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Study about the expression of void space composed by sequence of subdivided planes

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Abstract: In the preceding paper, we studied about the expression of void space composed by sequence of concave planes. We considered the figure cut off from planes as a parameter of the void space. Here we design the figure of the void space composed by sequence of subdevided planes. And we study about the expression of void space with a trigonometric function in the three axises that are the directions on the plane(X and Y-axis) and semi-continuous direction(Z-axis), and show more exciting space.

Keywords: Algorithm, Installation, Design Method, Python Script.

1. INTRODUCTION

There are many spatial expressions with semi continuous elements in all ages and cultures, for example colonnade of the Parthenon, a row of arch in Gothic cathedral, approach with Shinto gateways (Torii) of Fushimi Inari Taisha in Kyoto (Fig.1). These are frequently symbolic or spiritual spatial expression. The void space formed by semi continuous elements gives someone an exciting and impressive experience. In the preceding paper[1], we had reported a spatial expression composed by sequence of planes cut out concave shape as a case-study of the interior installation in Oyama container art 109 (Fig.2).

Fig.1. The spatial expression with semi continuous elements

There, the characteristics of the space depended a great deal on concave shape, spacing of sequencing planes, change of concave shapes in sequencing direction and so on. We generated some concave shapes by the script and adopted the gabled house shape (vertex n=3) which was simple and symbolic as the concave shape to create a void space (Fig.3 Fig.4). In this paper, we try to generate more complex design to improve the preceding design. In addition we pick out some problems on designing by scripting and in the virtual space.

Fig.2. Interior installation scenery

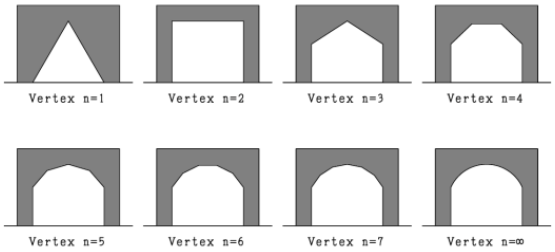

Fig. 3 – Cut out shape

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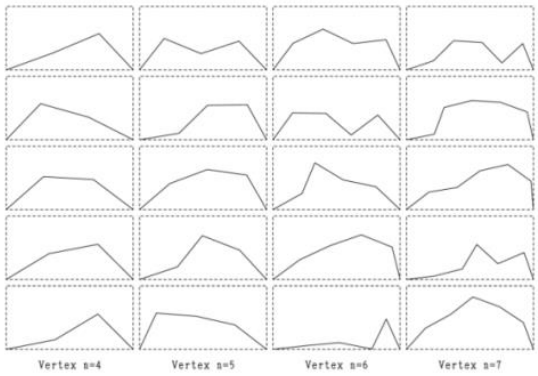

Fig. 4 – Example of generating the shapes by the script

2. Examination of the void space composed by sequence of subdivided planes

We make the void space composed by sequence of planes in the way similar to the preceding paper. Unexpectedly, the design of void space in the preceding paper put us in mind of the image of "NOREN" in Japan (Fig 5). Therefore we design the void space composed by sequence of narrow planes subdivided from this inspiration.

Fig.5. "NOREN" in Japan

The concave shapes on the sequencing planes were same and the void space became a constant space in the preceding paper. However, we design the void space to alter (X,Y) parameter on the sequencing planes and Z parameter in the semi continuous direction (Fig 6) in this paper. We use "Shade" (CG application) and Python script to generate shapes as well as the preceding.

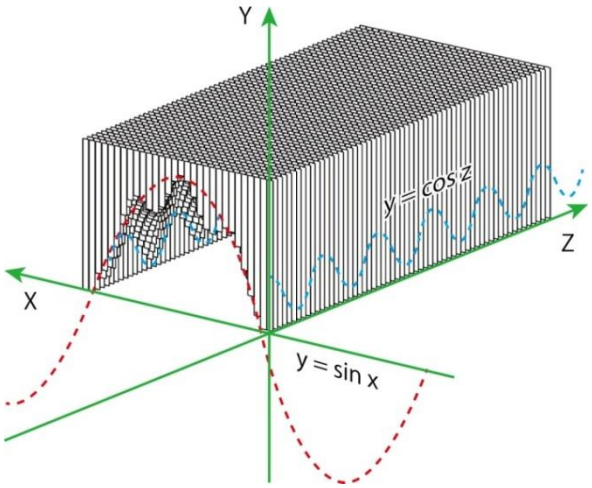

Fig.6. The void space

At first, each value of Y parameter which is the height of the void space is settled as a sine function of X (Eq.1). This shape is the constant space to the depth direction (Fig 7).

(1) $$Y = vH \times \sin Xn$$

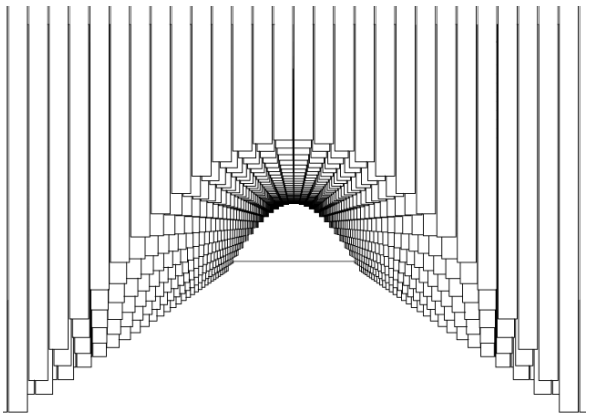

Fig.7. The shape by sine function

Next, the value of Y parameter is varied to draw a cosine curve to the direction of Z (Eq. 2). A cosine curve is the same to a sine curve by shifting. This shape is complex but not complicate because of a monotonous rhythm in the direction of forward movement and recognizing clearly a sine curve on the planes (Fig 8).

(2) $$Y = vH \times \sin Xn + \frac{(H - (hB + vH)}{2} \times (1 + \cos(2\pi Zn))$$

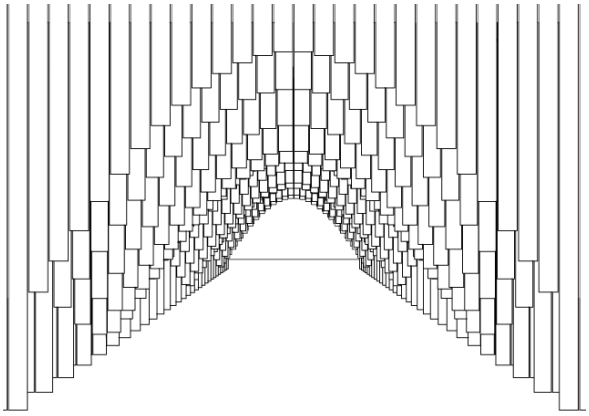

Fig.8. The shape by sine and cosine function

In addition the value of Y parameter is varied by shifting the phase angle of a cosine curve on the X axis (Eq. 3) (Fig 9).

$$(3) \quad Y = vH \times \sin Xn + \frac{(H - (hB + vH)}{2} \times (1 + \cos(2\pi Zn - \frac{\pi}{4} Xn))$$

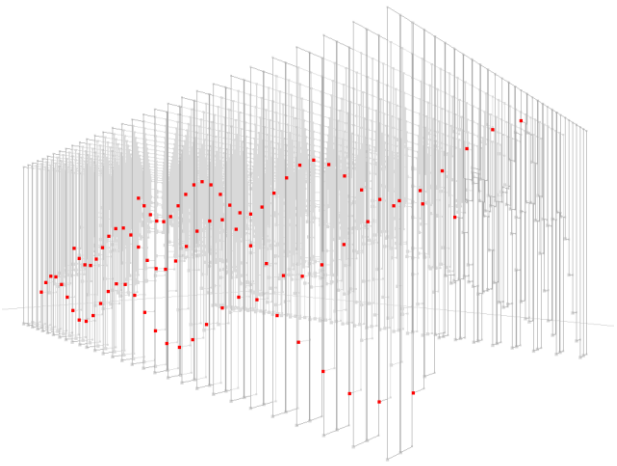

Fig.9. The phase shifting of cosine curves

Therefore a sine curve is not recognized at first glance and each layer has more complicate concave shape (Fig 10). However the tube space with semi continuous elements presents a sinusoid in the integration of them and the void space has more exciting spatial expression (Fig 11).

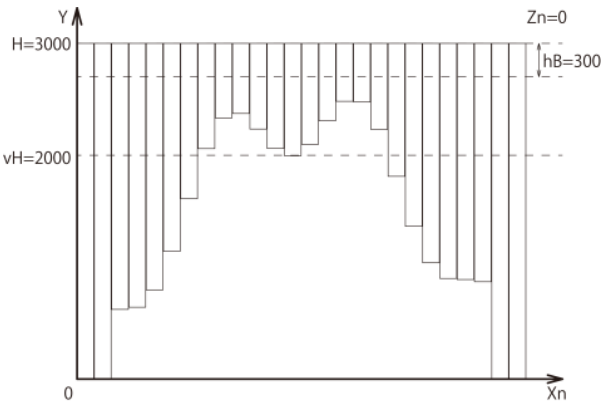

Fig.10-1. The shape on the sequencing planes

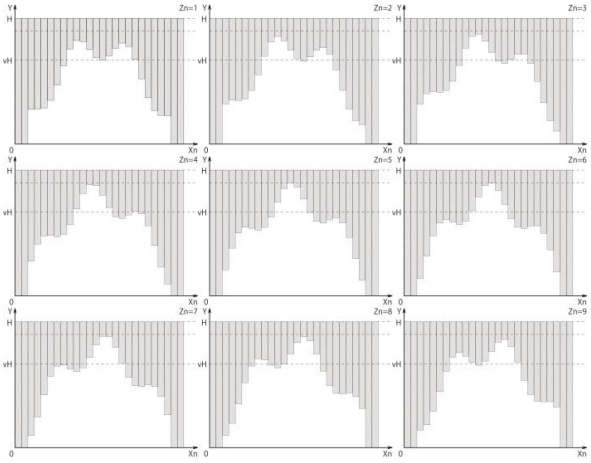

Fig.10-2. The shape on the sequencing planes

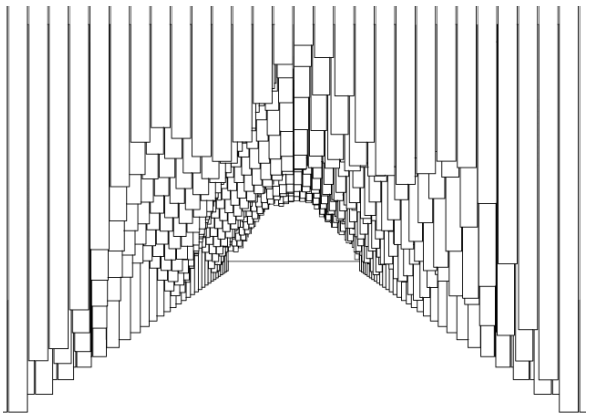

Fig.11. The shape by sine and cosine function with the phase shifting

3. Problems on designing by scripting

Next, we generate many patterns of the void space by the algorithm determined in chapter 2. 15 parameters - the total width, the number of pieces on a layer, the number of pieces on the end of plane, the clearance between pieces on the plane, the width of piece, the total height, the height of the void space, the minimum height of the void space, the margin in the height direction, the number of planes (layers), the clearance of planes, the number of planes in the cycle of cosine, the number of pieces in the cycle of sine, the phase shifting on the X axis, the maximum amplitude of cosine - are regulated in the script (Fig 12).

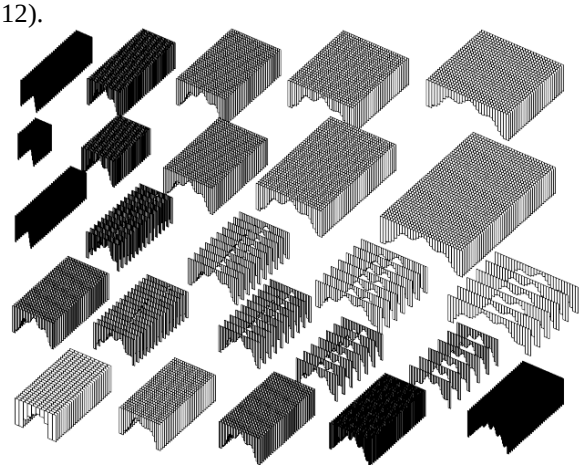

Fig.12. The variation of the void space

We can automatically generate many patterns by script. However, these are nothing more than parallel variations and we are unable to select the best shape for lack of the standard. We will not design by a brute force attack by hand work and build up some standards for selection through the process of designing. Beside the algorithm of design, we have to consider the logic for selection separately (Fig 13).

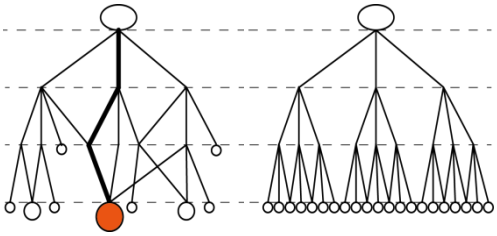

Fig.13. the process of designing

4. Production of the real work

In this paper, each parameter is adopted in consideration of the spatial constraint at the installation site and the aesthetic balance. Production and the installation work were done by the students at Oyama National College of Technology as on the previous case (Fig.14). Figure 15 shows the installation scenery. When we have designed with PC, some conditions of modeling are excepted for good workability, for example, thickness, texture, furring. And gravity, wind, retractility, stigma, etc. what is not directly related to design do not exist in the virtual space. It is impossible to design with PC occurring all events. Therefore we need to put some real operations in the process of virtual operation and feed-back bilaterally.

Fig.14. Production scenery

Fig.15. Installation scenery

5. CONCLUSION

The void space formed with the semi continuous elements is a very interesting. In this study, we have enhanced a spatial expression by segmentalizing the semi continuous planes and altering the height of void space in the depth direction. And we have picked up the problems of designing by scripts and in the virtual space. Not only algorithms for creating shape but also logics for selection are required separately.

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[1] STUDY ABOUT THE EXPRESSION OF VOID SPACE COMPOSED BY SEQUENCE OF PLANES CUT OUT CONCAVE SHAPE, AKIHIRO SHIBATA, NAOMI ANDO and, NOBUHIRO YAMAHATA, Proceeding of International Conference on Engineering Graphics and Design, Tom LVII (LXI), 2011, Fasc. 5, pp. 9-16