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An Internet of Musical Things architecture for performers-audience tactile interactions

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***Abstract*— This paper presents an architecture supporting novel forms of tactile interactions between live music performers and audience members. Such interactions are enabled by the multidirectional communication between Smart Musical Instruments and Smart Musical Haptic Wearables.**

I. INTRODUCTION

Smart Musical Instruments (SMI) are a novel 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 [1]. 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 SMI are the Smart Musical Haptic Wearables (SMHWs) [2]. This is a novel class of wearable devices for audience members, which encompass haptic stimulation, gesture tracking, and wireless connectivity features.

SMI and SMHWs are components of an ecosystem of interoperable musical devices that has been recently termed as "Internet of Musical Things" (IoMusT) [3]. Such an ecosystem can support novel forms of interactions between live music performers and audience members. This study presents an architecture enabling the multidirectional creative communication between performers playing SMI and audience members using SMHWs.

II. IOMUST ARCHITECTURE AND SUPPORTED INTERACTIONS

We designed a Smart Mandolin and a Smart Cajòn (Fig. 1), which enhance the acoustic instruments with contact microphones, sensors, actuators, the Bela board for low-latency audio processing, an embedded loudspeaker, Wi-Fi, and a lightweight power supply. At software level these instruments run an audio engine written in Pure Data (PD) that processes with effects the sound captured by the microphones, generates sounds from synthesizers and samplers, extract audio features, and maps the interactions of the player with the sensors to sound parameters.

We also designed four prototypes of an armband-based SMHW (Fig. 1), with hardware components similar to the SMIs as well as actuators and push buttons. A dedicated software synthesized tactile stimuli by means of Pulse Width Modulation.

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SMIs and SMHWs were connected to a local wireless network by means of a router (IEEE 802.11.ac standard over the 5GHz band). Interoperability between devices was achieved with Open Sound Control messages over UDP.

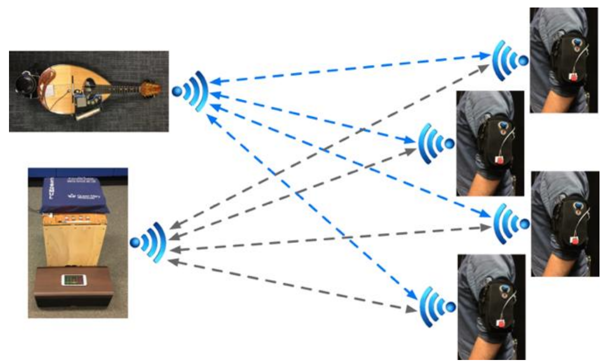

Figure 1. The developed IoMusT architecture.

The onset of hits and strums above an amplitude threshold are extracted in real-time from acoustic signals captured by the microphones. This information was sent to the four SMHWs and mapped to a strong and short vibration so that audience members can experience a tactile stimulation in correspondence of strongest hits and strums. To create participatory interactions, the SMHWs buttons can be used by an audience to deliver to the SMI players tactile vibrations conveying four directions: start/stop playing (continuous vibration of 2 seconds), play faster/slower (intermittent pulses of increasing/decreasing intensity in 5 seconds).

III. CONCLUSIONS

Results of the technical validation of the architecture proved to be stable and reliable in supporting the described interactions. Preliminary perceptual tests show that the latency between sounds and vibrations is perceived as negligible by audience members, as well as that performers correctly react to the tactile directions.

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