Somabotics Toolkit for Rapid Prototyping Human-Robot Interaction Experiences using Wearable Haptics

Feng Zhou[1], Dominic Price[1], Claudio Pacchierotti[2] and Ayse Kucukyilmaz[1]

I. Introduction

This work-in-progress paper presents a prototyping toolkit developed to design haptic interaction experiences. With developments in wearable and sensor technologies, new opportunities arise everyday to create rich haptic interaction experiences acting on our bodies. However, despite the growing number and forms of smart materials and devices at our disposal, many come with ad-hoc programming interfaces and APIs, which makes it challenging for a designer with little programming and hardware experience to integrate them into a single experience.

Windlin et al. have developed Soma Bits [1], which consist of soft materials and a series of actuators to be attached on the body. The Soma Bits allow rapid prototyping to create "somaesthetic" interactions [2], with the hindsight that the control of the actuators is not precise. Furthermore, the kit is limited to the selected actuators, with little room for extending it when new devices are available. Our work is inspired by the Soma Bits kit, with an aim to extend its use to applications of human-robot interaction and enrich interactive strategies that can be provided by robots.

II. Development of the SomaboticsToolkit

We developed a software toolkit named *Somabotics*, which allows the integration of not only actuators but also sensors that can be interfaced with the design environment, which consist of humans, robots, and the space they interact within.

Somabotics is a modular system, that can enable the communication between any type of sensing and actuation device. Somabotics features include: (1) an easy-to-use graphical user interface that can be used by non-programmers; (2) seamless extensibility to a range of devices through the utilization of Robot Operating System (ROS) [3] and modularized hardware design; (3) ability to develop complex actuation sequences via on-off button values (BVs) and continuous mapping function values (MVs); (4) ability to actuate sensations manually or adaptive to sensor readings.

Somabotics uses Robot Operating System (ROS) middleware to interact with existing sensor and actuator hardware. Somabotics is developed with a modular design allows easy system adaptation, and the ROS-based interface ensures simple communication with any sensor and actuator in the design ecosystem. ROS provides an abstraction layer to hardware resources (i.e. sensor and actuators) and transfers physical data between hardware nodes using ROS message types (std_msgs). A simple ROS wrapper is the only requirement to integrate a new sensor or a new actuator to be used with Somabotics.

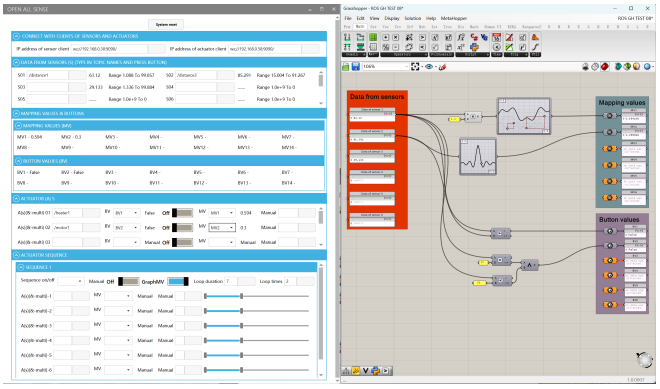

Fig. 1. Somaboticsgraphical user interface.

Figure 1 shows the two user interface windows of Somabotics. The interface consists of a menu window and a design window based on Grasshopper, which is widely used in parametric design for its user-friendly interface and component-based programming [4]. The menu window is used to set the topic names where messages are published over, and is used to define connections between sensor and actuator clients. The design window shows a Grasshopper canvas for value conversion, i.e., how to map values from sensors to set actuation values for specific actuators set in the menu window.

Somabotics is currently being tested for a number of sensors (pressure, distance, capacitative, etc.) and actuators (heat, vibrations, audio, etc.) and will be soon tested in a design workshop for usability.

*This research is supported by EPSRC under grant reference number EP/V00784X/1: TAS-Hub and EP/T022493/1: Horizon.

[1]F.Z., D.P and A.K. are with the University of Nottingham, United Kingdom. e-mail:feng.zhou, dominic.price, ayse.kucukyilmaz@nottingham.ac.uk

[2]C.P is with CNRS, Univ Rennes, Inria, IRISA, France e-mail: claudio.pacchierotti@irisa.fr.

References

[1] C. Windlin, A. Ståhl, P. Sanches, V. Tsaknaki, P. Karpashevich, M. Balaam, and K. Höök, "Soma bits-mediating technology to orchestrate bodily experiences," in *RTD 2019-Research through Design Conference 2019, the Science Centre, Delft, on 19th to 22nd March 2019.*, 2019.

[2] W. Lee, Y.-k. Lim, and R. Shusterman, "Practicing somaesthetics: exploring its impact on interactive product design ideation," in *Conference on Designing Interactive Systems*, 2014, pp. 1055–1064.

[3] M. Quigley, K. Conley, B. Gerkey, J. Faust, T. Foote, J. Leibs, R. Wheeler, A. Y. Ng *et al.*, "Ros: an open-source robot operating system," in *ICRA workshop on open source software*, vol. 3, no. 3.2. Kobe, Japan, 2009, p. 5.

[4] A. Leitão, L. Santos, and J. Lopes, "Programming languages for generative design: a comparative study," *International Journal of Architectural Computing*, vol. 10, no. 1, pp. 139–162, 2012.