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A MARRIAGE OF THE DIRECTOR MUSICES PROGRAM AND THE CONDUCTOR PROGRAM

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ABSTRACT

This paper will describe an ongoing collaboration between the authors to combine the Director Musices and Conductor programs in order to achieve a more expressive and socially interactive performance of a midi file score by an electronic orchestra. Director Musices processes a "square" midi file, adjusting the dynamics and timing of the notes to achieve the expressive performance of a trained musician. The Conductor program and the Radio-baton allow a conductor, wielding an electronic baton, to follow and synchronize with other musicians, for example to provide an orchestral accompaniment to an operatic singer. These programs may be particularly useful for student soloists who wish to practice concertos with orchestral accompaniments.

1. INTRODUCTION

This paper is intended to serve two purposes. It is a celebration of one facet of Johan Sundberg's long and brilliant career which continues at an undiminished speed, despite his "nominal" retirement from KTH. It is also a progress report on the recent ongoing collaboration which the other authors have been privileged to have with Johan. One author (Mathews) felt that a paper describing this research would be both an appropriate vehicle to honor Johan and would also allow the world to share some of his recent results. It also seemed necessary and appropriate that he should be included as an author of this paper.

Because of its unusual dual objectives and because the authors are now on different continents, the paper is being drafted by one of the authors (Mathews) and he accepts full responsibility for any mistakes and for any possible misrepresentations of the other authors' opinions.

2. THE QUEEN OF THE NIGHT ARIA

In the mid 1970's computer music was in the frustrating position of theoretically being capable of synthesizing any sound but practically unable to generate many timbres, particularly those of the human voice. Johan spent a few months at the newly formed IRCAM in Paris working with Gerald Bennett and Xavier Rodet [1] and Yves Potard. Together they developed an "analysis-by-synthesis" technique for synthesis of the singing voice. The result was the first professional quality singing voice synthesis. It depended on Johan's knowledge of the human voice along with Rodet's formant synthesis program, Bennett's musical expertise. The detailed synthesis was mostly done by Potard.

3. BICYCLE BUILT FOR TWO

The "queen" aria still is the most convincing example of computer singing which exists. It also illustrates the power of utilizing speech research knowledge for musical purposes. Johan, from his position in the KTH speech and music laboratory, has long been a prime example of the power of this liaison.

The first computer singing synthesis also depended on basic knowledge from KTH. The bicycle song, became famous in the movie "2001: A Space Oyssey" as the computer's swan song. It was created by John Kelly and Carol Lochbaum at Bell Telephone Labs in 1960. They used the vocal tract area function data from Gunnar Fant's famous book [2].Their synthesis used a tube model of the vocal tract in which the areas of the tubes were manipulated by the computer to achieve the proper spectrum for both vowel and consonant sounds. Their program was the first example of the physical modeling approach which only became popular to create music timbres much later in the 1990s [play example in talk]

4. SYNTHESIS OF SINGING BY RULES

The synthesis for both "queen" and "bicycle" involved hand tailoring the sounds, a very tedious process. This and the desire to better understand the rules singers use led Sundberg into studies of rule synthesis [3]. His experimental vehicle was a hybrid synthesizer, MUSSE, a formant analogue machine driven by a minicomputer.

Data for the rule synthesis consisted of a table of the first five target formant frequencies and the first three target formant bandwidths for both vowels and consonants ("queen" being a vocalise had no consonants which much simplified its synthesis). The target information for the sequence of vowels and consonants to be sung were then converted into smooth time functions by coarticulation and other rules in the minicomuter computer program.

The resulting time functions were sent to MUSSE. The resulting singing showed both that expressive rule synthesis is possible and that the rules that singers use are very complex and many factors in addition to formant frequencies and bandwidths must be evoked to achieve acceptable quality.

5. DIRECTOR MUSICES

Johan later extended his interest in rule synthesis to rules for expressive performance of instrumental music [4]. By then sampling synthesizers had developed useful timbres for most

orchestral instruments and midi files had become a lingua franca for representing scores and playing them automatically with a computer and synthesizer. With sufficient effort, scores in general music notation can be converted to midi files. But most resulting midi files are too "square" to yield expressive performances when played directly on a "dumb" synthesizer. The performances lack the phrasing and dynamics that trained musicians would always add when performing from a traditional paper score. Director Musices ameliorates this limitation.

Director reads a "square" midi file and writes out a modified midi file where the times of starting and ending notes, the loudness of notes, and possibly the timbre quality of the notes are adjusted to create a more expressive performance.

Usually Directror applies a pallet of about a dozen rules to the input midi file. The weight with which each of the rules is applied can be adjusted by the user from zero which produced no change to a maximum which produces unacceptably large changes. Negative weights can even be commanded by an iconoclastic musician.

Some rules only use the pitches and durations of the notes in the "square" input score–for example making high pitched notes louder or increasing the duration contrast between long and short notes. Other rules require additional information beyond what is in the midi file.

Phrasing rules require that phrase beginnings and endings be added to the midi file. Melodic and harmonic "charge" rules emphasize notes and chords that are unusual in the key of the music. These rules require a harmonic analysis be added to the midi file. Adding a harmonic analysis can be a substantial task.

6. THE CONDUCTOR PROGRAM

The Conductor Program was conceived by Mathews at Bell Telephone Laboratories in the mid 1980s and further developed at CCRMA after 1987 [5]. It was intended as a mode of computer aided live performance. The model for the program was not a performer but rather a conductor leading an orchestra. A synthesizer provided a virtual orchestra and the Radio-Baton provided two batons with which the conductor controlled the synthesizer.

The score was an augmented midi file. The main augmentation was a conductor track added to the midi file with trigger points corresponding to expected baton beats. A baton beat causes the program to play the next beat's worth of score in the midi file. The time between the previous two beats sets the tempo used to play the next beat's worth of the midi file. Thus the conductor's baton controls both onset of each beat's worth of midi file and the tempo at which it is played.

The Conductor Program also requires a preamble score which defines how motions of the second baton control the dynamics and balance of the various voices in the orchestra.

Perhaps the most important strength of the conductor program is its precise control of time so that it can function as a social instrument playing with other instruments and supporting its share of the task of synchronizing with the other performers. It can provide orchestral accompaniments for soloists who can not afford real orchestras.

Its greatest weakness is the lack of intelligence of the synthesizer and midi file score compared to that of an orchestra of highly trained musicians.

7. MARRIAGE OF DIRECTOR MUSICES AND THE CONDUCTOR PROGRAM

By 2000 Gerald and Verena Bennett in Switzerland had experimented for some time with the Radio-Baton and the Conductor Program accompanying piano students and singers. They were dissatisfied with the lack of musicality in the "square" midi file scores which were all that were available to them. Gerald believed that processing the midi files with Director Musices could greatly improve the accompaniments. He raised support to bring the authors of this paper together in Zurich for a total of four weeks in 2000 and in 2001 to develop and try his idea.

Although I much looked forward to the opportunity to work with Johan and Gerald, I had doubts that the marriage of our programs would work. I feared that the expressive control by the conductor during the live performance would fight with the expressive changes made in the midi file by Director. I also thought there might be computer conflicts in joining the two programs that we would not have time to solve during our short time together. I think Johan shared some of my concerns.

Happily my fears were unfounded. Thanks to midi files as a lingua franca, the programs worked together immediately. Also we were able to achieve useful compromises on who was in charge of various expressions.

Our working procedure started with a square midi file. Next a baton track of trigger points was added to the midi file. This required committing to the number of beats per measure which usually, but not always, corresponded to the time signature of the score. Occasionally we would double the number of trigger points to give the conductor finer control of timing. Extra trigger points could be added to terminate fermatas.

The augmented midi file was then passed through Director after choosing a trial set of weights for the pallet of rules. Director would adjust the loudness via the midi key velocity byte for each midi note in each voice. Director would also introduce pauses and timing changes by moving midi note start and end times forward or backward various numbers of midi file ticks. The same timing changes were made in all tracks so all the voices would remain synchronized including the baton track. Adding the baton track to the midi file before applying Director was necessary so baton trigger points would remain associated with the notes they were supposed to trigger.

In the live performance, the conductor completely controlled the performance times of the trigger points notes and the overall tempo at which the notes between two trigger points would be played. Director could adjust relative times of notes between trigger points.

With a baton, the Conductor could control the loudness and balance of the voices by varying the synthesizer volume control (C11 in midi terminology) for each voice. Since C11 is completely independent of the midi key velocity byte, no technical conflict could exist between Director and the conductor.

The sharing of expressive control which I just described worked better than we expected. It yielded performances that were both pleasant to conduct and lively to hear.

We mainly tried orchestra accompaniments for piano concertos and vocal pieces. Purely piano pieces did not prove to

be as satisfactory as orchestral pieces. We do not yet understand why.

Some of Director's rules depend only on information in the midi file. These can be used without much additional work. Other rules require that phrasing information be added. The Director program has provision for marking three levels of phrasing. Putting in phrase marks is not overly tedious.

Other rules, like those for harmonic and melodic charge, require a harmonic analysis of the score which may be more work than the user wishes or is able to invest. The interest in having a program to do this work motivated Craig Sapp to write a new harmonic analysis program which generates a two dimensional analysis. The X dimension is the usual performance time going from beginning to end of the composition. The Y dimension is the degree of aggregation over which a sub analysis is made. At the top of Y, the entire piece is analyzed to estimate the key of the piece. At the bottom of Y, each individual chord is classified. The date is shown as a two dimensional color plot. Sapp's program makes the use of harmonic analysis in Director much more practical. But in addition the program is interesting in its own right.

The program has not yet been integrated with Director and the Conductor Program. All programs use the same midi file as input, but the results of Sapp's analysis must be manually entered into the Director score, which is still time consuming. To make wide usage simple enough to be practical , Sapp's program needs to be combined with Director and Conductor.

8. CONCLUSIONS

The Director-Conductor-Baton system has been convincingly demonstrated at universities in Switzerland and Austria, in Stockholm at a meeting of pan European singers, at Stanford in student classes at CCRMA, and at the Bourges electronic music festival in France. The success these demonstrations encourage us to continue to develop a simple unified device which can accept a midi file and allow the conductor to play an expressive score without having to fight either equipment or computer programs. The hardware box would contain both a Radio-Baton and a synthesizer. Its output would be a stereo signal ready to be sent to a speaker-amplifiers. Director Musices, the Radio-Baton program, the Conductor Program, and a harmonic analysis program would be combined into a single program.

9. REFERENCES

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