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HapTune:An Open-Source Visual Tool for Designing User-Defined Haptic Signals

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***Abstract*—This demonstration presents HapTune, an open-source visual authoring tool for no-code design of low- and high-frequency haptic signals, either created from scratch or adapted from existing waveforms. The tool supports point-based editing, spline interpolation, envelope modulation, and tunable multi-frequency synthesis, enabling fine-grained control over both temporal and spectral characteristics. It provides a unified graphical interface for waveform construction, parameter adjustment, spectral visualization, and export to actuator-compatible formats. HapTune supports a wide range of use cases including haptic feedback design, texture rendering, thermal signal shaping, and robotic actuation control. Source code is available at: https://github.com/mudassir-awan/HapTune.**

I. Motivation

Haptic signal design relies on two primary components: low-frequency force profiles and high-frequency vibration patterns. Low-frequency signals represent kinesthetic interactions such as torque modulation in car doors or grasp force regulation in robotic hands, while high-frequency signals convey fine tactile cues such as surface texture, button click sensations, or tool-surface impacts. Together, these signals enable realistic feedback in applications including robotic manipulation, virtual texture rendering, touchscreen interaction, and thermal systems. Although haptic signals are often recorded and replayed, there is an increasing need for tools that allow designers to author or modify them manually, especially when working with synthetic combinations of frequency and envelope structures. Existing solutions typically require programming expertise or depend on commercial platforms, which limits accessibility for researchers, developers, and designers. Currently, no open-source tool offers an integrated, no-code environment for designing both types. To fill this gap, we introduce HapTune, a visual signal authoring tool that enables intuitive editing, creation, modulation, and export of both low- and high-frequency haptic signals in a format ready for actuator rendering.

II. HapTune Design Workflow

The following section describes how low and high frequency signals are constructed and controlled in HapTune.

High-FrequencySignal Design: Users define the amplitude envelope by placing individual control points, which are interpolated using spline curves to form a smooth shape. An inverse envelope can also be generated to create symmetrical signal structures. Once the envelope is defined, users specify multiple frequency components with corresponding amplitudes to synthesize the vibration signal. There is no restriction on the number of frequencies, enabling fine control over the spectral content. HapTune provides a real-time preview of both the waveform and its frequency spectrum using a Fast Fourier transform (FFT), as shown in Fig. 1. This mode supports a range of applications, including tactile event feedback, dynamic surface interaction, and texture rendering.

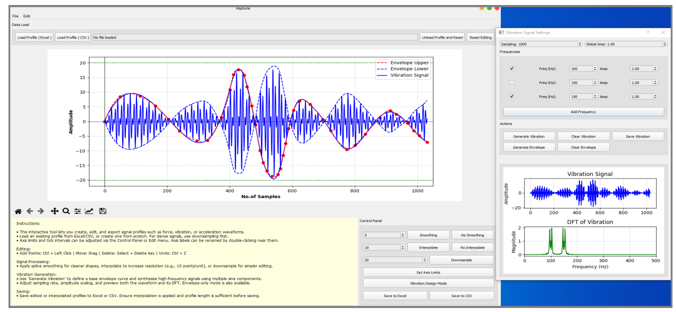

Fig. 1. HapTune interface for real-time haptic signal design, shown with a multi-frequency vibration synthesis example and spectral visualization.

Low-Frequency Signal Design: These signals are manually defined by placing control points, using the same editing approach as in the high-frequency mode. Real-time spline interpolation provides smooth shaping, while additional smoothing and resampling tools support adaptation to different devices and control systems. They are used to represent kinesthetic effects such as torque modulation, compliant motion, and thermal feedback shaping. Fig. 2 shows an example where a car door signal is edited to produce multiple variations, demonstrating HapTune's capability for waveform reuse.

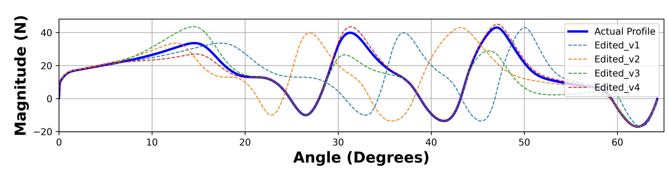

Fig. 2. Edited torque profiles of a car door signal for augmentation and reuse.

III. Demonstration Description

Participants will use the HapTune software to design and edit signals in real time by adjusting control points and configuring frequency components. The generated signals will be perceived through a vibrotactile actuator and a car door simulator during the demonstration.

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