CoCHI BSc topics 2024

Family stories, sharing of family trees and data quality, physically and/or through online platforms like MyHeritage

Supervisors: Susanne Bødker

Several services offer ways for people to trace their family history and family trees. MyHeritage [1] is one example where users can sign up, create, explore, visualize, share and develop their family tree. This often leads to discovering new ancestors, overlaps between the family tree of others and new aspects to their family history. This also includes searching for information and dealing with the (lack of) quality and conflicting information when managing their family trees.

Perhaps without knowing it, using these services become a kind of data work [2], human-data interaction [3] or casual information visualization [4] (depending on framing). The services all adopt the GEDCOM [5] data format and common tools and visualizations around this. Hence, understanding the particular aspects of genealogy as an example of HDI/casual infovis can inform how citizens approach data in other areas of life.

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

- Empirical work could examine how users of MyHeritage or amateur genealogist [6] engage with and share records, data, visualizations and more in their search and hobby.
- Participatory design activities could be used to examine alternative redesigns, tools, representations and applications on top of GEDCOM or other resources within the practice.

References

[1] https://www.myheritage.dk/

[2] https://en.wikipedia.org/wiki/GEDCOM

[3] Møller, N. H., Bossen, C., Pine, K. H., Nielsen, T. R., & Neff, G. (2020). Who does the work of data?. *Interactions*, *27*(3), 52-55.

[4] Victorelli, E. Z., Dos Reis, J. C., Hornung, H., & Prado, A. B. (2020). Understanding human-data interaction: Literature review and recommendations for design. *International Journal of Human-Computer Studies*, *134*, 13-32.

[5] Pousman, Z., Stasko, J., & Mateas, M. (2007). Casual information visualization: Depictions of data in everyday life. *IEEE transactions on visualization and computer graphics*, *13*(6), 1145-1152.

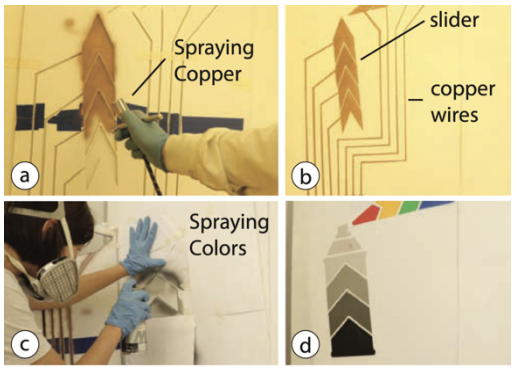
[6] https://www.aakb.dk/nyheder/lokalhistorie/slaegtsforskning-for-begyndere-saadan-kommer-du-i-gang-med-slaegtsforskning

Fabricating large-scale user interfaces in architecture

Advisor: Michael Wessely. Michael.wessely@cs.au.dk. www.michaelwessely.com

We explore how to make large-scale user interfaces using spraying as the fabrication method. Unlike many existing techniques, such as 3D printing, screen printing or inkjet printing, spraying is not bound to a specific volume and as often demonstrated by graffiti artwork, can create output that covers entire walls and even building facades. By using sprayable inks such as conductive copper ink, or light-emitting phosphor ink, we demonstrated that it is possible to create touch buttons, sliders, proximity sensors and electroluminescent displays on large surfaces such as the walls of a room or on furniture [1].

https://youtu.be/UXzyFbqGYOU



The goal of this project is to extend the current state-of-the-art to computer-controlled spraying drones. The first step is to mount a spraying system on a drone that can apply functional inks (or colors) on entire buildings. The drone can be controlled by a computer system where a user can digitally design the appearance and the function of the building/wall, and the drone will automatically spray the designs.

Outlined below are several elements to enable this project. One or multiple of those can be a bachelor thesis.

- Engineering Spraying System on a computer-controlled drone
- Tracking system for a drone
- Computational Model for Wind Compensation in the flight trajectory of a drone
- UI for designing large-scale user interfaces
- Material Exploration for spraying smart materials (e.g., sprayable solar cells, electroluminescent displays)
- User study with architects and city planners for applications of large interfaces at building-scale for the future of smart cities

This project requires maker skills and/or computer graphics/optimization skills. Drop me a mail to know more about this project.

[1] Michael Wessely, Ticha Sethapakdi, Carlos Castillo, Jackson C. Snowden, Ollie Hanton, Isabel P. S. Qamar, Mike Fraser, Anne Roudaut, and Stefanie Mueller. 2020. Sprayable User Interfaces: Prototyping Large-Scale Interactive Surfaces with Sensors and Displays. CHI '20. https://doi.org/10.1145/3313831.3376249

Fabricating In-mouth Interfaces

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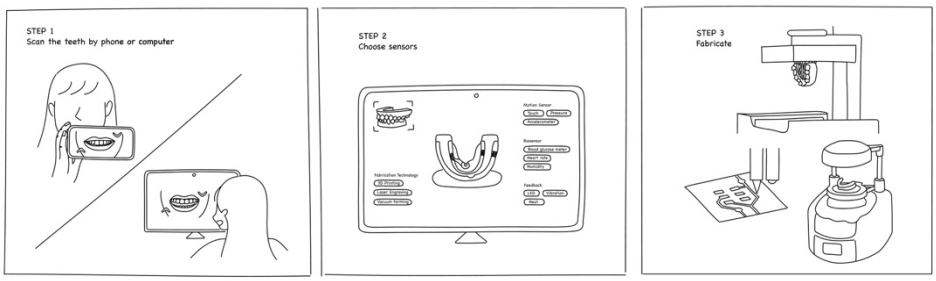
Co-supervision: Yijing Jiang. y.jiang@cs.au.dk

In-mouth interfaces can provide a variety of discreet hands-free interactions and help improve the efficiency of multitasking [1,2]. Additionally, they can serve as assistive technologies to help people with physical disabilities regain basic interaction abilities [3,4].

This project aims to develop a technique that enables the personal fabrication of in-mouth interfaces. Building circuits, microcontrollers, and batteries in the mouth is challenging and requires balancing comfort, waterproofing, and safety. Our vision of this technology would be that users can easily customize their in-mouth interfaces by scanning teeth with a phone or laptop and then selecting the sensors and actuators in software, after that, users can fabricate using commodity machines for example vacuum forming machine, 3D printer or laser cutting machine with commercial materials.



Outlined below are several elements to enable this project. One or multiple of those can be a bachelor thesis.

- Explore materials and fabrication techniques for in-mouth interfaces. (e.g., stretchable silicon, fiber laser cutting, vacuum forming with 3D-printed sheets)
- Participatory design with medical experts, dentists, or other stakeholders about the potentials and challenges of in-mouth interfaces.
- Develop a user interface for scanning intraoral and designing in-mouth sensors and actuators.
- Study and development of in-mouth biosensors for long-term monitoring.
- Develop in-mouth assistive technologies to help people with physical disabilities.
- Exploring battery or power supply solutions for in-mouth technologies.

This project requires maker skills and/or computer graphics/optimization skills. Drop me a mail to know more about this project.

[1] Gallego Cascón, P., Matthies, D. J. C., Muthukumarana, S., & Nanayakkara, S. (2019). ChewIt. An Intraoral Interface for Discreet Interactions. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–13. https://doi.org/10.1145/3290605.3300556

[2] Li, R., Wu, J., & Starner, T. (2019). TongueBoard: An Oral Interface for Subtle Input. *Proceedings of the 10th Augmented Human International Conference 2019*, 1–9. https://doi.org/10.1145/3311823.3311831

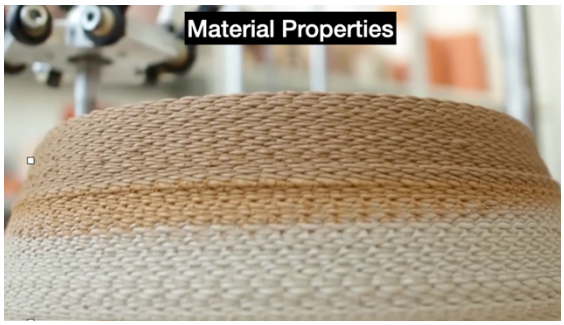
[3] Huo, X., Wang, J., and Ghovanloo, M. (2008). A magneto-inductive sensor based wireless tongue-computer interface. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 16(5):497–504

[4] Struijk, L. N. A. (2006). An inductive tongue computer interface for control of computers and assistive devices. IEEE Transactions on biomedical Engineering, 53(12):2594–2597.

Haptic textures in 3D printing

Advisor: Michael Wessely. Michael.wessely@cs.au.dk. www.michaelwessely.com

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 glass when users touch them. The key idea is to create microstructures on the surfaces of 3D prints that change the way they feel. To enable printers to create such microstructures, this project explores the utilization of vibration during the printing process. 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.

LLMs in computational notebooks

Supervisor: Clemens Nylandsted Klokmose & Caroline Berger

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.

Please write Caroline an email (caroline.berger@cs.au.dk) to chat more about this project.

Violations of personal digital sovereignty

Supervisor: Clemens Nylandsted Klokmose

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.

Handling and versioning binary assets in a CRDT-based version of Webstrates

Supervisor: Clemens Nylandsted Klokmose

Webstrates (https://www.webstrates.net) is a platform for creating real-time collaborative software on the Web by persisting and synchronizing the state of the document object model (DOM) of a web page. Webstrates' data synchronization is realised through operational transformation (https://en.wikipedia.org/wiki/Operational_transformation) using the ShareDB framework (https://github.com/share/sharedb). We have been working on a new implementation of Webstrates using conflict-free replicated datatypes (CRDTs) using the Automerge framework (https://automerge.org). This has the benefit that collaboration can happen in a peer-to-peer fashion, and work can continue without an internet connection. A webstrate can in the original implementation store file-based assets (e.g., binary images or javascript files). However, we haven't found the proper way to handle assets in our new Automerge-based prototype. We hypothesise that files can be stored directly in an Automerge document and served using a service worker (https://developer.mozilla.org/en-US/docs/Web/API/Service_Worker_API). The bachelor project revolves around testing this hypothesis and exploring other possible ways of handling assets in the CRDT-based version of Webstrates.

This bachelor project requires high technical proficiency with Web technologies and JavaScript as well as a capacity and willingness to familiarise with complex software frameworks.

A Case study of an IT development project in an organization

Supervisor: Olav W. Bertelsen

Development of IT-systems in a real world setting often differs from the ideals of textbook system development methods. This is true for large systems developed in large organisations, as well as systems development taking place in smaller start-ups.

The task of this project is to conduct a systematic case study of an IT-development project in an organisation or company. The purpose of this is twofold, firstly to learn something about systems development and about the specific project, and secondly, for the students to learn to conduct a qualitative study in an organisational setting. These research methods will also be useful as part of a systems development project, for analysis and requirements gathering.

Methodically, the project will be a single case study (Yin 2009), based on qualitative research interviews (Kvale 2006). The case will be analysed and discussed through selected perspectives on work and IT-development, depending on the case chosen (e.g. Andersen et al. 1990).

Points of interest in the study could be, how tools and techniques are used and appropriated, how requirements are being specified and turned into running systems, how the project is organized, the relation between development methods and actual practice, and similar topics.

The project and organisation to be studied will be chosen jointly by the students and the supervisor.

References:

Andersen, N.E., F. Kensing, M. Lassen, J. Lundin, L. Mathiassen, A. Munk-Madsen, P. Sørgaard (1990). *Professional Systems Development: Experience, Ideas, and Action*. Prentice Hall

Darke, P., Shanks, G., Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism, *Info Systems J. (1998) 8, 273-289*

Kvale, Steinar (2006). *Doing Interviews.* SAGE Publications.

Yin, R. K. (2009). *Case Study methods, 4th ed,* SAGE Publications.