Towards a Taxonomy of Realtime Interfaces for Electronic Music Performance

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ABSTRACT
This paper presents a discussion regarding organology classification and taxonomies for digital musical instruments (DMI), arising from the TIEM (Taxonomy of Interfaces for Electronic Music performance) survey (http://tiem.emf.org/), conducted as part of an Australian Research Council Linkage project titled "Performance Practice in New Interfaces for Realtime Electronic Music Performance". This research is being carried out at the VIPRe Lab at, the University of Western Sydney in partnership with the Electronic Music Foundation (EMF), Infusion Systems[1] and The Input Devices and Music Interaction Laboratory (IDMIL) at McGill University. The project seeks to develop a schema of new interfaces for realtime electronic music performance.

Keywords:
Instrument, Interface, Organology, Taxonomy.

1. INTRODUCTION
Despite the continuing and strong interest in the design and creation of new Digital Musical Instruments (DMI) [6], the classical taxonomy of acoustic instruments focuses on the initial vibrating element in an instrument that produces its sound (air, skin, string). Developed by Mahillon [1] and later expanded by Hornbostel and Sachs [2] the taxonomy consists of four top-level classifications—Aerophones, Chordophones, Idiophones and Membranophones. Each of these top-level classifications is broken into numerous sub-categories creating over 300 basic categories in all. In 1940 Sachs expanded the classification system to include a fifth top-level group, electrophones for instruments involving electricity. In Sachs' classification system the electrophones were separated into three sub-categories—

1. instruments with an electronic action
2. electro mechanical, acoustic sounds transformed into electric through amplification;
3. radioelectric, instruments which are based on oscillating circuits.

The classification system is of course woefully inadequate to capture the richness, diversity and trends of digital musical instrument design. By placing the focus on the initial sound making device, the differences, similarities and relationships between instruments such as the eShofar [3], tooka [4] and T-stick [5] are lost.

More recent approaches to developing taxonomies of DMI have focused on the sensor types used, the nature of the interface, the way gestures are captured and the mappings between interface and sound generating functions [6]. Pringer [7] compared DMI with respect to expressivity, immersion and feedback. While Pressing [8] and Birnbaum et al. [9] have proposed multi-dimensional spaces to represent DMI, incorporating their interactive potentials. Birnbaum et al.'s seven axes are—

1. Role of Sound
2. Required Expertise
3. Music Control
4. Degrees of Freedom
5. Feedback Modalities
6. Inter-actors
7. Distribution in Space

2. REVISING DEFINITIONS
The TIEM survey received submissions across a wide range of innovative approaches to electronic music performance. Whether seen as an instrument or interface (a more detailed discussion about proposed definitions follows), it is clear that their principle focus is live music making, and as such have an underlying foundation concept of 'Instrument'. It is useful to unpack that concept to illuminate the influence it has on design and development.

Again, organologies [6] [11] fail us here too. They present a method of categorising musical instruments, but they do not explicitly detail an underlying schema, a generic concept of musical instrument.

In developing such a schema, an examination of musical performance is very helpful as it establishes the constraints and requirements of a musical instrument. Godlovitch [12] carefully unpicks the construct of the musical performance. He lists, among other things, the following as essential:

- a datable sound sequence (that is, sonic event),
- immediately caused by some human(-like) being,
- the immediate output of some musical instrument,
- intended to be caused at a specified time and place, and in a specified manner,
- the exercise of skilled activity,
- an instance of some identifiable musical work,
- intended for and presented before some third-party listener, exercising active concentrated attention.

Three items emerge as thematic undercurrents of the model of performance offered.

- First, the significance of performance is strongly emphasized. The model displays the major musical constituents - musicians, works, sound, listeners - as converging upon performance, and deriving their musical purpose in and through it.
- Second, performances can fail both by misrepresenting the work and by disaffecting the listener.
- Third, performance is action-centred.

[1] see http://infusionsystems.com (viewed 02/02/10)

Godlovitch's model establishes certain primary causal conventions that may or may not apply when considering new instruments, which differ from acoustic instruments by the disconnection of the excitation and sonification mechanisms. The laptop music performance is a classic example of where the causality may be opaque.

Endeavouring to address new instruments Godlovitch puts forward the concept of 'remote control', saying that "*Computer assisted music, musical quasi-readymades, and experimental music challenge the centrality of immediate agency. ... Primary causation involves direct control. Not all causation is primary. Causation is indirect when what the maker does skilfully is at a significant procedural remove from the final effect. Indirect causation is standard in computer art and music. I will call the process remote control.*"

The terms "*computer assisted music, musical quasi-readymades*" refer to a performance which entails the replay of predetermined sequences of musical material without intervention. Much has changed since Godlovitch coined these definitions in 1998. Computing power facilitates realtime software synthesis languages such as Supercollider[2], Max/MSP[3], Pd[4], Chuck[5], Impromptu[6], JSyn[7], Audiomulch[8] etc. wherein variables within these software synthesisers can be controlled in realtime. Such a paradigm is not considered by Godlovitch.

3. METHOD

The online TIEM Questionnaire[9] consisted of 72 questions examining the practice and application of new interfaces for real-time electronic music performance. The questions consisted of a mix of textural and numeric, qualitative and quantitative, arranged into six sections—

1. General Description
2. Design Objectives
3. Physical Design
4. Parameter Space
5. Performance Practice
6. Classification

Participants were not required to answer all questions and were able to revisit the questionnaire to complete their submission. The questionnaire was launched in June 2008 and attracting over 800 unique survey views with 80 completed responses.

4. Analysis

An online database of the interfaces/instruments submitted to the survey (if they elected to be listed publicly) has been created at – http://vipre.uws.edu.au/tiem. Since launching the online database in September 2008 the web site has had over 1900 unique visitors (500 per month) and 6400 page views (1800 per month). The TIEM database has also been referenced on (amongst others) WIRED[10], CNN[11] and Electroacoustic Resources[12].

Table 1 presents a summary of the responses given to question six that asked for a brief description of the submitted interface/instrument.

Table 1. Summary of instrument families.

Tree node - Parent	Child node	Sub node	References	
collaborative			1	
	live		3	
computer software			8	
	Max/MSP		12	
	MIDI control		10	
	Supercollider		2	
	synthesis algorithms		2	
	audiocube		1	
	sound tracker VSTi		1	
controller				
	glove		2	
	joystick		2	
	digital controllers		1	
	game pad		1	
	glass sheets		1	
	mobile phone		1	
	movement sensor		2	
		Gesture	9	
	movement-body		6	
	optical locator-eye		1	
	sensate surface interface		1	
	steering wheel		1	
instrument category				
	keys		12	32.43%
	string		8	21.62%
	wind		8	21.62%
	voice		4	10.81%
	drum		3	8.11%
	percussion		2	5.41%
				100.00%

Analysis for the brief descriptions, using NVivo[13], produced the parent nodes in Table 1; Collaborative, Computer Software, Controller and Instrument. It can also be noted that gesture forms a substantial child node.

Further classification was sought in the final question of the survey (Q72) that asked, *"Do you consider the interface instrument to be part of a group of other interfaces/instruments."* Answers included:

- DJ equipment
- Looping family of instruments...
- Virtual musical instruments.
- Tabletop interfaces/instruments
- Collaborative instruments
- Tangible interfaces
- Multi-player controllers including game consoles.
- Free-gesture interfaces
- Synthesizers
- MIDI controller
- Hacked device used and available for other application (tablet, joystick etc..)
- Hybrid controller
- Information visualization interfaces
- USB controllers

[2] see http://supercollider.sourceforge.net (viewed 02/02/10)
[3] see http://www.cycling74.com (viewed 02/02/10)
[4] see http://crca.ucsd.edu/~msp/software.html (viewed 02/02/10)
[5] see http://chuck.cs.princeton.edu (viewed 02/02/10)
[6] see http://impromptu.moso.com.au (viewed 02/02/10)
[7] see http://www.softsynth.com/jsyn/ (viewed 02/02/10)
[8] see http://www.audiomulch.com (viewed 02/02/10)
[9] see http://tiem.emf.org/survey (viewed 02/02/10)
[10] see http://www.wired.com (viewed 02/02/10)
[11] see http://edition.cnn.com (viewed 02/02/10)
[12] see http://ressources.electro.free.fr (viewed 02/02/10)

[13] see http://www.qsrinternational.com/ (viewed 02/02/10)

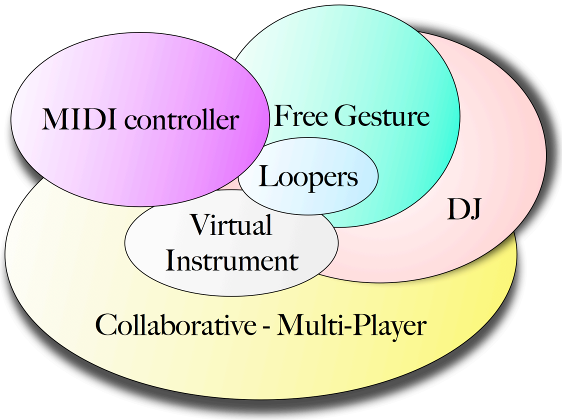

Figure 1 Overlap in classifications

Figure 1 represents an analysis of the crossover of the applications inherent in the classifications provided above. It also shows how technological descriptors (MIDI Controller, Virtual Instrument) are freely mixed with performance methods (Collaborative, Free Gesture) and performer roles (DJ). Such a classification then becomes somewhat meaningless as all these areas overlap at some level.

A combination of the two approaches to classification as discussed above leads back to the principle classifiers illustrated in Figure 2. The instrument families in Figure 1 can be seen as examples of the top-level families defined in Figure 2.

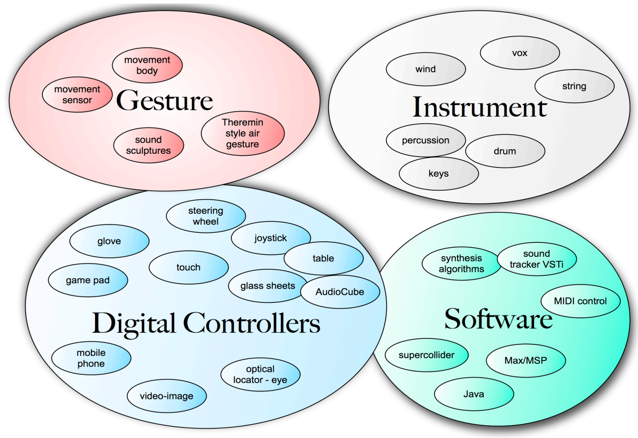

Figure 2 Principle classes of instrument defined in Q6

In order for these classifications to be of use in practice, a taxonomic approach is needed. Taking the top-level classifiers of Figure 2, a taxonomy might look something like Figure 3.

The taxonomy outlined in Figure 3 takes as its starting point the classifiers of Gesture, Digital Controller and Software, but excludes Instrument as it is a wide descriptor of all musical performance tools and therefore of no value here. Above these levels of classification, the discourse surrounding causality is introduced, as per Godlovitch's [12] notion of remote control. Software only instruments remain separate in this taxonomy and should probably be integrated in further iterations.

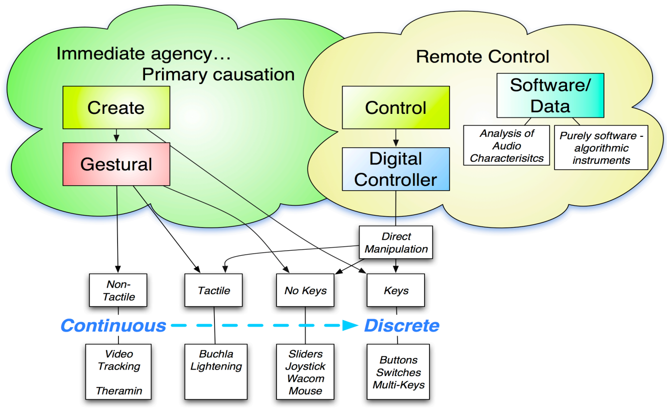

Figure 3 a Taxonomy - combining the above analysis

The distinction between Create and Control is applied as higher order classifiers above Gestural and Digital Controller respectively. As in the previous classification discussions however, the distinction is not clear-cut. For instance as we look to the lower order definitions in the taxonomy, where control is distinguished as moving from continuous to discrete, inter-relations proliferate. The range of continuous to discrete was also examined in the TIEM survey, with 59.62% of respondents described their instrument/interface as process based, meaning continuous control and variation of musical material, and 40.38% as event based, equating to the triggering of samples/loops or sequences. The next layer down in Figure 3 seeks to differentiate between tactile gestural interfaces, and digital controllers that contain discrete or continuous interface elements. For instance video tracking systems are generally not tactile and require gestural input. Some musical controllers such as the WiiMote, and the Buchla Lightning[14] are driven by gesture, but held in the hand of the user (tactile). All digital controllers require direct manipulation to activate the interface elements such as sliders, joysticks or buttons and switches and as such are tactile. The Wacom tablet[15] currently sits under the Digital Controller category, under the No Keys node, however it clearly requires gestural input, but unlike the low order gestural nodes, gestural input is highly constrained, limiting the perform to addressing the interface directly rather than the broader performance space.

Tracing the lines from both the Create and Gestural categories also illustrates the issue of complexity. All of the interface descriptors can be utilised in music creation that shows both immediate agency and primary causation. Similarly, the digital controllers equate with all interface types except non-tactile.

5. DISCUSSION

One of the characteristics of DMI that becomes clear when analyzing the data from the TIEM questionnaire, and attempting to develop a taxonomy (as in Figure 3 above), is that most digital musical instruments simultaneously utilise elements of both the creation of music in the moment, and the control of the system of which the interface/instrument is integral.

It is useful to apply the above analysis to innovative and commercially available digital musical instruments.

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[14] see http://www.buchla.com/lightning3.html (viewed 02/02/10)
[15] see http://www.wacom.com/index.html (viewed 02/02/10)

6. CONCLUSION

The taxonomic approach proposed in this paper is acknowledged to have weaknesses, and to be incomplete. It is a first iteration of an attempt to make meaningful categories that facilitate comparative studies of DMI, and a step towards a considered inclusion of DMI within the existing musical instrument classification frameworks.

The classification, electrophones, should be of equal standing as the existing top-level classifiers within the Hornbostel and Sachs [2] taxonomy - Aerophones, Chordophones, Idiophones and Membranophones, but in order for that to be the case, they must encompass a framework of sub-classification that is at least as rich in nuance as that existing in the other top level classifiers. One might quickly see sub headings of Synthesisers, Wind-controllers, Percussion-controllers etc, however as discussed at the top of this paper, such classifications fail to address many evolving approaches to the design and use of DMI. The classification of Gestural Controller, Digital Controller and Instrument as outlined in Figure 2 may be the first level of division, but as outlined in the commercial examples discussed above, new interfaces/instruments display a multi-faceted quality not previously seen in musical instruments. They do so by combining the roles of creation of realtime content and the control of the system. In an area of music practice where the excitation-sonification mechanisms are not inherently connected, the analysis of design trends and the TIEM international survey suggest that the interplay of *control* and *create,* seems to be one possible path towards a taxonomy of realtime interfaces for electronic music performance.

Perhaps a new taxonomy would seek to differentiate instruments where mechanically linked excitation-sonification (i.e the existing taxonomy) is inherent as subclasses in a new taxonomy that includes electrically linked excitation-sonification with subclasses as defined by the electrophones, and an additional category of digitally linked excitation-sonification, with subclasses based on the create and control paradigms.

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