Demo of interactions between a performer playing a Smart Mandolin and audience members using Musical Haptic Wearables

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ABSTRACT

This demo will showcase technologically mediated interactions between a performer playing a smart musical instrument (SMIs) and audience members using Musical Haptic Wearables (MHWs). Smart Instruments are a family of musical instruments characterized by embedded computational intelligence, wireless connectivity, an embedded sound delivery system, and an onboard system for feedback to the player. They offer direct point-to-point communication between each other and other portable sensor-enabled devices connected to local networks and to the Internet. MHWs are wearable devices for audience members, which encompass haptic stimulation, gesture tracking, and wireless connectivity features. This demo will present an architecture enabling the multidirectional creative communication between a performer playing a Smart Mandolin and audience members using armband-based MHWs.

Author Keywords

Smart Instruments, Musical Haptic Wearables, Internet of Musical Things

CCS Concepts

•**Applied computing** → **Sound and music computing;** •**Human-centered computing** → *Human computer interaction (HCI);* •**Networks** → Sensor networks;

1. INTRODUCTION

This demo will showcase an architecture supporting novel forms of interactions between live music performers and audience members. Such interactions are enabled by the multidirectional communication between smart musical instruments (SMIs) and Musical Haptic Wearables (MHWs).

SMIs are a family of musical instruments characterized by embedded computational intelligence, wireless connectivity, an embedded sound delivery system, and an onboard system for feedback to the player [10]. They offer direct point-to-point communication between each other and other portable sensor-enabled devices connected to local networks and to the Internet. An example of devices that can be connected to SMIs are the MHWs proposed in [8].

MHWs are a novel class of wearable devices for audience members, which encompass haptic stimulation, gesture tracking, and wireless connectivity features. MHWs were devised to enrich musical experiences by leveraging the sense of touch as well as providing new capabilities for creative participation. Their conception was grounded on the findings of research in the field of haptic technologies developed for musical applications (see e.g., [1, 2, 5]) and of participatory live music performances (see e.g., [11]).

SMIs and MHWs are components of an ecosystem of interoperable musical devices that has been recently termed as "Internet of Musical Things" (IoMusT) [9]. Such an ecosystem can support novel forms of interactions between live music performers and audience members.

2. THE DEMO

This demo will present an architecture enabling the multidirectional creative communication between a performer playing a prototype of SMIs, the Smart Mandolin, and audience members using a prototype of MHWs based on an armband.

The Smart Mandolin (see Figure 1) is an exemplar of smart musical instrument, which is based on a previous prototype belonging to the family of augmented instruments [4], the Hyper-Mandolin reported in [7]. It consists of the enhancement of a familiar acoustic mandolin with a contact microphone, sensors, actuators, the Bela board for low-latency audio processing [3], an embedded loudspeaker, Wi-Fi, and a lightweight power supply. Software-wise, a Pure Data application was coded to processes with effects the sound captured by the microphone, generate sounds from synthesizers and samplers, extract audio features, and map the interactions of the player with the sensors to sound parameters.

Four instances of an armband-based MHW were developed (see Figure 2). These devices feature various hardware components also present in the Smart Mandolin as well as two actuators and two push buttons. A dedicated Pure Data application synthesizes tactile stimuli by means of Pulse Width Modulation techniques.

The Smart Mandolin and the MHWs are connected to a local wireless network by means of a router (featuring the IEEE 802.11.ac standard over the 5GHz band). Interoperability between the two devices is achieved with Open Sound Control messages over UDP. Figure 3 shows a schematic representation of the interactions between the Smart Mandolin player and the audience members, which are enabled by the developed architecture.

The Smart Mandolin is configured to extract in real-time from the acoustic signal captured by the microphone, the

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NIME'18, June 3-6, 2018, Blacksburg, Virginia, USA.

strums performed on the strings, thanks to an onset detection algorithm [6]. The timing and amplitude of those strums having an amplitude above a certain threshold are sent synchronously and simultaneously to the four MHWs. This information is mapped to vibrations of amplitude and duration proportional to the detected strum.

To create participatory interactions, the two buttons present in the MHWs may be used by an audience member to deliver to the Smart Mandolin player messages capable of triggering backing tracks. The selected backing tracks are then delivered by the instrument's integrated loudspeaker.

During the demo we will first illustrate the Smart Mandolin prototype. Secondly we will provide attendees with the developed prototypes of MHWs. Thirdly we will showcase the interactions described above.

Videos of the Smart Mandolin and of the of the developed MHWs are available at `www.iomut.eu/video.html`.

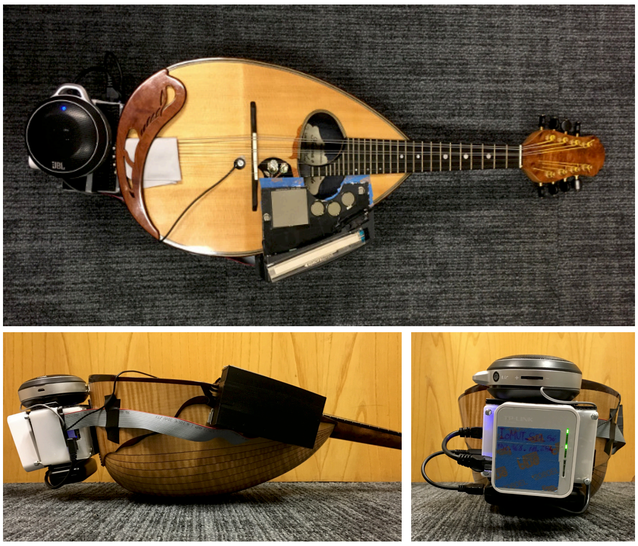

Figure 1: The developed Smart Mandolin.

Figure 2: The developed armband-based MHW.

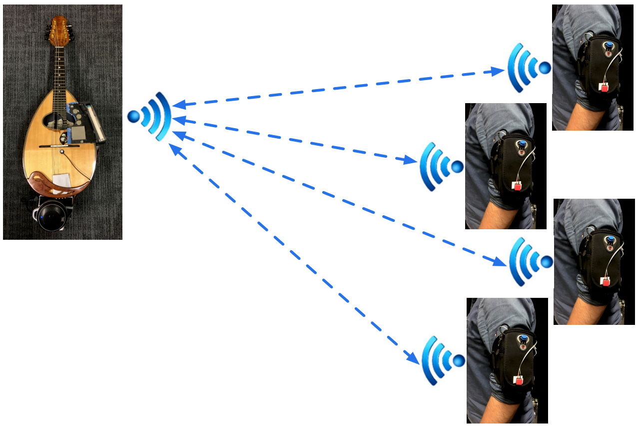

Figure 3: Schematic representation of the architecture connecting the Smart Mandolin to armband-based MHWs.

3. ACKNOWLEDGMENTS

The work of Luca Turchet is supported by a Marie-Curie Individual fellowship from the European Union's Horizon 2020 research and innovation programme, under grant agreement No. 749561. Mathieu Barthet also acknowledges support from the EU H2020 Audio Commons grant (688382).

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