A Haptic Compass for Navigation

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Figure 1. Handheld haptic compass for use as a navigation aid.

Over the past decade, interest has grown in using haptic cues to aid navigation, both for people with visual impairments and for people with normal vision walking in unfamiliar environments. Many devices offer GPS-based audio instructions, but haptic cues are appealing because they're private and more practical in noisy environments. Numerous wearable devices based on vibrating motors have been developed and evaluated as navigation aids. In these systems, the location on the user's body at which the vibration occurs conveys information to the user about the intended direction of movement.

In "Development and Experimental Validation of a Haptic Compass based on Asymmetric Torque Stimuli," Jean-Philippe Choinière and Clément Gosselin describe the design, control, and experimental validation of a handheld haptic compass for use as a navigation aid (*IEEE Trans. Haptics*, vol. 10, no. 1, 2017, pp. 29–39). The device, shown in Figure 1, comprises a direct drive motor that generates open-loop torques around an axis orthogonal to the palm of the hand by accelerating the internal masses (the motor's rotor and flywheel) in one direction or the other. A haptic-signal feedback generator translates the user's location and orientation relative to an environmental target to determine the delivered torque's direction and amplitude. For example, if the user experiences a torque to the left, then the target is on the left; torque amplitude provides information regarding the distance to the target.

Experimental validation of the haptic compass indicated that with torque amplitudes greater than 10 mNm, users could accurately identify the initial direction in at least 90 percent of the test trials. Users responded faster to the torque signal as torque amplitude increased, averaging 8 seconds for torques greater than 50 mNm. Signals in the 5–15 Hz frequency range were perceived most clearly; the orientation of signals at lower frequencies took longer to be perceived. Users also performed best when the haptic feedback was proportional to the angular error between the user and the target.

In a more realistic evaluation of the haptic compass, the authors tasked blindfolded subjects with finding 15 indoor waypoints. Not only did all the users find the waypoints successfully, but they also considered the device intuitive to use with readily perceivable signals.

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