Augmenting Mixed Reality Applications with the Vibro Motors Wearable

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Abstract

In this demo, we demonstrate the use of the mobile Vibro Motors Wearable device, and we explain how it can be used to enhance Mixed Reality applications with tactile human-machine hand interactions. The presented device is capable of providing tactile feedback while interacting with virtual objects, e.g., when elements of a 3D user interface are touched. The device enables to run vibro motors mounted on a user's fingers while interacting with synthetic objects. In order to control the vibe of a particular vibro motor in a wireless manner, we have developed an HTTP-based API. The API can be used to develop mobile-tactile Mixed Reality applications to enhance user experience by giving an impression of fading in/out effects when interacting with 3D objects. To show the device's capabilities, a 3D demo application has been developed in which a user can experience tactile feedback effects while interacting with a virtual object.

Index Terms: Hardware [Communication hardware, interfaces and storage]: Wireless devices—Sensors and actuators; Human-centered computing [Mixed / augmented reality]

1 Introduction

In spite of increasing development of Mixed Reality (MR) technologies – including software and hardware – there is still a lack of easy-to-use mobile solutions providing tactile human-machine hand interactions for MR applications. The mobile nature of MR applications imposes several design limitations on the tactile feedback we can apply [2]. Wearable devices providing tactile feedback should be lightweight, easy-to-use, and comfortable for a user. Moreover, a device should not limit the user's movements and his or her body degrees-of-freedom (DOFs) [1], e.g., by the use of wires supplying voltage. Furthermore, the design of such a wearable device should take into account small amounts of energy consumption in order to provide enduring haptic experiences. Such a device should be supplied with a small, rechargeable accumulator not crucially increasing the weight of the device.

2 Vibro Motors Wearable (VMW)

We have developed a wearable device haptic device – Vibro Motors Wearable (VMW). The presented device can enhance mobile MR applications with tactile human-machine hand interactions by vibrating a particular motor with various level of voltage. For instance, the device enables to design fading in/out effects in case the user increasingly penetrates the shape of a virtual object using fingers. Also, it is possible to implement short and straightforward tactile feedback when touching elements of a 3D user interface, e.g., a 3D button, to confirm the user that a virtual object has been successfully pressed in 3D space.

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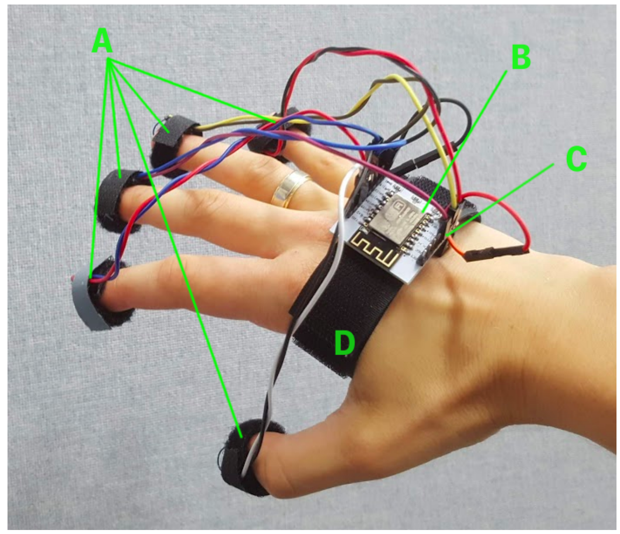


Figure 1: The prototype Vibro Motors Wearable hardware consisting of: (A) five vibro motors mounted on a user's fingers; (B) an ESP8266 microcontroller serving as an asynchronous server that provides API for controlling voltage of each sensor; (C) a LI-ION rechargeable battery; (D) regulating velcro strip.

The VMW device consists of five vibro motors connected to the device's board, each mounted on a user's fingers (Fig. 1A). An ESP8266 microcontroller serves as an asynchronous server providing an HTTP-based API for controlling voltage of each sensor (Fig. 1B). Furthermore, a lithium-ion battery supplies voltage to the device (Fig. 1C). Finally, a regulating velcro strip is used with the mounted ESP8266 board in order to make it easy to put the device on the user's hand (Fig. 1D).

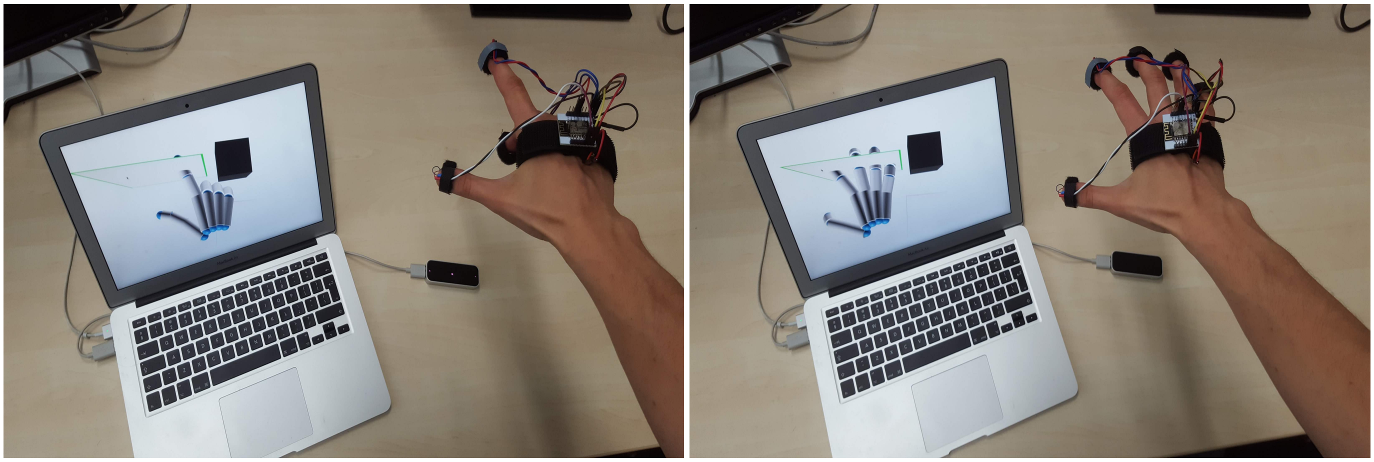
The device is lightweight and easy-to-wear on a hand. It does not limit the user's hand movements. It is supplied with a small, rechargeable LI-ION battery. Alternatively, it can be connected to the 3.3V power supply with wires.

In order to control the vibe of a particular vibro motor in a wireless manner, we have developed a simple-to-use HTTP-based API. For instance, to run a vibro motor with 3.3V mounted on an index finger, an AR or VR application should call HTTP GET method with the following command:

http://device-ip-address/motor?finger=index&voltage=3.3

where:

- *device-ip-address* – is an IP address of a Vibro Motors Wearable device;
- *finger* – is a parameter that expresses which vibro motor should be run (possible values are: thumb, index, middle, ring, and pinky);
- *voltage* – is a parameter that indicates which voltage should be supplied from the range [0, 3.3].



(a) (b)

Figure 2: Interacting with a virtual object. In Figure (a) the user experiences tactile feedback only on the index finger while Figure (b) presents tactile feedback differentiating for each finger.

3 Demo

To show the device's capabilities, a 3D demo application has been developed in which a user can experience tactile feedback while interacting with virtual objects. To track a hand and motions of fingers, a Leap Motion device has been used. The application tracks position of a hand and fingers in 3D space which consists of two virtual objects. When a particular finger intersects on of the virtual objects, the application sends an asynchronous HTTP GET request to run a vibro motor (Fig. 2a). The further the boundary of a virtual object is penetrated, the more requests are dynamically sent to increase the voltage of a particular vibro motor giving the user an impression of the 'fade in' effect (Fig. 2b). Vice versa, when the user moves their hand back, the device decreases the voltage giving the user an impression of a 'fade out' effect.

The presented application also allows moving virtual objects in a 3D space. This function gives a user possibility to test that implemented tactile feedback is not fixed, but is dependent on the position of virtual objects.

4 Uniqueness

For the first time, the device will be presented as part of a demonstration of ISMAR 2018 demo session. The device has been designed during the internship at TUM under Prof. Gudrun Klinker supervision. The device provides an easy-to-use API that can be used to build mobile AR and VR applications. The presented demo application demonstrates fade in/out tactile feedback that can be easily adapted to MR applications.

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