Foot Augmentation 101: Design your own Augmented Experiences

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ABSTRACT

This studio aims to collaboratively build foot augmentations, experiment with different materials and techniques, and create new designs for low-cost, wearable, and accessible devices that can be used by researchers, makers, designers, and artists. Considering the heightened focus on the human body with the rise of AR/VR/XR technologies, foot augmentation has great potential. To explore this potential, we invite researchers, designers and artists to share their applications, experiences, and ideas while designing foot augmentations. Participants will share knowledge, brainstorm ideas, and explore tools and materials for rapid prototyping. Finally, they will tinker and explore, discussing their design strategies to derive common approaches and best practices. Based on the hands-on session results, we will write a paper on design strategies for foot augmentation that will help facilitate more sustainable investigations and design of future foot interfaces.

CCS CONCEPTS

• **Human-centered computing → Haptic devices**; Systems and tools for interaction design.

KEYWORDS

foot interaction, foot augmentation, augmenting experiences

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1 INTRODUCTION AND BACKGROUND

Feet are one of the foundational modality to mediate the interaction between humans and the world. However, the vast majority of foot augmentations act as disembodied devices for the user. Thinking of foot augmentations beyond disembodied devices opens up opportunities to design embodied, embedded, ubiquitous and experiential interfaces. Furthermore, the wellbeing of our feet has a significant effect on the overall quality of life [11, 17]. Yet, foot augmentation systems are merely a sidenote in the wider human-computer-interaction discourse. We therefore propose a workshop focusing on a topic we find both important and underrepresented in literature.

Foot augmentations rely on foot-worn mobile interfaces with sensing and output capabilities [3]. They have been used in various application scenarios in research, design, and as consumer products [8, 16, 20]. The concept of smart shoes as consumer products has been widely applied in sports performance and human activity tracking [27]. Furthermore, input and output foot interfaces have been used in applications such as VR and mixed reality [2, 21], rehabilitation [1, 15], context aware-computing [12], and cognitive load tracking [5, 6, 9]. In artistic installations, wearable foot interfaces have been used to track movements of dancers [13, 14]. These examples show a steady increase in the number of foot augmentations found in literature covering a broad range of applications.

However, attempts to develop foot interfaces to solve a specific problem, guidelines for designing sensing and actuating mechanisms for feet, appear to be underdeveloped. Addressing these challenges provides an opportunity to enable richer interactions, through our feet, with the world. In the process, we will realize new designs for low-cost, wearable, accessible, and sustainable interfaces to be used in HCI. However, this needs a collaborative effort from experts in different domains such as technology, design, art and sports. Hence, in this studio, we invite researchers, practitioners, designers, and artists to share their applications, experiences, and ideas for designing foot augmentations.

The aim is to get our feet wet, experiment with different materials and techniques to prototype foot interfaces collaboratively. We will share knowledge from previous work in the field, and use tools for rapid prototyping to bring ideas to life. Participants will tinker and explore, while collaboratively sketching design strategies, common approaches and best practices. Based on the observations of hands-on sessions, we plan to write a paper on design strategies for foot augmentation to facilitate more sustainable investigations and designs around the human foot.

2 STUDIO PROPOSAL

Foot Augmentation 101 studio aims to provide participants an opportunity to explore, experience and design foot augmentations by using different sensing (pressure [5], motion [23], capacitance [12]) and actuation technologies (vibration [7], EMS [10], touch [2]) in their prototypes. These augmentations can range from abstract information provided by vibrotactile patterns [22] to realistic and embodied feedback in closed loop manner [4, 19].

We plan for an interactive in-person studio, which focuses on creating a collaborative environment to design, explore, and discuss foot augmentations. Based on the number of participants, their interest and preferences, the participants will be split into groups with one of the themes described below serving as an inspiration. However, participants are free to explore other questions and directions they find interesting.

Designing for realism: We will use vibrotactile rendering coupled with user action to create virtual textures using *Haptic Servos* [18], and tactile shoes [4, 25]. Participants have the opportunity to augment objects and/or the body. The prompts to participants would revolve about this idea and participants would be free to explore different input-output mappings, sensing-actuation integration, vibrotactile renderings to change the walking experience, etc.

Designing for abstract information: Questions like *'How would you design foot interfaces as information displays? What information can and should it provide, and how should the user experience it?'*, will be explored. We will provide participants with a real-time collaboration system (advanced version of TactJam [26]) for co-designing tactile patterns.

Ideate-Prototype-Experience-Repeat: We will introduce participants to rapid prototyping approaches for creating shoe soles like using hot-glue guns, etc. Questions like *'How can you rapidly prototype foot interfaces? How to utilize a procedural and data-driven design pipeline? Can large language models assist in the process?'*, will guide this theme.

Compare and contrast: Augmentation is thought of as one thing, while in reality, there are multiple approaches. We want participants to compare and contrast different foot interfaces, and document their experiences of the interaction. Prototypes brought by the organizers as well as participants will serve as samples. *'What are the essential elements to create a homogeneous experience? Which augmentation strategies worked and which ones did not and why?'*, are the questions this theme aims to answer.

Virtual shoe customization: Participants will be provided with virtual shoe models to customize their own shoes. Questions like, *'How can I customize shoes to suit different functions, ergonomics and applications? How can we further improve virtual footwear design?'* would be addressed.

2.1 Learning Goals

There are multiple directions being explored in the field of human augmentation, each with their own challenges. However, one of the most difficult challenges with promising outcomes is augmenting foot. In this studio, we plan to scratch the surface of this problem and subtly make people aware of these challenges in foot augmentation. The studio offers a space for participants to ideate, prototype and reflect to understand different augmentation methods and get a chance to design and implement their own augmentation. Specifically, the high-level learning goals of the studio are as follows:

- Explore existing foot augmentation approaches and learn about the opportunities and challenges.
- Ideate, prototype and reflect to understand different augmentation methods like embodied and hermeneutic augmentation and their respective advantages and disadvantages.
- Using iterative and modular design approaches, rapid prototyping, while understanding and empathizing with the challenges of software and hardware integration into a comfortable wearable foot interface.

2.2 Materials to be Explored

This studio will primarily be based on prototypes and materials provided by the organizers. These will include:

- *Haptic Servos* [18], a system rendering vibration coupled with user action.
- The next iteration of TactJam [26] to prototype vibrotactile patterns collaboratively.
- Gymsoles++ [4], A prototype to provide feedback of center of pressure using vibration motors.
- TickleFoot [2], A novel actuation mechanism that can render human tickling action.
- Augmented shoes [25] that alter the perceived softness of the walking surface.
- Materials to build custom shoes and shoe soles prototypes.

3 STUDIO SCHEDULE

This studio is an interactive event lasting for 6 hours (table 1). There will be three main sessions which focus on ideation, prototyping and synthesis. The ideation session focuses on brainstorming ideas which the participants want to explore, along with themes listed in section 2. In the hands-on session, participants will actualize their ideas while gaining experience in exploring and implementing different augmentation strategies. They would also be able to extensively explore the prototypes brought by the organizers and other participants for inspiration. The final session will be a round of prototype demonstrations, followed by a group reflection session among all participants and organizers. The demonstrations

Table 1: Detailed schedule of the studio.

	Duration	*Description*
Open	**60 minutes**	**Introducing the studio**
	5 minutes	On-boarding
	5 minutes	Introducing foot augmentations
	20 minutes	Organizer and participant introductions
	30 minutes	Prototypes and material exploration
Break	10 minutes	
Ideate	**50 minutes**	**Group Discussion #1**
	30 minutes	Brainstorming and exploring augmentations
	20 minutes	Presenting and pitching ideas
Lunch Break	60 minutes	
Hands On	**120 minutes**	**Exploring, prototyping and implementation**
Break	10 minutes	
Synthesize	**50 minutes**	**Group Discussion #2**
	30 minutes	Promising augmentations, modalities, tools
	15 minutes	Concluding results and artifacts
	5 minutes	Next steps and closing

will be accompanied by PechaKucha[1] visually highlighting the designed artifacts and main takeaways. Therefore, we will prepare dedicated slide decks and provide participants support during the hand-on session. Following the demonstrations, we plan to reflect the experiences gained during the ideation and prototyping phases. We plan to guide these sessions with questions like, '*What type of foot augmentations are promising? Are there lessons learned across augmentation modalities? What tools (hardware and software) do we need?*' Based on the reflections, the studio will conclude with deriving the next steps in foot augmentations and formulating specific goals for a follow-up publication.

4 STUDIO SUPPORTING RESOURCES

We will create a website for this studio providing relevant information about the studio's context, a reading list of inspiring prior work, schedule, details of provided materials including tutorials and documentation, and a call for participation including important dates. Furthermore, we will set up a Discord server to engage with participants before, during (mainly for virtual participants), and after the studio. This might form a diverse community around the field of foot augmentation, help organize and discuss a write-up of the results afterward.

A Miro board would serve as a centralized hub for sharing ideas, insights, and outcomes, ensuring that everyone involved has an opportunity to contribute and access the collected information. Prior to the event, we will grant participants access to this board so they can input the things and materials they intend to bring to the studio. During the studio, the organizers will create a photo-wall on Miro to document certain aspects of the ideation and design process as well as the final artifacts, which can serve as resources for a follow-up article or further iterations leading to future research.

[1]https://en.wikipedia.org/wiki/PechaKucha, last accessed on October 23, 2023

All resources will remain accessible and editable for participants on Miro after the studio.

5 POST-STUDIO PLANS

Based on the hands-on experience on developing foot augmentations during the studio, we aim to articulate a design space, including a collection of sensing, actuation and interaction scenarios that could foster future foot augmentations. We will offer participants to co-author a write-up of the results as a journal article in ToCHI or conference paper for subsequent TEI, which was done similarly for a previous studio at TEI'21 [24, 26]. Potential topics for such follow-up publications are, 1) the design space of foot augmentations, 2) strategies for ideation to fabrication of foot interfaces, or 3) Design guidelines for foot augmentation. We believe this studio will serve as a collaboration platform for future work.

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