Music Maker using Music Generator with Fractal L-System

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Abstract: Nature gives us a depiction of beauty and art since the beginning. Artist creates beautiful painting and a replica of nature. Tree is the most common and frequently appear in nature painting. L-system (Lindenmayer system) was designed for recreating tree models in the form of 3D models nowadays. For the result, L-system generates the tree model in the scale of extraordinary result. Thus, L-system has proven as excellent method for tree model generation subjects. Other fields of science also able to apply L-system as a fundamental method for process and generate products. One of those applications is music generation using L-system for generating chord. Small research already conducted about the application of L-system in music generation. Since, the nature of L-system to create a visualization of tree structures or parameterization. L-systems still hold many potentials for creating remarkable researches. This paper reviews several implementations of L-system in various fields.

INTRODUCTION

L-system (Lindenmayer system) was first introduced as a mathematical method for tracking plant growth. Present day usage of L-system, used for generating plant models in video games. L-system gives a replica of natural shape and environments of open world games or has a realistic nature world such as Assassin's Creed, Ghost Recon: Wildlands and DIRT[1]. The other use of this method for a different range of implementations, e.g., pattern design to arterial branching based on human retina.

This study will review several implementations of L-system. L-system already has a wide implementation in several subjects. Such as cloud modeling, music generation[2] and generating molecule structure.

MATERIALS AND METHODS

In this study, review will discuss about data mining algorithms that exist for classification and clustering.

L-systems: L-system has a rewriting nature. It can call itself for doing task according to the rule[3]. Rewriting is replacing the initial object with a set of other objects according to the rules or production successively. L-system able to generate more fractal, since, L-system has recursive feature[3]. In L-system the application of rewriting happens in parallel and simultaneously. It differs from Chomsky grammar by comparison, Chomsky grammar productions are conducted sequentially. L-system characteristic fit for simulating living organism growth. Below is the grammar of L-system:

$$G = (V, \omega, P)$$

G = L-system grammar
V = Contains alphabet of the system
ω = Initial state (Axiom)
P = Finite set of productions (Rules)

For L-system, G defines for grammar and consisted of V, ω, P. In another definition V is a variable that contains simply characters, constant or another value. Initial state or ω called axiom. Axiom contains the initial state to indicate the initial before beginning the process. P contains rules that determined the result of the entire system. Example of L-system:

ω : C
P:
- A→A B
- B→B D
- C→D C
- D→DA B

Result:

- n = 0 CA
- n = 1 D CA B
- n = 2 D A BD C A B B D
- n = 3 D A B A B B D D A B D C A B B D B D D A B

As we know the axiom or initial value is "C A" then according to rules A is producing "A B" and B is producing "B D", so, the result for n = 1 is "D C A B". Next, repeat the same step. If we generating according to rules for n = 2, we have "D A BD C A B B D" and so forth. This can continue until reaching the needed result. As the nature of L-system, fractal trees are also one of example L-system implementation. Below, three examples of fractal tree based on L-system. Each tree has different V. Each bracket represents Push ([ ) and Pop ( ]). Push is for saving current position and Pop for load the latest saved position. Both symbol "+" and "-" determine the degree need to turn for current point. Figure 1 gives a depiction of the result. Another example of L-system is generating a Koch island. In this example involving following the symbols:

- Z = Draw a straight line
- z = One step of length j (distance value) without drawing a line
- * = Turn left by angle 90
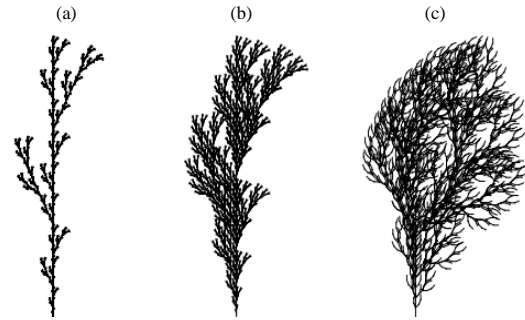- / = Turn right by angle 90
- ω = Z/Z/Z/Z
- P = Z→Z/Z*Z*ZZ/Z/Z*Z

Fig. 1(a-c): Examples of plant-like structures generated by L-systems (a-c) are edge-rewriting, (a) n = 5, δ = 25.7° F, F→F[+F] F[-F] F, (b) n = 5, δ = 20° F, F→F[+F] F[-F] F and (c) n = 4, δ = 22.5° F, F→FF-[-F+F+F]+[+F-F-F]

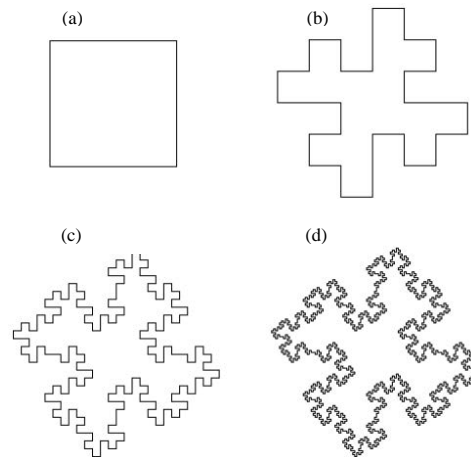

Fig. 2(a-d): Generating Koch island, (a) n = 0, (b) n = 1, (c) n = 2 and (d) n = 3

Starts from n = 0 as ω (Axiom) the initial state. According to P, Z generates "Z/Z*Z*ZZ/Z/Z*Z". Thus, for n = 1 the result should be "Z/Z*Z*ZZ/Z/Z*Z/Z/Z*Z*ZZ/Z/Z*Z/Z/Z*Z*ZZ/Z/Z*Z/Z/Z*Z*ZZ/Z/Z*Z/" this process repeatedly occurs until reach value of n = 3. Figure 2 represent the progress start from n = 0 until n = 3.

MIDI file (.mid): Musical Instrument Digital Interface (MIDI) is a communication protocols that created with the purpose of connects musical instrument towards computer and otherwise[4].

The .mid file is a .mid file that contains the instruction layer including tone notation, tone duration and many other functions. MIDI files are widely known among single organ services to the electronic music class that requires a lot of this .mid file. Almost all synthesizer manufacturers make their devices that can read and write MIDI.

Table 1: Results of casual respondent

Sample (n)	Musicality (1-10)	Efficiency (1-10)	Pattern (1-10)	Average
1	8	7	8	7.67
2	7	9	8	8
3	6	8	7	7

Table 2: Results of professional respondent

Sample (n)	Musicality (1-10)	Efficiency (1-10)	Pattern (1-10)	Average
1	9	9	8	8.67
2	9	9	8	8.67
3	9	9	8	8.67

RESULTS AND DISCUSSION

The result of this program will be tested as several sample will be given toward respondents. Respondents will listen toward the song generated with this method then give a proper score toward each sample. There are several aspects of score such as Musicality, efficiency and pattern of notes. There are two categories of respondent. Casual listener, people who listening to music for their hobby or have interest toward music, professional, expert of music who works in the field or has a career such as music producer, composer and music teacher[5].

Casual listener: Table 1 shows the result of casual respondent. According the score result, each sample has an unusual pattern. Thus, casual respondent feel uncomfortable. In other hand, samples may fit with the theme of game background music.

Professional: Table 2 shows the result of professional respondent. According to response of professional respondent, the sample have a good musicality value since the sample has unique rhythmic. The pattern and movement of notes is efficient and variative.

CONCLUSION

This method is able to implemented as method for music generator. The result of survey from professional respondent received a good score and good response. Several casual respondent give opinions about this method may benefit as game background music due to the characteristic of 16-bit nuance.

IMPLEMENTATIONS

Implementation of interface: This program only run in the form of command line. Thus, the user required to call the compiler for able running the program.

Implementation of L-system: For the implementation of L-system starts from where axiom already determined according to user's input and the result of identification of successor and predecessor from axiom.

Generating MIDI: From the process of L-system, program will generate MIDI file. While the program generating the MIDI file a composition of song will be played and stored in the same folder of the program. This process happen due to MIDI sequencer module.

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