

# Free-Space Haptic Feedback for 3D Displays

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What if you could not only see but also feel virtual objects as you interacted with them? This would enable richer and more realistic user experiences. We have designed a low-cost air-vortex generator to provide free air haptic sensation when a user touches a virtual object. The system consists of a 3D printed chamber and nozzle, five low-frequency transducers, and a custom-designed driver board. The air-vortex generator can provide localized haptic feedback up to a range of over 100cm. With increased driving power and a more optimized nozzle design this range could be extended to several meters.

To demonstrate the device in operation, we have created a simple virtual environment in Unity 3D, where a user can interact with a virtual object and feel haptic stimulus in the real world. The user's hands are tracked with a Leap Motion controller and replicated in the virtual world. When a hand touches the virtual object at the center, a signal is sent to a microcontroller, The microcontroller then sends a trigger to our driver board, which activates the vortex generator.

