Toward Expert-sourcing of a Haptic Device Repository

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ABSTRACT

Haptipedia is an online taxonomoy, database, and visualization that aims to accelerate ideation of new haptic devices and interactions in human-computer interaction, virtual reality, haptics, and robotics. The current version of *Haptipedia* (105 devices) was created through iterative design, data entry, and evaluation by our team of experts. Next, we aim to greatly increase the number of devices and keep *Haptipedia* updated by soliciting data entry and verification from haptics experts worldwide.

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Figure 1: Device designers and interaction designers think differently about haptic interfaces.

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INTRODUCTION

Creating touch experiences often entails inventing, modifying, or selecting specialized haptic hardware. However, interaction designers are rarely engineers. Despite surging interest in incorporating haptic feedback into a broad range of applications, most contemporary designers are largely unaware of hundreds of haptic devices that exist. Reasons abound: the corpus is fragmented across disciplines (haptics, robotics, virtual reality, human-computer interaction) and described mainly by device mechanism and output, rather than interactions, use, and potential purpose. Non-engineers may find descriptions impenetrable, and even technically literate readers are challenged to leap from an engineering description to how a device feels or the ways its concepts can be reused.

Haptipedia provides a practical taxonomy, database, and visualization to efficiently navigate this fragmented corpus [4]. It is created to be a community resource that supports designers of all persuasions and is publicly available at http://haptipedia.org. Our evaluation results show that through *Haptipedia* both device and interaction designers can search and browse our database of 105 haptic devices, examine their design trade-offs, and repurpose them into novel devices and interactions (Figure 1).

Our next goal is to scale *Haptipedia* through both automation and input from the haptics expert community. While *Haptipedia*'s snapshot of the field can have a long-lasting impact on inspiring new designs, a living library would be an invaluable resource. Building on existing research on crowdsourcing with special user groups [1, 2, 5], we aim to investigate a range of mechanisms for motivating the haptics expert community to enter and review haptic device data in *Haptipedia*. Furthermore, we plan to devise techniques and algorithms for streamlining the data collection, verification, and aggregation from experts.

Our work mainly fits within the "augmenting the individual" theme for the workshop but also has group components. On an individual level, *Haptipedia* aims to support an individual's creative process in inventing or adapting a device through a library of examples that are annotated by a community of experts. On the group level, haptics experts have diverse backgrounds and skill sets; some are hardware designers, while others are specialized in human perception or interaction design. An effective expert-sourcing pipeline should solicit, aggregate, and display information according to an expert's profile.

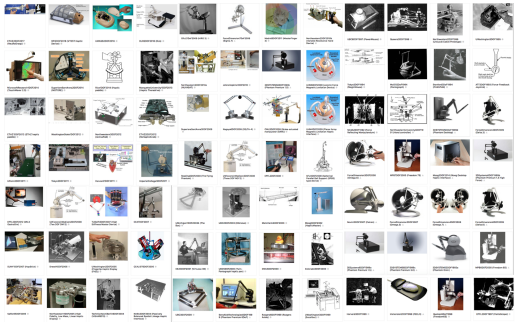

Figure 2: Designers can browse a library of 105 haptic devices in *Haptipedia*'s gallery visualization.

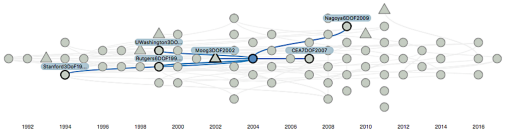

Figure 3: The publications visualization in *Haptipedia* depicts the development context and interconnections between all devices in the database.

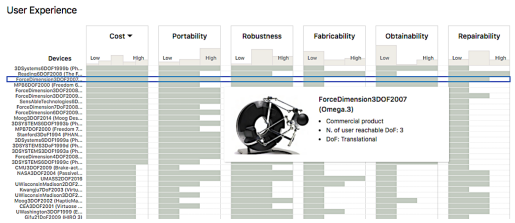

Figure 4: The user experience visualization in *Haptipedia* uses a bar chart to show the seven rated usage attributes for all devices in the database.

In the next section, we provide an overview of *Haptipedia* and then present our considerations in devising an expert-sourcing pipeline for haptic devices.

HAPTIPEDIA

To create *Haptipedia*, we followed an iterative process: We a) selected 105 devices based on a review of 2812 papers in the primary haptics venues, b) identified the most important device attributes for the *Haptipedia*'s taxonomy by reviewing the haptics literature and collecting input from over 100 haptics experts during conference demonstrations, c) extracted these attributes for our 105 selected devices by reading through their publications and datasheets, d) designed a set of interlinked visualizations around the salient attributes in our taxonomy, and e) evaluated *Haptipedia* through demonstrations, focus groups, and interviews.

Haptipedia has three main components: a taxonomy, a database, and a visualization interface. *Haptipedia*'s taxonomy consists of 62 attributes that describe the devices according to: 1) machine attributes (e.g., motion range, sensors) , 2) usage attributes (e.g., robustness, ease of programming), and 3) context attributes (e.g., release year, device creators, device ancestors). *Haptipedia*'s database of 105 devices captures 74 research prototypes and 31 commercial devices released between 1992 and 2017. *Haptipedia*'s visualization (available at http://haptipedia.org) consists of eight interlinked visualization pages for accessing the database. Users can browse the devices, filter to a subset using a side panel, search for a device or inventor name, and bookmark and compare all attributes for two or more devices in a table.

We iteratively evaluated *Haptipedia* through conference demonstrations, focus groups, and interviews with interaction and device designers. Our results showed that *Haptipedia* can help designers learn about new devices, examine their trade-offs, and ideate new devices and applications. Our participants also inquired about our data collection process and commented on using crowdsourcing to scale the database and further develop standards and performance metrics for haptic devices.

EXPERT-SOURCING FOR *HAPTIPEDIA*

We plan to solicit contributions from the haptics expert community in the forms of a) entering specifications for a haptic device one has read about, used, or invented but that is currently not included in the *Haptipedia* database, b) verifying the correctness of device attribute values already in *Haptipedia*, and c) providing additional data or design assets (e.g., images, videos, CAD files) for an existing device in the *Haptipedia* database. Below, we summarize our main considerations and challenges for expert-sourcing these tasks:

Community engagement - Entering data for haptic devices is a time-consuming and cognitively demanding task without an immediate reward. While some experts may care about the visibility of their inventions or progress of the field, others may be too busy to think about these long-term and

altruistic motivations. Following guidelines from [2, 3], we aim to devise a range of reward mechanisms to engage experts with different motivations and goals.

Data verification - In our interviews with haptics designers, the source and validity of device data were important factors for trusting the *Haptipedia* database. Data contributors can have different relationships to a device (e.g., inventor, seller, user, reader) and thus different interests and biases when reporting the data. Furthermore, data entry is an error-prone task. Thus, even data entered by an expert needs to be verified before being added to the database. We are exploring crowdsourced and automated approaches for data verification.

Data aggregation - The same piece of data entered by different experts may not match. Haptics experts have diverse backgrounds and goals. Some are hardware engineers, while others may be perception scientists or interaction designers. Furthermore, a device attribute (e.g., peak force, stiffness) can be measured and reported in a variety of ways. We need an effective mechanism to aggregate input from various sources and effectively highlight the commonalities and discrepancies in the data.

Sustainability - Our aim is to devise an efficient long-term data entry, verification, and aggregation pipeline that requires minimal supervision from our team. Thus, we are seeking mechanisms that can integrate with the haptic community's existing research practices (e.g., paper submission and review process) and/or natural language processing and machine learning techniques for automating parts of the process (e.g., inferring device attributes, verifying data).

CONCLUSION

We aim to scale the *Haptipedia* database through community engagement and crowdsourcing in order to improve its utility and support for haptic design. We hope to discuss our use case with the other participants in the workshop on "Designing Crowd-powered Creativity Support Systems", brainstorming novel expert-sourcing solutions for *Haptipedia* and other community repositories.

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