Encounter-Type Haptic Device Enabling Edges, Vertexes and Plane Palm Interaction: the Haptic Origami Device

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I. Introduction

Interactive tasks in virtual reality scenarios represent an open challenge when haptic stimuli to the palm is required [1], [2], [3]. In this work we introduce a device characterised by an origami structure providing diverse surfaces to render haptic cues on the palm. The device presents a static part, holding eight motors, and a mobile part, characterised by a 7-DoF platform posing and activating an origami-like structure, as shown in Fig. 1. The two parts are connected by eight articulated legs, which actuate the different shapes/configuration of the origami structure.

II. The Device

The presented device is composed of two main platforms connected by eight curved links, through Revolution-Universal-Universal (RUU) configuration, as shown in Fig. 1. The first platform, on the dorsal part of the hand, it is used to hold eight Hitec servomotors HS85MG and to secure the device on the user's hand. The mobile platform under the palm is passively jointed with 3-DoFs universal joints and it is characterised by a parallelogram frame holding an origami structure. The designed parallel configuration enables the frame to reconfigure the origami-like structure as shown in Fig. 2, in order to resemble a flat or an angular surface type. The device reaches seven degrees of freedom, allowing the moving platform to orient and pose to contact the palm, and to independently control the parallelogram configuration as in the figure. Given its number of actuators, the system results over-actuated, a compromise that allowed to us to set all the actuators on the supporting platform at the top of the hand.

III. Planned Experiments

Two types of scenarios are planned to test this device.

a) Wearable configuration: The device is worn on the user's dominant hand in this experiment. The user interacts with an invisible virtual object in a VR scenario. An active tracker detects when the user's hand reaches the object, causing the origami structure to transform into one of six shapes and touch the user's palm. When not in contact, the origami structure detaches. After the interaction, the user tries to identify the touched object from six shapes.

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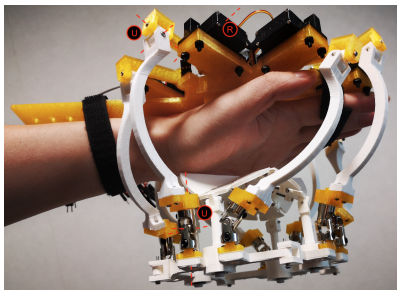

Fig. 1: The origami-like haptic device worn on user's hand.

b) Cobot configuration: In the second experiment, the device is mounted as an end-effector on a physical collaborative anthropomorphic robot. The user interacts with six visible virtual objects in a VR scenario. An active tracker follows the hand and indicates where to move the robot's end-effector ensuring contact with user's hand. When in position the origami structure takes the shape of the virtual object. When not in contact, the origami structure appears flat and detaches. After each interaction, the user rates the perceived similarity to the touched object on a scale from 0 to 7 (0 = "not at all", 7 = "totally").

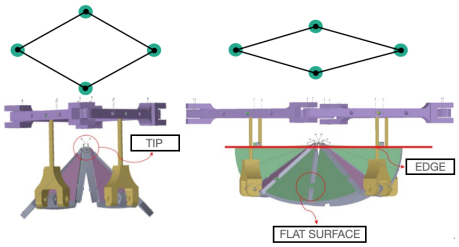

Fig. 2: Parallelogram structure and origami structure configuration.

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