Possibilities Emerging on the Trajectory from IoT to IoMusT: Enabling Ubiquitous Musical Interactions for Wellbeing

Azeema Yaseen^{1,*}, Joseph Timoney¹

¹Maynooth University, Co. Kildare, Ireland

Abstract

The Internet of Musical Things (IoMusT) and ubiquitous music (ubimus) are interrelated research fields concerned with the design and development of advanced technology to support novel musical and artistic experiences. IoMusT primarily motivates the deployment of embedded computing devices and platforms for musically oriented individual or collaborative activities. Ubimus schemes are musically driven while keeping the participating agents and entities (such as tablets or computers), interfaces (hardware, or software), interaction metaphors (visual, tactile, or gestural), and instruments (traditional or novel) not necessarily complex. It also encourages the design of new musical interactions for participants with little know-how of the musical domain. Within the context of initiatives embracing the internet of things (IoT) for healthcare, alongside remodeling IoT devices for IoMusT interactions, this paper considers the area of ubiquitous musical interaction design for music therapies, offering an example application. This convergence, with the appropriate technologies, could enable new opportunities for the promotion of wellbeing, both individually and collectively, in-person and remotely.

Keywords

Internet of Things (IoT), Internet of Musical Things (IoMusT), Ubiquitous music (ubimus), Wellbeing, Music Therapy

1. Introduction

The Internet of Musical Things is a confluence of cross disciplinary fields including music technology, the internet of things, human-computer interaction, and artificial intelligence applied to musical contexts. As a technological perspective, the IoMusT ecosystem is composed of three core components: i) musical things, ii) connectivity and iii) applications and services. In the IoMusT network, musical things are computing devices of any form such as wearables, computers, and tablets dedicated to the production and/or reception of musical content. Musical information is data detected and processed by a musical thing and is sent to a human or another musical thing across a network [1]. IoMusT scenarios offer possibilities to support remote musical experiences and interactions between users involved in a musical activity. These interactions are also supported by the direct interconnection of interoperable musical instruments. Smart musical instruments (SMIs) are a subpart of IoMusT applications. SMIs are

- D 0000-0002-4652-0875 (A. Yaseen); 0000-0001-5822-4742 (J. Timoney)
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[🛆] azeema.yaseen.2020@mumail.ie (A. Yaseen); joseph.timoney@mu.ie (J. Timoney)

embedded with sensors and actuators, and are able to perform intelligent operations allowing connectivity to both local networks and the web. On the other hand, the growth of IoT has facilitated many proposals for healthcare technologies that should provide better life quality. The main purpose of this paper is to discuss the integration of IoMusT, ubimus, and IoT paradigms, to present a framework, and to discuss a simple application. The potential of this area is for applications that could be quickly successful in supporting new creative therapies that could simultaneously help both the musically experienced and inexperienced. We commence with a brief review of music technology enabled therapies for wellbeing and then mention some of the established contributions by ubimus regarding everyday devices for music making. IoMusT would be the glue that joins them together.

2. Related Work for Motivation

2.1. Wellbeing and its Relationship to Music Therapy

Wellbeing is broader than just the absence of a disease in human body. It brings psychological, social, and spiritual health along with physical health. Music has been widely used for therapies improving resilience and building confidence to deal with various scenarios of anxiety and stress. Recently [2] used beat-making technologies for improvisation during music therapy. The Ableton Push 2, a Roland TR-8 drum machine and audio interface were used for the sessions. These MIDI-Linked devices were set up to play and control presets at a synchronized tempo. Improvisation is an even freer form of music therapy where users are deeply involved in spontaneous music creation using different instruments, tools, or technologies.

2.2. Ubimus and its Implementation

Ubimus believes that music is universal, and everyone has the potential to create sounds that are musical. It started in 2007 and affords new metaphors for creative actions (e.g., soundsphere [3]), interaction modalities (gesture, touch, visualization) and everyday devices to create musical content. Ubimus research involves performing participants, material resources and extends musical activities by means of creativity supported systems. An example is Playsound.space, a web-based tool that searches the sounds of Freesound.org, that can then be dragged and dropped into a mixing window for free improvisation and experimental music production. In [4], a hand metaphor (Handy hear and Handy see) was developed to enable camera-based touchless sonic interactions mapped through gesture recognition for modifying pitch, amplitude, and /or duration. Using these metaphors even a lay person can interact with it. Ryan Monro designed Bloomish [5] as a web-based interface implemented in JavaScript to generate tones and melodies by just screen tapping. The pitch gets higher from bottom to top in the given space. It allows improvisation, or presets can be played based on user selection.

2.3. Relationship to IoMusT

IoMusT uses Wireless Sensor Networks (WSNs), IoT, and Tactile Internet (TI) as background communication technologies. These technologies enable the development of SMIs. SMIs cross

boundaries of traditional music settings and venues such as studios and stages due to embedded technologies for sound production and processing [6]. The smart guitar and smart mandolin are two examples of SMIs for ubimus remote interactions. The embedded instruments give flexibility to deliver sonic interaction using hardware (instrument) and software. The real benefit of IoMusT is the built-in assumption of networked interaction. Such systems can be connected via local area networks (LAN), wide area networks (WAN), or WSNs. It gives freedom in choices of collaborations as well as experiences. A known example of a networked music performance (NMP) system is Reactable [7]. It consists of a touchable table interface which allows users to control musical output when objects are moved on the surface. Musicians can participant from different locations to collaborate with each other.

3. Ubimus Driven IoT and IoMusT: An Application for Active Music Therapies

Figure 1 highlights where IoT and IoMusT can share the same devices and computing resources for healthcare and music making together. To let cross modal devices and sensors communicate for such applications, protocols and communication standards for wireless data collection, processing and transmission are required as a common language. For example, electromyography sensor (EMG) measures small electrical signals generated by human muscles as they are moved. This includes lifting an arm up, clenching a fist, or gestures like moving a finger.

With IoT-based monitoring devices designed in form of bands or headsets that observe physiological data, the next stage of IoMusT is to give meaning to this data. Thus, the data is analyzed to detect an artistic intention that reflects some emotion. This data is sent to a musical interface that configures the smart instrument presets or music sound repositories based on the users' requirement. The physiological data can be mapped to various music parameters such as pitch, timbre, or volume. In active music therapy, users create melodies or improvise, and this process is continuous. Designing interfaces for such interactions is a challenging task. The prediction of human musical activity can also inform the interface configurations to offer more customized resources, but it is also difficult. To accommodate an "active" role of music, the user would perform gestures that are simpler as the interaction begins. In the therapeutic scenario, the configuration of movement-musical events would partially depend on the user but the system would take responsibility for constraining the user to a selection of musical objects on the interface that are specifically designed for IoMusT. If the initial interaction is based on the triggering of musical events when two arms are moved, the user would have the control to add more such mappings between their movements and the music objects as the interaction evolves. It might be too optimistic to say at this stage, but use of artificial intelligence for human-centered interfaces presented in [8] suggests a direction towards musical interfaces that adapt to user scenarios. Though, the designer must ultimately draw a line between how much control users have and where the system comes forward. Achieving the correct balance is crucial for such applications.



Figure 1: IoT enabled emotion detection and IoMusT based musical interactions in therapeutic context.

3.1. Short Description about Work in Progress and Future Steps

In our ongoing project we are working on interaction modalities for musical interaction including color-based metaphors for amateurs and gesture-based musical interactions using computer vision techniques. The aim is to design and develop low-cost, easy-to-use, and available technologies for music making and defining new applications based on these systems as an application to the field of IoMusT. Currently, sensing of the heart rate and galvanic skin response as shown in figure 2 (b) are used for a low fidelity prototype design of a wrist band (see figure 2 (a)) that triggers music based on the Solfeggio note frequencies for body and mind health. These Solfeggio tones are known as sound healing modalities for various mental, emotional, and physical ailments [9]. During an investigation across the multitude of soothing possibilities, we experimented with a vibration motor to give tactile feedback to users on their wrist as rhythmic vibrations. In the activity, the prototype was ascertained to operate as was intended, and the output responses were expected for particular inputs. The alignment of movements along with IoMusT based musical interactions require mapping between these two domains, and in the current prototype the selected solfege tones are independent of the user's control, as it was simply a rhythmic presentation of the sounds and the vibrations that were delivered. Thus, this prototype is an example of a passive approach to music therapy. The long-term goal however is to extend it for active therapies by giving the users more control over the devices.



Figure 2: Initial design of band (a) equipped with sensors (b) to provide music with soothing frequencies.

4. Conclusion

The short paper has introduced a music-based rhythmic vibration device that responds to a users' stress level. It embraces the concepts and ideas of using IoT (the sensors), ubimus (the ease of use), and IoMusT (the musical responsiveness) together in the context of health and wellbeing. This proposed framework is a work in progress and the mapping of movements to music, inclusion of interaction over the network and user testing are the next tasks.

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