Integrated Wireless and Wearable Haptics System for Virtual Interaction

Andualem Tadesse Maereg, David Reid, Atulya Nagar & Emanuele Lindo Secco
Robotics Laboratory, Department of Mathematics & Computer Science, Liverpool Hope University, Hope Park, Liverpool, UK
15010333@hope.ac.uk, reidd@hope.ac.uk, nagara@hope.ac.uk, seccoe@hope.ac.uk

Abstract. This demonstration introduces a simple, cost effective approach which provides wireless and wearable haptic feedback for the interaction in a customized Virtual environments. The setup consists of 5 vibrotactile ERM actuators, providing multi-finger haptic sensation, and a Virtual Reality environment, tailored in Unity 3D, which is combined with Oculus Rift Head Mounted Display and Leap Motion controller. The Head Mounted Display allows the user to be immersed within the virtual environment, while Leap Motion integration with Oculus Rift make the user able to naturally interact with the objects within the virtual environment by his/her hands motion. Interaction with the virtual objects and sense of immersion are enhanced by returning real-time touch feedback on user fingertips. Touching sensation will be modulated through 5 different vibration based on virtual dynamics occurring between the immersed hands of the user and the interacting objects, namely the Virtual impact forces and collision impulses. The overall haptic architecture (i.e. 5 ERM actuators and controllers, processing and communication module, power unit) consists of a wearable unit, which is embedded on the right wrist of the user. Real-time data processing and communication is performed through wireless IEEE 802.15 communication protocol.

Keywords: Virtual Reality · Virtual Dynamics · Oculus Rift · Leap Motion · Vibrotactile Haptics· Wearable

1 Introduction

Virtual Reality (VR) technology is incredibly growing and making experiences more immersive throughout sensory information that make the user feeling "inside" the virtual environment. Different sensorial channels, such as the visual, auditory and tactile ones, can be stimulated for this purpose [1]. To attain real time interaction, VR systems must also be able to manipulate inputs from the real world and continuously and naturally feedback those stimulus within the VR environment.

Human sense of touch is a combination of various different receptors, which can easily recognize texture, geometry, hardness, temperature and weight of the objects. Sense of touch, in a kinesthetic and cutaneous feedback, is a fusion of all these sensations, which makes it hard to achieve a full touch simulation using haptic devices [2].

Vibrotactile haptic cues have been broadly used in this context for different applications. Here, we explore different modulation technique of vibrotactile cues in order to increase immersion of the user in a customized VR environment [3, 4]: amplitude, frequency modulation and scaling based on the impact force during interaction with virtual objects will be experimented, based on the dynamics occurring between the immersed

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hands of the user and the interacting objects, namely the virtual impact forces and collision impulses.

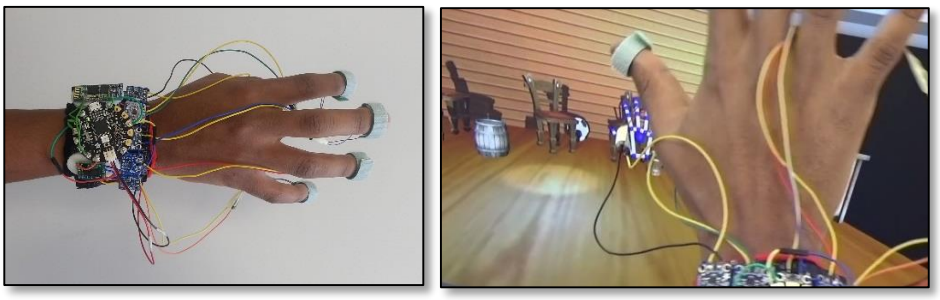

Figure 1 – The Wearable Haptic System (left panel) and Unity 3D VR interface (right panel)

2 Demo

The haptic architecture is made of 5 ERM vibrotactile actuators (Precison Microdrives, 310-113) and their respective haptic controllers (Adafruit, DRV2605). An overall controller integrates wireless IEEE 802.15 communication module (Bluetooth RF Transceiver HC-06) and the microcontroller (Adafruit Flora) handling the logic and PC communication. ERM actuators are miniature DC motors with an offset mass attached to their shaft. DRV2605 is controlled over I2C, using TCA9548A 1-to–8 multiplexer on I2C address from 0x70 to 0x77. This chip enables us to control up to 8 same address DRV2605 driver connected to the same I2C port. The multiplexer put the commands form the microcontroller to the selected motor driver. The microcontroller has a function of choosing the correct motor driver and desired waveform type according to the finger type used to interact in virtual environment. The used virtual environment has been customized in Unity 5.3 with built-in VR support, Leap motion assets and Oculus SDK 0.8.

3 Video links

- Short video (30 s) - www.youtube.com/watch?v=8l4YgWFZv_U
- Full video (~ 2 min 30 s) - www.youtube.com/watch?v=617qeYd_564

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