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Gestural Control in Music and Sound Synthesis

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Abstract:

Gesture, is frequently related to the movement of body part that is linked with speech, particularly hand movements and facial expressions. In this review paper, discuss about the various topics of gestural control of music and sound in the context of design and evaluation of digital musical instruments. Digital musical instruments do not depend on physical limitations that is faced by their acoustic counterparts, such as characteristics of tubes, membranes, filaments etc. Huge diversity of possibilities regarding sound production permitted by this fact but on the other hand these new instruments are perform and design by strategies that need to be developed in order to provide the same level of control subtlety available in acoustic instruments. This paper focuses on mainly control of digital musical instruments, gestural controllers.

Keywords: *Gesture, Digital Musical Instruments, Acoustic Instrument, Facial Expressions*

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Introduction

Computer music evolution has brought to light an excessive amount of sound synthesis methods that is available in general and inexpensive computer platforms which is allowing a large community direct access to real-time computer-generated sound. Different human movements are captured by using input device technology that also viewed as in advanced stage which is considering both manipulation and non-contact movements. Regarding to manipulation, tactile and force feedback devices for both musical and non-musical contexts have already been proposed. At advanced stage, such devices and sound synthesis methods can be combined that create new computer-based musical instruments or digital musical instruments (DMI) which producing gesturally controlled real time computer-generated sound. It contain ultimate goal is to design new DMI which is capable of obtaining similar levels of control subtlety as those available in acoustic instruments.

This contain the branch of knowledge known as human computer interaction (HCl). Various questions need to addressed that is as follows:

- Which are the specific limitations that exist in musical context with respect to general HCl?
- In sound generation system, given various contexts related to interaction, what are the similarities and dissimilarities within these contexts (interactive installations, DMI manipulation, and dance–music interfaces)?
- How to design systems for these various musical contexts? Which system characteristics are common and which are context specific?

Human Computer Interaction (HCl) and Music

HCl involving simultaneous control of multiple parameters, timing, rhythm, and user training are highly specialized branch for the gestural control of computer generated sound. According to Hunt and Kirk, various attributes as characteristics of a real-time multi-parametric control systems, that is as follows:

- Human computer dialogue don't have fixed ordering.
- It don't have single permitted set of option (choice from a menu) but rather a series of continuous controls.
- User's movements have an instant response.
- Control mechanism is learned by user that is a physical and multi-parametric device and its action become automatic.
- Increased control intimacy and competence of operation by further practice.
- The human operator that is familiar with the system, is free to perform other cognitive activities whereas operating the system.

Interaction Context

Interaction in a musical context may mean:

- Instrument manipulation (performer-instrument interaction) contain in the context of real-time sound synthesis control.
- Device manipulation in the context of score-level control
- Other interaction context which is related to traditional HCl interaction styles such as drag and drop, scrubbing or navigation.
- Device manipulation in the context of post-production activities, in case of gestural control of digital audio effects or sound spatialisation.
- Interaction in the context of interactive multimedia installations.

Control of Digital Musical Instruments

Instrument represented by Digital Musical Instrument that includes a separate gestural interface (gestural controller unit) from a sound generation unit. Both units are independent and related to mapping strategies.

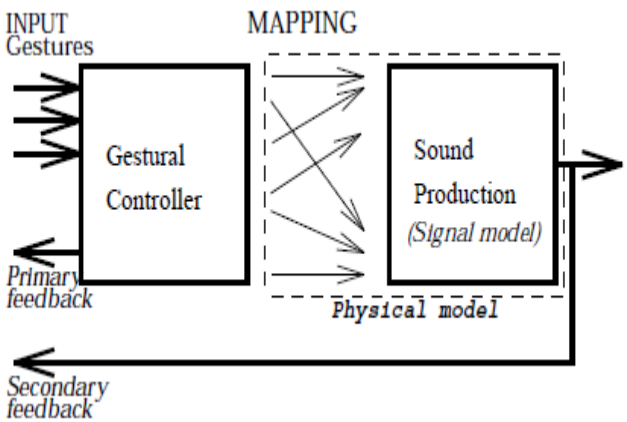

Figure: Digital Musical Instrument Representation

Gestural controller is referred to as input part of DMI where physical interaction with player take place. But sound production unit can be seen as the synthetic algorithm and its control. The mapping layer is referred to as link strategies between output of the gestural controller and input controls of synthesis algorithm.

In case of acoustic instruments, this separation is most of time impossible, where the gestural interface is also part of sound generation unit. The basic characteristics of existing instruments may be lost and difficult to reproduce such as tactile/force feedback.

Gesture and Feedback

For gestural control of sound synthesis, design of new DMI, it is essential to analyze the characteristics of actions produced by expert instrumentalists during performance and this actions are commonly referred to as gestures in musical domain. Let us initially consider performer gestures as performer actions produced by the instrumentalist during performance meaning both action such prehension and manipulation and noncontact movements.

Performer gesture: During performance, instrumentalists simultaneously execute various types of gestures. Some of them are related to production of sound, others may be not related to production of sound but nevertheless present in most highly skilled instrumentalists performances. Feedback can also be considered depending on its characteristics which is as follows:

Primary/secondary, in which primary feedback includes visual, auditory (clarinet key noise) and tactile-kinesthetic but in secondary feedback relates to the sound produced by instrument.

Passive/active, in which passive feedback relates to the feedback provided through physical characteristics of system while active feedback is produced by the system in response to a certain user action (sound produced by instrument).

Gestural Acquisition

Gesture contain the characteristics in which acquisition system is important. In case of performer instrument interaction, this acquisition may be performed in three ways.

Direct acquisition: for performing actions, one or various sensors are used. The signals from these sensors present isolated basic physical features of gesture: pressure, linear or angular displacement, speed or acceleration. Each physical variable of gesture to be captured will normally require a different sensor.

Indirect acquisition: sound produce by using the instrument, where gestures are extracted from the structural properties. In order to drive performer's action, signal processing techniques can then be used by analysis of fundamental frequency of sound, its spectral envelope, its temporal envelope etc.

Short-time energy that is related to dynamic profile of signal indicates the dynamic level of sound but also possible differences of instrument position with respect to microphone.

Fundamental frequency that is related to sound melodic profile and gives information about fingering.

Spectral envelope representing the distribution of sound partial amplitudes that give information about resonating body of instrument.

Amplitudes, frequencies and *phase of sound* partials that provide much of information obtained by previous parameters.

Physiological signal acquisition: in which analysis of physiological signals such as Electromyography (EMG). Analysis of muscle tension and used in musical context are developed by the commercial systems.

Gestural Controller

Once one or several sensors are gathered as part of a unique device, this device is called an input device or gestural controller. DMI contain the part in which one of them is gestural controller where physical interaction take place. Physical interaction means action of performer, be they body movement, empty handed gestures or object manipulation and perception by performer of instrument's status and response by means of tactile-kinesthetic, visual and auditory senses.

In order to analyze the various possibilities, a three-tier classification of existing controller which is as follows:

Instrument-like controllers: Each feature of existing instrument to be reproduce by designing input device such as electronic keyboards, guitars, saxophones, marimbas etc. This classification contain the sub-division which is Instrument-inspired controllers that is largely inspired by existing instrument's design.

Augmented Instruments or Extended Instruments: It is also called Hybrid Controllers that is augmented by the addition of extra sensors. Commercial augmented

instruments included the Yamaha Disklavier which is used for instance in pieces.

Alternate controllers: whose design does not follow an established instrument's one such as hand, graphic drawing tablets etc. Gestural controller using the shape of oral cavity has been suggested in.

These instruments or controllers can be classified into different categories.

- Touch, expanded range, or immersive controllers depending on the amount of physical contact that is required from the performer.
- Individual or collaborative controllers [78], depending on whether the instrument is performed by one or multiple performers at one time.
- Metaphorical or ad hoc controllers.

Review of Literature

Filatriau and Arfib, concluded that gesture is not gesticulation, it is restricted by two things: first one is the feasibility of this gesture and this constraint is linked with ergonomy research and second is gesture is linked with sonic result and it is aesthetically restriction. It contain the double meaning of musical gesture: it is an action and perception movement. Many musical experiments uses gestures and textures, there is no real state of art of this powerful combination or alliance.

Wanderley, Depalle and Warusfel, stated that the study of influence of performances' ancillary gestures in the production of sound by clarinet. During performance, these gestures have an undeniable visual impact, which is part and parcel of top instrumentalist's technique. Ancillary gestures also effect on the sound production and may generate strong sound modulations which are perceived as beating or phrasing like effects. In order to identify the causes of modulations that have the recorded an extensive set of clarinet sound in different reproducible environments such as a variable acoustic auditorium and an anechoic chamber.

Godøy, Haga and Jensenius, in this study, imposed restrictions on sound material that is shortness and salience feature of sounds, the fair amount of consistency in some of the responses is perhaps not so surprising. The study of gestural primitives is applied to systematic and large scale studies of sound gesture relationships as well as more complex objects.

Wanderley, concluded that analyzing the existing classification of gestures in music in the light of behavior of acoustic wind instruments, gesture usually not referred to as important in sound synthesis should be considered, they are affect the sound captured from the instrument.

Iazzetta (2000), new listening models is electroacoustic music force which are more extensive and unsteady than the ones that support traditional music. It do not have limitation to instrumental or vocal models. In case of absence of performers, instruments and visual and gestural references provide a radically expanded experience: "everything remains to be revealed by the composer and discovered by the listener". Electroacoustic music works deviated from the instrumental gesture to acousmatic listening, music have lost the expressive and dramatic power conveyed by the gestural realization of the performer.

G´omez (2006), by using Hidden Markov Models, show the segment fundamental frequency contours of note-to-note transitions but still need to extend the approach to inclusion of any kind of instrumental gestures in performance, gestures are formed by more than one segment and recognizing and segmenting the contour into gestures and micro-gestures.

Schacher (2007), concluded that gesture control of sources in periphonic surround sound. In modular structure, use a few key software components which should permit the construction of frameworks for gesture interaction that are simple to use and powerful in their expression.

Marshall, Malloch and Wanderley (2009), dictated that examination of a number of different existing spatialisation systems in order to determine the types of parameters used in such a system which might be controlled using gesture. Gesture control by using the human computer interaction literature and examining a number of mapping issues which impact the design of systems. In this paper, explain the three main role for controlling of spatialisation, which have been developed in conjunction with composer to allow for good compositional use of gesture controlled spatialisation.

Bouënard, Wanderley and Gibet (2010), in this paper, analyzing and synthesizing new percussion performances from real pre-recorded gestures and facilitating the interaction process between gesture and sound. On mallet trajectories, led to the identification of consistent control parameters (position, velocity and acceleration with their corresponding time stamps).

Conclusion

This paper play an important role for controlling the gestural in music and sound and cover some topic such

as gesturally controlled computer-generated sound, gesture acquisition etc. It is start from the interaction between human and computer in various musical contexts and describe in detail of interaction to music/sound control. In this paper, discuss about the constitute parts of new instruments and current developments instruments focus on the design of new gestural controller or on the proposition of different synthesis algorithms. Indirect acquisition that is the type of gestural acquisition, through which analysis of sound produced by acoustic instruments that may help the design of new gestural controllers.

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