PEGASUS-2 : Real-Time Composing Environment with Chaotic Interaction Model

Yoichi NAGASHIMA  Haruhiko KATAYOSE  Seiji INOKUCHI
nagashima@nara-inst-pc.ac.jp  katayose@crl.ntu.ac.jp  inokuchi@pe.cs.nara-u.ac.jp

Laboratories of Image Information Science and Technology

Abstract

This is the second report of the PEGASUS (Performing Environment of Granulation, Automata, Succession, and Unified-Synchronism) project. In the first report at ICMC'92, compact / portable / real-time Granular Synthesizer was installed into the system, and used in some pieces. This paper focuses on "automata", not only simple generated randomization but also "chaos", in particular focusing on its dynamic characteristics. This paper describes (1) Chaotic Interaction Model (CIM) to generate flexible and dynamic musical elements, and (2) CIM experimental application for hierarchical structure in music. We chose simple Logistic Functions for that of chaos generators, but the generated output has much variety with well-tuned combination of parameters. In addition, CIM generator is applied to automatic composition systems. Considering the hierarchical structure in music, the system is constructed with three hierarchical modules (tempo / rhythm / note), and each module is controlled by an individual CIM generator.

1 Background

"Musical automata" and "automatic composition" are interesting themes. Many theories and models have been discussed, and many systems and software has been developed [1]. Today we have good tools for composing musical information in real time. PC-based "real-time composing" and "interactive composing" has been developed recently [2].

One of authors has produced one compact system of real-time Granular Synthesis. This research project was called the PEGASUS (Performing Environment of Granulation, Automata, Succession, and Unified-Synchronism) project [3]. The target is not only producing a hardware / software system, but also experimentally composing with this system. The piece called "Chaotic Grains" was performed on Feb. 11th in Tokyo [4].

2 "Chaos" in Music

2.1 Logistic Function

"Chaos" is easily generated with the following simple function:

$$X_n = \mu \cdot X_{n-1} \cdot (1 - X_{n-1})$$

this function is called "Logistic Function".

There are many complicated and two or three dimensional chaotic functions. But we chose the most simple one, because we wanted observe chaos dynamics.

With the area $1 < \mu < 3$, the value of $X_n$ is converged into only one value, but on increasing in the area $3 < \mu$, the value of $X_n$ is branched into two, four, eight, ... and into the "chaos zone" [5].

In the "chaos zone", some kind of randomness is generated, but there is a particular difference.

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from other "noisy" random systems. The parameter $\mu$ is very important to control the random characteristic, and it is possible to control the "chaos" dynamics with the value of $\mu$.

2.2 Around the "Window"
We were interested by the fact that the resulting state of chaos cannot be determined in spite of its deterministic definition. Many critical points in the "chaos zone" were observed in our previous work [6].

Even branching many values of $X_n$ in the "chaos zone" of $\mu$, it is impossible to obtain finite values normally. But there are many points with finite values of $X_n$ in the chaos zone of special $\mu$, which is called "Window".

If the value of $\mu$ is varied widely, the finite "chaos vibration" (sequence of values of $X_n$ with calculation cycle) falls into perfect random state.

When the value is slightly varied on the edge of the "Window", the "chaos vibration" is shifted somewhere in short term. It may return back to the finite state in some cases, as if it were pushed back by an active something. This reaction is very critical and sensitive for the value of $\mu$.

2.3 Musical Replacement
As a simple replacement of "chaos vibration" to music, it is easy experimentally to assign the value of $X_n$ to the "pitch", and the calculation cycle to the "duration". For example, the MIDI notes which are generated by chaos simulator with the value of $X_n$ in "chaos vibration", are perceived as "arpegio" or "trill" performance in music.

When we add a heuristic tuning of parameters, a "slight shift of the value into the chaos zone" may cause some kind of variations or improvisation of the musical phrase.

3 CIM and Application

3.1 CIM
In order to use this effect, two individual chaos generators are connected to each other. The output of one generator is led to the other input as the value of the parameter offset. We call this "Chaotic Interaction Model (CIM)", and use the value range (interaction range) of $\mu$.

If we add expression to the music using only one chaos generator, we must control the dynamics of it interactively. But it is possible to control or interface with chaos dynamics n
CIM, and we can observe and consider the actions from outside. Like the CIM system, the edge area of chaos (Window) is considered a somewhat "intelligent system", and its application may be useful for composition [6] [7].

3.2 Real-Time Composition

CIM is not considered a perfect musical generator, but it is useful tool in musical composition.

With the "Sensor Fusion" system and musical recognition system, CIM is applied in the musical environment with its real-time composing characteristics.

In this system, there are two compositional job streams. As "composition" is an interactive process, both streams contain an information loop. One loop, "non real-time composition" means the traditional style of composition. Composers write scores, input sequence data, and repeat test-listening with arrangement many times. The other loop, "real-time composition" has two meanings: (a) improvisation and (b) real-time generation. Improvisation is real-time control of musical parameters by performers with many sensors. Real-time generation is constructed with CIM, and parameters of "chaotic vibration" are interactively controlled by performers in real-time.

3.3 Musical Information Processing

Note: Scale and Tonality is in some pieces, notes are selected from some scales with 12 equal temperaments. Each probability of note assignment is described in the table. It is controlled with special MIDI command, computer console, and sensors of the performer. Global scale and tonality are frequently metamorphosed.

Rhythm: Event Timing Percussive sounds are used for most of the chaotic notes in the piece. The interval of each note event makes a form of "Rhythm", and are also generated by CIM.

Performer / Conductor There are many sensors to detect controls and cueing of performers and the conductor. All actions are detected and converted into special MIDI signals, and transferred in order to control all parameters, the value, and mapping tables. The conductor can send the message of best control as "Tempo Rubato".

4 Conclusion

The second step approach of the "PEGASUS" project, focusing on facets and chaos, and the CIM application system has been described in this paper. There still remains many areas for experimentation.

More discussion and a demonstration of CIM is planned, and an experimentally composed piece called "CIF (Chaotic Interaction Show)" is to be performed at IAKTA Workshop (15th Sep.) in Osaka.

References