CoChI Bachelor Projects

EXPLORING MULTIMODAL BACKCHANNEL COMMUNICATION IN HYBRID MEETINGS

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Backchannel communication—like whispering, making faces, or sending instant messages—is common in meetings. However, in hybrid meetings, remote participants often struggle to convey these subtle signals, like making facial expressions, especially during presentations or when muted. In this project, we'll dive into the challenge of creating multimodal prototypes to bridge this gap in backchannel communication! Together, we'll build multimodal prototypes, and then conduct user studies to get an understanding of how participants interact with these prototypes and how they feel about using them.

We're looking for students with skills in building multimodal devices and a passion for conducting either qualitative or quantitative user studies.

LLMS IN COMPUTATIONAL NOTEBOOKS

Supervisor: Clemens Nylandsted Klokmose (clemens@cs.au.dk)

Computational notebooks such as Jupyter Notebook or Observable have become popular tools in data science and for programming that involves data processing or visualisation.

They are used by many scientists who do not have formal training in programming. Hence, large language model-based (LLM) tools such as ChatGPT or Github Copilot are more and more used to quickly generate code to solve problems that would otherwise be extremely time consuming for the scientists. In this project, the students will explore different techniques for integrating interaction with an LLM directly into a notebook interface. This involves charting the current state of the art, as well as coming up with new concepts for integrating LLMs, and prototyping them in a computational notebook system such as Jupyter.

The ideation and prototyping will involve working with scientific users of computational notebooks. Hence, the bachelor project will require engaging in user-centred design as well as technical implementation of functional prototypes.

VIBROTACTILE FEEDBACK FOR MOBILE TEXT ENTRY

Eve Hoggan (eve.hoggan@cs.au.dk)

This project involves a study of finger-based text entry for mobile devices with touchscreens. You will run an experiment to compare devices with a physical keyboard, a basic touchscreen and a touchscreen with tactile feedback added. You will test this in both static and mobile environments.

This project requires knowledge of HCI and usability evaluations.

UNIQUE FEATURES = UNIQUE PRODUCTS
Simon Christensen (simon@cs.au.dk)
Eve Hoggan (eve.hoggan@cs.au.dk)

Using high end and consumer grade 3D scanning technology, this project aims to develop scripted 3D model generation of computer peripherals ergonomically and custom designed for unique features

Students will need good 3D modelling and printing skills.

THE FUTURE OF PHYSICAL COMPUTING
Simon Christensen (simon@cs.au.dk)
Eve Hoggan (eve.hoggan@cs.au.dk)

You will not be trying to design a new paradigm within Physical Computing, however you will be didactically designing and user testing new learning designs and methods focusing on newer microcontrollers and surrounding technologies. If the project is highly successful, your material might be used in the future for teaching Physical Computing at AU CS.

AI-DRIVEN DESIGN AND MANUFACTURING: LEVERAGING LLMS FOR CAD, SLICING, AND 3D PRINTING AUTOMATION
Advisors: Doga Ozbek, Michael Wessely, www.interactivematterlab.org

This project explores the use of Large Language Models (LLMs) to automate key stages in the design and manufacturing pipeline of 3D printing. A key component involves implementing generative AI in 3D printing slicer programs, aiming to enable more intelligent and adaptive slicing methods that consider material, speed, and precision. This research seeks to streamline the design-to-production workflow, enhance customization, and expand the capabilities of computational fabrication.

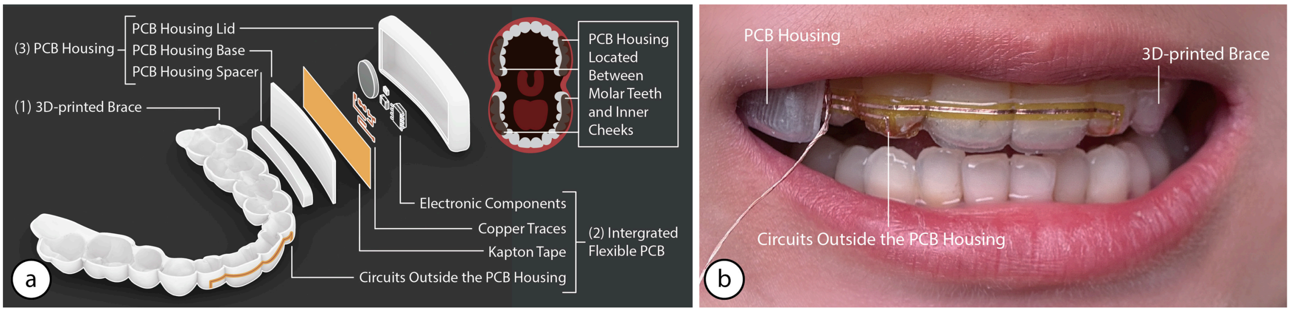
Recommended Skills:
Computational Design and Modeling
- Proficiency with CAD software and experience in parametric or generative design

Machine Learning and Generative AI
- Understanding of LLMs and experience in applying them for workflow automation and AI-driven slicing adjustments

3D Printing and Slicing Software
- Familiarity with 3D printing slicers, particularly in customizing slicer settings to optimize for material and print quality

INTERACTION AND SENSING WITH ORAL USER INTERFACES

Advisors: Yijing Jiang, Michael Wessely, www.interactivematterlab.org



Oral interface technology offers exciting opportunities for health monitoring and human-computer interaction. Using the prototyping platform MouthIO (see ACM link), we can explore a range of projects across different scenarios and user groups to better understand and expand the potential applications of intraoral interactions including:

- Haptic VR interface. You project is to create a MouthIO brace with touch sensors and a vibration motor to simulate haptic sensations in VR. For example, the haptic interface may simulate chewing in VR. The project may include a user study on the perception of the oral VR interface.
- Oral BioSensing. Design a one-way flow structure within the brace that directs saliva into the device to interact with embedded biosensors, preventing backflow. This setup will allow us to integrate various biosensors, such as glucose sensors (for diabetes monitoring) and oxytocin sensors (for depression research), creating a reliable system for health monitoring.
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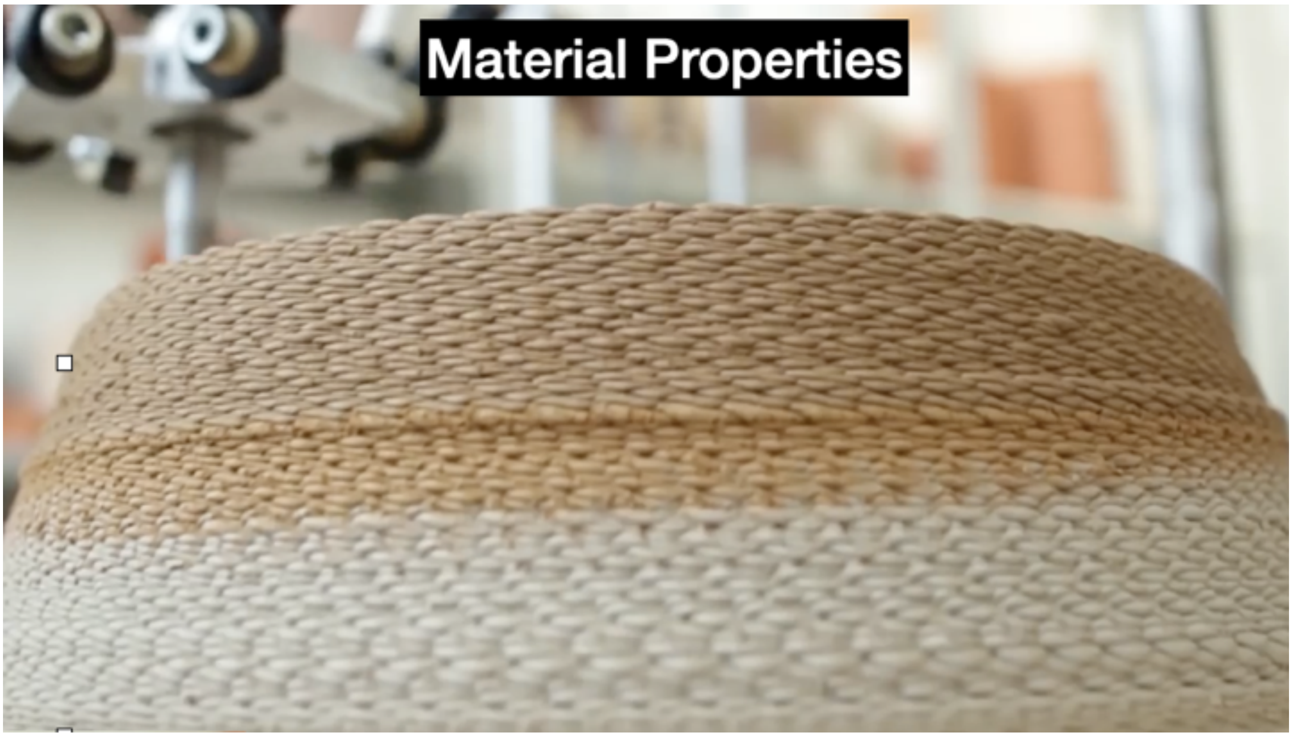
Recommended Skills:

- Experience in Prototyping and Electronics
- 3D Modeling
- Proficient Programming Skills

HAPTIC TEXTURES IN 3D PRINTING

Advisor: Michael Wessely. www.interactivematterlab.org

3D printing enabled a wide range of users to create highly detailed geometries without expert knowledge in crafting and design. However, the materials that can be 3D printed are still limited to plastic-like substrates but fail to print other materials such as metal, glass, wood, or stone.



The goal of this project is to develop a novel 3D printing technique that creates objects that are printed with standard filament such as PLA but create the haptic experience of wood, stone, or. The key idea is to create microstructures on the surfaces of 3D prints that change the way they feel. To create these microstructure, you will add a vibration motor to the nozzle of the 3D printer. By letting the printer nozzle vibrate during printing in a computer-controlled way, it might be possible to create microstructures on the final print that alter the way the objects feel.
Some Inspiration: https://youtu.be/1JjaqKUUMMw
Below I outline several steps where each can be a bachelor thesis.

- Modifying a 3D printer to support vibration of the printing platform the printer nozzle
- Computational Model to simulate effect the of vibration on 3D printed objects
- Study and development of a metric to define the similarity of a printed surface texture to real-world materials
- Material Exploration on 3D printable filaments with varying heat-transfer rates and studying the combination of surface roughness and heat transfer on the perceived material characteristics

This project requires maker skills and/or computer graphics/optimization/ML skills. Experience in haptics is useful. Drop me a mail to know more about this project.

HOW CAN MIXED REALITY BLEND DIFFERENT SPACES FOR COLLABORATION?

(Jens Emil Grønbæk – jensemil@cs.au.dk, Ken Pfeuffer - ken@cs.au.dk)

We need better tools for doing work together over distance! During COVID, Virtual Reality (VR) increased in popularity as a commercial solution for embodied collaboration at a distance. Metaverse apps like Frame (https://learn.framevr.io) have since been adopted for creative meetings, education, and conferences, where people can break out of their Zoom windows and be together as avatars in a virtual 3D world.

Beyond VR, new Mixed Reality headsets (such as Meta Quest 3 and Apple Vision Pro) enable collaboration experiences that combine elements from the virtual and the real world to provide a “blended” space. This provides new exciting opportunities. For instance, users can be in different rooms and sit at their individual tables, move physically around, and draw on their individual whiteboards, while seeing each other’s avatars embedded in their own physical environment as if they were sitting at the same table, or drawing on the same whiteboard. While Mixed Reality has exciting prospects, there are still many open challenges for future research.

- How can Mixed Reality interfaces incorporate elements such as furniture and walls from multiple users’ physical spaces?
- How can such physical elements be mapped to each other, when users’ physical rooms are dissimilar?

In this project, you will explore and develop this design space of possibilities for blending spaces. The outcome will be a set of prototypes that demonstrate new techniques for blending spaces, with considerations for how to scale to multiple users and spaces. These can be evaluated with pairs of users to study their collaborative benefits and limitations.

Related Literature:

[1] Grønbæk, et al. (2023). Partially Blended Realities: Aligning Dissimilar Spaces for Distributed Mixed Reality Meetings. CHI’23. https://dl.acm.org/doi/full/10.1145/3544548.3581515

[2] Wong, E, et al. Practice-informed Patterns for Organising Large Groups in Distributed Mixed Reality Collaboration. CHI’24. https://dl.acm.org/doi/full/10.1145/3613904.3642502

MIXED REALITY WHITEBOARD COLLABORATION

(Jens Emil Grønbæk – jensemil@cs.au.dk, Ken Pfeuffer - ken@cs.au.dk)

Being creative together over distance is challenging. Tools such as Zoom provide features for spontaneous creativity, such as virtual whiteboards. But there is simply no replacement for getting the right people in a room at the same time, with a whiteboard. Imagine being able to break out of your 2D Zoom window, and instead meet remotely in 3D with your friend or colleague around your own physical whiteboard, where you can freely sketch and place both physical and digital objects (such as documents, post-it notes, or even 3D models) while you generate ideas together.

In this project, you will explore how to use Mixed Reality headsets (such as Meta Quest 3/Pro and Apple Vision Pro) to enable remote creative collaboration around real whiteboards. Users can move around in their respective physical rooms, with a real whiteboard each while seeing remote others as avatars, such as in the figure (see [1] for details and video). You will design and develop tools to enhance creativity around a Mixed Reality whiteboard. Examples include:

- Ink: Virtual ink could be interactive and animated to support ideation
- Beyond ink: Multimedia content (e.g. video playback, 3D models) could be integrated
- Using AI: Generative AI could be integrated as a sketching tool (like in [2]), combining LLMs with multimodal input combining speech and sketches, etc.

This is where students can be creative and have fun, and only the sky is the limit! Once students have a prototype of this interactive experience, they will learn how to conduct a small collaboration experiment, using their prototype as the platform to study with users how a novel Mixed Reality whiteboard experience compares to Zoom whiteboards and/or real whiteboards in terms of supporting collaborative creativity.

Related Literature:

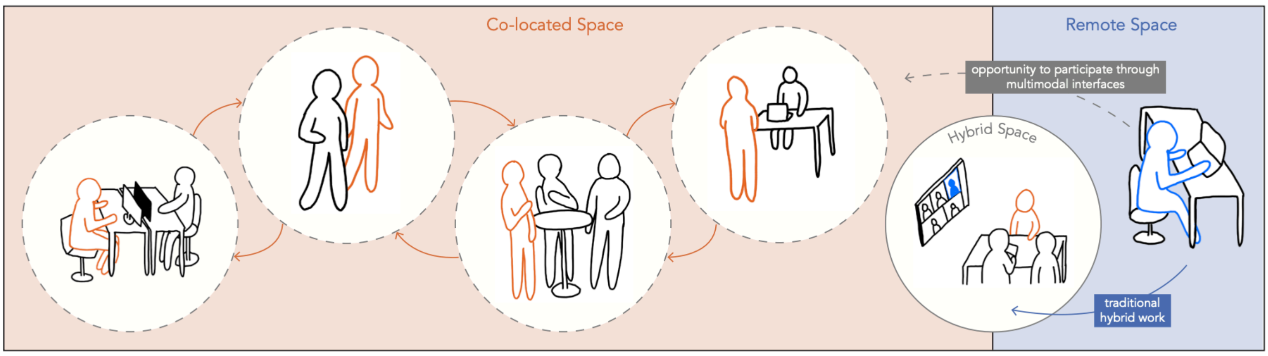
[1] Grønbæk, et al. Blended Whiteboard: Physicality and Reconfigurability in Remote Mixed Reality Collaboration. In Proceedings of CHI'24. https://dl.acm.org/doi/full/10.1145/3613904.3642293

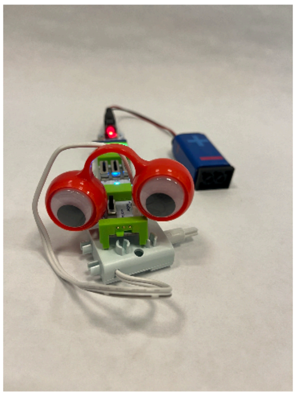
[2] Rosenberg, et al. 2024. 2024. DrawTalking: Building Interactive Worlds by Sketching and Speaking. In Proceedings of UIST '24. https://doi.org/10.1145/3654777.3676334

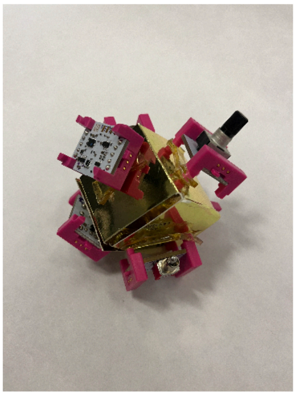
MULTIMODAL PHYSICAL COMPUTING INTERFACES FOR MOBILE HYBRID MEETINGS

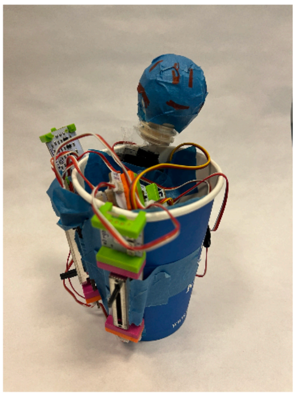
(Jens Emil Grønbæk – jensemil@cs.au.dk, Eve Hoggan – eve.hoggan@cs.au.dk)

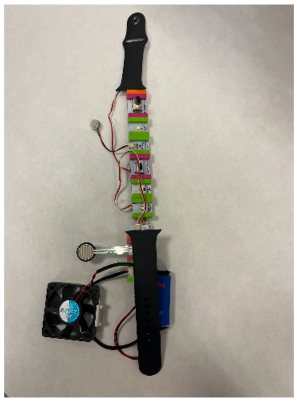
As workplaces become increasingly flexible and dynamic, traditional hybrid meeting setups—which rely on fixed, room-based video conferencing—fail to support the spontaneous and mobile nature of many collaborative work environments. Current technology limits co-located participants' ability to move around and remote participants' ability to be included and stay engaged [1, 2]. However, Multimodal Interfaces has the potential to solve these challenges (e.g. [2]).











In this project, you will be able to contribute to our ongoing research by developing Multimodal Physical Computing Interfaces, aimed at enhancing engagement and mobility for both remote and co-located participants in hybrid meetings. These interfaces will combine various sensory channels (e.g., audio, gesture, and haptics) to address the most significant barriers to mobile participation—i.e. maintaining presence and situational awareness across distance. Potential project directions could be (but are not limited to):

- Gesture and voice integration: Leveraging gesture and voice-based inputs to allow remote participants to "follow" or "center" on specific speakers or locations in real-time.
- Haptic feedback: Utilizing haptic signals to support coordination and spontaneous interaction between remote and co-located participants.
- Spatial audio: Developing spatial audio capabilities to enable better spatial awareness, allowing remote users to sense and respond to on-site participant movements.

Related Literature:

[1] Bjørn, et al. 2024. Achieving Symmetry in Synchronous Interaction in Hybrid Work is Impossible. ACM TOCHI. https://doi.org/10.1145/3648617

[2] Mu, et al. 2024. Whispering Through Walls: Towards Inclusive Backchannel Communication in Hybrid Meetings. In Proceedings of CHI '24. https://doi.org/10.1145/3613904.3642419

TRACKING PAPER WITH COMPUTER VISION FOR DYNAMICLAND-INSPIRED 'REVERSE AUGMENTED REALITY'

(Clemens Klokmose – clemens@cs.au.dk)

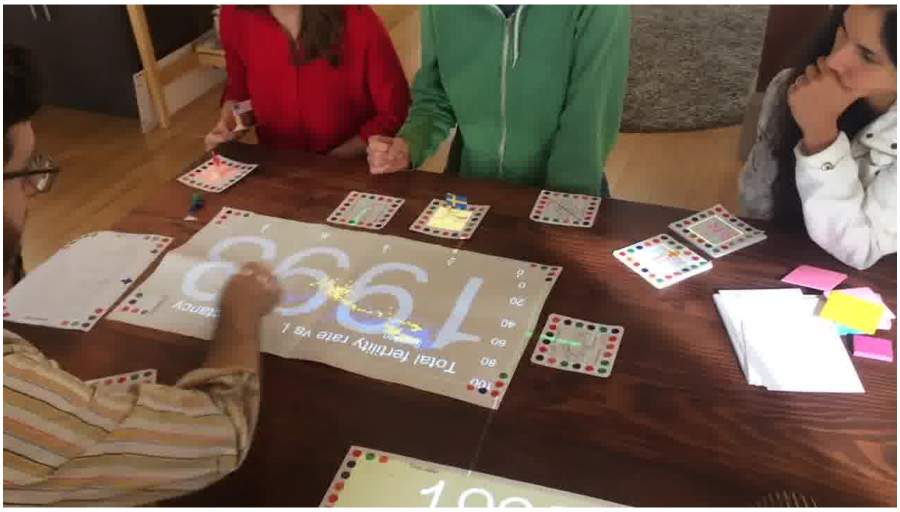
When we think about augmented reality, it usually involves seeing digital content overlaid on physical surroundings, either through a handheld device or an augmented reality headset like the Meta Quest 3 or Apple Vision Pro. However, there's another approach to augmented reality: projection mapping, which displays digital content directly in physical spaces.
The Dynamicland project by Bret Victor and colleagues (https://dynamicland.org) creates interactive spaces by projecting digital content out on pieces of paper that are tracked using computer vision. Here's a couple of images from the Dynamicland intro video (that you ought to see).

In this project, you'll build paper-tracking software inspired by Dynamicland, running directly in the web browser using OpenCV.js. The project involves designing, developing, and evaluating a robust technique for paper tracking and projection mapping. For those with the skill and ambition, an optional extension could include projection mapping onto 3D objects on these pieces of paper, such as 3D-printed models.

This project requires web development skills and familiarity with computer vision, or a willingness to learn basic computer vision concepts as the project progresses.

EXPLORING MINIMAL SOCIAL CUES IN ARTEFACT-INSPIRED ROBOTS

(Majken Kirkegård Rasmussen mkirkegaard@cc.au.dk)



The landscape of social robotics is largely characterised by cute aesthetics, as exemplified by robots such as Pepper, Jibo, Kuri, and Buddy. Which all in different ways showcase the prevalent adoption of cute baby-like characteristics such as large eyes, small chins, and rounded facial features and limbs. Despite the evident appeal of cute robots in studies exploring robot appearance (e.g. [2, 4, 5]), the cute toy-like design in some cases has been found to be perceived as condescending and a source of rejection due to their child-like associations, which does not match personal perceptions and desired home aesthetics [3, 6].

This project aims to explore minimally visible social cues as an alternative way to indicate robot sociality. By focusing on artefact-inspired robots, the project will investigate a different trajectory from the dominant robot appearance categories: anthropomorphic (human-like), zoomorphic (animal-like), and technical (machine-like) [4]. This approach seeks to address the gap in current research and provide insights into how subtle social cues can enhance robot acceptance and integration into home environments.

The project can take on multiple directions depending on the interests and focus developed by the students, e.g.:

- Empirical work exploring the relationship between people's home aesthetics and robot design
- Development of a robotic platform, which uses back-projection similar to the Furhat robot [1], to explore the impact of the design of different minimal social cues in the form of artefact-inspired robots.
- Developing prototypes exploring minimal social cues and/or artefact-inspired robots.

References

[1] Samer Al Moubayed, Jonas Beskow, Gabriel Skantze, and Björn Granström. 2012. Furhat: A Back-Projected Human-Like Robot Head for Multiparty Human-Machine Interaction. In Cognitive Behavioural Systems, 2012. Springer, Berlin, Heidelberg, 114–130. https://doi.org/10.1007/978-3-642-34584-5_9

[2] Chien-Hsiung Chen and Xiaoyu Jia. 2023. Research on the influence of the baby schema effect on the cuteness and trustworthiness of social robot faces. Int. J. Adv. Robot. Syst. 20, 3 (May 2023), 17298806231168486. https://doi.org/10.1177/17298806231168486

[3] Simon Coghlan, Jenny Waycott, Amanda Lazar, and Barbara Barbosa Neves. 2021. Dignity, Autonomy, and Style of Company: Dimensions Older Adults Consider for Robot Companions. Proc. ACM Hum.-Comput. Interact. 5, CSCW1 (April 2021), 104:1-104:25. https://doi.org/10.1145/3449178

[4] Leilei Guo, Jianping Liang, Yanshan Huang, and Juncheng Shang. 2023. The impact of the cuteness of service robots on consumers' interaction willingness. Curr. Psychol. (October 2023). https://doi.org/10.1007/s12144-023-05365-8

[5] Alisa Kalegina, Grace Schroeder, Aidan Allchin, Keara Berlin, and Maya Cakmak. 2018. Characterizing the Design Space of Rendered Robot Faces. In Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction (HRI '18), February 26, 2018. Association for Computing Machinery, New York, NY, USA, 96–104. https://doi.org/10.1145/3171221.3171286

[6] Amanda Sharkey and Noel Sharkey. 2012. Granny and the robots: ethical issues in robot care for the elderly. Ethics Inf. Technol. 14, 1 (March 2012), 27–40. https://doi.org/10.1007/s10676-010-9234-6

VIOLATIONS OF PERSONAL DIGITAL SOVEREIGNTY
Supervisor: Clemens Nylandsted Klokmose (clemens@cs.au.dk)

Human-computer interaction (HCI) research should be concerned that the current design of software and modern digital infrastructures challenge personal digital sovereignty. Personal digital sovereignty consists of an individual's independence, autonomy, and control in their relationship with data, software, and hardware:

- Independence means not needing to rely on others and is challenged when, for example, users are unable to make changes to their software without the (global) market demanding similar changes.
- Autonomy means the freedom to self-direct and is challenged when, for example, users are forced to update their software at the schedule of the developer.
- Control means the proactive power to determine how to achieve one's goals and is challenged when, for example, users are unable to combine multiple applications in new ways to interoperate on the same data.

In this project, the students will pick a profession (electronic musicians, patent clerks, communication consultants, architects, teachers, medical doctors...) and document when the participants' personal digital sovereignty is violated and what aspect of the software they use are a cause of this. Methods can include qualitative interviews, cultural probes, future workshops, and more. Based on the results of this study, students will suggest what aspects of the studied software should change and how so that it grants greater independence, autonomy and control.

HYBRID MEETINGS (LIGHTWEIGHT INTERACTIONS AND MULTIMODALITY)
Julia Kleinau (julia.kleinau@cs.au.dk)
Eve Hoggan (eve.hoggan@cs.au.dk)

In hybrid meetings, participants often rely on on the visual (videofeed) and auditory (voice channel) modality. This can limit interaction options for remote participants compared to co-located ones. Multimodal input and output techniques (e.g. combining visual, auditory and haptic modality) could bridge these gaps, enabling a more inclusive communication environment. Lightweight, flexible tools could support "meetings on the go" within diverse office spaces, enhancing spontaneous interactions.

Potential Research Questions:
- How can multimodal interfaces help balance participation between remote and co-located meeting participants?
- Which lightweight technologies can support seamless meeting transitions across office spaces?
- How can non-verbal cues (e.g., gestures, touch interactions) be integrated to improve remote participants' engagement and immersion?

PRIMARY ROOM DOMINANCE
Julia Kleinau (julia.kleinau@cs.au.dk)
Eve Hoggan (eve.hoggan@cs.au.dk)

In hybrid meetings, power dynamics can shift depending on who controls the physical meeting space, often favouring in-person participants. This project would explore speculative prototypes that intentionally exaggerate these power imbalances, such as overstimulating notifications from remote users or disproportionate control over meeting features, to better understand the biases in these settings.

Potential Research Questions:
- How does control over physical meeting space influence power dynamics in hybrid meetings?
- What design interventions can raise awareness for primary room dominance?
- Can awareness raised through speculative design interventions prompt users to change their communication practices based on their experience, potentially mitigating the imbalance of room dominance and ensuring equal participation for all?