As Clear as Day! Considering Transparency in Haptic Design

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With growth in research examining haptic experiences as positive design elements for addressing topics such as content immersion and mental health, efforts within the haptics and HCI communities to explore novel haptic mediums has continued to blossom. For example, new software annotation tools have evolved for applying haptic feedback to video content, and one could imagine that these tools may one day be used to generate a more engaging content-sharing experience with family and friends. However, while past work has highlighted the capacity of haptics-enabled tools for unearthing powerful insights into entertainment and well-being paradigms, a greater emphasis on development considerations related to complexity and customizable design should be on the horizon. In this position piece, we explore the challenges of re-invention in haptic design through the lens of our current ideation processes toward addressing two different design spaces: (1) haptic authoring for video content and (2) mental health. Through a discussion of the design spaces, we posit pragmatic adjustments to documentation culture and for facilitating discussion in both the haptics and HCI communities surrounding transparency and clarity in implementation documentation.

CCS Concepts: • **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability.

Additional Key Words and Phrases: affective haptics, emotive computing, well-being

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1 INTRODUCTION

The integration of haptics has grown to permeate a wide array of research-related problem areas. Two major contexts in which haptics-based HCI research has continued to delve ever deeper are in (1) enriching multimodal experiences and (2) addressing approaches for managing mental health disorders, such as anxiety [4, 5, 7–9]. Over the past several years, haptics-based design in these spaces, respectively, has sprouted a number of novel engagement and intervention strategies. With regards to enriching multimodal experiences, our team is interested in considering new, innovative ways in which users could generate haptic effects to create more immersive video viewing experiences. Moreover, in the mental health sphere, we are also interested in creating assistive tools to address conditions like anxiety, while building upon previous haptics-based findings. In this position piece, we discuss design agenda in each of these spaces as a lens through which to consider the degree of "open-source-ness" implementation documentation, a discussion item with particular relevance to the oft specialized nature of haptic development.

Interested in forms of online interaction, we notice video content to be an increasingly popular medium through which to communicate, with the meteoric rise of platforms such as TikTok being prime examples. Video content is a popular form of shareable media in online social contexts, as platforms like Reddit, Instagram, and YouTube enable users to upload and share video. In an effort to generate a more engaging, multimodal experience, haptic authoring tools for video content have been developed, with software like *Haptic Composer* by Interhaptics and *HFX studio* by Danieau et al. (2018) affording users the ability to both craft and apply haptic overlays to video content [4]. Applications of haptics to video not only open the door for more engaging viewing experiences, but it also beckons the opportunity for improving accessibility of the video viewing. For individuals who experience some form of visual or auditory impairment, an additional sensory modality may help to relay more information than would be possible through solely visual and auditory channels.

Moreover, mental health, and in particular anxiety, is another problem area in which prior work into haptic interventions has shown positive results, and to which social interaction is a factor [5, 9]. As has become especially apparent during the COVID-19 pandemic, touch plays a noticeable role in everyday social dynamics, from handshakes to high-fives to hugs. Moreover, we have also seen haptic tools begin to leverage synchronization of bodily signals for influencing heart rate in anxious individuals [9].

While the context areas of haptic authoring of multimedia content and managing anxiety seem disparate, the historic nature of haptic development in these spaces sets the stage for discussing opportunities regarding flexible and adaptive qualities in haptic design research. This means taking into consideration the functionality we engender into the tools we create and the implementation strategies. Does our haptic tool require highly customized components to fulfill a specific function? How ubiquitous are our design materials, and might we take the same open-source approach to our hardware features as we do with software? In the following sections, we discuss our early ideation work in haptic authoring and mental health tools and consider re-invention challenges stemming from clarity in implementation presentation.

2 *HaptiTag*

With growing investment from companies to incorporate hardware capable of rendering haptic effects, especially in cellphones, there exists a rich opportunity to re-imagine the video sharing experience. As previously mentioned, software tools for authoring haptic feedback have sprung about to provide a manual approach for layering haptic effects onto video. However, current manual authoring software can be tedious and challenging to learn, and may not be as accessible for casual video sharers. Automated approaches for applying haptic effects have hit the scene, but the processing time for even short video can be lengthy, and the haptic feedback may be incongruent with the author's desired patterns. For example, in automating the application of haptic feedback to a video with a cacophony of complex sound sources, such as one with traffic, automated systems would struggle, and possible the author seeks to focus feedback on a single car.

To satisfy the control and nuance conferred by manual authoring tools with the creativity of the user, we propose *HaptiTag*, a haptic authoring tool that would allow for creating haptic layers through vocal sound effects. Vocal sound effects are a salient medium through which to compose haptic effects due to ease and enjoyment (who doesn't love making the "vroom!" sound of a car, after all?), and we would like to know how individuals favor to self-generated haptic patterns versus those that are automatically composed.

The existence of ready-made haptic hardware and open-source software makes the design challenge less strenuous, with many mobile phones now equipped with components like Apple's Taptic Engine. In conjunction, by virtue of being open-source, we can leverage Apple's Core Haptics API and extensive documentation for authoring haptic effects on Apple devices and compare against available, trained haptic authoring models. Indeed, our work in this space benefits greatly from the availability and openness of current design tools. Availability need not only imply ready-made tools, however. Rather, the transparency and existence of design documentation outside of brief descriptions found in papers plays an integral role in informing our design agenda due to the increased clarity in implementation. Next, we will build on our discussion of implementation transparency in overviewing our research interests in haptics-mediated design for regulating anxiety.

3 *BreatheBuddy*

Stress and anxiety are both highly common and natural emotional responses, with data from a 2019 report by the National Center for Health Statistics on anxiety prevalence among U.S. adults indicating that approximately 15% of U.S. adults age 18 and older had experienced some degree of anxiety-related symptoms in the two weeks prior to completing the survey [6]. To combat these negative emotional states, previous work has explored mechanisms for regulating emotional state to reduce stress and anxiety, which share very similar coping strategies [**?**].

One such regulatory approach that is being explored concerns the use of bodily signals, such as heart beat, to entrain the physiological behavior of the individual. This an especially interesting strategy given the suggested linkage between physiological and emotional health [3]. For example, an individual in a state of serious stress or anxiety may have an elevated heart rate in comparison to a more tranquil emotional state.

Previous work in entrainment has proposed a number of haptics-backed stress- and anxiety-reducing interventions, such as a vibrotactile-enabled seat for regulating stress while driving, a heartbeat vibration box, and a teddy bear capable of rendering vibration, breathing, and temperature output [5, 7, 9]. We would like to further understand the roles of breathing, goal setting, and feedback in the emotion regulation process via an easy-to-use, accessible haptic tool. To this aim, we propose *BreatheBuddy*, a small, handheld toy-like device that would allow users to set goal breathing rates and that could give auditory feedback based on the heart rate of the user. As an example use case, consider the case of an individual preparing for an upcoming exam. The individual has a history of test-taking anxiety, and would like to return from this anxious state. To reduce their test-taking anxiety, the user could set a goal breathing rate and breath deepness, at which point the user would hold the *BreatheBuddy* device and focus on matching the device's breathing pattern, with the *BreatheBuddy* acting as a guide. To inform the user on their progress, *BreatheBuddy* could also provide real-time audible feedback based on the users heart rate, akin to "Great job!", or "You're getting closer!".

In considering the design for *BreatheBuddy*, we find it especially valuable to consider, for example, how previous works have measured heart rate and provided users with feedback. For example, in their investigation of heart beat patterns on physiological response via haptic feedback, Zhou et al. (2020) created a handlheld device called which receives a heart beat signal via stethoscope and replays the heart beat pattern as a vibrotactile output from a handheld device [9]. In a space with as complex design challenges as in haptics, design tasks often beckon on the implementation of customized tools, as in the case of Heartbeat Picnic from Zhou et al. (2020), where custom circuitry is required for a complete implementation [9]. By nature of the nuanced problem spaces in haptics, implementation of custom hardware and software, as with the Heartbeat Picnic, is quite often a necessity, and *BreatheBuddy* is no exception. When reporting of implementation details is distilled down to broad brush strokes that solely imply custom design without providing appropriate description or documentation, it follows that re-invention is then a necessary evil. But it need not be, we believe, and we as HCI researchers and the community at-large may consider reflecting on expectations for what it means to thoroughly present design decisions and process.

4 DISCUSSION

In this position piece, we overview our research interests in the areas of haptic authoring and mental health, with a particular focus on stress and anxiety. Through the lens of these interests, we highlight several challenges that arise during the ideation process that can have bearing on the feasibility of building upon prior designs; namely, the transparency with which custom design features are reported. This is not a new dilemma, however. After all, design decisions are not always so cut and dry, and the degree of customization with which we instantiate our implementations is often not superfluous. We argue that, in order to keep up with complex and highly customized design decision-making, and to install greater agency within the HCI community for avoiding redundant design, there exists a need for a methodological culture shift that places greater emphasis on implementation details. In this sense, by prioritizing an understanding common, reoccurring patterns in the haptics design space, we have the opportunity to work towards developing a "haptic pattern language" [1]. Indeed, as a community, we tend to prioritize the "why" in our design reporting, but the "how" is a no less critical insight. To support a revised culture of implementation reporting, the question then arises as to how. Descriptions of custom features being introduced as such in the literature is often much appreciated for brevity - normally, we need not know all the nitty gritty. But in order to facilitate clearer design details, we might consider more universal standards for documentation-sharing of implementation choices as a way to allow others access to more nuanced aspects of implementation. To conclude, we hope this position piece prompts further fruitful discussions on current implementation reporting practices in HCI research, and how we might improve on current documentation culture to avoid obfuscation in design decision-making and to empower researchers.

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