

NeuroPhyllotaxis: An Interactive Application for Generative Art Based on EEG Data

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Abstract

Generative art is produced by procedural techniques. It has obtained a lot of attention since the beginning of computer graphics. Many works of art are inspired by nature, among which phyllotaxis is as well. It is a combination of mathematics and the beauty of nature. Not only can it be seen everywhere in nature, but also often appear in man-made objects, becoming part of culture or religion. This paper presents the development of an interactive generative art application that is created from a phyllotaxis pattern by using the user's EEG data. When people are using it, it will allow them to more easily relax and achieve the function of art therapy. We tried to use EEG data to make an interactive installation art which creates phyllotaxis patterns that are projected on the wall. Everyone has a different state, the generated patterns are also different from person to person, which creates interesting interactive contents. In addition, sound can also be changed by EEG to become dynamic and real-time contents.

Keywords: EEG, phyllotaxis, generative art, interactive art, installation art

1. Introduction

With the development of microcomputers and single chips, the way people interact with computers has changed. It has come a long way from the early keyboard and mouse to the development of the multi-touch. Developers always want to find better ways to let people interact with apps in a more natural way. Such as gestures (Leap Motion¹), wii², voice input, etc. However, these are all motor functions, that is, different people using the same operation method will get the same result. Compared with electroencephalogram (EEG), because people can't see how the user moves, it just exists in the brain's operation, so no one can copy the actions of another person and produce a personal style. Therefore, we aim at the state of concentration and meditation in the

brain waves as an interactive input method to bring a new perspective.

In addition, installation art is becoming more and more popular as a form of modern art. Compared with other art forms, installation art allows people to be more involved, use touch, and even play in it. Therefore, interactive methods are also added to allow people to enjoy, participate in, communicate, and interact with art, to become interactive installation art. However, most of the art content is fixed, arranged according to the creator. So there is not much change, resulting in people not wanting to repeat, come, and participate.

Generative art is produced by computer programs. It has the characteristics of non-repetition and endless evolution. It has received a lot of attention since the beginning of computer graphics. Many works of art are

inspired by nature, among which phyllotaxis is included. It is a combination of mathematics and the beauty of nature. Not only can it be seen everywhere in nature, but also often appear in man-made objects, becoming part of culture or religion. For example, Madala Kolam is not only the expression of art, but also healing people's body and mind. And Chakra's representative totem is also like phyllotaxis. When people are using it, it is easier to relax the mood and achieve the function of art therapy. Therefore, we try to use EEG to make interactive installation art, and use EEG input to create phyllotaxis patterns to project it on the wall. Because everyone has a different state, the graphics drawn are also different from person to person, creating interesting interactive works. In addition, the sound can also be changed by EEG, becoming a dynamic, real time content. More importantly, when the user looks at the graphics generated by his own brain, this can bring about communication with the heart and then achieve the effect of art therapy³.

2. Background: EEG Control art

2.1. The use of EEG in art

Since 1965, the use of EEG in artistic creation has been documented. Most of the content has an established pattern. Authors or users use their brains or mental states as artistic creations, such as focusing or relaxing to control sound and images⁴.

2.2. Passive control and aesthetics

Another way to use EEG as artistic creation is more passive. It uses the mental and emotional state of the author or participant to produce changes in sound and images, especially music that affects the emotional changes of the user. The changing screen synchronized with the music⁴.

However, this application goes beyond this way of expression, and focuses more on the communication between the self and the heart. Through the displayed graphics and sounds to perceive and explore one's mental state, open up internal communication and dialogue to achieve relaxation and meditation. This allows for self-reflection, and ultimately the opportunity to achieve the goal of art therapy.

3. Development and application

3.1. system structure

The development environment is Intel I7 PC on windows 10 system, with the NVIDIA GeForce RTX 2080TI graphics card. The programming language C# has been used to develop the application on the Unity SDK. The EEG headset is NeuroSky MindWave Mobile 2.

Figure 1 and Figure 2 show the EEG headset is connected to the computer via Bluetooth, and uses the intermediary software ThinkGear Connector⁵ to send the received data to Unity⁶ via UDP network protocol.

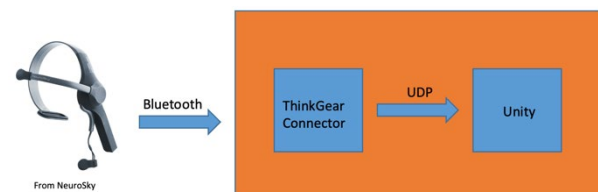


Fig. 1. EEG connecting to Unity

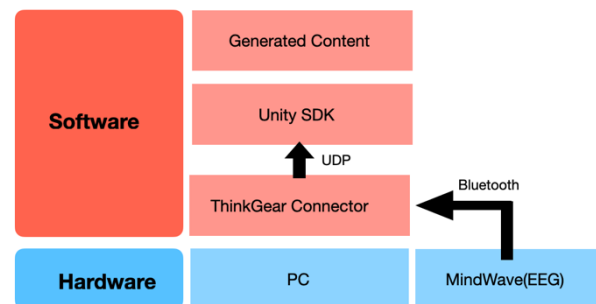


Fig. 2. System Structure

3.2. Content generation

The simple model for the florets of sunflower was Vogel 's formula. As the book "The Algorithmic Beauty of Plants"⁷ describe below:

$$\phi = n * 137.5^\circ, \quad r = c\sqrt{n}, \quad (1)$$

- n is the ordering index number of a floret, from the center to outer.
- ϕ is the angle of the n th floret in a polar coordinate system.
- r is the distance from the center of the capitulum to the n th floret.

- c is a constant scaling.

In Figure 3, it can be found that changing different angles will produce different pattern changes, so the angle is used as a variable in the program to generate changeable patterns.

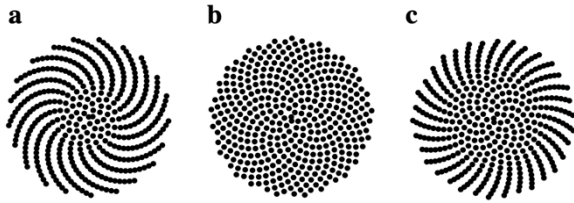


Fig. 3. Generating phyllotactic patterns from the Vogel's formula. (a) $\alpha = 137.3^\circ$, (b) $\alpha = 137.5^\circ$, (c) $\alpha = 137.6^\circ$

3.3. EEG Data

Different waveform data can be obtained from the signal from the brain waves, such as alpha wave, beta wave, etc., as well as data on concentration and meditation. We used the level of concentration to generate graphics, and use the level of meditation as a reference value for color and sound.

The degree of concentration can be divided into a value of 0-100. We divide it into 7 ranges. The value of concentration is low, the angle of the graph is small; and, the higher the value is, the larger the angle as shown in the Table 1.

Table 1. Use value of attention for angle ϕ .

Range of Attention	Angle ϕ
0-14	41
15-29	59
30-44	73
45-59	97
60-74	109
75-89	137.5
90-100	157

Similarly, the degree of meditation divides the value from 0-100 into 7 equal ranges, which are represented by 7 colors of red, orange, yellow, green, blue, indigo, and violet. Divided into 7 ranges, the number and color of the chakras are the same⁸, and they also form the basic color of white light. This correspondence is natural and conforms to the human body.

Table 2. Use value of meditation for color.

Range of Meditation	Color
0-14	RED
15-29	ORANGE
30-44	YELLOW
45-59	GREEN
60-74	BLUE
75-89	INDIGO
90-100	VIOLET

3.4. Installation

Figure 4 shows the installation for the application which used a projector to project the generated graphics onto the neutral wall, allowing users to sit in front of the projection screen and watch. This allows the user to relax and wear the EEG headset.

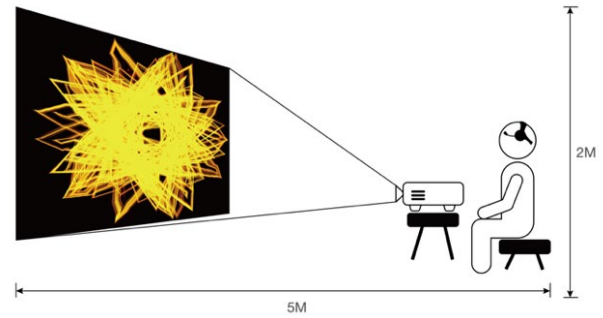


Fig. 4. Installation for the application.

4. User feedback

A user study was conducted over 50 university students, between the ages of 16 to 25. The experiment apparent and the projector was used to project the patterns to the neutral wall. Each subject used the applications for 2 to 5 minims. After that, they were asked to take an online survey. The questions included what they thought while using the application and how they felt when used the applications. Figure 5 shows some patterns made by different users.

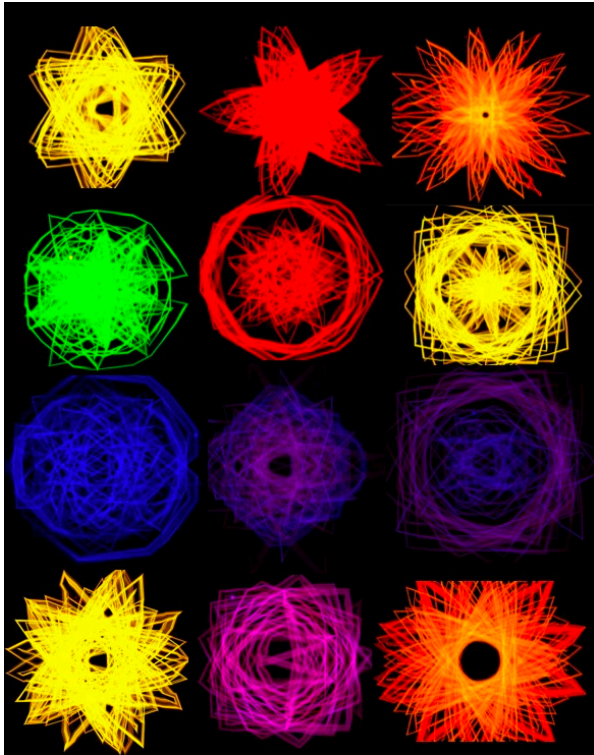


Fig. 5. Pattern generated by people.

Figure 6 shows when people used the application, 22/50 tried to think about different things to see the changes in graphics, colors, and sounds. 4/50 tried using different emotions to see different changes. 21/50 were in the state of emptying meditation. 3/50 were thinking about the meaning of these graphics and how did such things make.

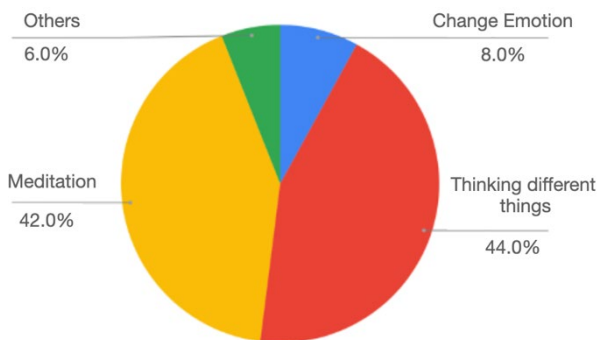


Fig. 6. How people thinking while using the device.

Among them, 42/50 found it interesting and novel. In addition to the artistry brought about by the graphics and color changes, almost everyone wanted to know the

meaning of these graphics and whether they can understand their emotions or psychological state.

5. Conclusion

The use of EEG to generate phyllotaxis is a very novel experience for most people. As an installation art, the generated graphics have different results according to the conditions of different people, making the installation art show a variety of effects.

Through some applications, users can also recognize their own state. Through different thinking patterns, imagination, and memories, people were able to produce graphics of different colors. Watching the visual and sound effects of these graphics can trigger psychological states, such as novelty, such as a sense of excitement and calmness, to achieve an increasingly relaxed state, and achieve the effect of meditation. It is like a dialogue and communication with the self, allowing the heart to settle, reflect, meditate, and think, and find the inner peace and answer.

After using this program, does it have a positive impact on the user? Can it improve people's concentration? Does it allow people to be more relaxed? Will it increase people's creativity and work efficiency? These can all become further research projects.

Acknowledgements

This research was supported in part by the Ministry of Science and Technology of Taiwan under the grant (IV) MOST 109-2218-E-002-038-.

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