The Con-Tactor: A Novel Tactile Stimulator that Makes and Breaks Contact with the Skin

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Introduction: Haptic devices called *tactors* are commonly used in consumer equipment and research to stimulate the sense of touch with vibration, generally through continual contact with the skin. Some issues with such tactors include difficulty in distinguishing temporal sequences and decreased sensitivity to the vibration over time [1]. The goal of our work is to improve on traditional tactors by providing the user with an easily detected sensation that enhances temporal pattern perception and avoids the loss of sensitivity resulting from continuous vibration. To this end, we designed a novel haptic stimulator that makes and breaks contact with the skin, thereby creating tactile sensations in the form of repeated discrete onsets and offsets. Our design inspiration is the mosquito's foot, which is sensed as it first makes contact without significant deformation of the skin or extended vibration. Our new device, which we call the *Con-Tactor*, contains a delicate lever arm with a foot-like projection that moves downward until it contacts the skin, at which point electrical conductivity between the device and the skin initiates its retraction.

Materials and Methods: Figure 1 shows our Con-Tactor prototype. It is designed as a hand-held tool for convenient application of the vibrating tip to various locations on the skin. A lever arm extends from the fulcrum through a housing where a voice-coil (solenoid with a moving coil and fixed magnet) is attached to push the lever up or down. This motion is relative to magnets mounted within the voice-coil and above the housing. The lever extends beyond the housing where a gold-plated tip can make and break contact with the skin. The design maximizes displacement of the tip for relatively small currents in the coil, while providing the small driving force required at the skin for impact detection. The voice-coil is shaped to permit its orientation to change as the lever moves up and down. The current in the voice-coil is controlled by an Arduino microprocessor connected to a custom digital-to-analog control circuit, using electrical continuity with the skin as feedback to adjust displacement to make and break contact with the skin. The present Arduino program can generate sine, triangle, ramp, and square wave voltage inputs at frequencies ranging from 1-40Hz. We initially tested the Con-Tactor on the thenar eminence, as shown in Figure 1.

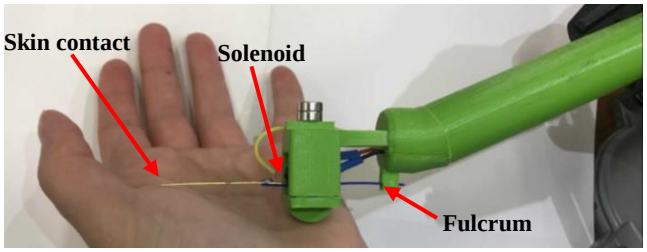

Figure 1. Con-Tactor prototype in use.

Results and Discussion: Stimulation by the Con-Tactor was easily perceived on the thenar eminence, demonstrating that the lever-arm design provides the necessary displacement for making and breaking contact with the skin. Generation of a square wave voltage showed the largest displacement, with the mechanical elasticity of the lever arm contributing significantly to the movement. We are in the process of characterizing the device to classify control variables for psychophysical testing. Tests will include free magnitude estimation to characterize how perceptual intensity varies with input parameters and skin sites, as well as threshold measurements.

Conclusions: Based on preliminary tests, the Con-Tactor shows promising potential as a stimulation device. Applications for our device are potentially widespread, including basic research into low-intensity tactile phenomena and diagnostic point localization tests for neurological disorders in the clinical setting.

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References:

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