Exploiting Mimetic Theory for Instrument Design

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ABSTRACT

This paper will present a first instrument and discuss its design method, derived from principles informed by mimetic theories. The purpose of these design principles is to create new and innovative digital music instruments.

Even though mimetic theories are known to be important in the communication, engagement and expression of music performance, this ongoing enquiry represents the first consolidated effort to develop design principles from mimetic theories. [1], [2]

As part of the project, a development cycle is being followed to produce, evaluate and improve the design principles, and as part of this paper, a first prototype will be presented.

This paper covers a short description of the first prototype, describes the design process towards developing some generically applicable design principles and covers some of the underlying theories around empathy, communicative musicality and mimetic participation.

1. INTRODUCTION

This paper presents first outcomes and an initial prototype instrument, produced as part of a project that aims to develop instrument design principles informed by theories of communication and perception collectively referred to (in this paper), as mimetic theories. These theories include inter-modal perception [3], empathy [1], [2], [4], communicative musicality [1] and mimetic participation [2].

Existing digital music instrument (DMI) design theories have also been taken into consideration, looking at gesture [5], instrument efficiency [6], inevitability [7], affordances[8], [9] and Human Computer Interaction (HCI) [10], [11].

The first prototype was designed by applying these mimetic theories to the existing DMI theories, guiding the choice of features, instrument shape, materials and mapping of controls to synth parameters. We began with the premise that if design principles were to be developed that took mimetic theories into consideration the production of instruments following these principles should ideally improve what Trevarthen & Malloch have coined as communicative musicality [1] of the instrument (see chapter below). Thus an effective mimetic instrument should be successfully employed/exploited in therapeutic, community music and/or performance/audience contexts.

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2. PROTOTYPE DEVELOPMENT

Figure 1. Prototype 1.

The first prototype (Figure 1, the first of three so far) was developed to explore the initial premise of these principles. All prototypes have some basic features that can be found in many gesture-based instruments and that allow simultaneous control of independent parameters. Basic features include a range of sensors to accommodate the independent manipulation of several controls simultaneously, as well as controlling the initiation, length and pitch of the notes. The integration of physical body/movement gestures rather than limiting gestures by using knobs, button and faders, allows a full range of small, medium and large gestures creating a much wider range of gestural movement to control the sounds.

The first design (Figure 1) was based around the guitar. A version of Delalande's classification of gesture [12], modified by applying mimetic principles, has been used to develop the gestural elements of the prototype:

2.1 Initial Gesture

Initial gestures begin the sound wave transient, and are quite often percussive. With an acoustic instrument's sound this transient is often important for the recognition of the timbre [13]. Daniel Levitin gives this description, "The gesture our body makes in order to create sound from an instrument has an important influence on the sound the instrument makes. But most of that dies away after the first few seconds. Nearly all of the gestures we make to produce a sound are impulsive" [14].

When a gesture is seen to be initiating the sound the two senses of sight and hearing are working together to create a perception of the instrument being played. Depending on the movement of the gesture it could be possible to either enhance the audience's perception of the instrument or conversely reduce its impact, by intentionally subverting the natural expectation of the audience. For example, the visual expectation of the audience, when hearing louder sounds, might be to see larger movements, which in acoustic instruments would be the case, but in electronic instruments could be inverted. In this situation smaller movements creating louder sounds might confuse an audience.

If further such subversion to audience expectancies is created the sounds being heard may no longer be perceived as being connected with the instrument on stage. If the listeners do not connect the sounds with the instrument then they may not be able to imagine creating those sounds on the instrument themselves. Therefore the affect of mimesis would be greatly reduced.

2.2 Modulating Gesture

Modulating gestures are gestural movements that occur after the sound has been initiated, modulating parameters that affect the sound in some way. Synthesisers generally have many parameters that may be changed during the sound production, and so there are several modulating gestures to complement these synth parameters. These modulating gestures may be split into three sizes: small, medium and large. Small gestures are difficult to see but affect the sound; medium gestures can be seen from a small distance; large gestures are movements that can be seen from distance.

As with the initial gesture, a compliance or subversion of expectation, using common parameters, such as pitch-bend, could have similar effects as discussed above. However, parameters that affect the sound in new ways, not analogous to an acoustic counterpart, may not be treated in the same way by the listener. The new sound and connected gesture may intrigue the listener with its uniqueness and unfamiliarity. This may allow new associations to be made with the instrument and how it should be played. This could lead to interesting relationships between the gesture and synthetic sound, and provide informative movement that enhances the sound rather than remaining abstract and detached from the aural information.

In conjunction with the initial gestures, carefully designed modulating gestures should strengthen the mimetic impact.

2.3 Inter-Modal Gesture

Inter-modal gestures include all components/features that do not affect the sound but have a visual presence. Although the gestures do not directly change the sound, taking the McGurk effect [3] into account, they influence the perception of them.

An important inter-modal consideration is in the way that the instrument looks and feels. The first prototype was created to look more like an acoustic instrument than a typical controller. It is made mainly from wood and great effort has been made to hide the technology where possible. This is not only so the performer may feel more like they are performing with an acoustic instrument, but also so that listeners may be given the impression of an acoustic musical instrument similar to a guitar.

Creating an 'acoustic' look to the instrument should elicit a mimetic response in the audience, allowing them to form an impression of the mechanics of the instrument.

3. PROTOTYPE 1

With consideration to mimetic theory the aforementioned guitar based design gives the observer a starting point from which to understand the performance motions and gestures. This allows an initial understanding of the controller and a basis to build in new gestures specific to the device.

The initial gesture requires the 'plucking' to initiate the sound, and the positioning of the 'fret board' hand to alter the pitch. This will be familiar enough for guitarists to immediately pick up the controller and begin playing with an intuitive sense of control, but will also be familiar enough for non-guitarists to gain a modicum of control with little effort.

The prototype utilises a variety of sensors to exploit the various movements that are possible with a guitar-based instrument, producing modulating gestures that control synthesizer parameters. Sensors placed at fret and bridge positions can detect small modulating gestures, mapped to appropriate synthesiser parameters.

Other sensors detect medium modulations from the hands, and large modulations from movements of the controller. Guitarists will be familiar with these larger gestures but in most cases, on an electric guitar they will be intermodal, (not actually affecting the sound). On the controller they are modulating gestures, and are mapped to additional synth parameters.

The concept of mimesis is an interesting one to consider when analysing the performer-audience relationship. However, this concept allows us to furthermore align instrument design not only to the creative aims of performers or instrument makers but to address specifically parameters that might be considerably involved in allowing audiences to feel that performed music on digital instruments is accessible to them. It is apparent through this research, so far, that the inclusion of mimetic theories during the design and development of controllers will open up interesting avenues for new devices.

There is a compromise between a shape suited to synthesised sounds and one influenced by theories of mimesis that will promote mimetic participation. The guitar base should afford users to know how to initially generate sounds, which should in turn improve mimetic understanding of the instrument thereby enabling mimetic processes.

The design is also an attempt to balance many facets of instrument design: a unique digital instrument/controller vs. traditional acoustic form; small nuance based performer orientated gestures vs. large spectacle audience orientated gestures; ease of play for beginners vs. complexity of play for mastery; simplicity of design and use vs. complexity and flexibility of control.

These design facets are pulled together with the common thread of mimetic theory, including empathy, communicative musicality and mimetic participation.

4. MIMETIC THEORIES

There are many relevant areas of research important to instrument design, such as affordance, gesture, inevitability and efficiency [6]–[10]. However the main thrust of research for this project has come from three key areas: empathy, communicative musicality, and mimetic participation.

4.1 Empathy

Empathy is intrinsic to the mimetic process. Trevarthen and Malloch [1] describe how musical mimesis may facilitate improved social empathy. Communicative musicality produces an empathy and understanding between mother and baby [15]. This imitative process is essential to creating empathy. How we understand each other and the way we communicate involves empathetic, mimetic response. Cox states that ‘part of how we comprehend music is by way of a kind of physical empathy that involves imagining making the sounds we are listening to’ [2].

Empathy and sympathy are key processes in communicative musicality, which Malloch [15] describes as ‘movement that allows mother and infant to express themselves in ways that are sympathetic with the other’.

4.2 Communicative Musicality

Trevarthen’s [16] studies of the earliest interactions between newborn babies and their mothers, known as motherese or proto-conversation have been shown by Malloch [15] to contain patterns, repetitions, rhythms, pitch and intonation variations which are very musical in nature. Trevarthen’s collaboration with Malloch suggests that the presence of this ‘communicative musicality’ between mother and baby is essential for healthy social and cognitive development of the child [1], [15], [16].

This innate, imitative ability is utilised throughout our lives to communicate, empathise and to make sense of the world around us. We understand music and performance through this visceral ‘empathy’, wanting to ‘join’ in through mimetic participation.

4.3 Mimetic Participation

Mimetic participation can be used to describe how we understand and imitate a process such as playing a musical instrument. It can be an uninvited urge to copy someone or join in such as tapping your foot or humming to music [17]. Arnie Cox asks ‘Do you ever find yourself tapping your toe to music?’ and then suggests that ‘Informally conducting, playing ‘air guitar’, and ‘beat boxing’ (vocal imitation of the rhythm section in rap) are similar responses’ [17].

Through researching the mechanisms of empathy and communicative musicality it should be possible to emphasise/exaggerate the effect of mimetic participation, creating instruments that invoke their ‘air’ cousins in audience/listeners.

5. DESIGN PROCESS AND FUTURE EVALUATION

Figure 2 below shows the development cycle to be followed to produce, evaluate and improve the design principles.

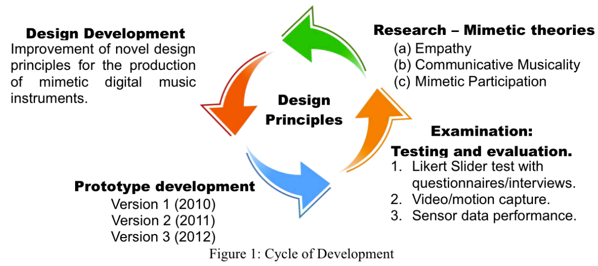

Figure 2. Cycle of Development.

The design process of the cycle of development includes taking measurements at live performance events as well as using video interviews. Analysis of video footage and audience/performer sensor data provides additional data sets, to compare mimetic designed instruments with traditional instruments.

An instrument with greater mimetic effect should elicit more imitative gestures. To test this hypothesis design principles are developed throughout the research project duration using multiple iterations of the above process. All prototypes are created using these principles and examined in the following ways. Cox suggests that ‘For many if not most of us, and for most kinds of music, music nearly demands mimetic participation (overt or covert)’ [2]. Cox’s ‘covert imitation’ involves imagining physical actions and ‘overt imitation’ refers to outward movements or gestures such as tapping your feet [2]. This overt/covert mimetic participation will be examined during a series of performances.

A composition using modulated, synthesised sounds will be carefully composed so that it can be performed identically, using the same sound generator, by both standard keyboard controller and BazerBow. The composition will be performed to a click track ensuring consistency in performance and time stamping for data analysis. Separate performances of this composition, one using keyboard, another the BazerBow, will allow a comparison of the ‘mimetic’ features of the BazerBow and their associative non-mimetic gestures of the keyboard.

At each performance the performer and audience (approximately 20 people) will be videoed to allow comparison of specific performance gestures and audience response. This video footage will show medium/large mimetic gestures of the audience, such as ‘air’ guitar type motions. Time stamped data from movement, force and vibration sensors arranged around audience seats will be analysed for small/medium gestures such as foot/finger tapping.

Due to the nature of convert mimesis, it will be necessary to investigate directly with the audience to understand their thought processes during the performance. Video interviews will be undertaken after each performance to discover how each audience member felt they were affected by the performance and if they had any desire to imitate or join in. The interview videos will also be analysed to look for imitative gestures used in the interviews.

Interviews will be retrospective and reliant on the interviewee’s memory. However an additional Likert[1] Slider test will be implemented during the performances. Before the performance, each audience member will be provided with a physical slider. They will be asked to move the slider during the performance from 1 to 10, in response to an appropriately designed question, such as how much they would like to join in with the performance, and/or how engaged they feel with the performance. These sliders will produce data that is time-stamped so the values can be compared with the other data/video analysis.
Once the data/video has been analysed it can then be used to compare the differences/similarities between the keyboard and BazerBow performances, looking to see if the features of the BazerBow have an increased mimetic effect causing greater imitation and desire to join in.

6. CONCLUSION

We believe that even though mimetic theories are known to be important to the communication, engagement and expression of music performance, this ongoing enquiry represents the first consolidated effort to develop design principles from mimetic theory. Our initial prototypes point towards the validity of the assumption that an instrument designed with mimesis in mind should elicit more imitative gestures.

This project, which is in the middle of the first iteration, will demonstrate a development cycle that produces, evaluates and improves the design principles, which are the core output of the PhD project.

These mimetic design principles will be tested and developed initially using progressive versions of the first guitar-based prototype design, following the development design cycle (Figure 2). A future paper will cover the results of these tests and the following iterations of design. To further develop the design principles, new and different mimetic prototype designs will be created and tested.

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[1] A Likert scale is a psychometric scale used in questionnaires, named after its inventor Rensis Likert.

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