MADDM -- DANCE-DIRECTED MUSIC

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Abstract

A myoelectrically-activated dance-directed music system (MADDM) is described with which a dancer may control music using the very movements of the dance. The system is based on a myoelectric control system strapped to the performer and linked by radio to a receiving unit. Prototype components have been designed and constructed.

1. Introduction

The concept of kinetic control of musical material is not new in the field of electro-acoustic music. Mumma's motion sensors for the Merce Cunningham Dance Company, Chadabe's proximity-sensitive antennae, and Buxton's glove transducer for the Structured Sound Synthesis Project synthesizer, are ready examples of the technique.

The control of music through dance may be accomplished conceptually in a number of ways [1,2]. In general, one envisions a set of switches, accelerometers, or pressure sensors of some type for detection of body movement and conversion of this movement into an electrical signal.

Once a corresponding electrical signal is derived, it is apparent that some scheme may be devised by which a synthesizer may be controlled, ideally in a standardized way, using a system such as MIDI. However, the extent to which the dancer may control the music to which he or she dances is highly dependent on the scheme employed. Thus it is appropriate to establish design criteria before considering design details. The creation of such design criteria is discussed below.

2. Formulation of Design Criteria

Firstly, it is desirable that the dance be allowed to proceed as the music evolves, without the requirement for severe (or perhaps impossible) control movement. Without this feature, creation of the music would be at the expense of the dance itself, making impossible a totally artistic and satisfying performance.

Secondly, the music itself must be the result of the spontaneous and creative instincts of the dancer, not simply of an unseen composer. Obviously, to have the dancer precompose music would be unacceptable. In a particularly narrow sense such an approach could satisfy the notion of a dancer controlling music, but the music itself would be unaffected by the dance, and the result would be the traditional interpretation of a preconceived musical passage.

Finally, there are some compromises which must be made to reconcile the criteria above with the expectations of different audiences to whom the resulting performance is to be pleasing, both visually and musically. Thus, in one piece it may be inappropriate to provide a dancer with means to produce any musical note or combination of notes at any time, yet in another work this could be desirable. Greater license in the choice of notes would likely place severe restrictions on allowable sequences of movement which simultaneously result in pleasing music and dance. Clearly the appropriate balance will come with experience. Thus to be effective, a dancer-controlled music-synthesis system must be conveniently adaptable in this regard.

3. Design Overview

There are two separate performance-related aspects of the MADDM system. Firstly, the system provides the dancer with essentially unencumbered movement through the use of a set of lightweight modules strapped around the waist. Secondly, the system provides a musical framework within which the dancer is given control only over selected events contained in a series of precomposed subscores. This framework is not static; while the progression of the subscores is predetermined, the selection of events from these subscores occurs only under the control of the dancer, and reflects the spontaneous movement and expression of the dance.

The system design for dance-directed music must be approached in two separate phases: The first is to identify an appropriate means of detecting various body movements of the dancer and producing a corresponding electrical stimulus. The second is to produce a device which will receive the stimulus and provide control to an appropriate electronic instrument.

4. The Hardware

The approach chosen to sense body movement involves the detection and amplification of myoelectric signals [2,3]. These signals are voltages which result from contraction of any muscle. Such voltages may be detected easily within the muscle itself, and without enormous difficulty (but at lower amplitudes), on the surface of the skin.

The amplitude of the myoelectric signal varies as a function of muscle-contraction force and velocity. A contracting muscle is associated with a larger myoelectric potential than that produced by a relaxing muscle. By comparing the levels of myoelectric signals from two opposing muscle groups, the MADDM system may detect movement produced by these muscles.

The design of MADDM's myoelectric motion-sensor stage involves the use of instrumentation amplifiers to detect and buffer myoelectric signals appearing on the surface of the skin at the electrode sites. Such an instrumentation amplifier amplifies the tiny myoelectric signal appearing betwen the electrode contacts while rejecting all voltages common to both contacts. This is necessary in order to eliminate much larger voltages at 60 Hz and its harmonics which are also present on the surface of the skin, picked up from nearby wiring and connected appliances.

The detected myoelectric signal is then full-wave rectified and smoothed in order to provide a dc voltage reflecting the level of myoelectric activity at the associated electrode site. By comparing two such levels from electrodes placed over opposing muscle groups, the system provides information regarding the direction of the movement produced by these muscles, as well as the velocity of this movement.

Each movement which is selected for control of the music thus requires two control sites, each site located over one of the opposng muscle groups responsible for the movement. While this system has the disadvantage of requiring a fairly high component count, the physical size of the system has been minimized through the use of the low-power circuitry, modular construction, and careful layout techniques.

The components which must be resident on the peformer have been reduced to two kinds: a group of small modules which are to be secured around the waist on a belt, and a set of straps holding the electrodes against the surface of the skin at the selected control sites. Each strap contains one or more pairs of electrodes with each electrode carrying its own preamplifier. Each preamplified signal, still in balanced-signal form, is connected via twisted pairs to its associated signal-processing module mounted on the belt.

The belt contains a separate signal-processing module for each pair of electrodes and, as well, a single transmitting module. Each signal-processing module receives two balanced, zero-average preamplified myoelectric signals. It compares the relative levels of these signals and notifies the transmitting module of a significant difference between them. This difference, when it exceeds a preset threshold, indicates that one muscle group has contracted significantly more than the other.

The notification which the transmitting module receives from each signal-processing module is of the form of a pair of binary signals obtained from the outputs of comparators in the signal-processing module, one for each direction of motion.

The transmitting module contains a number of sinusoidal oscillators, a summing amplifier, and an FM transmitter. Each oscillator represents a distinct channel of the system in which information regarding a single movement is transmitted.

When a processing module feeds a high level to the transmitting module, its associated oscillator is switched on. The resulting tone is fed to a summing amplifier to be included in a composite signal. Using a single FM transmitter, this composite signal is transmitted to a fixed receiving unit located at some distance from the dancer.

The fixed receiving unit consists of an FM receiver, decoding circuits, and all of the necessary logic devices to store subscores and to control a synthesizer according to the received signal. This unit represents the second phase of the design; once a radio-linked signal indicating various body movements has been received, there is essentially total freedom in what is done with this information and how it is interpreted.

5. Musical Frameware

The MADDM system is to be designed so that each detected movement controls one event of a subscore. However, depending upon which subscore is present, a specific motion will produce a different event, since the subscores change according to a preprogrammed progression. It may be desirable to set up the system so that each movement controlling an event simply triggers the event to begin, with the event persisting until the same movement is repeated. Usng such an arrangement, the music would continue even while the performer remains stationary.

In addition, should the performer desire the presence of a constant musical pattern, a subscore may be played continuously, thereby avoiding the need for repetition of a motion. As stated previously, decisions regarding the optimum arrangement for the MADDM system remain to be made after experience has been gained through experimentation.

6. Conclusions

The MADDM system provides a dancer with means to create music which is dependent to a great extent on the dance itself. By restricting the events available to the dancer, MADDM facilitates a performance having a desired musical framework, yet still provides the dancer with control over the actual music heard during the performance. The advantage of this arrangement lies in the ability of the dancer either to concentrate solely on the dance and let the system convert the movements of dance into music, or to perform/compose with the system in an interactive manner.

7. Acknowledgements

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8. References

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