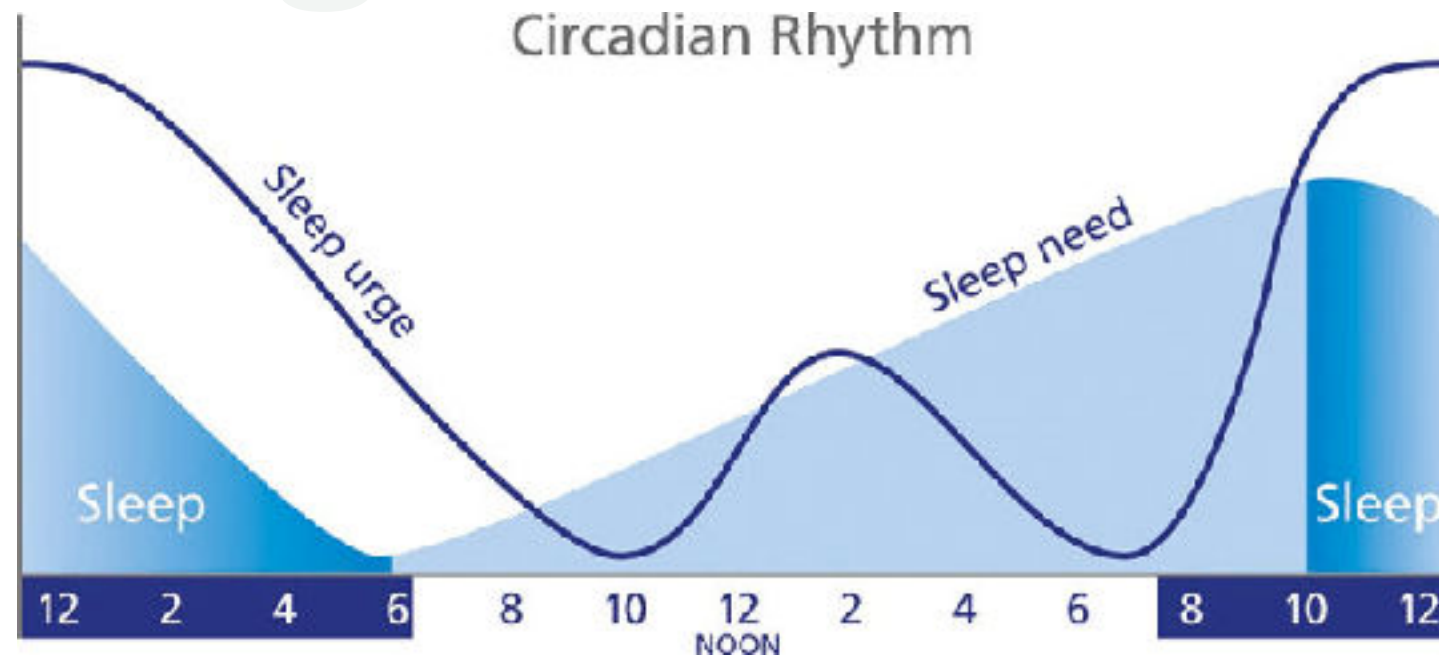


J!NS M3ME

3-axis accelerometer
3-axis gyroscope
2-axis EOG



Cognitive Fluctuation Studies



Cognitive load, Circadian Rhythm, **Fatigue/Alertness**

20 participants, 3 weeks

At least 10 hours a day:

Electrooculography + Motion Sensors

“Groundtruth” every 2 hours:

Standard Cognitive Tests

Karolinska Sleepiness Scale

Psychomotor Vigilance Task (PVT)

Stroop Test

Log Caffeine intake and Naps

Sessions in the lab with FNIRS

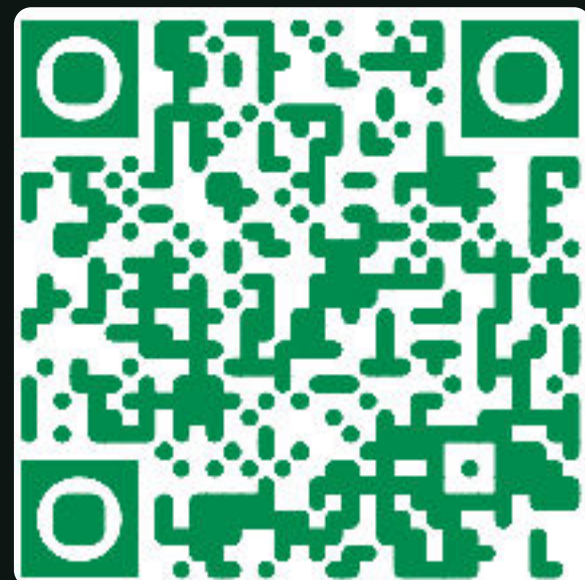
Tag, Benjamin et al. "Continuous Alertness Assessments: Using EOG Glasses to Unobtrusively Monitor Fatigue Levels In-The-Wild." CHI, 2019.



Faces Without a Camera



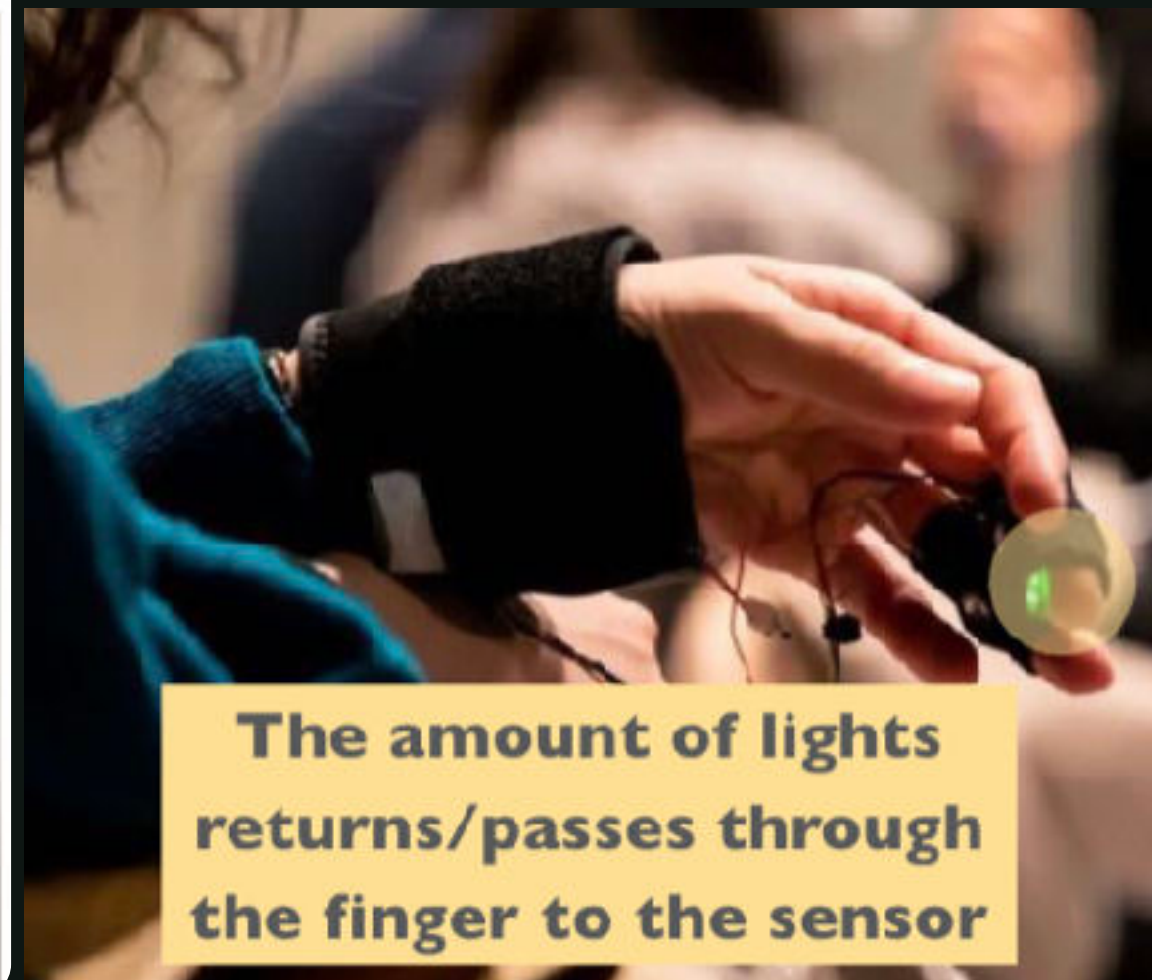
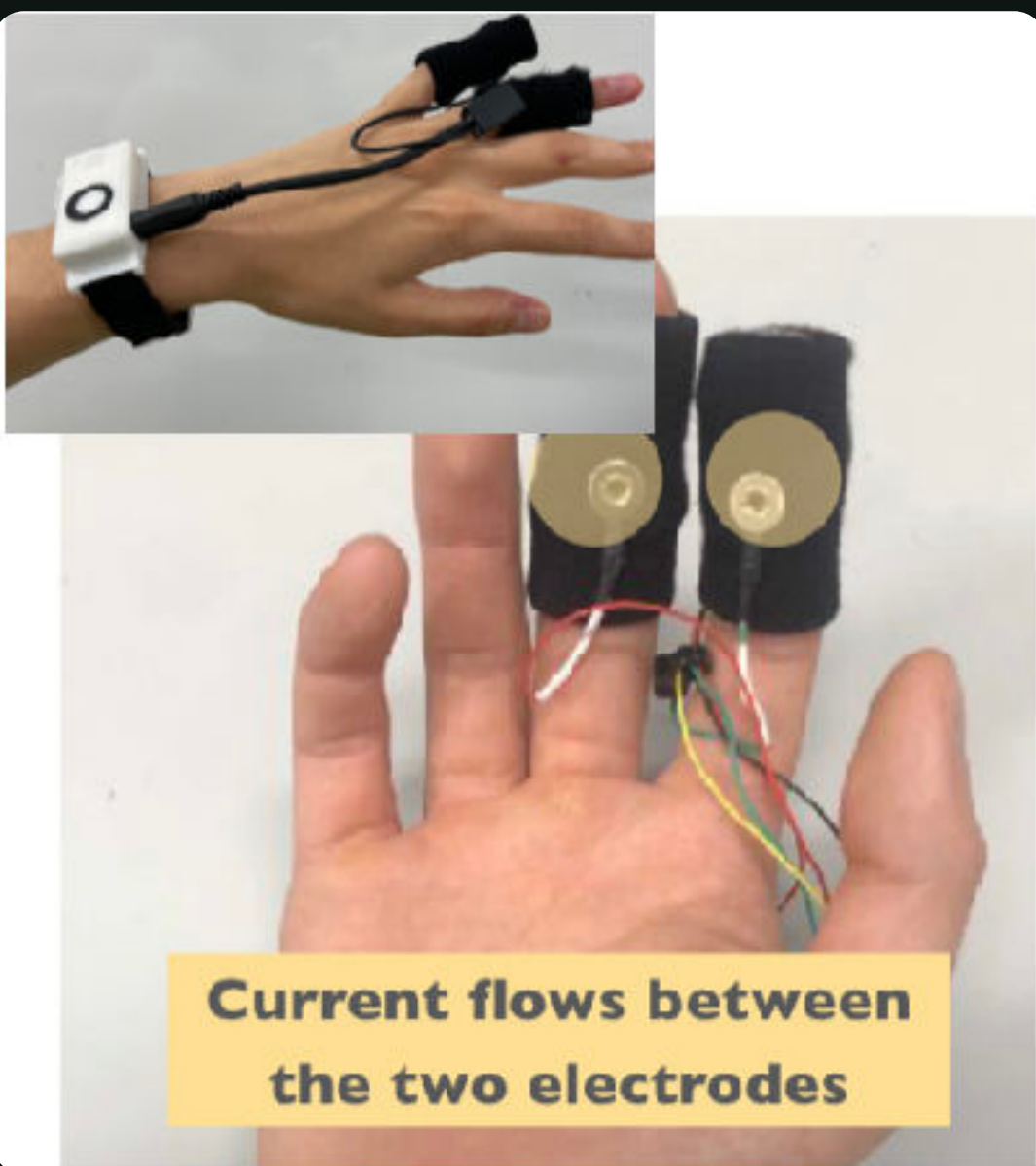
Evaluation of Facial Expression Recognition by A Smart Eyewear, ACM Transactions on Interactive Intelligent Systems, 2017.



Physiological Sensing Platform

Electrodermal Activity and Blood Volume Pulse

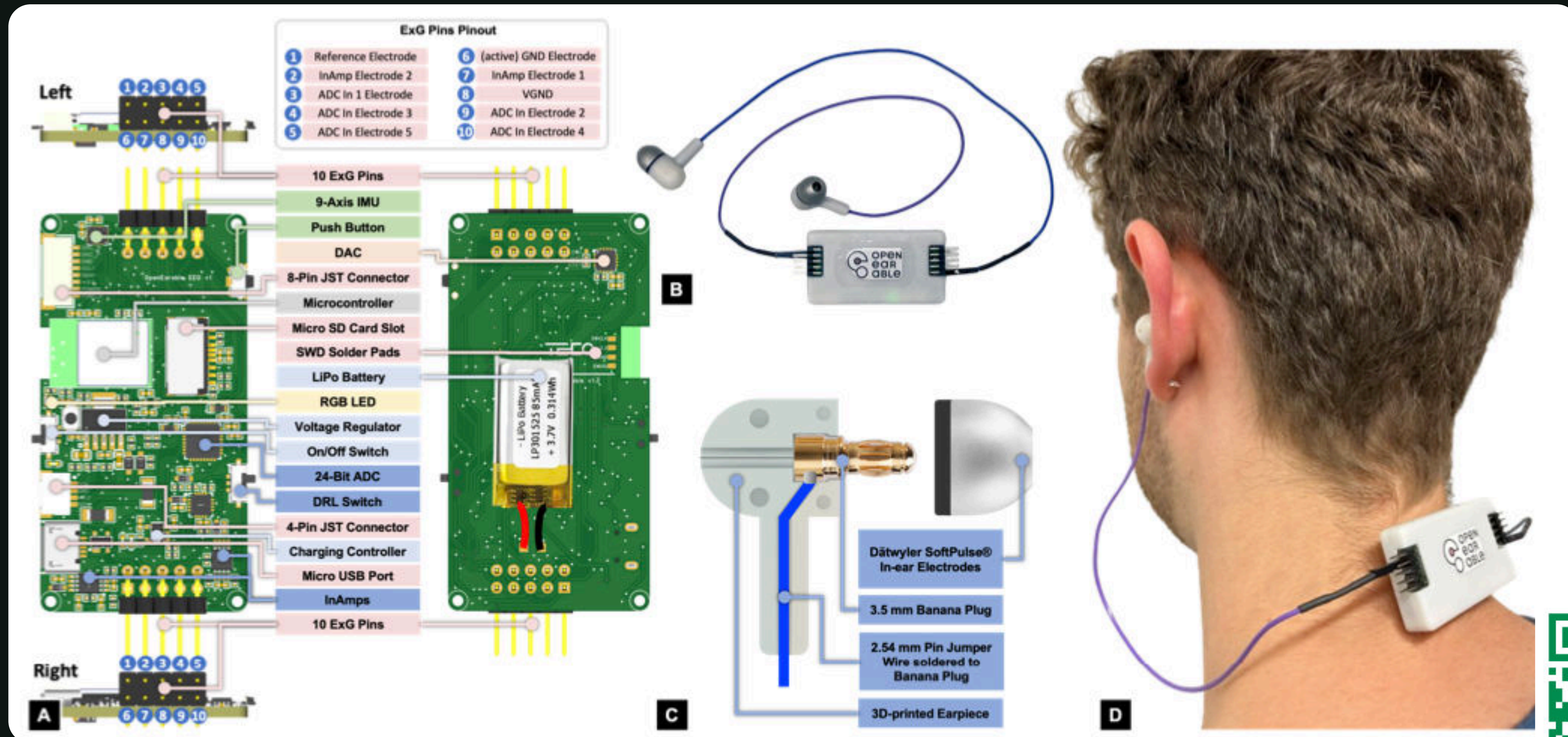
For larger scale deployments, live streaming
Electrodermal Activity and Blood Volume Pulse.





OpenEarable ExG

Open-Source Hardware for Ear-Based Biopotential Sensing Applications



Philipp Lepold, Tobias Röddiger, Tobias King, Kai Kunze, Christoph Maurer, and Michael Beigl. 2024. OpenEarable ExG: Open-Source Hardware for Ear-Based Biopotential Sensing Applications. In Companion of the 2024 on ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '24). Association for Computing Machinery, New York, NY, USA, 916–920. <https://doi.org/10.1145/3675094.3678480>



Augmented

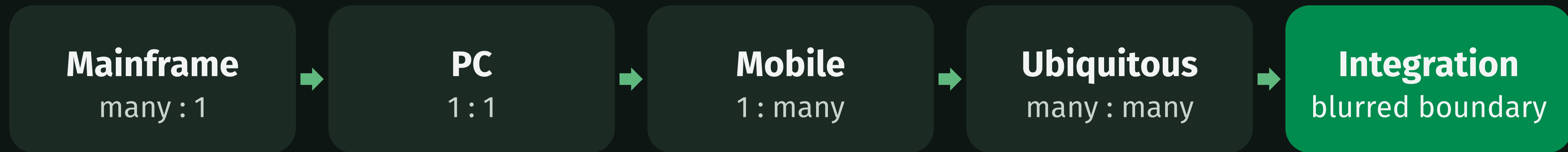
HCI Studies and beyond



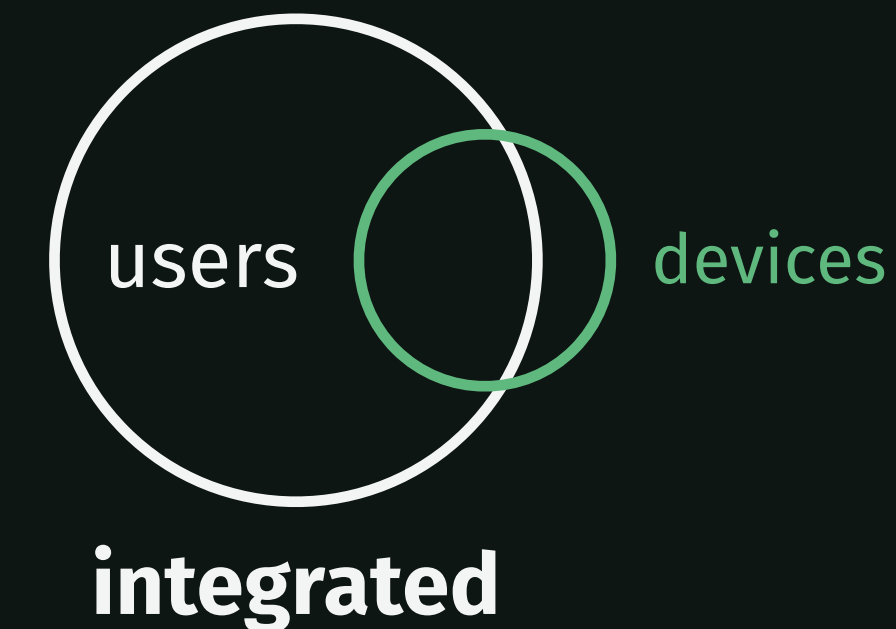
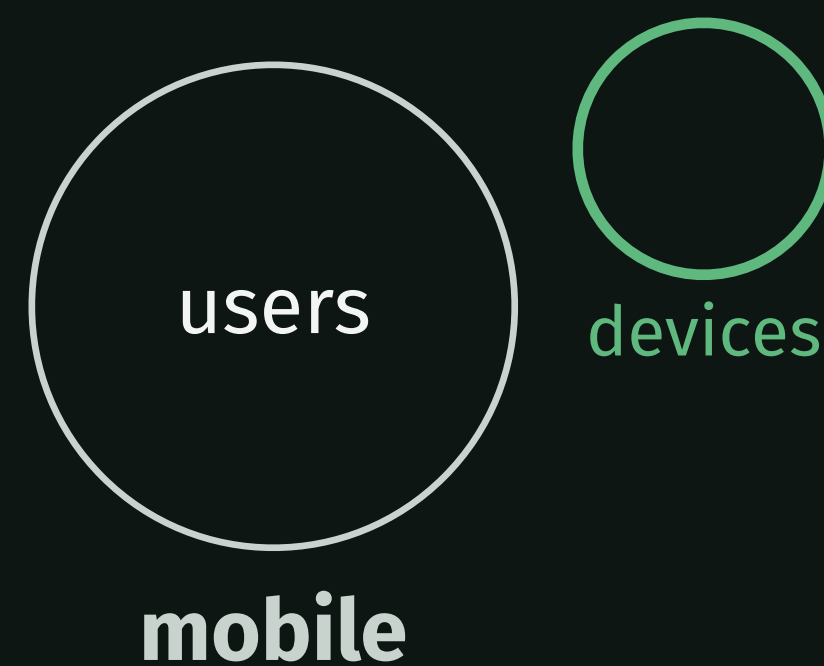


From Interaction to Integration

Next Steps in Human-Computer Integration



Users : machines per era



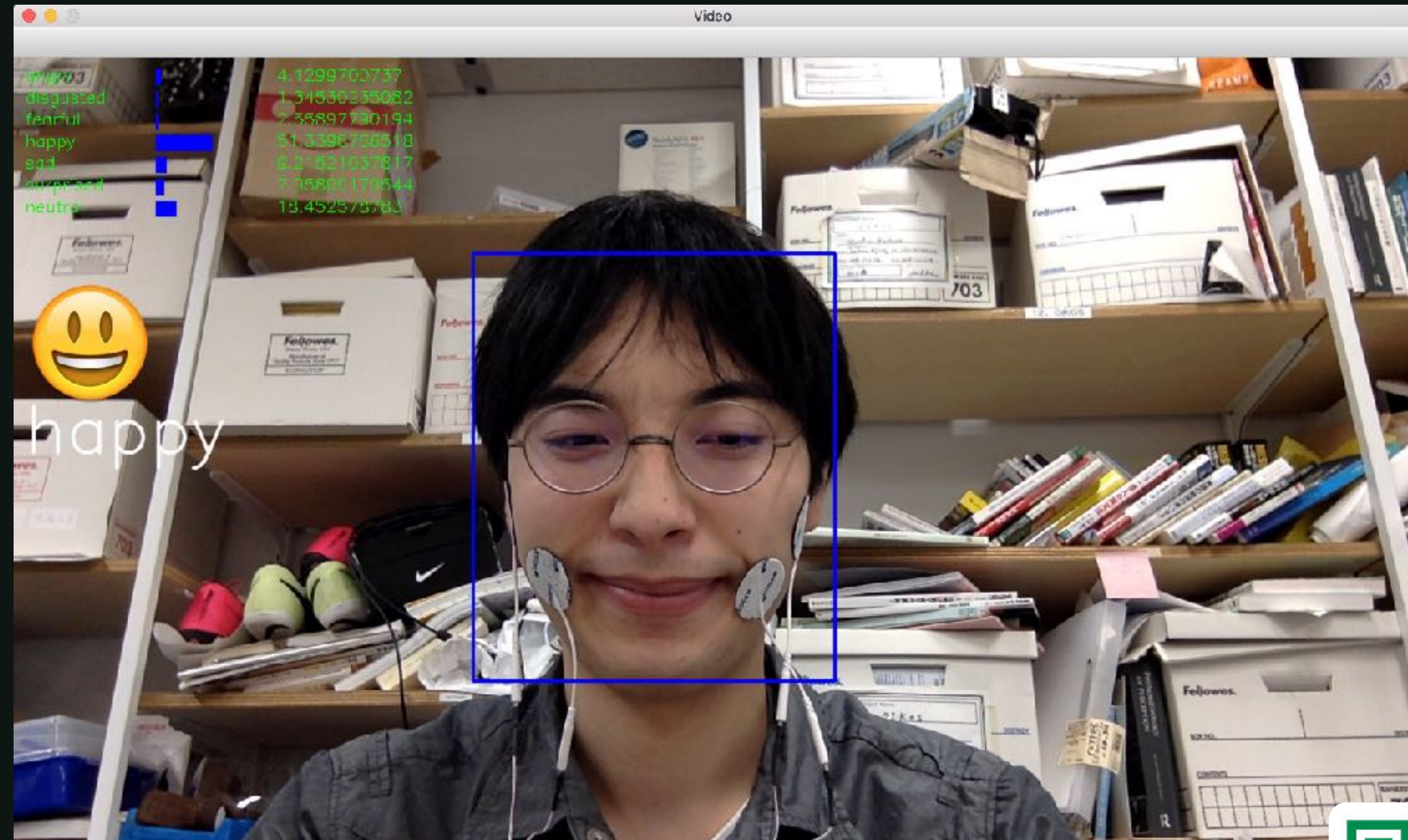
Mueller, Lopes, Strohmeier, ..., Kunze, ..., Maes, CHI 2020





When the Machine Moves Your Face

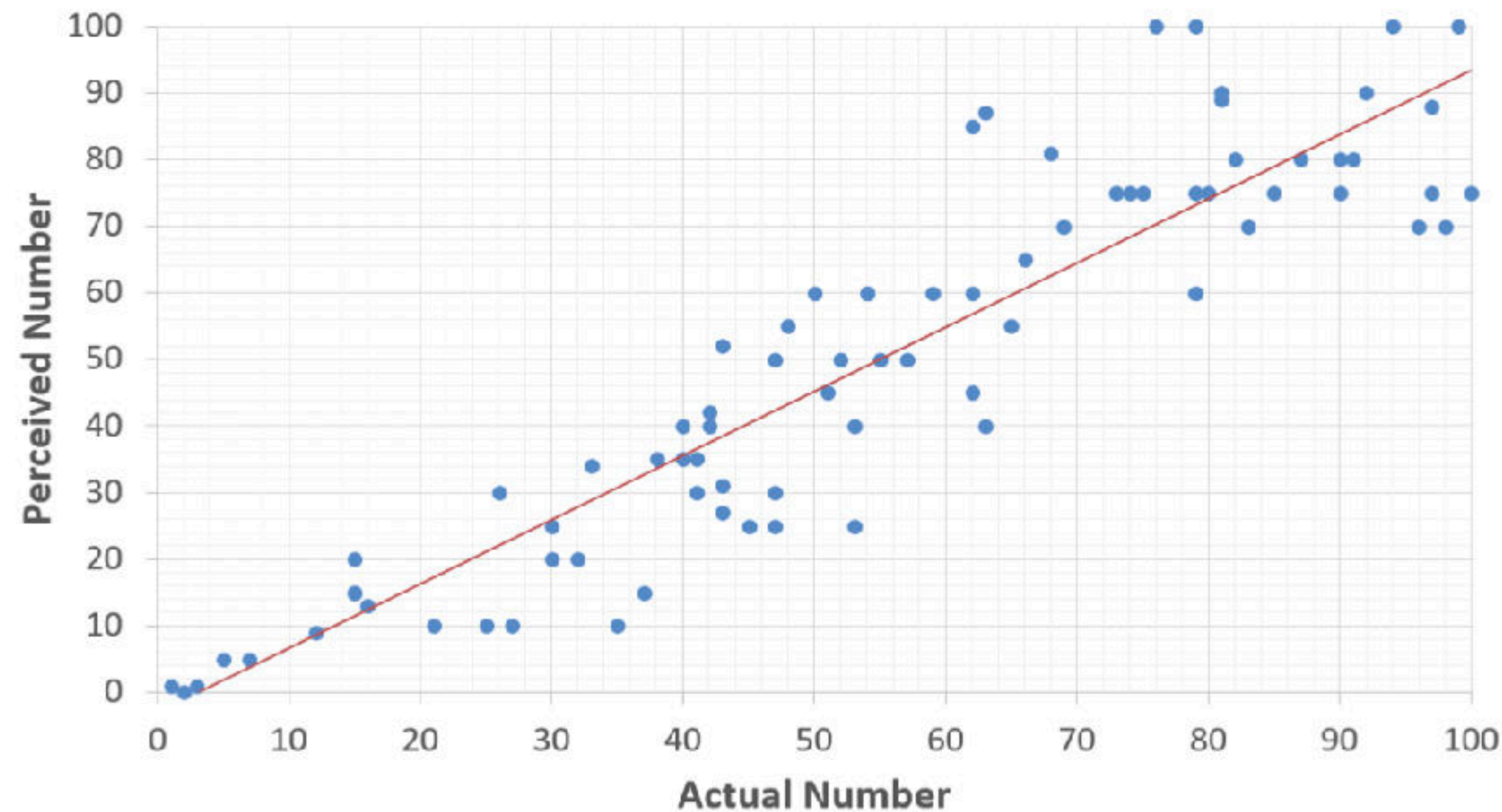
EMS smiles, recalibrated by a camera in a closed loop



Goto, Tag, Kunze, Dingler. Auto-calibrating EMS for emotional responses to media. Augmented Human 2018 · Lai et al. Eyewear to make me smile. TEI 2017



Feel a Progress Bar on Your Finger



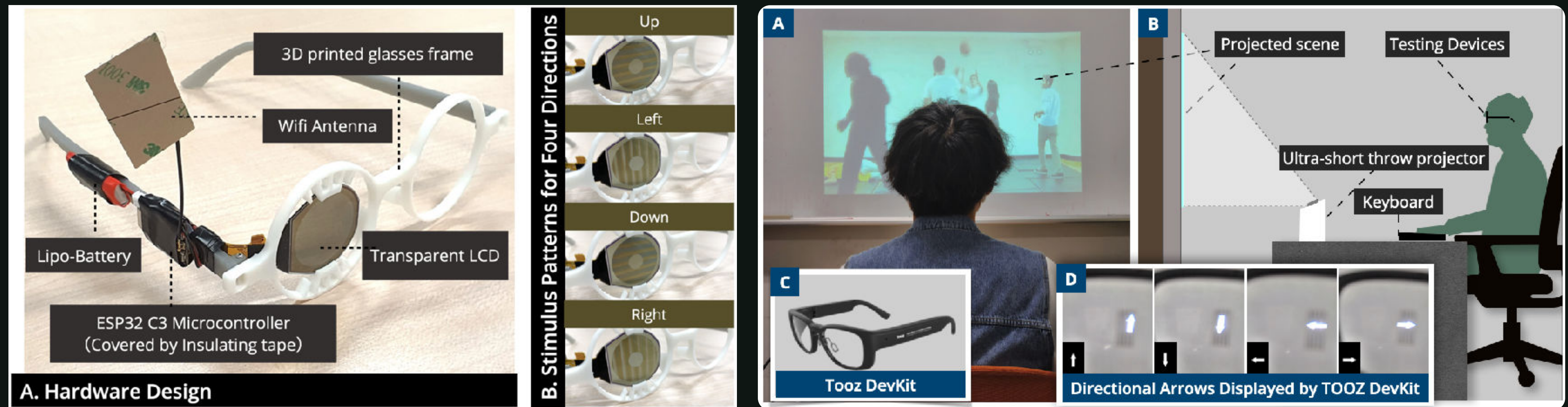
Chernyshov, George, et al. "Shape memory alloy wire actuators for soft, wearable haptic devices." Proceedings of the 2018 ACM International Symposium on Wearable Computers. ACM, 2018.





Directions Without Symbols

Beyond Symbols: Motion Cues in Peripheral Vision



Zhang, Chen, Huang, Huang, Starner, Kunze, Rekimoto, ISWC 2025





Directions Without Symbols

The Stimulus on the Monocle Display

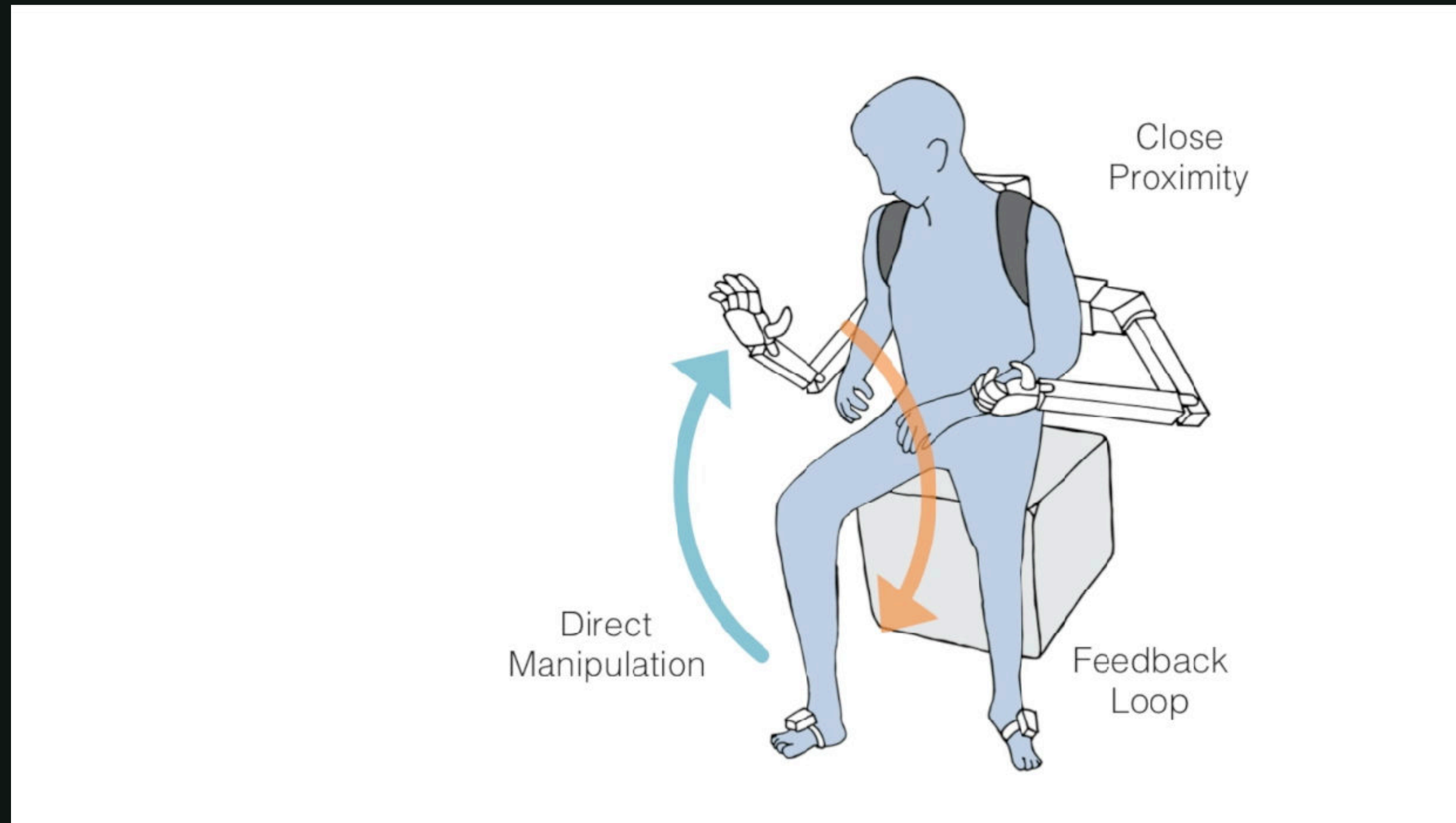


Zhang, Chen, Huang, Huang, Starner, Kunze, Rekimoto, ISWC 2025





Explore how can Tech overlap with our bodies

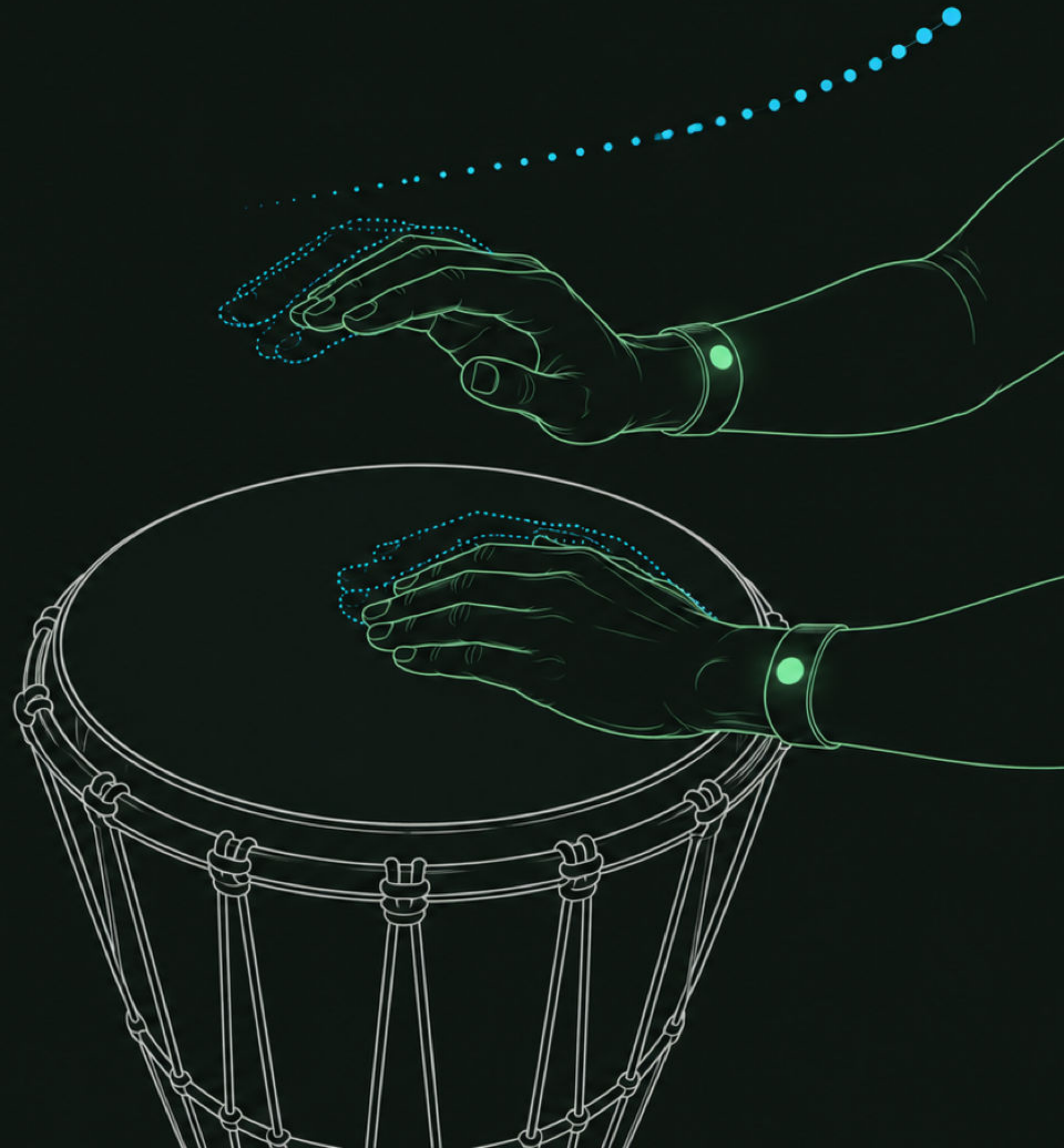


Saraiji, M. H. D., et al. "MetaArmS: Body remapping using feet-controlled artificial arms." *The 31st Annual ACM Symposium on User Interface Software and Technology*. ACM, 2018.



Skill

Which skills do I need, which should I develop?





Improves Skill Acquisition in Percussions

Pneumatic Artificial Muscles

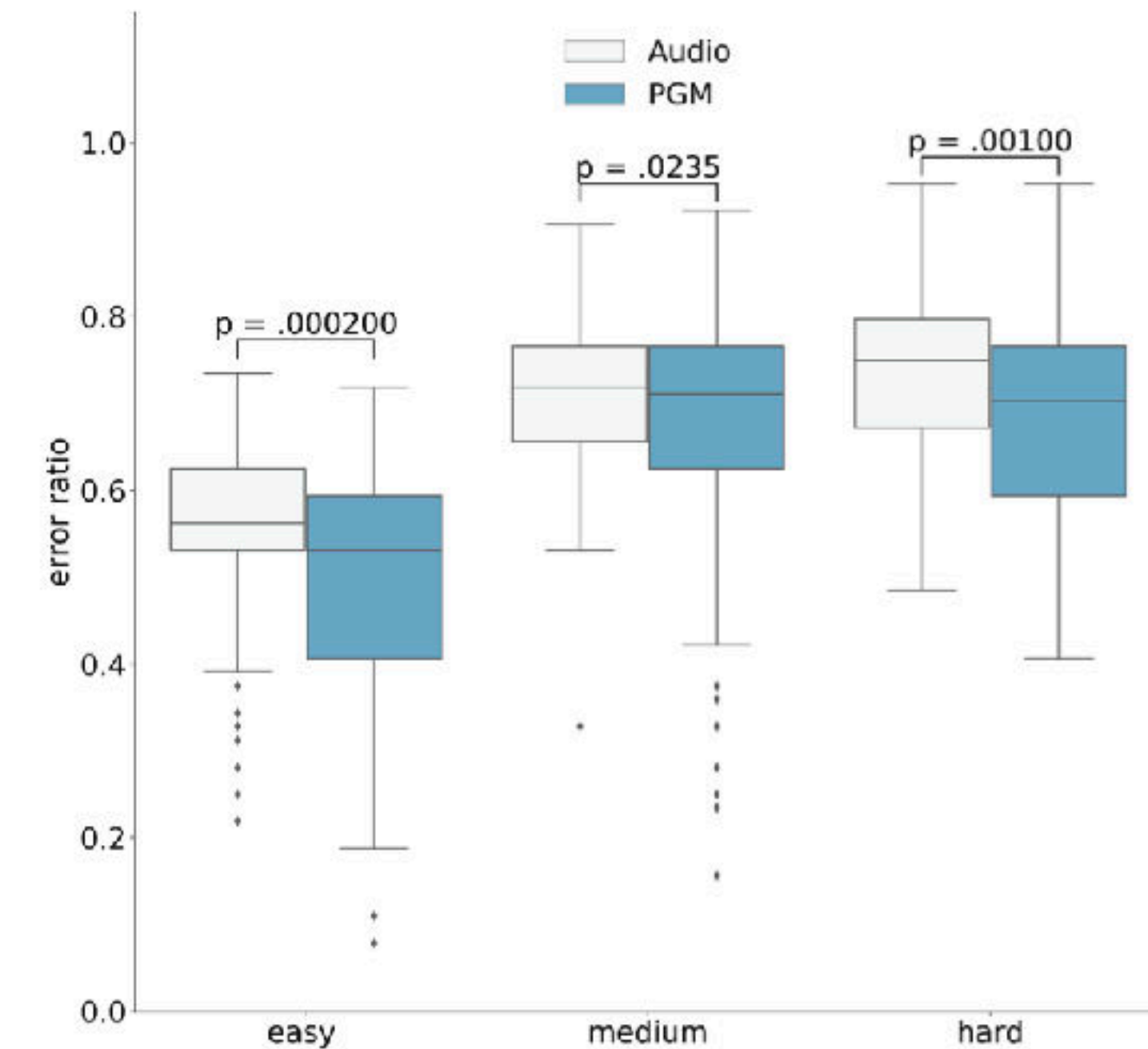


Figure 8. Results of error rate for each task.

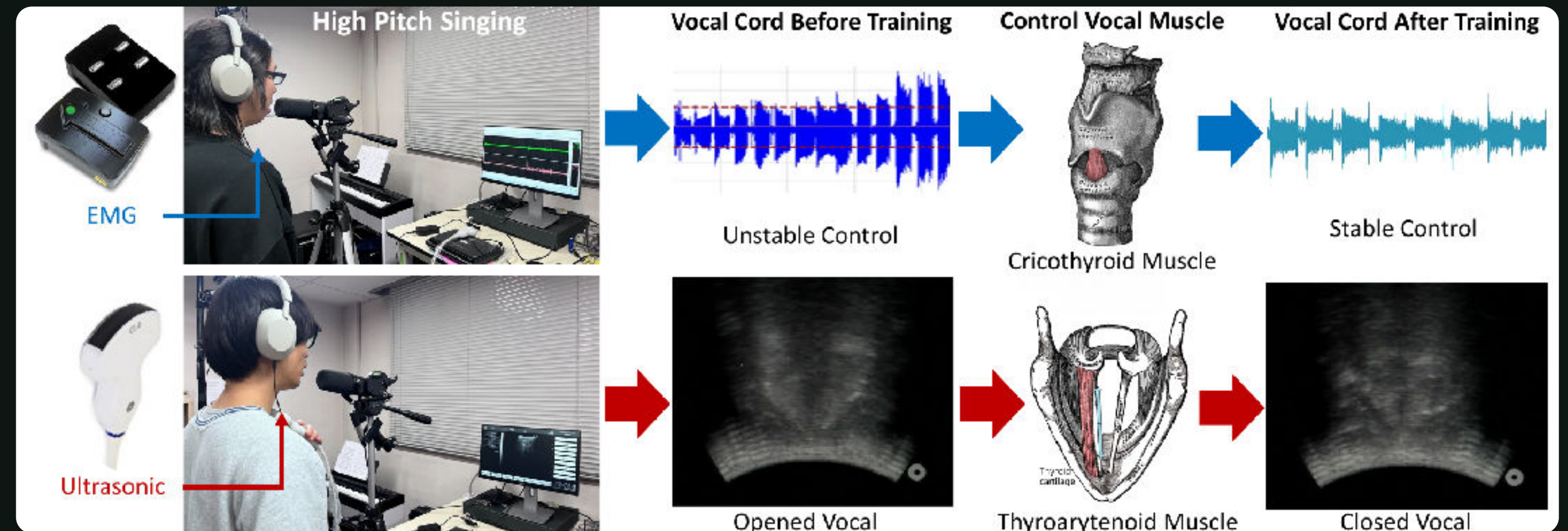
Goto, Takashi, et al. "Accelerating Skill Acquisition of Two-Handed Drumming using Pneumatic Artificial Muscles." Proceedings of the Augmented Humans International Conference. 2020.





Sensing Your Vocals

EMG and ultrasound make the vocal cord muscles visible



Honorable Mention · CHI 2026

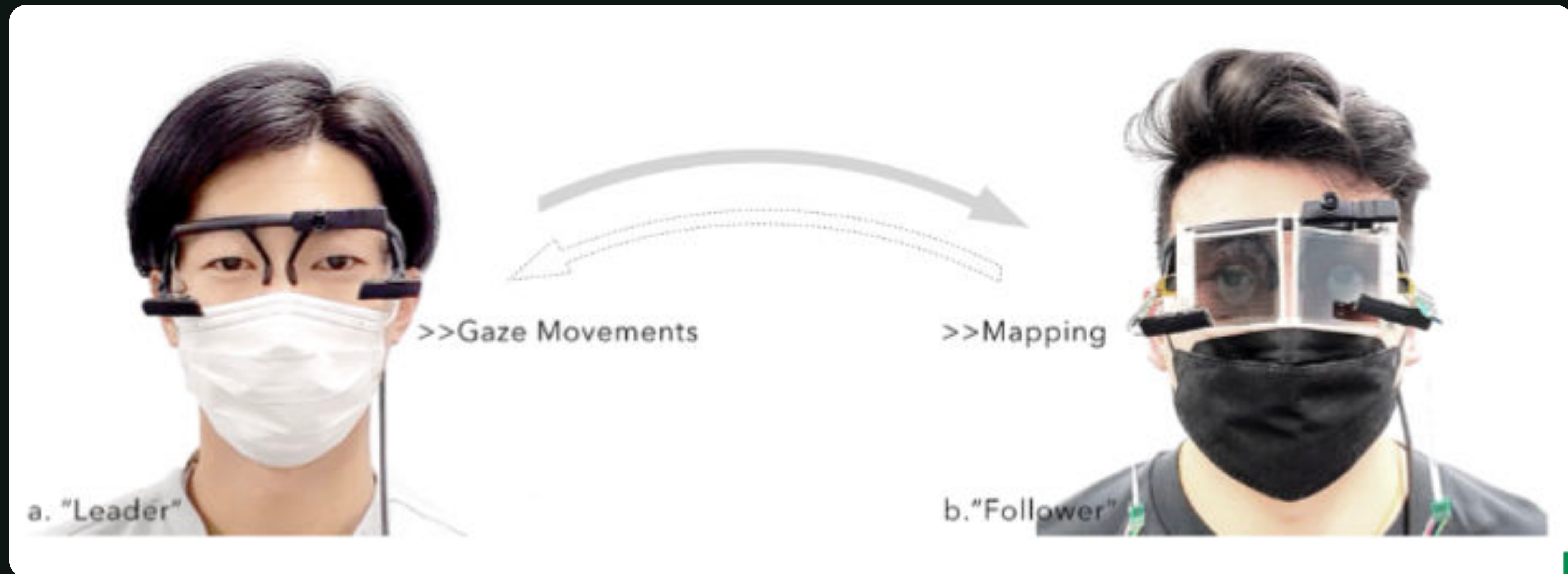
Chen, Pankus, Wu, Peng, Saito, Kamiyama, Li, Liao, Marky, Kato, Koike, Kunze. Sensing Your Vocals: Exploring the Activity of Vocal Cord Muscles for Pitch Assessment Using Electromyography and Ultrasonography. CHI 2026. doi 10.1145/3772318.3790965



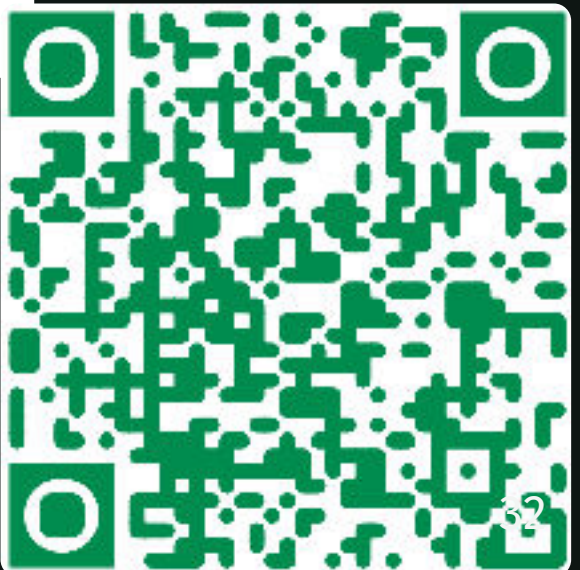


Can we share our visual perception with others?

GazeSync (IUI 2022)



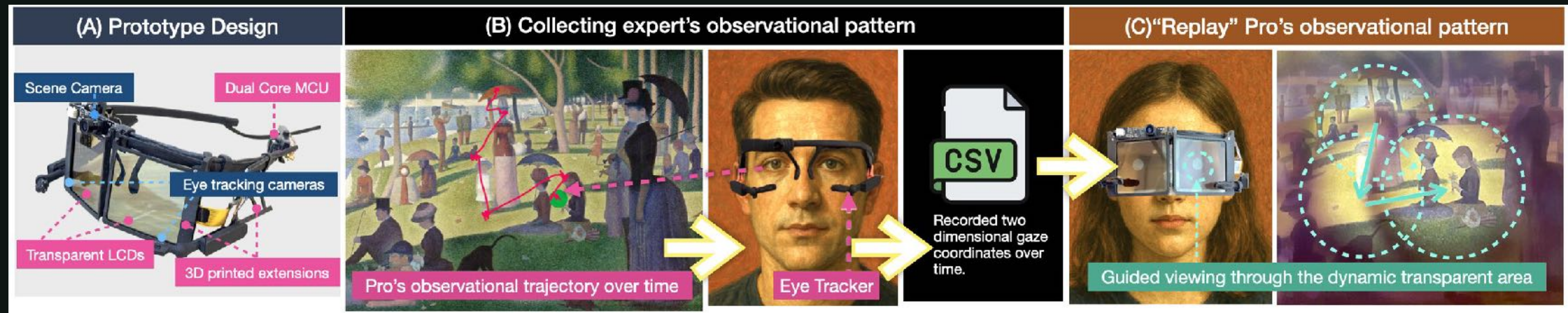
GazeSync: Eye Movement Transfer using an Optical Eye Tracker and Monochrome Liquid Crystal Displays. IUI 2022.





Learning How Professionals Observe

Pro's Eyes: follow an expert's gaze path

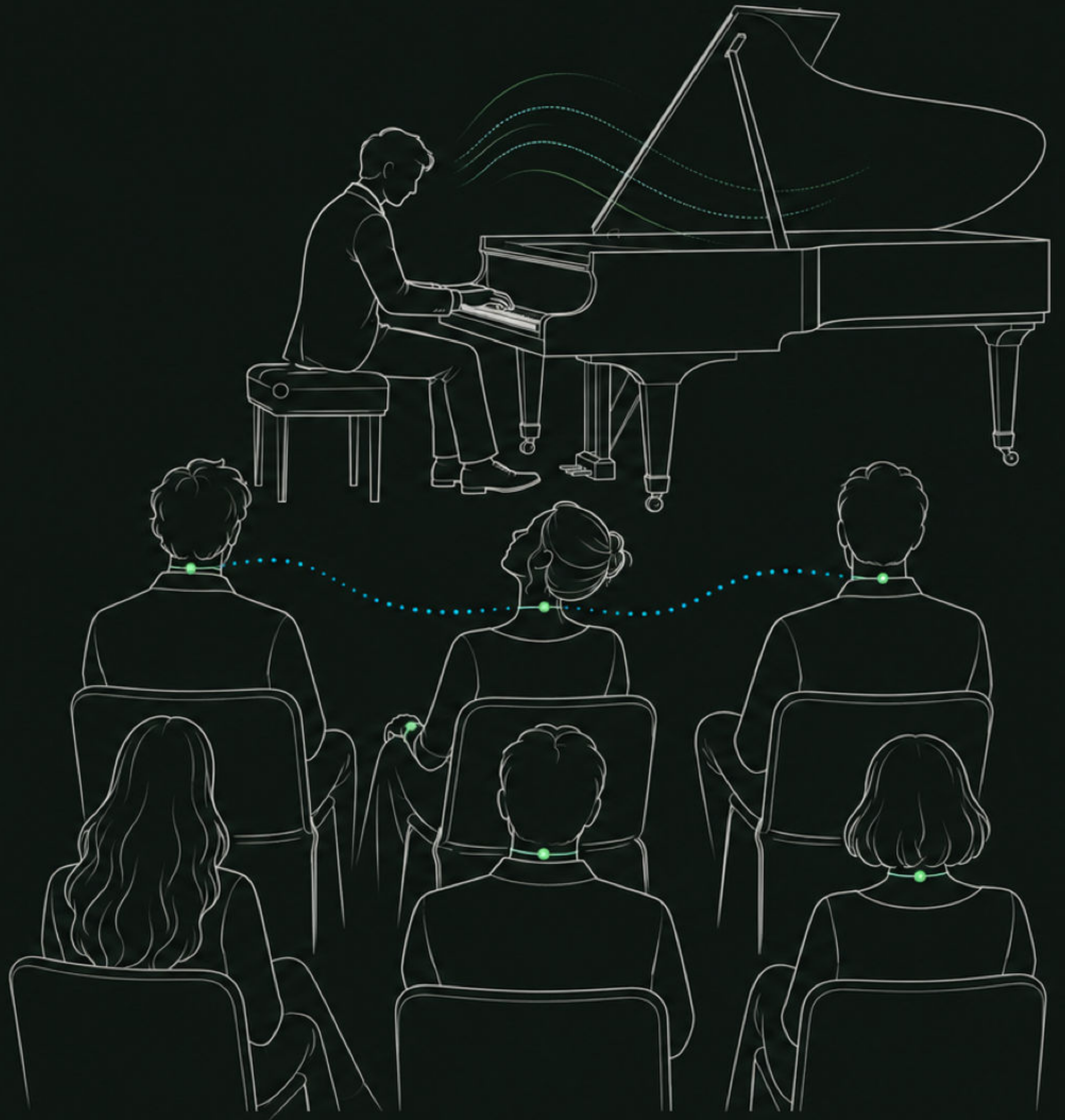


Zhang et al., SIGGRAPH Asia 2025 E-Tech



Experience

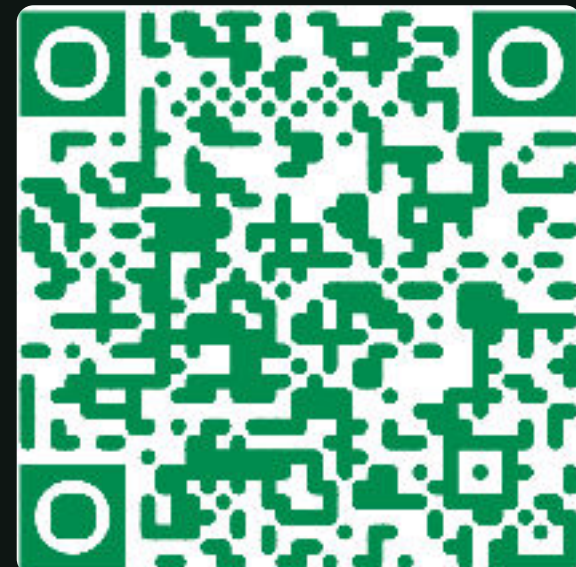
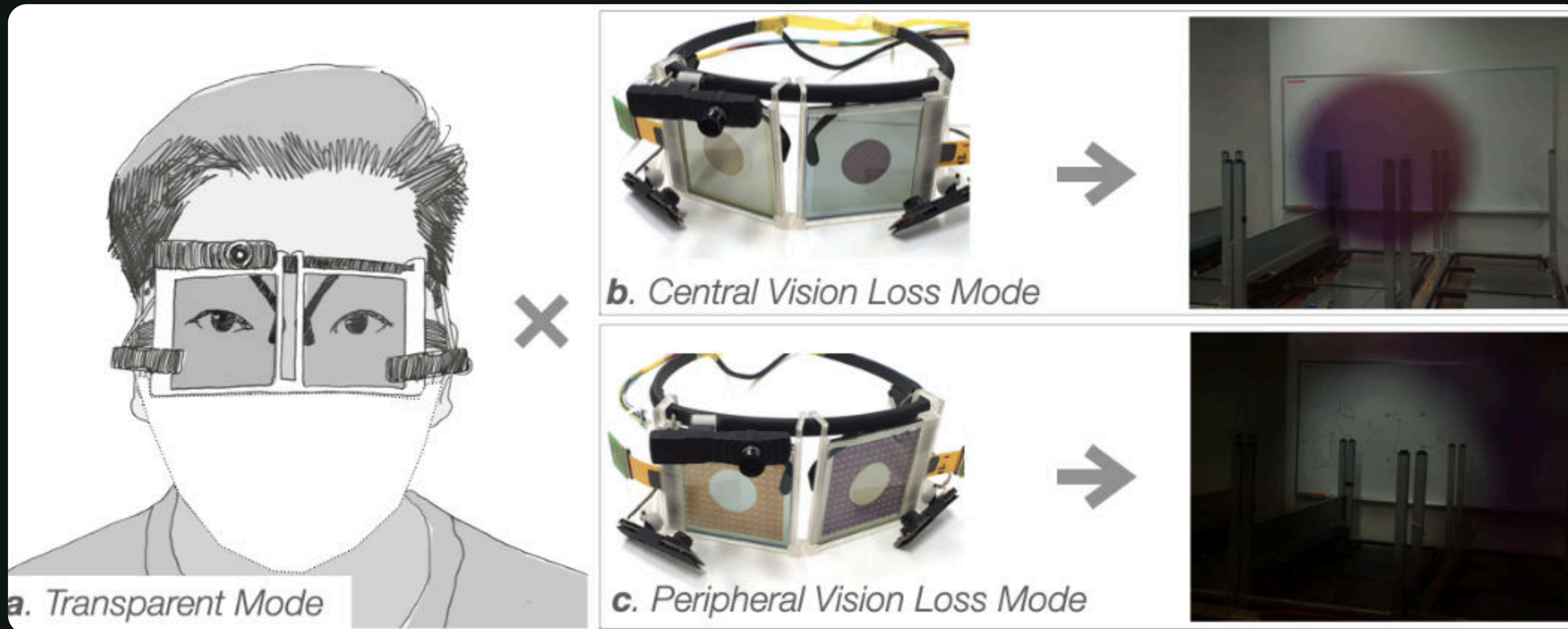
Can we design meaningful moments to share?





Visual Impairment Simulation

Seeing our Blind Spots: Smart Glasses-based Simulation to Increase Design Students' Awareness of Visual Impairment

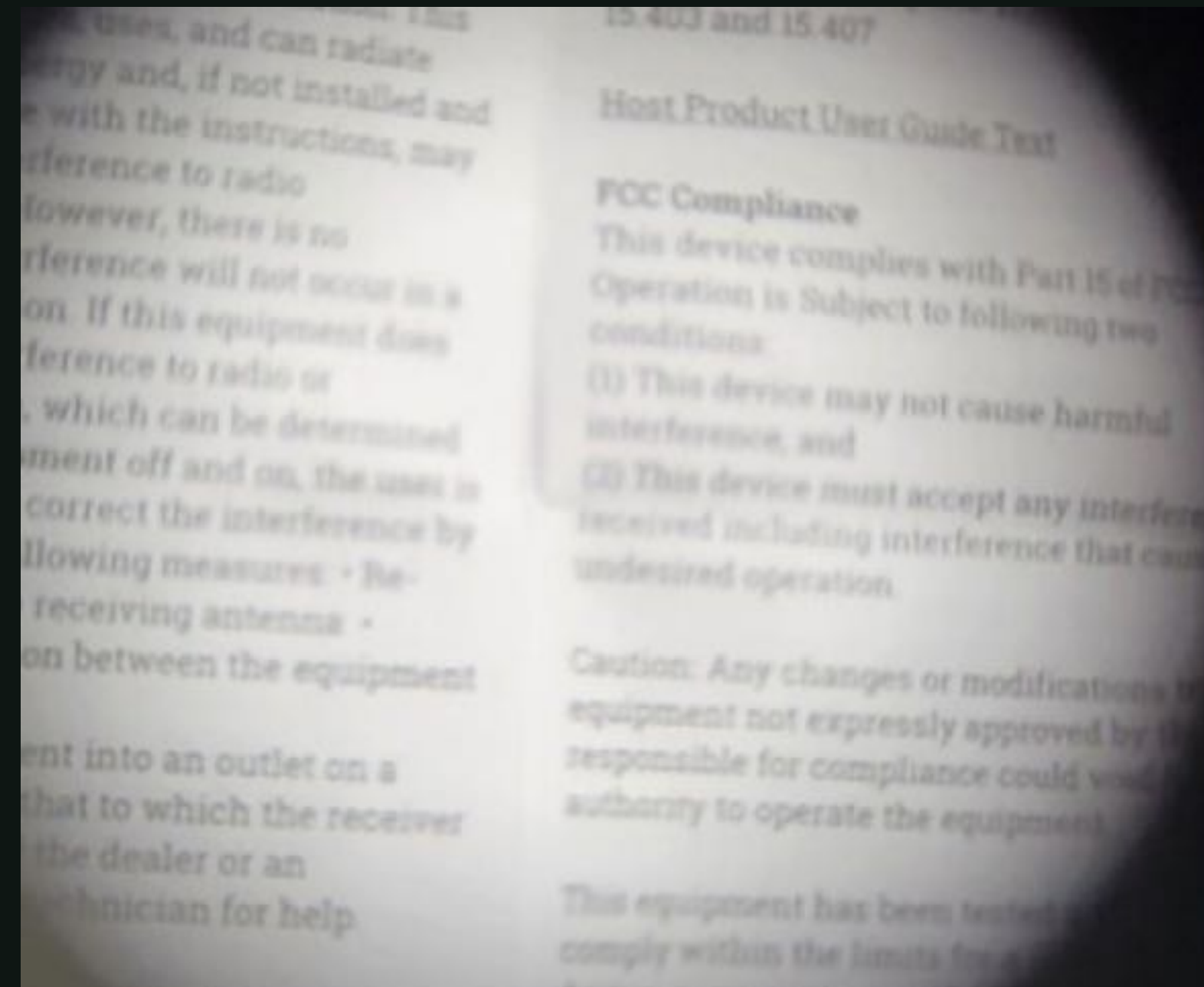


Zhang, Qing, et al. "Seeing our Blind Spots: Smart Glasses-based Simulation to Increase Design Students' Awareness of Visual Impairment." UIST 2022.



Simulating Ageing Eyes

Optical Aging: tunable lenses for age-inclusive design



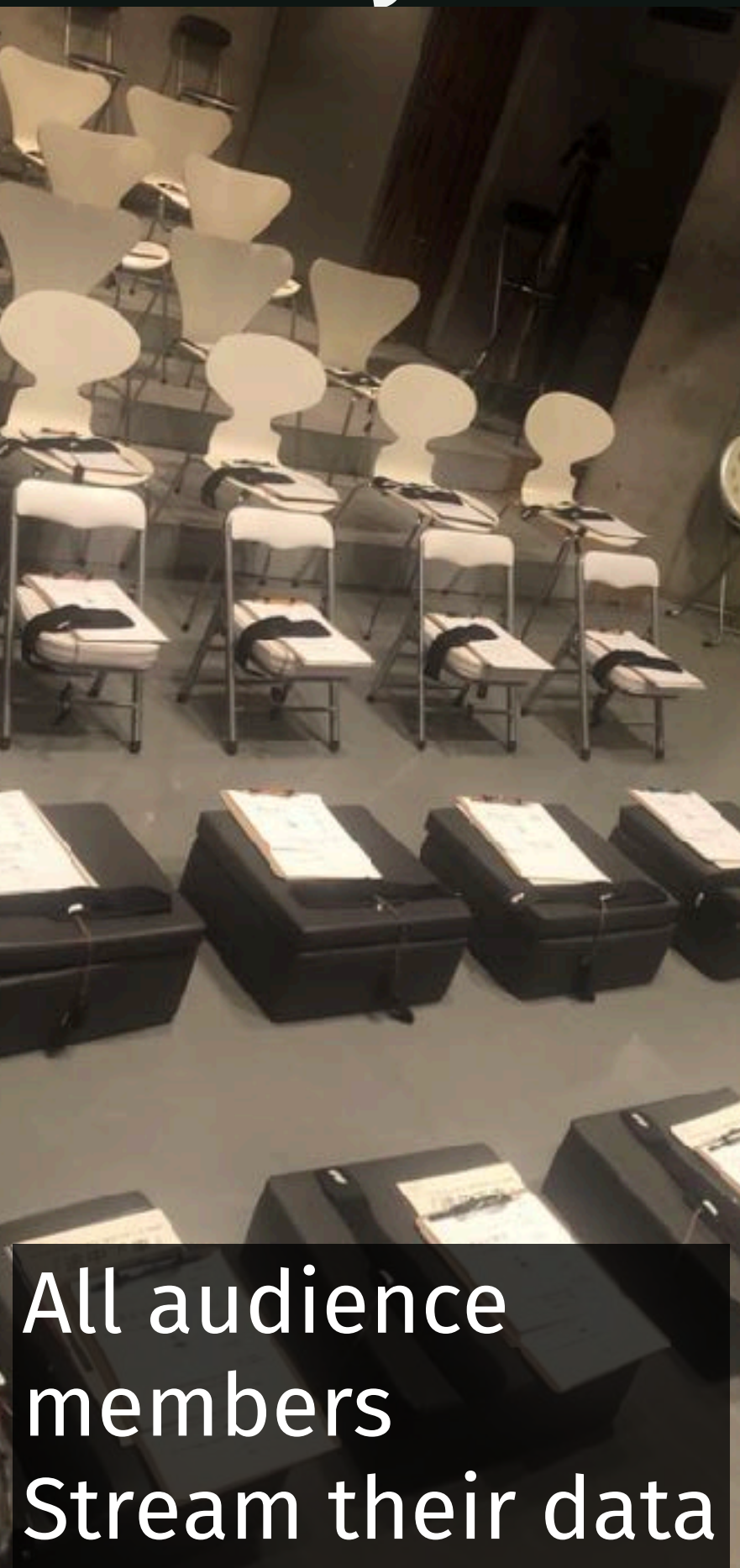
Zhang et al., Augmented Humans 2026





Putting the Audience on Stage

Why we chose the setup



All audience members
Stream their data



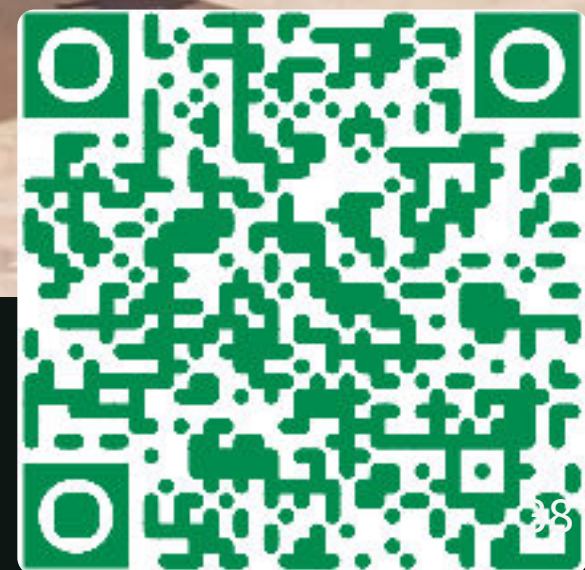
Heart Rate/ Variability
Galvanic Skin Response



Projection, Lights, Sound change
based on Sensor Data

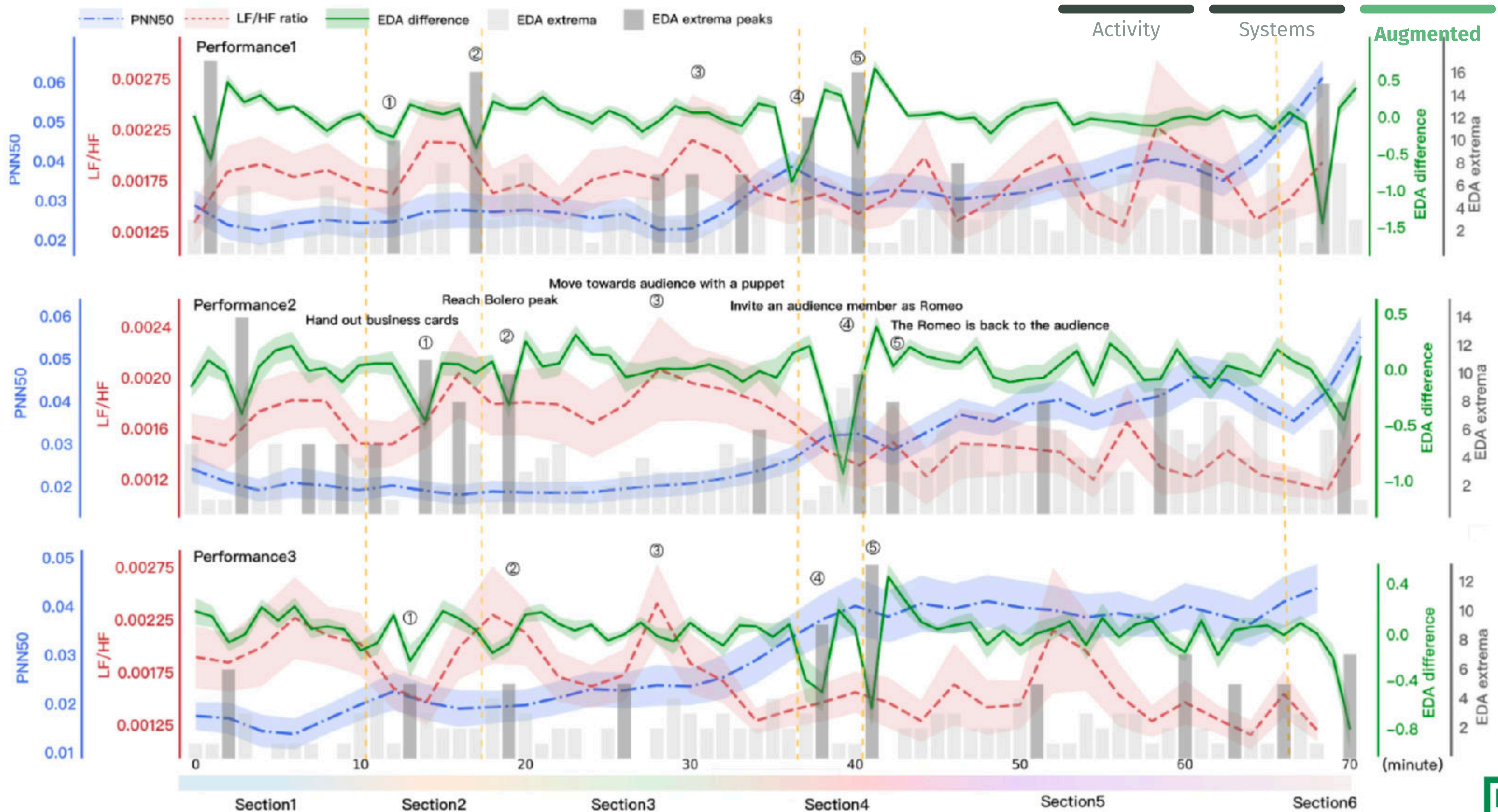
Special thanks to: Dingding Zheng, George Chenyshov, Danny Hynds,

Linking Audience Physiology to Choreography.
TOCHI Journal 2023.
<https://dl.acm.org/doi/10.1145/3557887>





Our approach to the stage production relies on the transformation of the physical sensations of the dancers and the audience

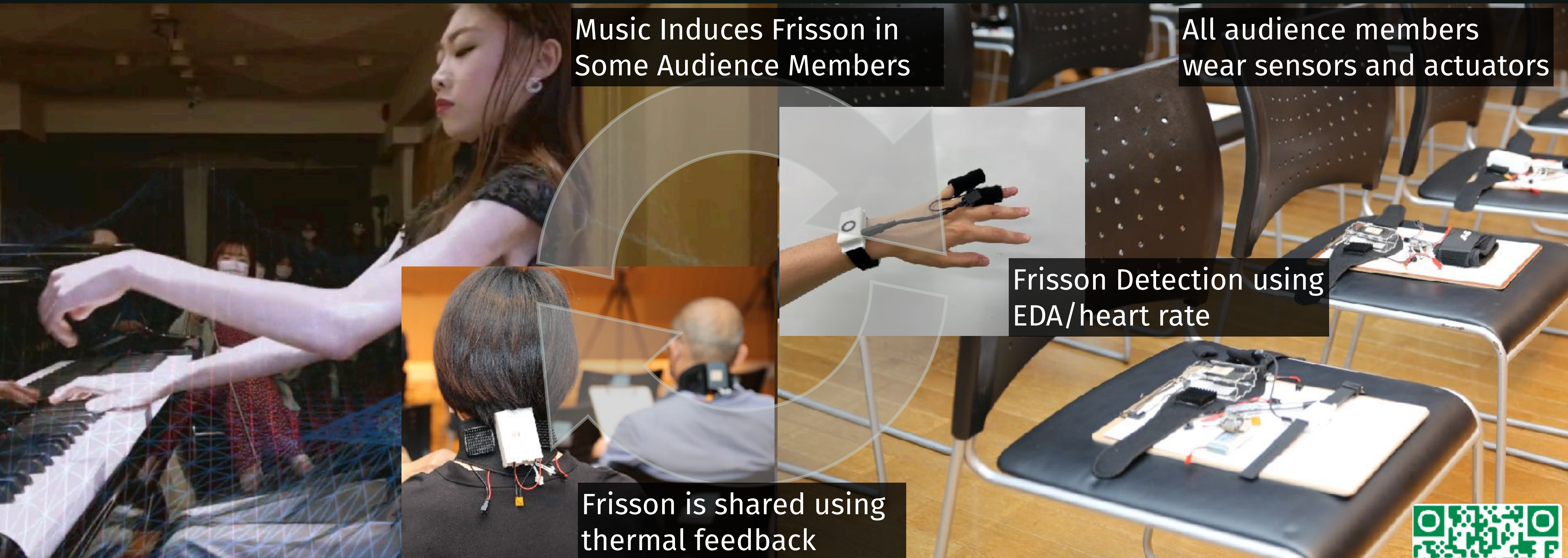


Han, Chernyshov, Sugawa, Zheng, Hynds, Furukawa, Padovani Macieira, Marky, Minamizawa, Ward, Kunze. Linking Audience Physiology to Choreography. ACM TOCHI 30(1), 2023. doi 10.1145/3557887

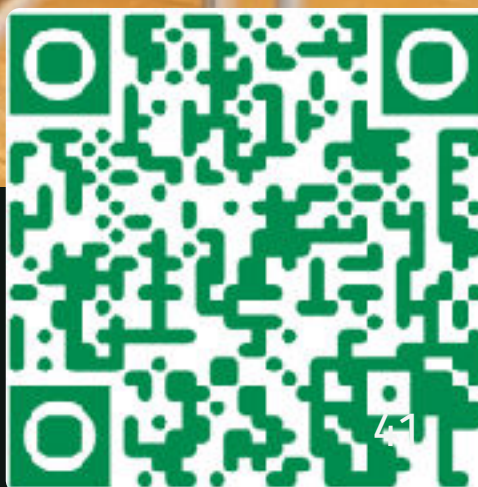




Recording the Physiology in Classical Concerts



Yan He, George Chernyshov, Jiawen Han, Dingding Zheng, Ragnar Thomsen, Danny Hynds, Muyu Liu, Yuehui Yang, Yulan Ju, Yun Suen Pai, Kouta Minamizawa, Kai Kunze, and Jamie A. Ward. 2022. Frisson Waves: Exploring Automatic Detection, Triggering and Sharing of Aesthetic Chills in Music Performances. Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 6, 3, Article 118 (September 2022), 23 pages. <https://doi.org/10.1145/3550324>





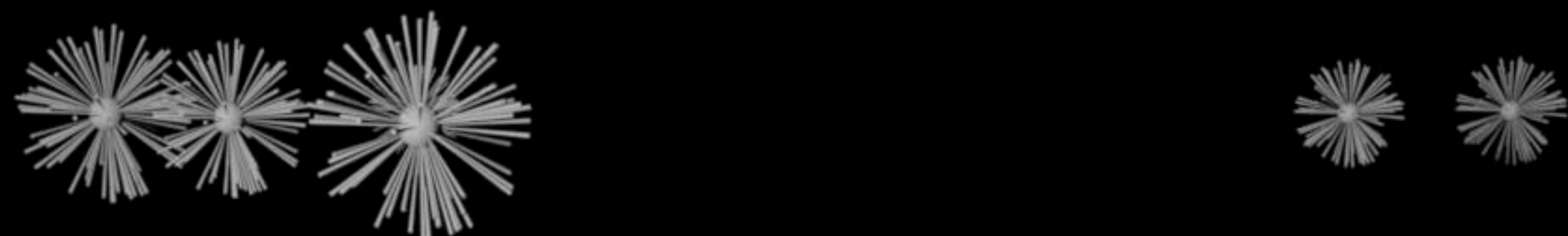
Physiological measurements to recreate collective experiences in VR



A Placebo Concert: The Placebo Effect for Visualization of Physiological Audience Data during Experience Recreation in Virtual Reality CHI 2025

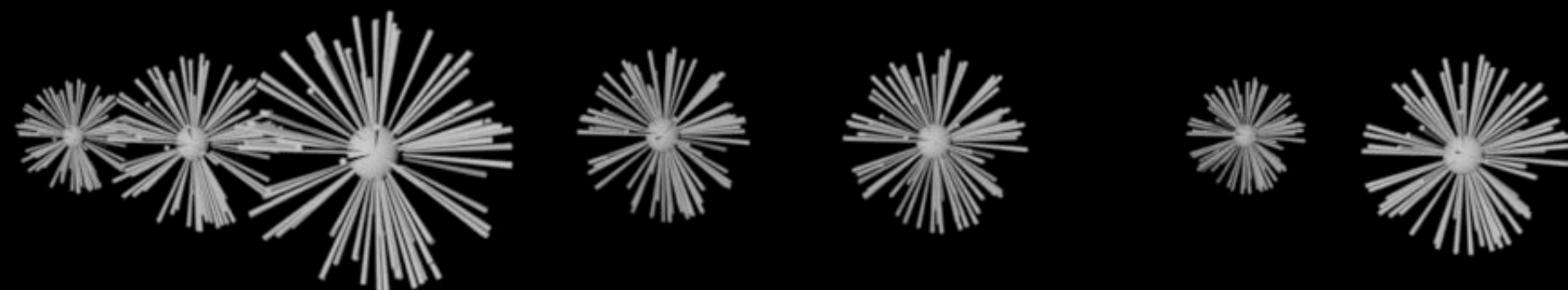


Real Data



Visuals change dynamically based on real audience data (EDA, BVP), reflecting authentic responses.

Fake Data



Visuals driven by random data, showing

Meng et al., CHI 2025



User Study

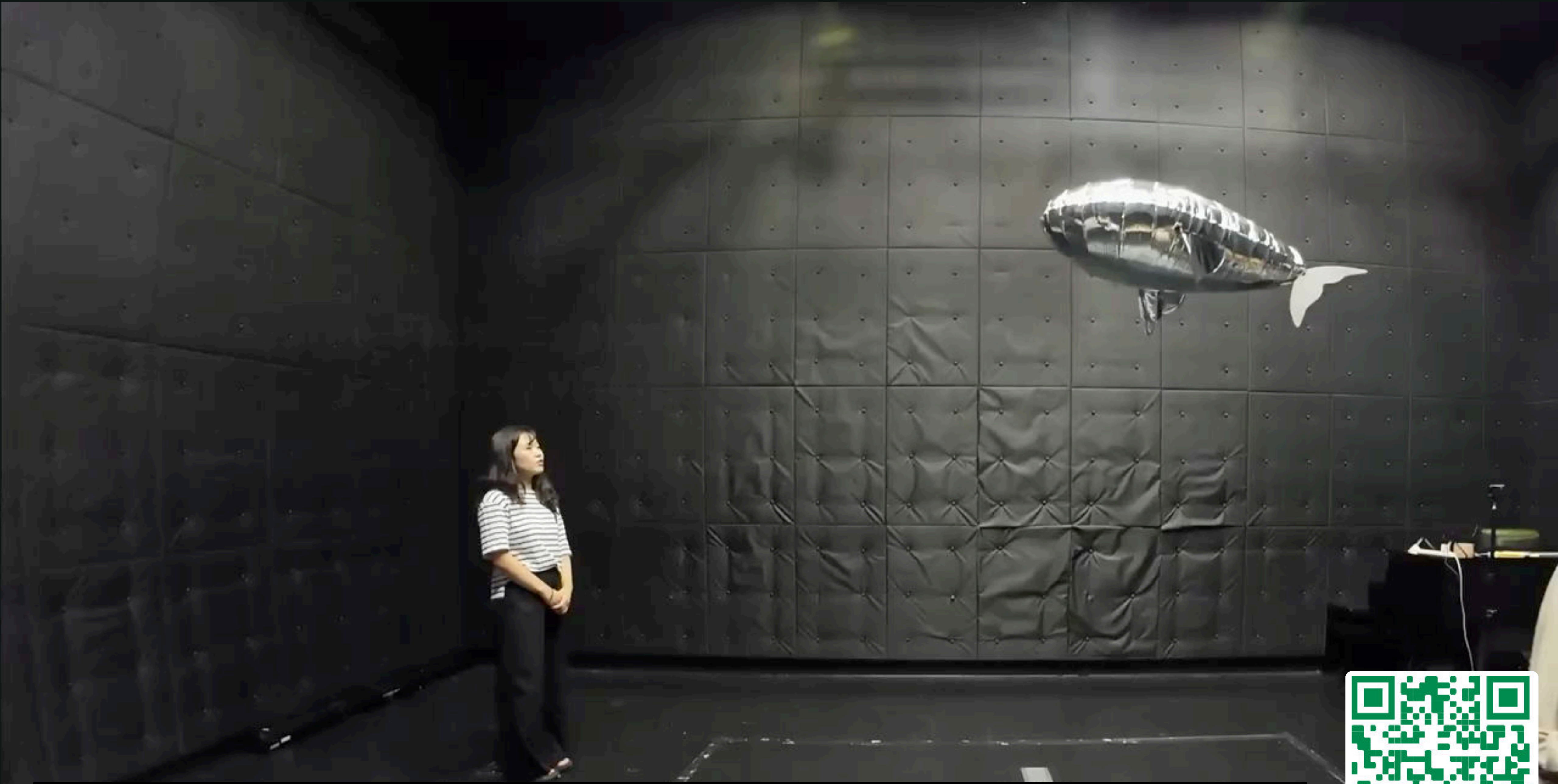
Mixed-Design Study (n = 44)

Physiological data



Live Concert Audience (N=50)





Cuddle-Fish: Exploring a Soft Floating Robot with Flapping Wings for Physical Interactions. Augmented Humans 2025



Floating Companion

Exploring Design Space for Soft Floating Robots in Indoor Environments



Mingyang Xu ^{1*}



Yanheng Li ^{2*}



Burcu Nimet Dumlu ¹



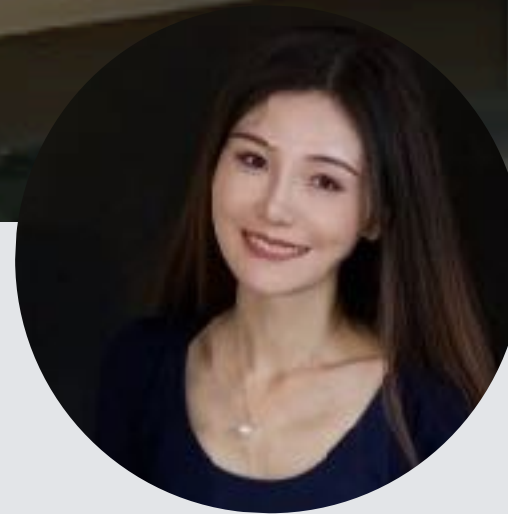
RAY LC ²



Giulia Barbareschi ³



Matthias Hoppe ¹



Jie Li ⁴



Kouta Minamizawa ¹



Kai Kunze ⁵

¹ Keio University Graduate School of Media Design

² City University of Hong Kong

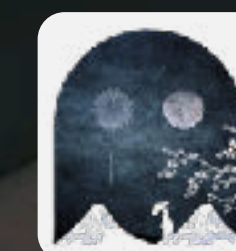
³ University of Duisburg-Essen

⁴ Cake Researcher, MIT Media Lab

⁵ TU Clausthal

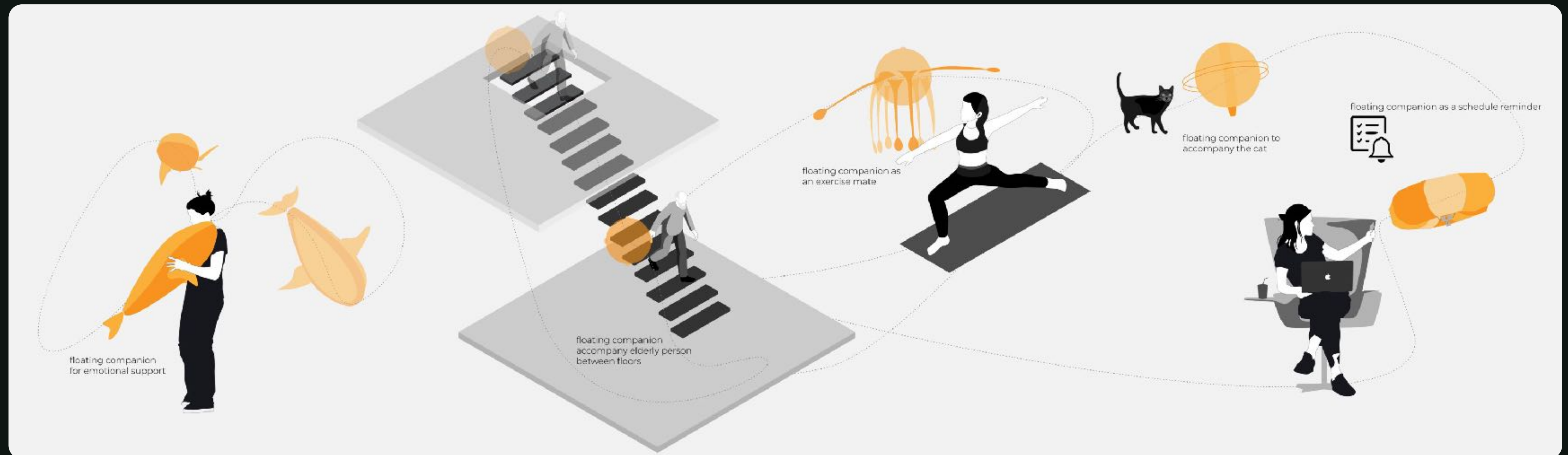


EMBODIED MEDIA



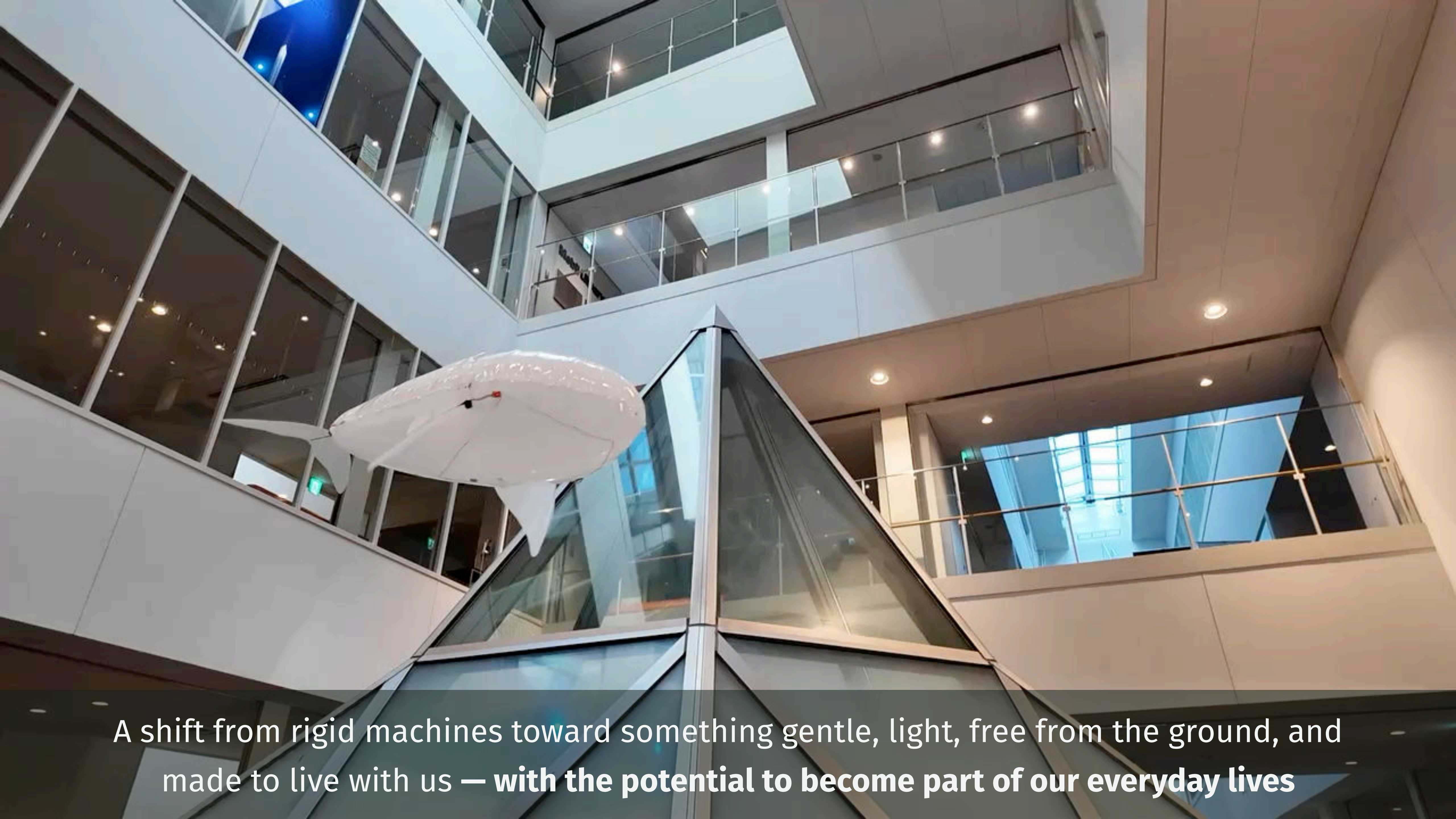
Floating Companions in Everyday Life

Soft, lighter-than-air robots that share our rooms



Xu, Li, Dumlu, LC, Barbareschi, Hoppe, Li, Minamizawa, Kunze. Floating Companion: Exploring Design Space for Soft Floating Robots in Indoor Environments. DIS 2026. doi 10.1145/3800645.3813051



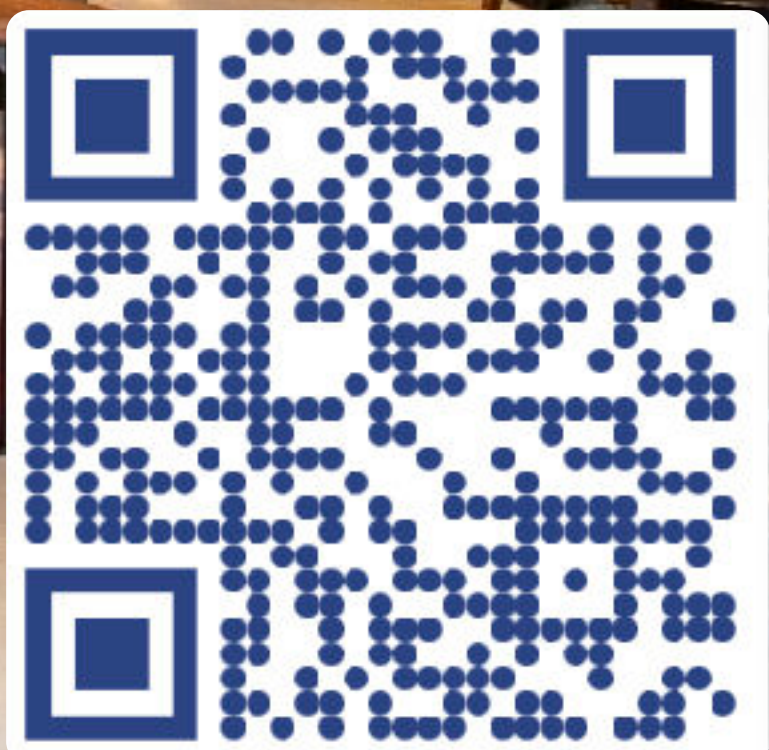


A shift from rigid machines toward something gentle, light, free from the ground, and made to live with us — **with the potential to become part of our everyday lives**




DAWN
with TAILORED CAFE

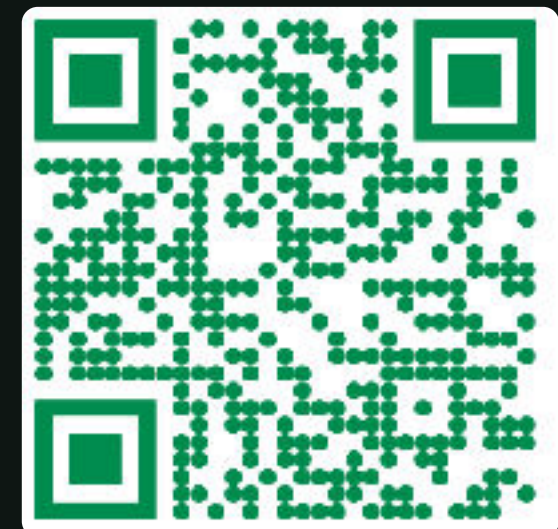
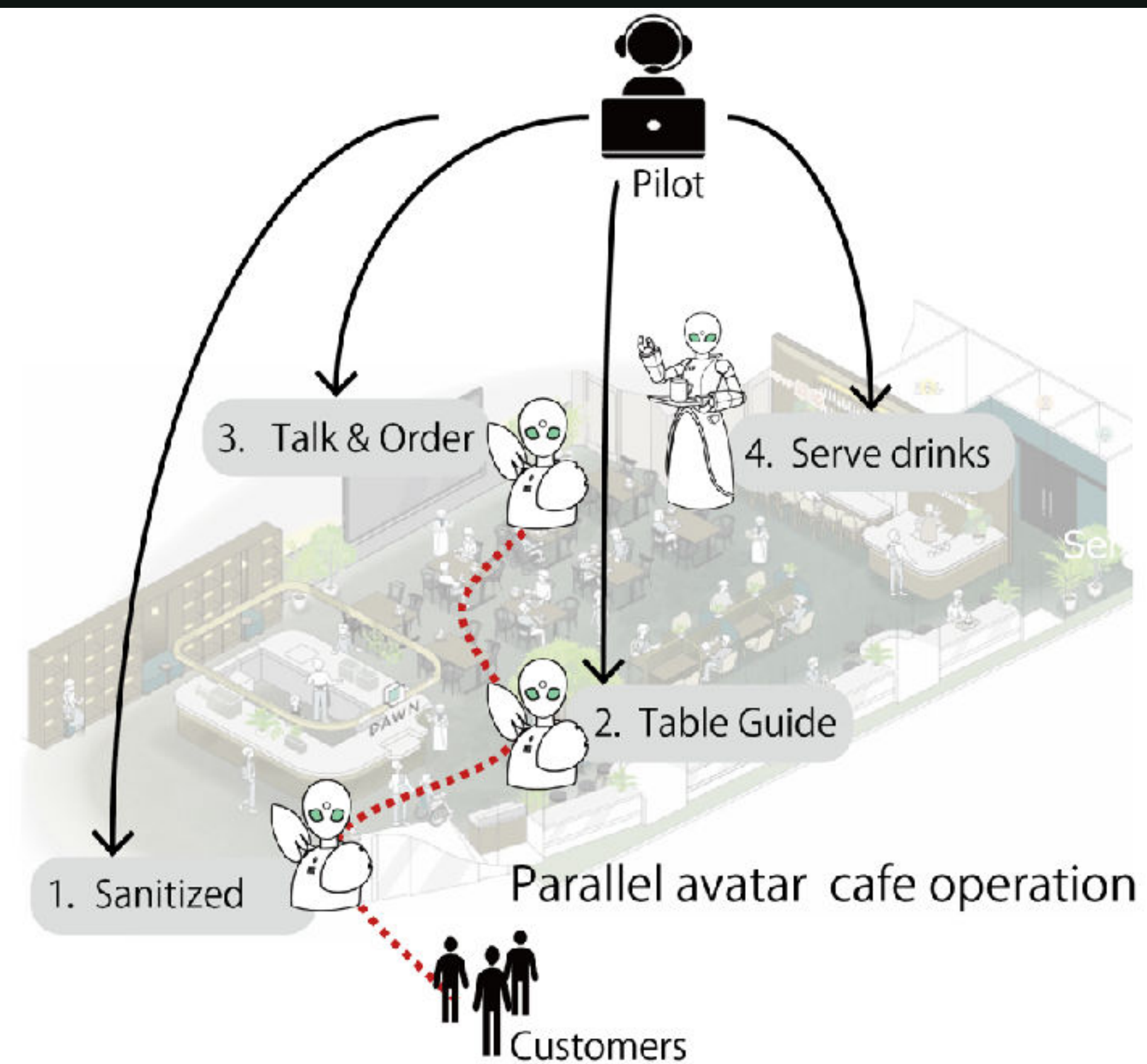
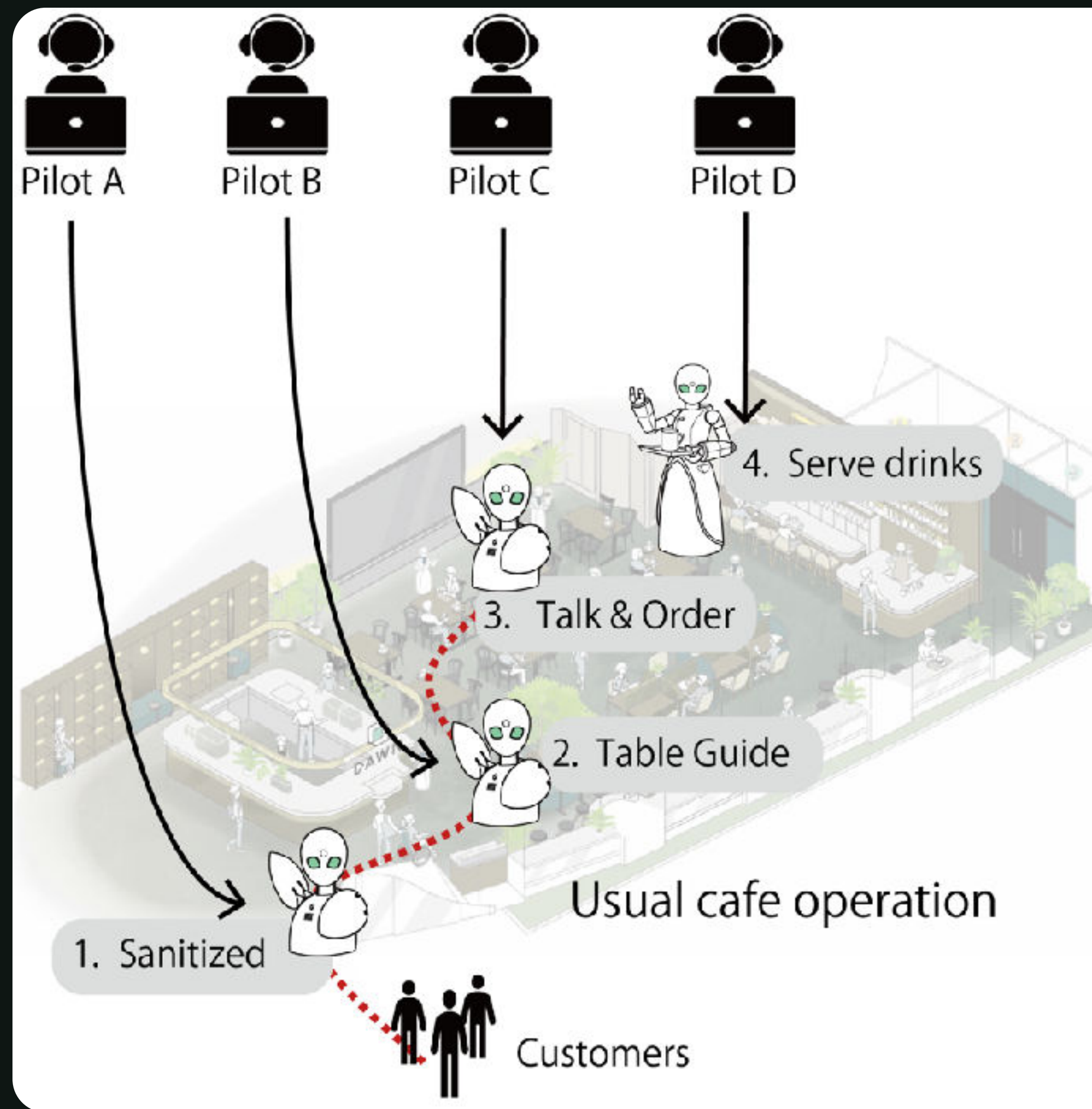
スナック 緑姫



Bar & Cafe
Barista = 06
Cafe Lounge = 30



Parallel Embodiment





Cybernetic being



“I am both here and there” Parallel Control of Multiple Robotic Avatars by Disabled Workers in a Café

Giulia Barbareschi, Midori Kawaguchi, Hiroki Kato, Masato Nagahiro, Kazuaki Takeuchi, Yoshifumi Shiiba, Shunichi Kasahara, Kai Kunze, Kouta Minamizawa



EMBODIED MEDIA



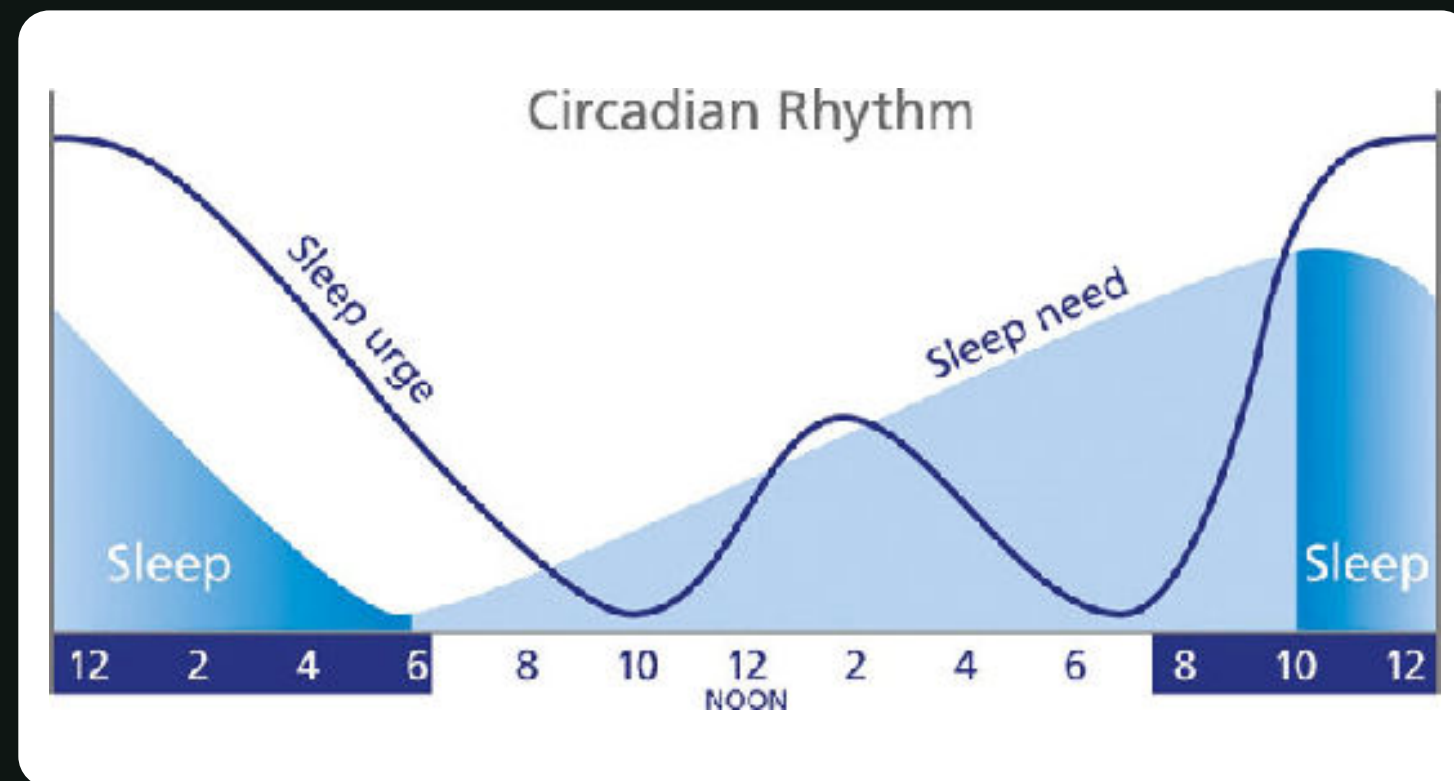
KEIO MEDIA DESIGN
慶應義塾大学大学院メディアデザイン研究科



Sony CSL

Design the Loop, Keep the Person

Three questions for augmentation with AI



Agency

Does it sense how you engage, and still feel like you doing it?

The system senses and suggests. You see it first, and you steer.



Skill

Which skills do you need? Which should you develop?

Take the device off. What is left should be yours.



Experience

Can we design meaningful moments with others?

Share what people feel, and share it honestly.

Tag et al., CHI 2019 · Goto et al., Augmented Humans 2020 · He et al., IMWUT 2022 · Meng et al., CHI 2025 · Bainbridge, Ironies of automation, 1983

What do you still want to ...

learn?

understand?

experience?

Thanks

To the people who actually did the work



Mingyang Xu



Danyang Peng



Kanyu Chen



Keio University · Graduate School of Media Design · GEIST



TU Clausthal · Human-Centered Information Systems · GEIST

Comments, remarks, violent dissent?

<https://geist.pro>