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Simulation of Grasping Sensations in Virtual Reality Using the Snail Haptic Display

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This demonstration is directly linked to the 1026 Transactions on Haptic paper submitted to the IEEE World Haptics 2025 conference for presentation [1]. It aims to demonstrate the Snail, a novel wearable haptic display that allows users to experience force feedback when grasping objects in virtual reality (VR). We propose to demonstrate how it can simulate grasping sensations corresponding to objects of different sizes and softness during a VR manipulation task.

I. The Snail Display

The display consists of a 3D-printed prop attached to the tip of the thumb of the user and that can rotate thanks to a small servomotor (Fig. 1). When performing a 2-finger grasp, the index finger comes in contact with the prop, so the users feel a force feedback.

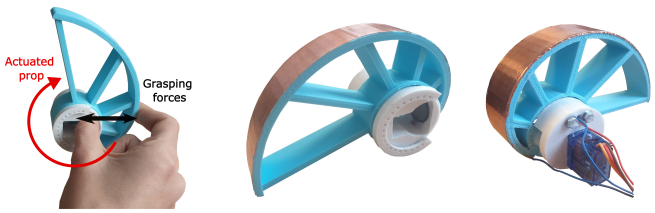

Fig. 1. The Snail is a wearable actuated prop that rotates around the thumb.

The prop is shaped like a snail to display different grasping sizes according to its orientation. It can also rotate under the fingertip when the prop is squeezed to simulate soft objects. The contact is detected by a capacitive sensor consisting of copper tape applied on the prop and $1M\Omega$ resistor. The force applied between the two fingers is measured with a resistive sensor at the thumb level (FSR 402 Interlink (min force: 0.2N, max force 15N) combined with a $10k\Omega$ resistor).

Compared to existing solutions, the forces are simulated by the prop and are tangential to the actuation forces. The Snail can then simulate convincing rigid objects with a small, low-power actuator, making the display portable. Direct actuation also allows for the simulation of soft objects. Finally, the Snail is mainly made of 3D-printed parts, so it is low-cost and easy to replicate.

II. The VR Scenario and Haptic Feedback

In the demonstration, users are immersed in a virtual scene with a VR headset and can manipulate different types of objects. These objects have various sizes, shapes, and softness to test the capability of the device (Fig. 2).

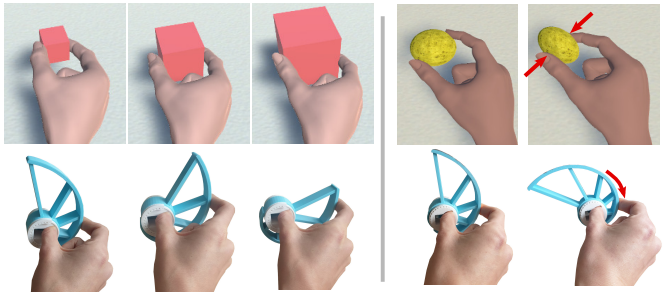

Fig. 2. The Snail can reproduce different grasping size and softness.

The user's hand is tracked with a tracking glove (Manus Glove) and represented by a virtual hand in VR. Users wear the Snail on the right thumb, and haptic feedback is displayed depending on the object being grasped.

A. Simulation of grasping sizes

Objects of different sizes, ranging from 1.5cm to 7cm, are displayed and can be grasped by the user. When users grasp an object, the prop rotates to display the right size before the index finger contacts the prop. The virtual object can then be moved in the virtual scene. When users release the prop, the object is released in the scene, and the prop returns to its minimal position.

B. Simulation of softness

Virtual objects displayed are either rigid (e.g., a stone) or soft (e.g., a sponge, a fruit). When users grasp and squeeze these objects, they deform visually between the fingers, and the Snail displays the corresponding level of haptic softness by rotating (e.g., 100N/cm for a stone and 7.5N/cm for a sponge).

For the users to judge the interest of the interface, the user can perform the task with the Snail feedback or without haptic feedback by switching mode using a controller in the left hand.

References

[1] J. Saint-Aubert, The Snail: A Wearable Actuated Prop to Simulate Grasp of Rigid and Soft Objects in Virtual Reality. IEEE Transactions on Haptics, 2025.