Tactile Internet to Share VR users' Experiences

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ABSTRACT

We propose the concept of "*Tactile Internet*" (*Tac-I*) that will be the next evolution of the Internet of Things (IoT). It enables sharing experiences of others with the sense of touch. In our case, *Tac-I* allows to multicast vibrotactile sensations from one node to multiple nodes via Internet. We developed vibrotactile shared devices which are physical bracelets connected between them through Cloud platform. We use the WebRTC as communication protocol to exchange data between tactile bracelets. Users can access *Tac-I* Web using a smartphone or Tablet and experience the vibrotactile sensation by manipulating virtual objects in a virtual reality environment from a Web browser. Multiple vibrotactile bracelets would be connected to the Cloud and transmit the tactile information from one node to another one or to multiple ones.

CCS CONCEPTS

• **Computer graphics**; • **Virtual reality, [Interaction paradigms]: Virtual reality, Mixed/augmented reality, [Human computer interaction (HCI)]: Interaction devices — Haptic devices.**;

KEYWORDS

Haptics, Internet of Things, Virtual reality

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1 INTRODUCTION

In the last decade, VR (Virtual Reality) technology evolution and the spread of smartphones and tablets enable to share experiences of individuals with others by using social networks. Among these experiences, it is interesting to convey the feeling and presence in the individual's body. This became feasible by enjoying the advance of the haptic technology which enables us to playback tactile experiences [Benbelkacem et al. 2018], [Maeda et al. 2017], [Matsuzono et al. 2017]. In the future, Internet 5G is targeted to allow the mainstream tactile Internet applications to share, anywhere and anytime, real time tactile experiences with remote users [Aijaz et al. 2017]. To fit into this dynamic, we, therefore, propose the concept of the *Tactile Internet* (*Tac-I*) which connects tactile nodes that measure and display tactile information via Cloud. Tac-I is composed principally of tactile bracelets and *Tac-I* Cloud. In our case, we consider tactile bracelets as physical nodes that can perform as gateways to exchange tactile information between humans' hands.

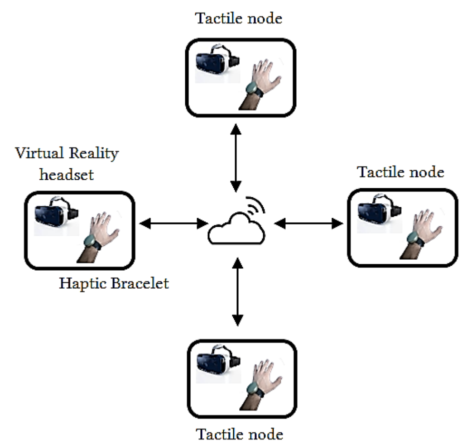

Figure 1: Concept of the Tactile Internet.

The *Tac-I Cloud* connects multiple haptic bracelets and manages the transmission of tactile information from one node to multiple nodes as well as one to one mutual connection (Figure 1). Thus, *Tac-I* enables us to share our experiences with the sense of touch.

2 HARDWARE DESIGN

The hardware concept of our haptic bracelet is lightweight and low cost. It is composed of eight tactors (vibrotactile actuators) homogenously distributed through the bracelet (Figure 2). The eight tactors are managed by an embedded control unit.

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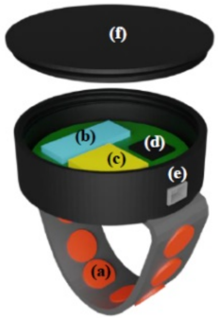

Figure 2: Exploded view of our haptic bracelet (some colors are changed for better view). Tactor (a). Communication module (b). Battery (c). STM32 micro-controller (d). charger plugin (e). Cover (f).

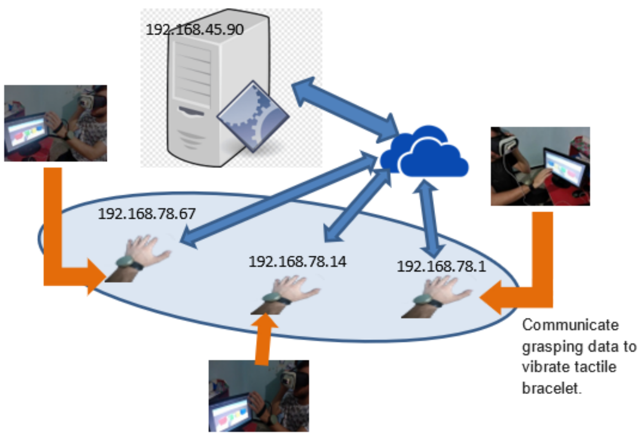

Figure 3: Network architecture design.

Communication module was used to transfer data from and to the bracelet with different VR devices. Also, this module is targeted to send data to another bracelet. The tactors are controlled with an STM32 micro-controller with a digital to analog converter (DAC) of 12 bits resolution. This configuration is used to generate variable intensity and duration of tactile vibrations.

3 NETWORK ARCHITECTURE DESIGN

Each node integrates a haptic bracelet. The nodes could be connected through *Tac-I Cloud* platform which allows multicast or single-cast transmission of tactile information using WebRTC protocol. As shown in Figure 3, users access *Tac-I Web interface* using PC. When users connect with their haptic bracelets to the *Tac-I Cloud*, IPv4 or IPv6 addresses are allocated to each node and automatically registered with the session ID in the Signaling Server. One user or several users could feel tactile sensation by selecting one or more nodes that they want to connect with.

Figure 4: An application of Tactile Internet including two participants.

4 USER EXPERIENCE

With the proposed tactile bracelet and *Tac-I Cloud*, the users could share their vibro-tactile experiences in addition to their visual sensation. To demonstrate the immersive experience of the proposed bracelet, we investigate VR tasks performed by two participants. Each participant wears a VR HMD device and view a VR environment (Figure 4) composed of four colored cubes (blue, yellow, green and pink).

Leap motion, associated to each participant, captures and then tracks, in real time, the movement of their hands (right hand for the first participant and left hand for the second participant) and apply the same movement on their corresponding virtual hands. Each participant holds the tactile bracelet and then grasp one cube for each time.

The first user is asked to grasp the yellow cube. Once the task is successfully realized, his/her haptic bracelet vibrates. The vibration data is then sent to the second user's bracelet, asking him to grasp one of the three free cubes (blue, green and pink) since the yellow cube was already grasped by the first user. This procedure continues until all the cubes are grasped.

During the tests, participants enjoyed the simplicity and the comfort of tactile bracelets, when communicating grasping tasks in VR shared experiences.

5 CONCLUSION AND FUTURE WORK

We proposed the concept of the "*Tactile Internet*" and developed the tactile bracelet as a physical node that can transmit tactile information to another node or to multiple nodes. The tactile information was applied on users' hand. We think that the proposed concept could be applied to various application and can contribute to enhancement of the VR technology.

For future work, we intend to improve the proposed bracelet to be able to communicate temperature and pressure information, so that we can more realistically share experiences of users immersed in VR environments.

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