A Phenomenological Study of Timbral Extension in Interactive Performance

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Abstract

This paper features an investigation of the interactive electronic extensions of the musical performance, based on an phemenological approach to the human perception of sound in a musical context. The interactive extension of the musical performance offers, through performer control over the produced sound in real-time, possibilities for the composer to take advantage of subtle features of acoustic sound, due to the individuality of the live performance. Richard Leppert understands musical activity as a synthesis of sound experience in accordance with a visual experience: the sonoric landscape. Using this concept investigations about perceptive characteristics of synthetic and human sound will be made, with a purpose of describing the advantages of real-time sound processing. Further, the structure of the interactive process will be sketched,and in the final section a brief overview of a piece, NoaNoa, for flute and interactive electronics by Kaija Saariaho will be given.

Introduction

In this paper I will investigate the phenomenologic difference between synthetic and human-produced sound, in order to explore the options for an interactive extension of the musical performance featuring real-time sound processing. This leads to a thorough description of the perceptive characteristics of the human produced sound in the musical performance, where composer, performer and listener have a certain common knowledge of the material, based on an empirically experienced musical idiom. By empirically experienced musical idiom is here understood music created in a tradition where there is a large degree of consensus in the experience of the sonoric landscape in composer, performer and listener. Utilisation of synthetic sounds interferes with this consensus by attacking the experienced expectations of accordance between cause (performance gesture) and effect (sound produced).

In the approach to composition of computer music, the role of the composer may therefore also encompass exploration of the field created between boundaries of the scientific representation of sound, to be manipulated by the composer, human perception, tradition and the cognition of sound, with an awareness of the fluid limits of human cognition within a musical context, but also within the boundaries of technology's still rather weak ability to accomodate human musical behavior. To serve this elucidation advantages of the interactive extension to the musical performance will be given. These will be presented in terms of the option for real-time sound processing to encompass a musical material embracing all perceptually significant details of the human produced sound. Providing these options, the interactive extension will offer a flexible expansion of the musical material, already anticipated in the traditional electronic extension.

Perceptive Timbral Connotations to Natural and Synthetic Sound

Correlation of Performer and Synthetic Sound

The exploration of the computer as a compositional tool and musical instrument have involved an investigation of features important for the human perception of sound. In the following, some traits will be set out concerning the perception of music. This will serve to expose the central differences between an interactively extended performance, where electronic sounds are triggered by the performing musician's physical and acoustic gestures, as compared to a non-interactive but electronically enriched performance, such as with a sequenced accompaniment where whole sequences of sounds, of relatively fixed temporal and dynamic relationships, are merely started by a trigger, or the case of a tape accompaniment which must be synchronized by click-track or pre-defined cues for the performer to follow.

Initially three issues can be set up:

- The performer is accompanied by an independent sound track, synchronization is provided e.g. by cues or click-track.
- The performer is "tracked" and used to synchronize a synthetic playback.
- The performer's sound is processed directly on the synthesis of sound.

The interactive performance takes often advantage of the two last issues; using the tracking of the performer to synchronize direct processing of the acoustic sound. Thus will the performer be tracked either by, e.g., a pitch-tracker or a MIDI interface. The tracking will be compared to a representation of the score in the computer, where cues for the execution of the respective sound processings are marked.

Outlining of Differences between Synthetic and Acoustic Sound

This approach requires an outlining of characteristics of the synthetic and the acoustic (human-produced) sound. This difference may serve to illustrate two main differences between perception of electronically and human produced sound, because the interactive (and sonic processed) technique permits a synthesis of the advantages of the musical performance within its frame of reference to tradition and the sonorous extensions provided by electronic means. The human produced sound involves automatically information referring to a musical convention, whether this information is contained in the musical texture itself, or in the performer's gestures as will be explained in the following. The electronic sound, on the other hand, does not necessarily refer to a musical "performance" convention itself, but seems merely to form a perceptual significance by virtue of its context; and this is conditioned on expectations in relation to the traditional musical performance.

The synthetic musical texture itself thus differs significantly from the human controlled sound in many ways, e.g., by the difficulties in obtaining control for the performer of sonoric gestures as vibrato, transition phenomena, attack, timbre and more subtle irregularities in phrasing, creating the uniqueness of the human musical performance.

In music, a distinction is therefore often made between synthetic sound and acoustic-instrumental sound solely from the sound image, without taking into account connotations of sounds in relation to conventions in a musical tradition. The most salient difference is that the behavior of the acoustic-instrumental sound can be changed in real-time by the performer according to musical tradition. The behavior of the non-interactive synthetic sound is pre-determined, i.e., it does not mirror the individuality of the performer and further does not refer implicitly to a tradition, but nevertheless often is perceived in accordance with a musical tradition.

The Significance of Gestures

The following conventions are considered to have significance for musical perception: The presence of a human performer affects the sound production in a musical performance in two ways, both of which are connected to conventional musical performance means; these two effects I will refer to as sonorous and physical gestures. The sonorous gesture can be exemplified by connotations of the perceived sound itself, required by the listener to make sense in the context of a particular musical idiom. Specifically in connection to the perception of timbre, it can be exemplified as follows: when a flute plays a piano dynamic, not only a change in loudness is of importance; significant perceptive cues are provided by changes in vibrato, timbre and attack, all this in relation to the specific context, required to give the listener the right feeling of piano. I will not judge to which extent this is due to a combination of traditional habituation that has turned into a convention and an innate result of the human hearing sense.

The physical gesture, on the other hand, is more immediately explained as actions used more or less consciously by the performer to accentuate the musical phrasing; most obvious is the use of the breath to underline phrasing, or the various body movements such as a nod of the head or facial expressions serving to mark entrances, downbeats or sudden shifts in the musical ambiance, like utilization of contrasting material engendering a sudden shift in the musical ambiance, used more or less consciously to underline the musical texture. That is: the visual presence of a performer may have significance for the perception of sound. These close relations between perception of music and bodily movements are described as a cognitive phenomenon by Ray Jackendoff in *Consciousness and the Computational Mind.*[1]

[1]Jackendoff (1987) accentuates in relation to perception of music, the association of bodily motion in perception of rhythmical patterns. I consider that this association has also a significance in the perception of rhythmical irregularities or breathings used e.g. in phrasing.

A Phenomenological Approach

A more phenomenological approach is found in the work of Richard Leppert[1]. Leppert defines the concept of a sonoric land*scape* as the reconstitution in our minds of something in excess of the factual: "This excess is experienced as a representation - and as such is discursive."[2]By this Leppert wishes to emphasize the perception of music, not only from the perception of the sound, but as the impression of sound from the perception of sound and sight perceived by means of human experience and consciousness: " Music connects to the *visible* human body, not only as the receiver of sound but also as its agent or producer."[3] By using Leppert's descriptions we can understand musical activity as a synthesis of sound experience in accordance with a visual experience[4]. This visual experience will be in accordance with a musical performance idiom where there will be a habitual relation between visual impression and sound forming the sonoric landscape. I will here add, that the nature of the visual impression could rather manifest itself as a bodily connotation to the perceived sound in the listener, not depending on the visual presence of a performer, but merely a cognitive aspect in the nature of music which Jackendoff names general-purpose abilities[5] where the sensation of certain traits of musical sound, such as rhythm and rubato, induce associations to bodily motions.

Connotations of the aural perception may therefore be influenced by connections to the assigned visual perception, that is to say, a performer's movements and the perceptor's expectations of the sound in connection with a musical idiom, may have significance for the comprehension for the interpretation of the musical performance to the listener: the creation of a sonoric landscape. These relative perceptions I will define as casually interdependent, when the perceptor's expectations of the sound depend on the degree of conformance between the visual impression, the assigned emotional impression and the sound perceived.

The Importance of Causality for the Perception of Sound

The notion of causality[6] is important in connection with synthetic sounds, when the perceiver more or less consciously tries to identify the sound source. Causality should then be understood as a listener's immediate unconscious image of the sound producing *instrumental-mechanism*, not literally understood, but rather whether the *instrumental-mechanism* refers to traditional categories, e.g., voice, wind, string or percussion instruments, etc., or, rather as not referring to any instrument category, e.g., some kinds of noise, or, sound without the characteristics of the human performer such as subtle irregularities in vibrato, transitional changes, etc. Identification with known sound sources, might thus help the listener to place the sound picture in relation to a known sonoric landscape. In extension of the human performance with synthetic sound, the relation between sound picture and the visual impression might be segregated compared to the perception of a traditional musical performance, and this segregation could then be used by the composer to extend the sonoric material in the musical performance.

The distinction between sonorous and physical gestures can be used as a tool to elucidate idiomatic properties of the acoustic-instrumental sound in relation to the synthetic sound, with a purpose being to evaluate real-time sound synthesis as a qualitative phenomenon in relation to the musical work.

Interaction between Computer and Performer

The Sonoric Extension of Interactive Sound Processing

The interactive extension of the musical performance is a very important technique for taking advantage of electronic means within the context of traditional musical performance. The musical texture is extended in conjunction with traditional musical performative means, thus allowing the performer to directly control the synthesis of sound or the execution of synthesized material under traditional performance circumstances. In this paper I will not consider current implementation problems, but I will define and discuss the principle of interaction as a concept.

Interactive extensions to musical performance can enrich the musical texture in different ways according to the kind of processing the musical material is subjected to. These processes could be divided in accordance with the origin of the source material to be processed, and the nature of the processing itself as sonic and

[1] Leppert 1993, p. 17.
[2] Ibid. p.17-18.
[3] Ibid. p. 18.
[4] I do here consider any musical experience to give rise to notions about a visual experience in accordance with previous musical experiences including visual impressions.
[5] Jackendoff 1987, p. 216.
[6] This concept was introduced by Chabot in Leonardo, vol 3 1993.

gestural processing. In the sonic processing, the instrumental sound itself is processed and transformed by means such as reverberation, filtering, pitch-shifting or modulation. This affects mainly the timbral attributes of the sound. In the gestural processing, sonorous gestures such as pitch and dynamic (as opposed to timbre) are "abstracted" from the performance and subjected to higher-level processing, e.g., as sequences played back with a different distribution in time, or diffused in space: spatialisation. These played back sequences can also be sonically processed, or the instrument could simply trigger stored sequences in the computer, which can be considered as the ideal case of synchronization between performer and a pre-recorded sound track. The nature of the higher-level processes could be more or less in accordance with traditional musical gestures.

I have not here considered audification of the performer's physical gestures in this connection, since they do not provide any sonorous source material to be processed. The assignment of sonoric material to the performer's gestures, offers a rich spectrum of options for the composer to interpret the perception of the musical performance, thus allowing the composer to consciously create a sonoric landscape and not only a sound image.

The Structure of the Interactive System

An important aspect of interaction, compared to the traditional performance accompanied by a stored sound track, is the freedom provided by the synchronization mechanism between the interactive system and the performer. The synchronization is realized by a coordinator concept essential for interactive systems. An overview of an interactive system is shown on Figure 1:

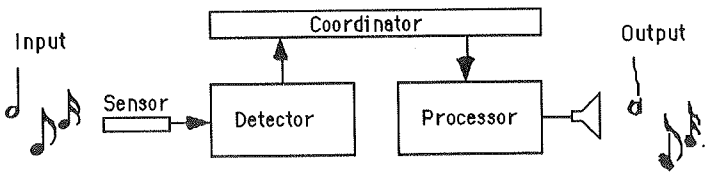

Figure 1

As can be seen on the figure, there are four principle parts of an interactive system: a *sensing* system that gleans information from the sound source, e.g., with a microphone; a *detecting* system, detecting pitch or trigger information, a *coordinator*[1] providing synchronization of the input and its respective events; and a last stage executing the sound *processing*.

Advantages offered by Real-time Sound Processing

The presence of this coordinating mechanism, effected by the score follower[2], provides a freedom for the performer to take advantage of traditional performance means, such as rubato, individual phrasing, etc., as well as timbral extensions provided by the sound processing. Real-time synthesis, as opposed to tape music, for example, provides possibilities for using a technological approach while permitting composer and performer to take advantage of traditional means as sonoric and physical gestures. Another important point is the possibility for the electronic extension of the musical performance to move, or even reduce, the border between non-idiomatic and idiomatic musical gestures, an elimination to be provided through renewed possibilities for changing connotations to, or causality of, sound, as explained in the previous section.

An approach to understanding these options is offered partly by the timbral exploration. Timbre contains in itself fairly limitless extensions of new sound textures, amalgamations of different timbral idioms, causality of sound as an artistic effect: taking advantage of the options for manipulation of the acoustic properties of the instrument, or capturing the performer's gestures to process a sound in order to emphasize the

[1] The significance of the coordinator varies in this connection from the more specific notion of a score follower requiring a representation of the score in the coordinator e.g. as it is defined by Rowe 1993. It signifies here a mechanism maintaining a synchronization of particular detected events or conditions in relation to more or less predetermined responses executed by the computer.

[2] See Lippe and Puckette 1992.

significance of physical gestures. The last issue requires an exploration of the significance of bodily motion in a musical performance. These advantages can be best treated by considering the experience of sound phenomenologically, as shown in the previous section. The conceptual flexibility of interaction thus provides a possibility to let the work allude to something external as, for instance, the musical performance as a perceived phenomenon: the sonorous landscape, within the musical work's own means of expression: the timbral texture.[1]

NoaNoa by Kaija Saariaho

A Brief Introduction to the Interaction in NoaNoa

In the following section I will examine the processing provided by interaction in the piece NoaNoa by the Finnish composer Kaija Saariaho. The piece was originally conceived for solo flute and electronics in a Macintosh version.There, the interaction was provided by the performer's release of certain events by a pedal. In a new version the real-time processing of the acoustic sound is adapted for the IRCAM Signal Processing Workstation (ISPW). NoaNoa provides an illustrative example to evaluate the contributions to the acoustic sound image provided by the interactive extension of the sound. The schematic structure of the workstation is similar to the construction shown in figure 1.

The Interactive System in NoaNoa

The sensing is performed by two microphones; one right in front of the blowhole to sense the words pronounced by the performer, and another one "beside" the flute to capture the flute's sounds. The signals from the flute are pre-amplified, and sent through an analog-to-digital converter. The information from the microphones is scrutinized by the pitch-tracker, so as to be used by the score-follower to synchronize the performer with the processing employed in relation to given cues in the internal representation of the score in the computer[2], the other is connected to a pitch-tracker. The selection of which microphone to take the input from, is pre-determined in the internal score. The sound processing, score following and pitch detection are designed in MAX. The sound processing, in the recent version, such as filtering, play back of stored sequences and real-time sampling is executed by the ISPW, the reverberation by a Lexicon sound processor, and the superposed envelopes from crotales are made through a Reson8.

Contributions to the Musical Texture by Means of the Interaction

In NoaNoa the use of electronics helps to fulfill some of the composer's musical intentions, which would not be possible without an electronic extension. The primary intention is concerned with conveying a continuos character to the monophonic musical line. This is obtained by adding reverberation to the flute sound: "the quieter the sound, the longer the reverberation."[3] The breathing is also smoothed by reverberation, but retains never the less a character of breath determined phrasing while still maintaining a continuos musical texture. The timbre is extended using special techniques, for instance, is the pitched nature of the flute contrasted by the whispered (noisy) "second voice" made by the performer, sometimes played back from stored segments in the ISPW, and sometimes sampled from the performer and played back. Further the flute timbre is contrasted by using special effects: whisper tones, flutter-tongue, or fingered tones solely attacked by the consonant sounds of the spoken voice of the performer, a technique resulting in a percussive effect. The monophonic line of the flute part is fractured using multiphonics and whispering into the instrument while playing, but additional timbral layers are provided by the sound processing. The composer thus approaches the nature of the acoustic sound image to encompass an electronic sound image containing sounds that are not within the flute's normal spectrum.

It remains to discuss what is conveyed to the piece by the use of interactive means. The first attribute is a more homogenous sonic extension, perfectly synchronized with the performer part, permitting the performer an extended timbral and rhythmic control over the course of events, thus providing freedom in the shaping of musical phrases. This results in a synchronization between performer and a synthetic sound image provided by a virtual performer, but crystallized over the soloists individual sound. The electronics further extend the polyphonic character, anticipated in the instrumental voice itself, by implementation of several instrumental techniques at the same time, resulting in a very complex sonoric texture, enriching the flute sound.

[1] I do not in this include *musique concrète* , when it is merely constituted as montage referring to the surrounding world by virtue of collocations of fragments origining in the surrounding world.

[2] The pitch-tracker does not respond to the unpitched sound of the spoken voice, because of that, a pedal is used to trigger during voiced events.

[3] Preface in the Chester Music edition 1992.

Conclusion

Thus having outlined some important traits of the human experience of electronic and acoustic sound in a musical context, I have ignored an evaluation of any technical means to provide the discussed extensions. Many problems seem to be connected to this field. A major problem is, of course the costs of equipment and soft ware, and following; the problems of performing pieces made for other equipment and requiring a knowledge about the actual equipment and the systems used in the piece.

Another important feature concerning the representation of sound in the computer, is the difference between the phenomenological and the physical description of the same sound caused by the different approaches to description of sound: the phenomenological description, based on empirical musical experience often taking into account the origin of the sound; and the numerical description, based on scientific terms not immediately connected to the empirical experienced sound world, by opening possibilities for transcending the empirical experienced production of acoustic sound.

A main problem is that the creation of tools to implement computers in the creation of music is a hybrid area claiming knowledge of the scientific description of sound, computers, composition and human perception of sound in order to develop adequate tools for the artist. This evolution is far from fulfilled, but will probably get easier as interfaces between man and computer will make the approach towards control of sound, simpler and more immediate. Neural networks open up possibilities, since they can be trained to approximate algorithms representing the details of human skills, and give the artist access to control permitting him to use more traditional artificial means; skills too complex and subtle to be represented as algorithms in traditional computer systems.

It seems several of the above mentioned approaches still belong to the future, requiring more reliable systems, and disseminate of equipment and knowledge to put the interactive performance on equal footing with standard performance institutions as symphonic orchestras and chamber ensembles, it is necessary to provide a sufficient performances number of for the composer to dare to use time and energy exploring the unknown.

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UM NOVO MÚSICO CHAMADO 'USUÁRIO'

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Resumo:
Nossa tradição ocidental estabeleceu uma separação aguda entre os papeis desempenhados pelos agentes da atividade musical: o compositor, o intérprete e o ouvinte operam em campos muito bem delimitados e específicos. As possibilidades de interação trazidas pelo uso do computador em música, de certa forma diluem estas separações e fazem surgir uma nova categoria, capaz incorporar habilidades específicas de cada um destes agentes tradicionais. Esta nova categoria estaria ligada ao que chamamos correntemente de "usuário".

Introdução

> "Estou plenamente certo de que chegará o dia em que o compositor, após realizar graficamente sua partitura, a terá automaticamente colocada em uma máquina que transmitirá fielmente o conteúdo musical ao ouvinte" [Varèse:1983, 92].

Quando o compositor Edgar Varèse fez esta previsão, o computador, do modo como o concebemos hoje, não passava de uma projeção num futuro incerto. Varèse encontrava-se, já no início deste século, profundamente interessado na criação de novos modos realização musical e de novas posturas de escuta e profetizava a emergência de novas maneiras de produção sonora que, até então, só podiam ocorrer na imaginação do compositor.

Poucas décadas depois, as previsões de Varèse foram se tornando realidade e não podemos deixar de nos sentir curiosos por saber quais seriam as soluções musicais concebidas pelo compositor de *Ionisation* e *Poème Électronique* se tivesse à sua disposição todo o arsenal tecnológico que pode ser empregado na música feita nos dias de hoje.

A história que se passa entre o surgimento dos primeiros instrumentos elétricos do início do século, como o *ondes de martenot* e o *theremin*, e a criação das atuais interfaces sonoras inteligentes controladas por computadores, é uma história repleta de idéias que apostaram numa transformação do nosso universo musical de um modo denso e profundo. Se observamos hoje, em diversas esferas da produção musical, um movimento de reflexão sobre estas transformações, isso não se deve ao fato de que o músico passou a ter à sua disposição uma gama de timbres maior do que se poderia obter através de instrumentos tradicionais, nem tão pouco à capacidade dos computadores para executar passagens musicais impossíveis para qualquer instrumentista virtuose, mas sim porque a própria música passou a ocorrer dentro de um contexto completamente novo.

Aquele que faz e aquele que ouve música

A música ocidental, dentro de sua tradição, estabeleceu uma separação explícita entre os agentes musicais, a qual recentemente vem sendo colocada em questão. Diferente do que ocorre em outras culturas onde a música é uma manifestação coletiva, o Ocidente foi estabelecendo, aos poucos, limites estritos entre aqueles que criam, aqueles que executam e aqueles que ouvem música.

O início deste processo pode ser identificado no final da Idade Média quando o cantochão passa a ser a base para a criação de novas formas dentro da música profana, ao mesmo tempo que reluta em ser influenciado por estas. É neste período que a música vai se desligar de sua função estritamente ritual para assumir um novo papel na cultura, muito mais voltado ao lúdico e ao estético. Impõe-se ao músico uma necessidade de criar novas fórmulas e padrões dentro da linguagem e, com isso, surge o desejo de compor. A música se afasta da tradição do canto gregoriano, tornando-se cada vez mais rica e complexa, exigindo, também, interpretes dedicados e ágeis em seus instrumentos.

Inaugura-se aí o grande processo delineador das figuras do compositor, do instrumentista ou cantor, e do ouvinte como os três elos centrais da produção musical. Este quadro já é explícito no período Renascentista e,