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 a phenomenological 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 Lepert understands musical activity as a synthesis of sound experience in accordance with a visual experience: the sonic landscape. Using this concept investigations about perceptive characteristics of synthetic and human sound will be made, with a purpose of describing the advantages of the 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, NonNu, for flute and interactive electronics by Kaija Saariaho will be given.

Introduction

In this paper I will investigate the phenomenological 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 sonic 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 accommodate 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 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 productions 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 of the musical alone provided by electronic means. The human produced sound involves automatically information referring to a musical container, whether this information is contained in the musical texture itself, or in the performer's conveyance, this information as will be explained in the following. The electronic sound, on the other hand, does not necessarily refer to musical in the same way as it will be explained in the following. The electronic sound, on the other hand, does not necessarily refer to a musical "performance" container itself, but seems merely to form a perceptual signification by virtue of its context and this is conditioned on expectations in relation to the traditions of 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 sonorous gestures as vibrato, transition phenomena, attack, timbre and more subtle irregularities in phrasing, creating the uniqueness of the human musical instrument.

In music, a distinction is therefore often made between synthetic sound and an entirely instrumental sound in connection with conventions in a musical sound, without taking into account the qualities of sounds in relation to conventions in a musical tradition. The most salient difference is that the explanation of the behavior of the acoustic-synthetic sound can be changed in real-time by the performer according to the 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 listener.

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 aesthetic and physical effects. 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 a musical instrument, it can be exemplified as follows: when a flute plays a piano dynamic, not only a change in loudness (in the case) of importance, but also connotations of sounds is provided by changes in vibrato, timbre and attack, all 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 idiom 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 accenuate 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 changes in the musical ambiance, the use of the muscular material engaging a sudden shift in the musical ambiance, or an unexpected material shift in the physical 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

A Phenomenological Approach

A more phenomenological approach is found in the work of Richard Leppert.1 Leppert defines the concept of a sonic landscape as the reconstitution of 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 perspective of the perception of the sound, but also the perception of the sound, both in excess of what is 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 sononic 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 impression may therefore be influenced by connections to the assigned visual perception, that is to say, a performer's movements and the perceptors 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 sononic landscape. These relative perceptions I will define as causally independent, when the perceptors expectations of the sound depend on the degree of conformance between the visual impression, the assigned emotional impression and the sound perceived.

The Impotence of Causality for the Perception of Sound

The notion of causality is in important connection with synthetic sounds, when the performer more or less consciously tries to identify the sound source. Causality should then be understood as a listener's immediate unconditioned image of the sound producing instrument-mechanism, not literally understood, but rather whether the instrumental-mechanism refers to traditional categories, e.g., voices, wind, string or percussion instruments, etc., or, rather, 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., known as sononic landscape. In distinction to the performance of the human performer with synthetic sound, the relationship between a musical 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 sononic material in the musical performance.

The distinction between sononic 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 Sononic 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 forms, 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

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2. Ibid., p.17-18.
3. Ibid., p. 18.
5. 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 high-level processing, e.g., as sequence. This is concerned with a different distribution in time, or diffused in space: spatialization. These played back sequences can also be 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 of various degrees in accordance with traditional musical gestures.

I have not here considered amplification of the performer's physical gestures in this connection, since they do not provide source material for sonorous material to be processed. The assignment of sonorous 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 scored 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](image)

As can be seen on the figure, there are four principle parts of an interactive system: a sensing system that gains information from the sound source, e.g., a microphone; a detecting system, detecting pitch or trigger information, a coordinator providing synchronization of the input and the 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, 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 consideration 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 nonidiomatic 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 manifestation 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 Ives 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.


significance of physical gestures. The last issue requires an exploration of the significance of body 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 adhere to something external as, for instance, the musical performance as perceived by the audience: the sonorous environment, within the musical work's own means of expression: the timbral texture.

NoNoNo by Knja Saaraho

A Brief Introduction to the Interaction in NoNoNo

In the following section I will examine the processing provided by interaction in the piece NoNoNo by the Finnish composer Knja Saaraho. 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). NoNoNo 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 NoNoNo

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 sound in the computer2, 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 e ropes are made through a Reverb.

Contributions to the Musical Texture by Means of the Interaction

In NoNoNo 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 conveyed by the polyphonic character is the monophonic sound. This is obtained by adding reverberation to the flute sound, "the quieter the sound, the longer the reverberation." The breathing is also smoothened by reverberation, but retains the same character of breath determined phrasing while still maintaining a continuous musical texture. The timbre is extended using special techniques, for instance, in 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 tone, cluster-tongue, or fingered tone. The acoustic nature of the flute is captured through the instrument while playing, and additional timbral layers are provided by the sound processing. The computer 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 homogeneous sonority, perfectly synchronized with the performer part, permitting the performer an extended timbral and dynamic 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 solos of individual sounds. The electronic element does not 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 collations of fragments originating 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.

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 software, 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 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 experience 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 musical 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.

References

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UM NOVO MÚSICO CHAMADO 'USUÁRIO'

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Resumo:

Nossa tradição ocidental estabeleceu uma separação aguda entre os papéis 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 traçadas pelo uso do computador em música, de certa forma diáveis estas separações e fazem surgir uma nova categoria, capaz de incorporar habilidades específicas de cada um destes agentes tradicionais. Esta nova categoria estará 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 transmitema eletronicamente os conteúdos musicais ao ouvinte" [Varèse:1983, 92].

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

Pouco 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 Poême Électroacoustique 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 órden de mantellos e o theremin, e a criação das atuais interfaces sonoras inteligentes controladas por computadores, é uma história repleta de ideias que apostaram numa transformação do nosso universo musical de um modo denso e profundo. Se observarmos hoje, em diversas esferas da produção musical, um movimento de reflexão sobre estas transformações, isso não deve ser ao fato de que o músico passou a ter à nossa disposição uma gama de tintas 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 virtuoso, mas sim porque a própria música passa 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 rebuta em ser influenciado por estas. É neste período que a música vai se desligar da sua função intrínseca ritual para assumir um novo papel na cultura, muito mais voltado ao ludico 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 componer. A música se afasta da tradição do canto gregoriano, tornando-se cada vez mais rica e complexa, exigindo, também, intérpretes 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 eixos centrais da produção musical. Este quadro já é explicado no período Renaissante e,