Abstract

Step quantized music lacks the expressive content of music rehearsed and performed by a conductor (randleader) and musicians. Notes and phrases played by individual instruments realize expression when the dynamics such as volume and rhythm undergo change while notes are held or phrases played.

By providing a general library of performance expressions that can be selected and attached to notes and phrases, an editable hybrid of live performance and step quantized music is realized. Quick and easy rehearsal changes can be made since expressions and phrases are editible.

^ SMALLTALK (Goldberg et al 1983) based object-oriented playback and composition system (Pope 1987) was built that attaches real-time music macro expression objects to notes and phrases. These objects define a performance modulation template consisting of continuous controller data and rhythmic data (e.g., when to start a note, note duration, etc.). Templates may be defined as one shot or looping.

Performance gesturing expressions captured from the performing dramatic arts were used to define the library of music macro expression objects. Expressions were then attached to a step recorded MIDI score and rehearsed to realize an artistically transformed MIDI performance. While this might be akin to the colorization of black and white music, it is also a valid way for an artist to go beyond choosing orchestration to that of choosing expression. Orchestration that used simple instruments with non-layered voices and standard-type attack/hold/decay/sustain/releases (AHDSR) enveloping were found to be more expressive than complex voices which already have predefined expression built into them.

Introduction

LiveStep is a computer music software platform that allows the easy creation of complex performance enhancements to step recorded music. By taking advantage of the real-time control possible in commercial MIDI voice boxes, LiveStep expands the intentions of an instrument "patch" by dynamically reconfiguring the "patch" during a performance. This is achieved through algorithmic interpretation of MIDI music data streams to add expression nuances. Each algorithm is encapsulated into a music macro object capable of following a continuous global musical context. Rhythmic and control parameter variations are thus generated for better expression articulation and phrasing (Wessel et al 1987). LiveStep capabilities include:

- data reduction by the use of algorithmic music macros. Music macros are data generators, not buckets for raw data. LiveStep eases the task of expression manipulation, revision, and editing in a musical score by allowing the creation, selection, placement, and parameterization of music macros.
- generation of complex expressive musical scores and performances by "composers".
- generation of complex interactive expressive performances by "conductors".

Music and dance coexist and in some cultures the words for music and dance are identical (Gilbert). Expressions from the performing arts were used to directly develop
LiveStep music macros. Musical interpretations of Laban's eight basic effort actions (Laban, 1955) for Modern Dance were developed and grammatically applied to step music. These dramatic gesture primitives are used to select parameters for instrument performance (e.g. legato, staccato, pitchbend, volume, ADSR waveform envelopes, filter cutoff and q).

LiveStep has also been used to developing musical "play along" music-minus-one algorithms which adjust a live performance to an existing musical context. Interpretive "musician competent" music macros, with rehearsal training tables, map a performer's phrasing, pitch, and rhythm onto an existing melody and/or harmonic structure to generate computer accompaniment (Vercoe et al 1985) (Block et al 1985).

Background

The computer music data problem:

A computer music performance generates lots of data. LiveStep tries to reduce the amount of data handled by a composer or performer by hiding (e.g. encapsulating) expression algorithms in music macros and using existing MIDI systems. MIDI reduces the amount of data by partitioning the player from the instrument with the concept of a "patch" (e.g. a preselected instrument sample and intonation). MIDI control messages can affect a "patch" by changing volume, pitch, filters, effects, envelopes, etc. LiveStep music macros are real-time control "patches" that reside and execute on a host computer that is controlling a MIDI voice box.

The music software problem:

Music notation, sequencer, and control music systems must allow a unified representation, creation and manipulation of music data. Notation must include complex performance nuances. Sequencing dealing with the raw recorded data must include abstract representation for easy and coherent manipulation. Control language programs must go beyond a role of limited pattern generators or low level "machine" computer languages.

LiveStep addresses these requirements with an "object-based" representation for all musical elements. Written in SMALL-TALK, LiveStep loads MIDI files created by other systems, attaches music macros to a staff (i.e. MIDI channel), and executes the music composition by sending MIDI data to a MIDI voice box or synthesizer.

The instrument performance problem:

Manufacturers' MIDI voice boxes have triggered synthesized sounds that seem rich but repetitive (Moore 1987) each time played. These patches with complex layered waveforms, predefined ADSR envelopes, and control routings to filters, effects, pitchbend, volume, modulation, etc. can be affected in real-time by an external computer to produce musical context sensitive expressive intonations. Inflections changing at a 500k data rate require an update every millisecond to select or set a control change. This is easily computed and transmitted by LiveStep. This allows the "patches" to reside in a host computer with inflection variations generated at performance time rather than being constrained to the manufacturers' "patches". MIDI voice boxes containing many MIDI controllable waveforms, effects, filters, low frequency oscillators (flos), and control routings offer the most expressive possibilities.

The LiveStep System

LiveStep is a multi-tasking software program that manages and reinterprets multiple MIDI data streams in real-time. Algorithmic music macros are used to control, modify, and generate a MIDI data stream. LiveStep can execute many algorithmic music macros concurrently, one each for a music staff which contains a single voice. Music is loaded from a MIDI file into LiveStep memory and when played LiveStep's macro interpretation is sent to the MIDI voice box.
Music Macros

The macros that have been defined and used fall into the following categories:

Generators:
These music macros provide repetitive control of pitches, duration, velocity, etc. A generator may contain several patterns which are played conditionally or randomly. They represent the best of the pattern creation capabilities present in "drum" machines. The interaction between parameters many be defined in a non-linear "instrument state fashion" to create instrument characteristics not available from a manufacturers supplied "patch".

Modifiers:
Examples include:
- rhythm: swing, syncopation
- duration: legato & staccato markings
- phrasing: velocity, duration, rhythm
- inflection: velocity, duration, rhythm, pitchbend, filters, effects

Control Interpreter modifiers:
These music macros algorithms provide MIDI output stream modification based on data in the stream and LiveStep global parameters. Examples include:
- simple interpreter
- convert pressure to velocity
- complex
- pressure to velocity and pitchbend
- gesture generated acceleration and pressure to volume and pitchbend

Performance Control
LiveStep allows the calibration of raw external MIDI and non-MIDI sensor data external inputs (e.g. sensors for pressure, velocity, acceleration, etc.) and routes them to LiveStep global parameters for use by music macros. This allows the musically competent reinterpretation of external performance commands by music macros before being sent to the output MIDI voice box. A global music macro is defined for "conductor-like" control for tempo, volume, legato and staccato duration, and velocity settings. A playback or recording of raw external sensor data is initiated from this control.

Modern Dance Macros
Concepts and nomenclature developed by Laban for Modern Dance were interpreted to form music macros of the same name. Laban defines four motion factors:
- Space: direct/flexible (e.g. the path taken direct or not)
- Time: sudden/sustained (e.g. duration/speed/acceleration)
- Flow: bound/free "in an action in which it is difficult to stop the movement suddenly, the flow is free" (Laban 1985).

From Weight, Space and Time, Laban describes eight basic articulated effort action combinations:
- thrust (strong, direct, sudden)
- slash (strong, flexible, sudden)
- wring (strong, flexible, sustained)
- press (strong, direct, sustained)
- float (light, flexible, sustained)
- glide (light, direct, sustained)
- dab (light, direct, sudden)
- flick (light, flexible, sudden).

"Efforts" having the following Weight-Time relationship are translated as follows (Preston-Dunlop 1981): light/sudden is staccato, strong/sudden is marcato, light/sustained is legato, and
strong sustained is made by setting velocity, duration, and rate parameters. Efforts defined as "direct" simply select the note to be played, whereas a "flexible" effort selects one of several note embellishments. Transitions from one effort to another are described as gradual, less gradual, or abrupt (Preston-Dunlop 1980) which LiveStep interprets by adding additional velocity (volume) emphasis to the note of the new effort.

MIDI patches are expressive for the context in which they were created. If played longer or shorter than the inherent patch expression they exhibit a discontinuity of expression. Within the fixed duration of a single dance movement the effort action must be completed and not have any discontinuity. This is done by the dancer changing the rate at which the action performed. Since MIDI presets have no notion of "rate of expression", LiveStep uses simple presets and generates all expressions "patch" changes in real-time for transmission to the MIDI box.

Summary
LiveStep provides for:

- Data reduction and concise representation of performance with algorithmic music macros.
- Redistribution of MIDI voice performance parameters to a host computer. The ideal target MIDI voice box is a compact MIDI digital signal processor with many raw waveforms, effects, filters, yes, and routings.
- Interactive Control through peripheral sensors of gestures to "musically competent" macros for reinterpretation of performance data rather than performing the raw data. This allows the use of rehearsed performances, corrected play along (e.g., "music-minus-one"), and other forms of interactive music.

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