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HARDWARE, SOFTWARE, AND COMPOSITION TOOLS FOR A REAL-TIME IMPROVISED SOLO TRUMPET WORK

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ABSTRACT

Brass players have been at a disadvantage when using their instruments as computer music controllers, because they have been limited to commercial pitch extractors which do not measure and use the unique spectral and control features of the brass instrument family. In this project, brass instruments were fitted with several sensors and were used in conjunction with a commercial pitch extractor to increase the bandwidth of control information for interactive musical performance.

Systems were constructed using a trumpet and a valve trombone. Pressure sensors in the mouthpiece, on the bell, and in a mute are used for pitch detection and pickup of direct horn sound. Switches and linear potentiometers were mounted near the valves for finger control, and traditional foot pedals were also available for control. Signals from the pitch detector and the controls were routed to a computer via MIDI. The computer was connected via MIDI to various synthesizers, samplers, and signal processing devices. The direct sound from the bell microphone was routed through computer controlled signal processors.

The software, written in MIDI Lisp, performs various functions under the control of the switches, pedals, and note information from the player. The switches and pedals can cue events, such as a section of an accompaniment, a small series of notes based on recent notes played by the performer, or the running of another program with different functions mapped onto the controllers. The programs can also provide automatic harmonization of melodies played on the horn, with the harmonic relationships determined by the positions of the switches. Other programs control the signal processing devices, modifying the natural trumpet sound, providing harmonization and control over spatial placement.

HARDWARE DESCRIPTION

Two versions of the hardware were constructed and mounted on two brass instruments; a trumpet and a valve trombone. All switches and pots were mounted in the region around the valves, so they are accessible using only the fingers. Brass players do not typically look down while playing, and many solo performers move about the stage rather freely. For this reason most of the applications that were implemented rely very little on foot pedals. The compliment of horn sensors is as follows;

1. Micro switches mounted so that they can be operated with the thumbs or fingers.

2. A slide pot with finger ring which can be actuated with the thumbs or fingers.

3. Three switches mounted under the valves, actuated by either depressing the valves, or by pressing the switch actuator extensions below the valves.

4. A transducer for pitch detection. On the trumpet, this is a transducer mounted in the mouthpiece. On the trombone, it is a condenser microphone element mounted inside a Harmon mute.

5. An envelope follower which provides a logic signal when signal is detected. The input for this circuit is the horn-mounted transducer.

The switches and pots are routed to a device which converts these to MIDI control signals. The three valve switches are connected to a resistor divider network for encoding as a single MIDI continuous controller. Figure 1 shows the control patching configuration. Figure 2 shows the audio patching configuration.

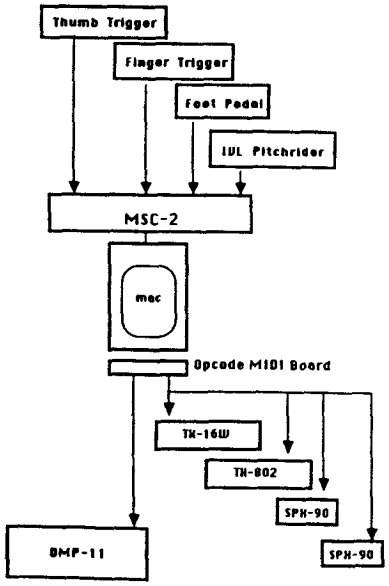

Figure 1 MIDI Patching for INVISIBLE MAN (1989)

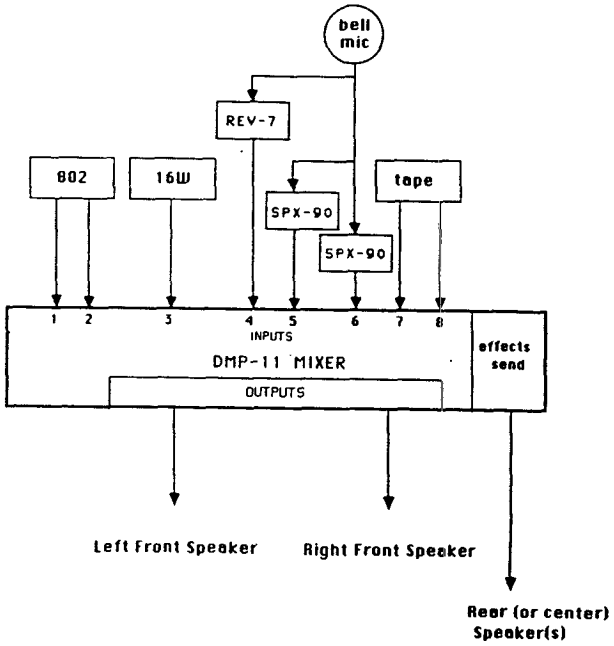

Figure 2 Audio Patching for INVISIBLE MAN (1989)

HARDWARE APPLICATIONS IN A SIMPLE MIDI CONTROL SITUATION

In the simplest configuration, the two thumb switches and the thumb controlled slide pot have been connected to a synthesizer as standard MIDI keyboard controllers. The pitch information comes from a pitch to MIDI converter, and the triggers can function as sustain, portamento, or program increment actuators. The slide pot can function as modulation, volume, or other synthesizer voice parameter control.

HARDWARE APPLICATIONS IN AN ACTIVE MIDI CONTROL SITUATION

Taking a step forward in complexity, some algorithms for more direct MIDI control have been constructed. In one such scheme, the pitch detector is not used and the horn need not be acoustically played. The slide pot selects the note range (selecting the particular overtone to be played), the valve switches provide chromatic transposition using normal brass instrument fingerings, and one thumb switch causes notes to play. The second thumb switch functions as a sustain 'pedal'. In this scheme, the instrument can be "played" under switch control only, leaving the player's mouth free to speak or sing.

SOFTWARE FOR ACTIVE MIDI CONTROL

In another class of control schemes, the pitch detector is used, but all MIDI information is routed through a computer for processing and synthesizer control. The software reads the positions of the controls along with the note information from the pitch detector, and controls synthesizers and signal processing equipment. Routines available include MIDI special effects such as echo-like effects, instrument-cued accompaniment systems such as switch controlled harmonies or pattern playback, and recorder-like functions. One other class of programs controls the signal processing equipment, which processes the natural horn sound.

MIDI special effects available in the system provide effects which are echo-like, but the echoes are arbitrary in pattern, decay, timbre, and other features. Non-linear amplitude, pitch, and timbre changes can simulate physical effects such as doppler pitch shift, or provide effects which have no physical paradigm whatsoever.

Accompaniment control is provided in two ways. In one routine, a simple one-to-one relationship is used between a switch gesture and a note played. Thus a bass line can be played with arbitrary tempo using a foot pedal or finger trigger. The other configuration uses switches to launch MIDI events, such as sequences of pre-loaded MIDI notes. Thus sections of an accompaniment can be started by depressions of the switches. Multiple instances of the same pattern can be started with repeated switch depressions, allowing dense textures to be built up from the pre-loaded patterns.

Harmonization algorithms are available which use either the MIDI synthesizers or the signal processors acting on the natural horn sound. Pre-loaded harmonies for each scale tone, and for each non- scale tone, are selected with two switches. The three switch-on positions produce a rich set of selectable harmonies, which can also be changed sectionally within a composition, or by a foot pedal depression. This provides unlimited harmonic possibilities, and eliminates the parallel harmony effect usually associated with simple pitch detector based harmonization schemes. Figure 3 shows a typical set of switch-encoded harmonies.

A set of routines based on a tape-recorder paradigm allow the player to enter pitch and rhythm information, then play it back immediately afterward. A one-track recorder records pitches and rhythms when the record switch is depressed, and plays back the pattern each time the playback switch is activated. The sequence is entered into the output buffer each time the playback switch is pressed, so many copies of the pattern may be layered on playback. A multi-track scheme maps each track into a synthesizer voice, and under switch control the player may record to each track. Playback occurs continuously in a loop, so the composition evolves as new information replaces previously recorded patterns. A pre-loaded track is available for accompaniment, and may be a different length than the recorder tracks for iso-rhythmic effects.

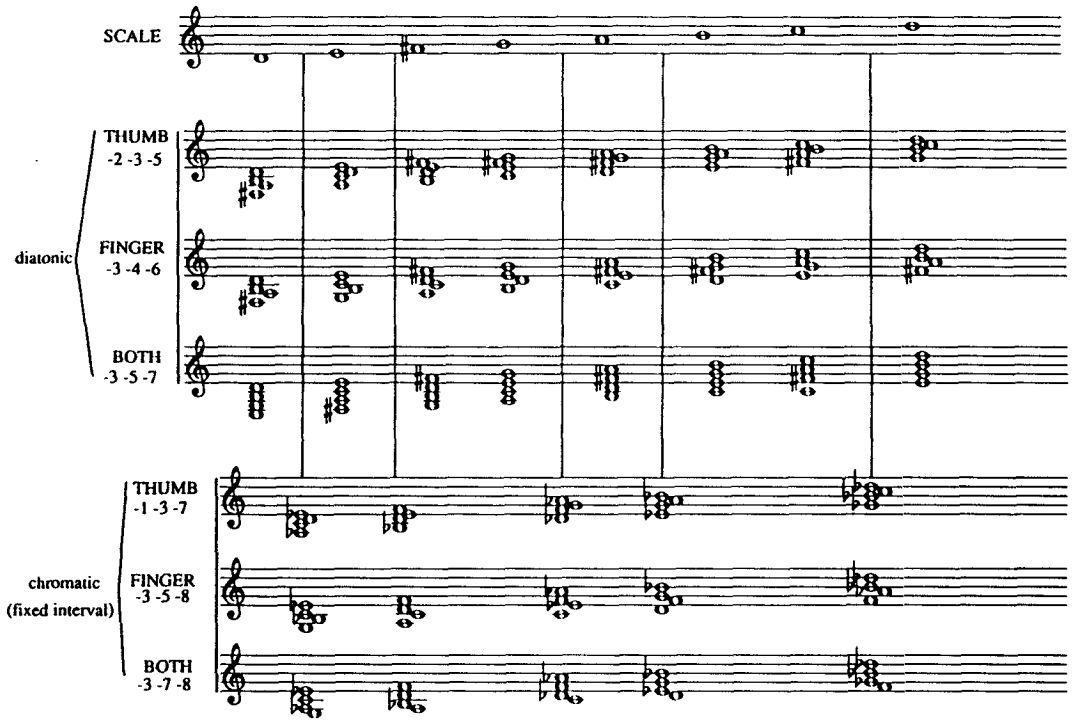

Figure 3 Harmonies used for INVISIBLE MAN (1989)

A MUSICAL COMPOSITION USING THE MIDI TRUMPET SYSTEM

Dexter Morrill has composed a work entitled SKETCHES FOR INVISIBLE MAN, for solo trumpet and computer music system. The piece is dedicated to the memory of Buddy Bolden, the legendary trumpeter from New Orleans who performed before the age of Jazz recordings. It was reported that Bolden had an enormous sound that could be heard across the city of New Orleans. In its current form the Sketches are simple designs for solo Jazz improvisation, performed with some pre-recorded music, processed horn sounds, and synthesizer sounds. Ralph Elison's powerful novel served as a point of departure for this composition, and seemed appropriate for a medium filled with incongruities, where pure masking is possible, where the solo player's heroic role is confused and so much lies beneath the surface, safely away from the listener's view. INVISIBLE MAN is a study in complex and odd relationships, bringing together Jazz Music and the phenomenal technology of computers (two American contributions of infinite worth for the Twentieth Century). Here, the MacIntosh computer processes the incoming stream of note data and processes it, often adding a stream of trailing notes or a harmony. A digital tape recording is used for an accompaniment, turned on at the correct time when the trumpet is playing.

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