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A Study on a Generating Method of Animation Controlled by Music (Rhythm)

Sadahiko Nagae, Yasuyoshi Takamatsu,
Takahiko Yonemura and Kazuya Kojima

Abstract

Aiming at realization of fusion of auditory information and visual information and of novel man-machine interface, a concept called interactive performance is introduced, and basic experiments are carried out. Interactive performance is defined in such that fusion of auditory information and visual information is carried out by a musical performer(s). Specifically, CG appeared on computer monitor changes according to performances played by musical instruments. On the other hand, performances are developed referring to changes in CG. We developed a software for trial purpose to realize interactive performance using CG characters and MIDI musical instruments. This software was installed on the personal computer, and basic experiments were carried out.

CG characters are run by MIDI information called "Note On". Execution of this software revealed that control of CG animation creation is made possible by MIDI signals used generally for control of electronic musical instruments. Though controls based on simple rhythm are used in this current basic stage, it is noticed that realization of diversified execution will be possible by further improvements.

1. Introduction

In our daily life, we frequently inspire images from auditory information rather than recalling sounds from visual information. For example, a sound of glass breaking immediately reminds us such a status without seeing actual scene. In the meantime, single word of [sound] denotes various kinds of sounds ranging from an effective sound as mentioned above to musical sounds. Of them, music plays an important role in human mental activities. Human figures out musical images based on his (her) past experiences and expresses it in the form of, for example, dancing.

A variety of stage garments are used at musical events such as concerts and live performances to enhance visual effects. On such an occasion, movement of moving lights seems to be synchronized with the music. In fact, as for controls of these devices, however, movements of the stage settings are programmed in advance to ensure expected effects. In other words, though the music seems to be well synchronized with illumination devices, a control command for stage settings, that is programmed in advance, is reproduced simultaneously with starting of the music and is stopped at the end of the music. It is not reasonable to say that such a system is synchronized thoroughly with the music.

Department of Electronic Systems and Information Engineering, Kinki University, Wakayama 649-6493, Japan

When considering interactive feature of music and image from above mentioned viewpoints, in the said example, it can be said that there is no association at all between visual effects and music played by the musical performer.

In this study, a concept of interactive performance [1] is introduced. Fusion of music and image through this concept is realized, and interactive features between the performer and CG animation are verified through generation of animations by music.

Interactive performance is defined as the performance in which fusion of 3-D CG dancers and music is made by performers of musical instruments. In conventional case, the musical performers perform a session by their performances alone. With interactive performance, performers can maintain a session with CG characters displayed on the screen. This time, we developed a trial software to realize this system on a personal computer. The rhythm used here denotes sounds generated by percussion instruments.

2. Treatment by trial software

In handling so called music, it is considered that the best way is to input performances played by actual musical instruments into the computer for processing. This is because the tone specific to each musical instruments and actual music are played by human while understanding and images of the performers are reflected to sound volume and way of performing. Thus delicate nuance over whole music is composed.

When musical composition consisting of sounds generated by various musical instruments is handled by computers, spectrum analysis becomes an important processing for signals input to the computer from CD (Compact Disk) and others. Speaking of a piano for example, its diapason is very wide and harmonic composition is also complicated. This means that for spectrum analysis, higher frequency resolution and wider frequency band are required at the same time. To meet with this requirement, Multi Band FFT [2] was proposed. Plural number of FFTs each taking care of different frequency band are executed in parallel. In order to process all of them with software manner, work stations with high speed computation capability should be involved. Therefore, this method does not meet with one of purposes of this study in which only one computer is used and no peripheral equipment is involved to realize the said fusion.

Then we adopted the standard called MIDI (Musical Instrument Digital Interface) which is used as the interface with conventional session systems. Normally, electronic musical instruments based on this standard are referred to as MIDI musical instruments which includes electronic piano, electronic drum and MIDI guitar system. When these instruments are compared with acoustic musical instruments, there is an evident difference between the two though musical quality of the former has come close to the latter. Reproducibility of delicate nuance when played by actual musical instruments is far from satisfaction. However, MIDI musical instruments are musical instruments developed on the assumption to be connected to computers. These instruments can convey performance information such as sound volume and musical interval correctly to computers

and can process them directly. This allows real time processing.

Figure 1 shows processing process in the software. The process from entry of performance information till creation of animation and music falls into following three categories.

(1) Performance information reading and analysis part
MIDI data are taken in, and Note • On message only is taken out and sent to the drawing engine while reproducing the data by the sequencer.

(2) Animation creation part
Sound generated by musical instruments is detected from Note • On message thus sent, and motions corresponding to that sound are selected. After motions are determined, they are combined with CG characters to be drawn as an animation.

(3) Musical instrument sound creation part
The data is converted to musical instrument sound by MIDI sound source and a voice is output from speakers.

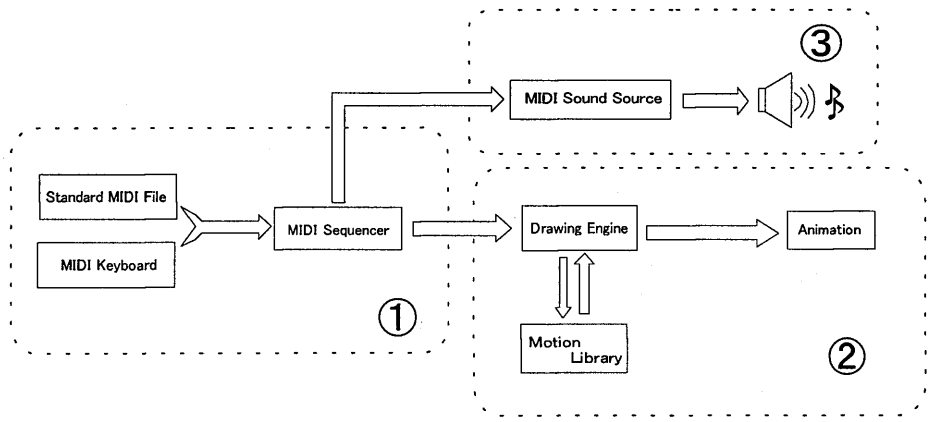


Figure 1 Processing by software

2.1 Note On/Off message

Note • On Message and Note • Off message are basic elements in the MIDI performance information. These information are corresponding to "Make sound (Note•On)" and "Absorb sound (Note•Off)" motions. Normally, by pressing any of keyset of MIDI keyboard, Note•On message is sent. When other keyboard being interconnected or MIDI sound source receives this information, it understands that its own keyset is being pressed and outputs a musical instrument sound.

This Note•On message includes information identifying which keyset is pressed and how strongly (actually "how fast") pressed. The Note number shows "which keyset is pressed", and the velocity conveys "how strongly pressed". For example, as shown in Figure 2, when "C (Note No.:60)" is pressed with strength of "100", a message with a combination of "90 60 100" is trans-mitted.

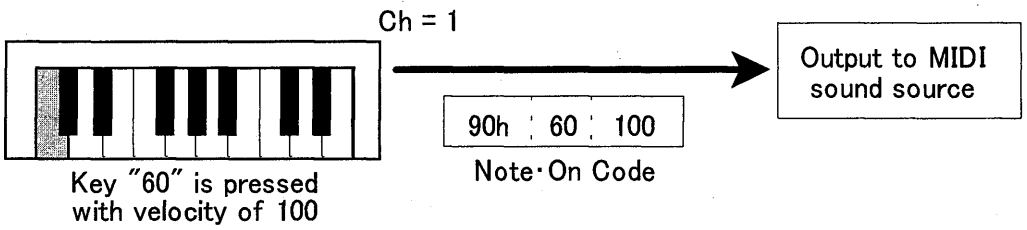


Figure 2 Processing of Note•On message

In the meantime, when drum beats are handled by MIDI as is the case of current study, it is different from note arrangement based on musical scale instrument sounds. With musical scale instrument sounds, a note number is assigned for every musical scale as explained previously. In the case of drum beats however, instrument sound itself is given. Making use of this, the trial software distinguishes musical instrument sounds by the note number.

2.2 CG characters

A simplified human body model is created to be used as CG character displayed on the monitor. Head, trunk, arms and legs of this model are numbered. One character is formed while these numbers are correlated in the form of a tree. It is then possible to determine basic posture of CG character by this configuration. In current study, total seven motions including basic three postures— heil, right arm and left leg are raised, left arm and right leg are raised— are g iven to the character.

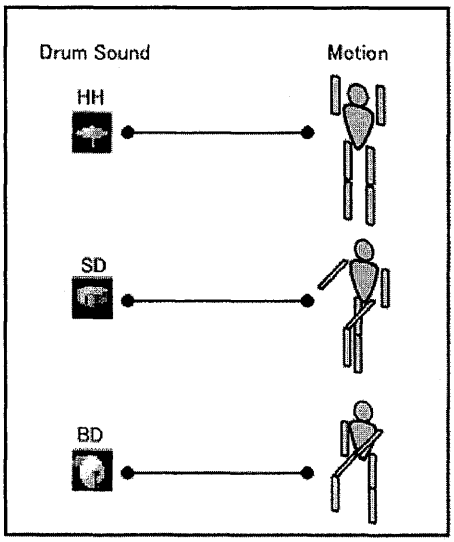


Figure 3 Association of drum beats with motions

2.3 Correlation of rhythm sounds with motions

The character has basic postures used while drum beats are not generated. Upon sound generation by the percussion instrument, one of motions thus mapped is selected, and the character per-forms motions using basic postures.

Drum beats and motions are directly associated, and basic motions are generated by means of bass drum (BD) and snare drum (SD). The basic motion used in the current study is standstill stepping. This is to follow the fact that even in ordinary drum performance, BD and SD play a role in building the most basic rhythm. When other percussion instruments are played, a unique motion is generated to mark an accentual event. Thus CG character is equipped with diversified alternatives. In the case of sounds generated by percussion instrument of cymbal family such as high hat (HH) and ride cymbal (RC), showy motions comparable to these noisy sounds are made. Rhythm sounds and motions are directly associated as shown in Figure 3.

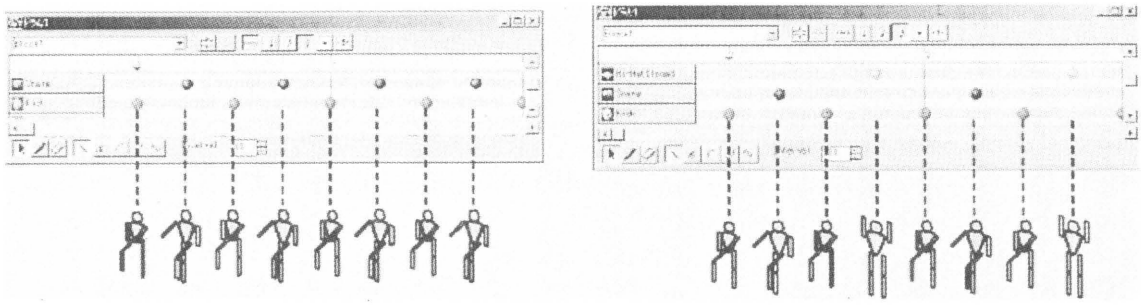
3. Experimental results and discussion

First, SMF was mounted to the trial software to be checked. Then CG character could present motions by the information from MIDI musical instrument playing information. Further, animations could be created almost real time manner. It was confirmed that creation of animation from playing information was entirely possible. Figure 4 shows changes in character motions caused by drum beat generation.

Human performance through MIDI keyboard was then input. In addition to changes in the animation caused by playing, such a phenomenon that playing pattern was intentionally changed in order to cause changes in the animation was observed between the player and the computer. Figure 5 is a photograph showing MIDI keyboard playing. Motions of the character shown in Figure 6 were displayed on the window at right lower portion of the monitor.

It is then considered that the player and CG character are affected each other thereby realizing interactive performance. Namely, it is entirely probable to improve performances through synergistic effect of music and CG. Further, it is confirmed from above discussion that interactive performances can be realized even by personal computers.

Generation of drum beats and corresponding character motions are expressed visually. Figure 4 (a) shows the case where MIDI data has no HH and (b) shows the case HH is input. Specific features are added to character motions by adding heil posture.



(a) Without HH (b) With HH

Figure 4 Association of drum beats with motions

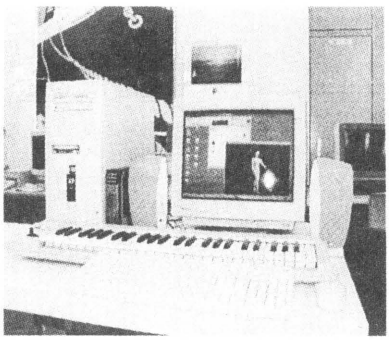
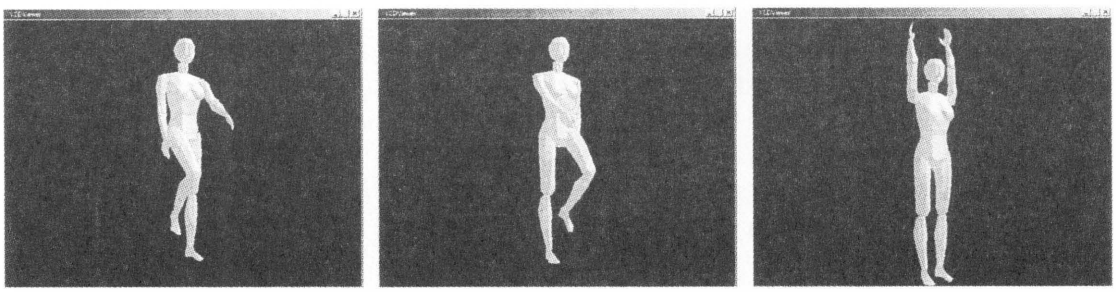


Figure 5 Results of execution (Musical instruments playing)



(a) Left arm and right leg are raised (b) Right arm and left leg are raised (c) Heil posture

Figure 6 Character motions

4. Future Development

For future development, we intend to introduce an algorithm that is capable of recognizing rhythm pattern in order to realize classification of other categories including tango and jazz. We also intend to develop expression of motions corresponding to categories of musical composition through analysis of transition

of musical interval of melody line and of code process.

In the future, an image of a certain musical composition will be estimated from tone of musical instruments to express strong and weak of motions and fine nuance.

Summary

It may be said that from the results obtained by this study, control of CG animation creation is made possible by MIDI signals used normally for control of electronic musical instruments. It is assumed that in addition to creation of animation, various controls as mentioned at the beginning of this paper can be realized if stage settings are connected to computers. In other words, it is possible to produce changes to motions of the illumination device with interactive manner according to playing of the music. Further, application to VJ (Visual Jockey) software may be possible.

As mentioned above, we could confirm the possibility of realization of interactive performance by the personal computer to which trial software is loaded.

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和文抄録

リズムによるCGアニメーション生成に関する研究

長江貞彦、高松康善、米村貴裕、小島一成

本研究では、音と映像の融合と新しいマン・マシンインタフェースの実現を目指した研究について、インタラクティブパフォーマンスという概念を導入した基礎的な実験を行った。インタラクティブパフォーマンスとは、音楽と映像の融合を楽器の演奏者によって行うというものである。具体的には、コンピュータのモニタに表示されるCGが楽器の演奏状態によって、また逆にCGの変化を見て演奏展開を行うことを狙ったものである。本稿ではCGキャラクタとMIDI楽器を使用して、インタラクティブパフォーマンスを実現するソフトウェアを試作し、これをパーソナルコンピュータ上で実装した。

なお、CGキャラクタは"Note・On"とよばれるMIDI情報によって動かされる。ソフトウェアを実行した結果、一般的に電子楽器制御用に用いられているMIDI信号によってCGアニメーション生成の制御が可能であることが確認できた。また、基礎段階として簡単なリズムによる制御であったが、更に改良することでより多様な表現が可能であることが見出された。