HapticViz: an Interface for Visualizing Free-form User Descriptions of Haptic Signals

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How do we support analysis of a large dataset of haptic signals and free-form descriptions through visualization?

Introduction

Over the past year, I collected a large qualitative dataset, consisting of 30 free-text user descriptions each for 256 haptic signals. This described the perceived sensory, emotional, and associative characteristics of vibrotactile haptic signals. This project aims to develop a tool for comparing and analyzing the diverse properties of these signals, enabling haptic developers and designers to easily select signals tailored to their application requirements, and natural language researchers to develop predictive models.

How is this helpful?

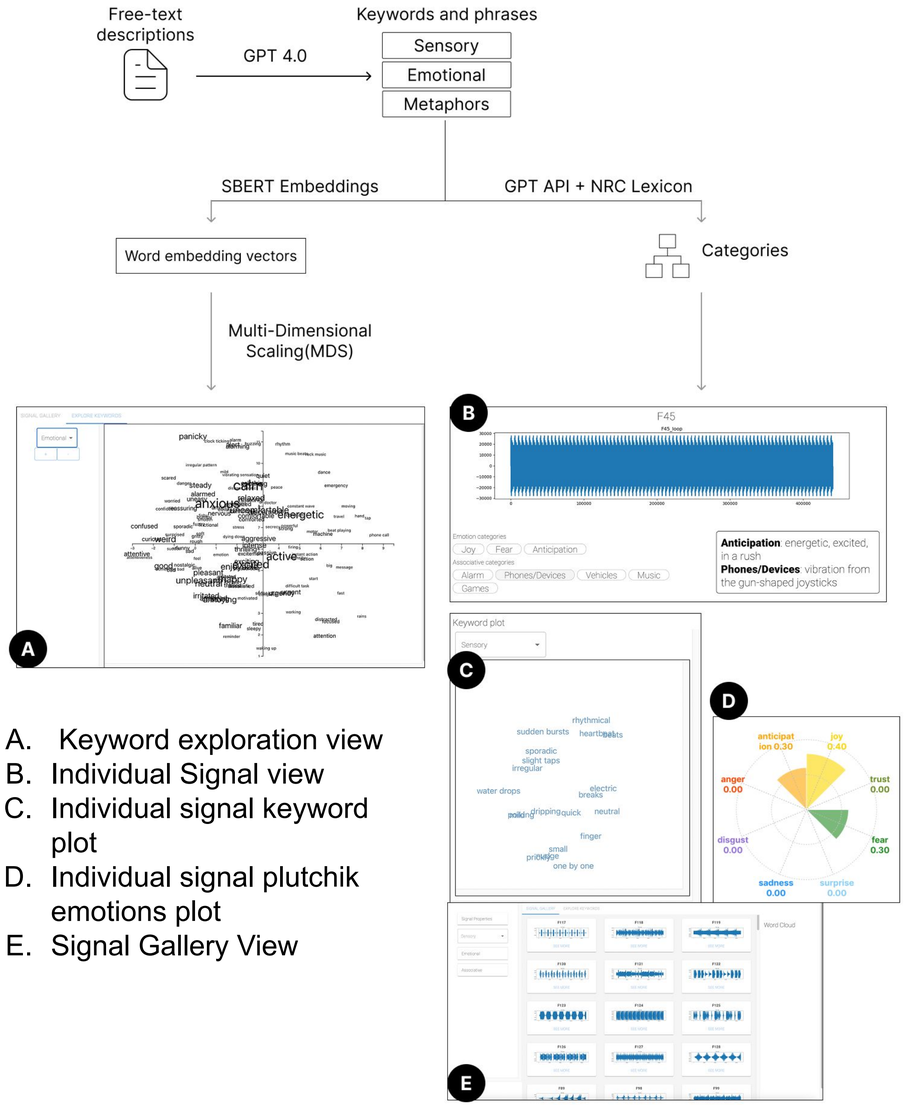
Vibrotactile haptic feedback is used by designers and developers to enhance user experience, improve accessibility, and provide cues (e.g., navigation) by delivering intuitive alerts or signals to users[2] in multimodal applications.

Factoring in the user's interpretations of haptic signals would enrich the process of haptic signal design[4] . User descriptions of haptic signals would allow multimodal researchers to analyze and compare the characteristics of signals, helping them in the development of machine learning models. The research aims to design and develop an interface that allows users to visualize and navigate the sensory, emotional, and associative descriptions of signals, enabling them to select signals tailored to their application requirements easily.

Methods - Data collection

To better interpret the descriptions, I wanted to extract the key words and phrases from the descriptions, identify categories of descriptions to create a taxonomy, and then find their semantic relationships. Since there were 7680 descriptions, too many for me to process manually, I used an NLP pipeline where I used GPT-4 API to identify the sensory, emotional, and associative keywords used to describe each signal. I then used the GPT-4 API and the NRC Lexicon[5] to identify sensory, emotional, and associative categories

To calculate semantic relationships, SBERT word embeddings and multi-dimensional scaling (MDS) used to represent the keywords as two-dimensional vectors[1] and create an interactive 2D plot of words.



A. Keyword exploration view
B. Individual Signal view
C. Individual signal keyword plot
D. Individual signal plutchik emotions plot
E. Signal Gallery View

User workflow

The interface, built using React and D3.js, comprises three views - a gallery view, a gallery view, and a page for individual signals. Users can use advanced filters and explore the relationships between keywords and their correlations to signal properties. Users can isolate specific categories—such as a particular emotion, sensation, or metaphor—and observe how the associated keywords cluster across the dataset.

Results

Multidimensional scaling(MDS) lead to 2D plots where some patterns began to emerge. In the associative keyword visualization, terms related to machinery, music, nature, and devices tend to cluster together, reflecting thematic similarities in how haptic signals are described. Similarly, in the emotion-based plot, words associated with calmness and anxiety form separate, coherent clusters. Using filters along with the interactive plot would allow users to further explore and analyze the described properties of haptic signals

References

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