The Grid with golden section

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Abstract

In a certain plane or space, the human creative act such as architecture, painting, calligraphy, etc., So the basis on certain rules and laws are not entirely out of conjecture; role in dividing the plane and space, Grid which originated in the Chinese civilization and the Golden Section for Western culture. They are consistent and uniform, but the Book of Changes in the Grid philosophy is based on more levels, also in the Sudoku game, it only represents the position, neither is the area of the region of space division. In the area of regional space segmentation, traditional Grid adopted Rule of Thirds segmentation method is not rigorous, but also not fully consistent with the actual application. If the Golden Section is introduced into the dividing line of the Grid positioning, can draw a consistent picture aspect ratio has nothing to do with the dividing line position; Grid dividing line that is no longer the average but by 28:44:28 the proportion of distribution. This new division ratio of the plane can provide more scientific and convenient help, including quick picture composition for photography and video, hieroglyphic writing exercises, architectural space layout and so on.

Keywords: the Golden Section Grid, four grid dividing line, positioning and proportions, significance of philosophical, application in practice

1 Introduction

According to legend, Grid figure appeared in the ancient Chinese book of He tu, which corresponds to the natural number from 1 to 9 to form a three vertical and three horizontal grid pattern, and whether. It is vertical, horizontal or oblique three digits of its three lines and are equal to 15. Later astrology, azimuth, hour, also take the form of Grid Square, said in addition to grid map, there is also a round figure. The Western Sudoku, also known as Grid: make 1-9 each digit can appear only once in each row, each column and each of the palace, Grid shown in Figure 1 [1].
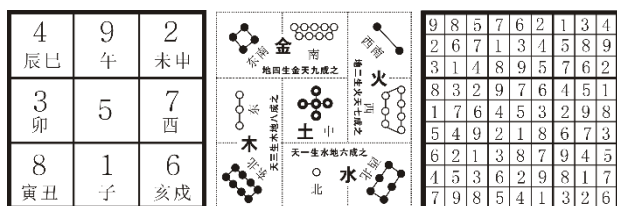

FIGURE 1 Grid forms: hour (the Book of Changes), orientation map (gossip), Sudoku

Is used since the type system, its main feature is that the rectangle is divided into nine average fully equal Box using grid dividing line.

2 The size of the problem on Grid's Box

Hetu book Grid represent the relationship between the number and orientation of the hour, and did not relate to the size of the grids, which is a time-and space illustrations or diagrams in Chinese ancient times, which reflects China ancient understanding of nature was later widely disseminated because "Book of Changes", making it a core foundation and principles of Chinese culture. In addition to the Book of Changes outside, Grid also widely used in flat region segmentation, such as Chinese character writing, architecture, painting and photography.

2.1 CHINESE WRITING GRID OF NINE BOX

To China's Tang Dynasty, Ouy Angxun, Chinese calligraphy "European system font" creator, Grid was introduced to the layout when writing Chinese characters, according to the characteristics of Chinese characters are so square. He created a "the Nine Box" Bounds lattice form; calligraphy control when using it in shape and strokes arrange suitable site, or as narrow and enlarged font, so easy to put a good word writing carved on wood and stone.

Later, appearing in many characters penmanship practice calligraphy grid, such as swastika grid, m word grid, Hui Gong grid, such as the MiG-back. They are carried out additions, deletions or deformed to Ouy angxun Grid basis; Now All characters can verify copybooks grid, including the introduction of the principle of the golden section "Golden coordinate grid" (inventor: Li Zhongyuan) and "Qi Gong grid" (inventor: Qi gong). They are the same size Box are evenly divided differing only in the number of Box. Therefore, the essence of Chinese characters copybooks grid, the average of nine palaces penmanship Grid is the basic type system.

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2.2 "RULE OF THIRDS" COMPOSITION-FOUR GRID DIVIDING LINE

Naturally, Grid also been introduced to painting, photography and other picture composition and segmentation; present theoretical description of the use of "Rule of Thirds" planar composition, whether it is painting or photography. Video, still images will be used is the average split, typically described as: "the long side and the short side of the screen is a three-aliquot, an aliquot from the point of intersecting each other by four straight lines dividing a screen into nine squares. This patterning method known as the 'Rule of Thirds' or 'Grid' composition, four cross point formed by the dividing line it is placed in the best position of the body [2].Shown in Figure 2.
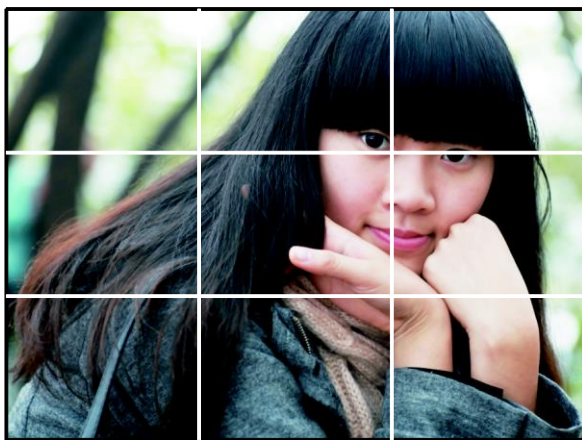

FIGURE 2 Camera viewfinder in the 'Rule of Thirds' grid lines dividing

Rule of Thirds grid lines (Grid) now has been widely applied to the camera, the viewfinder of the camera viewfinder or hunt, especially LED digital camera viewfinder screen. In the picture of the dynamic composition such as movies, television, etc. We need to attract the audience's attention using visual factors that constitute the center. Which is called the center of interest of the screen; center of the viewer's attention is usually subject movement, expression, form, event plot points [3]. The center attracts viewers eye movement on the TV screen, if these two centers coincident or near the center of interest of the TV screen and the visual center of gravity of the human eye, then the audience will feel relaxed, otherwise your eyes will be tired because they do not meet the visual habits. So with the 'Rule of Thirds'(Grid) can quickly determine the center of the screen fun, easy film composition.

However, with 16: 9 high definition video and panoramic photos of pop, those pictures Fun Center, which is the traditional way of grid lines dividing the average obtained in the visual center of the screen clearly too biased. Which indicates that the Rule of Thirds applies only to traditional 4: 3 TV screen, the other percentage of frame segmentation still need to re-examine.

2.3 CHINESE TRADITIONAL ARCHITECTURAL STYLE- 'YA' AND 'JING'(CHINESE CHARACTERS) SHAPED COURTYARD

In China's traditional architectural layout; Grid is building the basic "feng shui", with distinct isomorphic characteristics, such as palaces, temples, monasteries, houses and so on, they are all enclosed courtyard to the layout, and "hall patio "that introversion courtyard as the center," "eight Mansions" enclosure around this form and Ida-style "eight total a well" Grid prototype of schemata same. As the king of the home of the hall so as the man in the street of the same daily residence is no exception [4].

Although traditional Chinese courtyard-style layout from Grid, but the Nine palaces eight trigrams and Ouyang Xun's "the Nine Box" is slightly different; their biggest difference is the size of the Central's Box or hall. "Jing"-type layout or "ya" character structure resulting deformation (courtyard), without exception, with a non-uniform way split, its distinguishing feature is that the Central's Box greater than eight surrounding. In architecture, it is of practical significance on its regional function, when the Central's Box of the maximum. Because it is the core of a garden space of its construction system, especially the kind of large family shared courtyard, pay attention to our common with a patio, and this patio in feng shui and straight hailed hall, with four water-owned hall of stress. This not only speaks Chinese traditional architectural culture, is focusing on the exchange between man and nature, outdoor courtyard space. They will be seen as the core of the house also, so that even more squared diagram shows the strong influence of the ancient social life style; then we can understand that in the Book of Changes Gong, although the Central's Box and the other eight on the size or area of? The palace is used only on the sharing icon, but it is higher than the surrounding eight Box on the role and status; the Central's Box big is not the shape that position.

Therefore, each about the size of Grid's Box, either from a philosophical point of view or a flat-screen visual composition and architectural design, we need to re-use rigorous mathematical methods to calculate.

3 To calculate the size of each Box for Grid

Grid's Box size is essentially the position of four intersecting dividing line, this problem by introducing The Golden Section Principle to study, because it is the most respected in the structure of plane. Golden ratio was originally conceptual issues in the field of mathematics, Euclid's famous "Geometry" the second volume is devoted to describing the Pythagorean school writings, in which Section XI wrote: H by a point in the end than cut a straight line AB, to make into a golden section, namely AB:AH=AH:HB. [5] H that is golden point, mathematically prove: AB:AH=AH:HB=1.618:1=1:0.618 which is the golden ratio.

3.1 THE GOLDEN SECTION OF THE RECTANGULAR AREA

Its biggest advantage is quick when using grid lines of nine Box, especially dynamic screen; Prior to this, many scholars believe that the " Rule of Thirds" comes from the Golden Section; actually not the case.

The screen is divided using the golden ratio, which is derived from principle of flat the Golden Section derivation: X-point bisecting the square bottom, take the midpoint of X. Y is adjacent diagonally, connecting X and Y, with X as center to XY radius, and from the point in a clockwise direction as Y arc line. It will extend the line intersects with the bottom edge of the Z point, if the square of this edge extended to Z point; so will the original square as a rectangle extending. Shown in Figure 3 left.
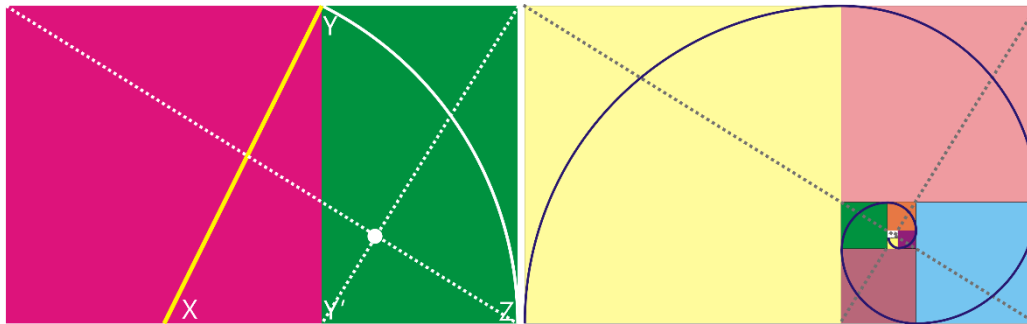

FIGURE 3 Illustration of golden principles of geometry and illustration of Fibonacci spiral curve

So we get a aspect ratio of 1.618: 1 Golden Rectangle (Y point is the golden point); Similarly, the extension of the rectangle is also a Golden Rectangle. So we can assume: a golden ratio rectangle it is by the side length of the golden ratio decreasing by an infinite number of squares, each square if you order a side length of radius, apex for the center to draw the circle, will form a Fibonacci spiral curves. Shown in Figure 3 right.

Fibonacci spiral curve not only has excellent visual beauty, it is also common in nature, such as the arrangement of sunflower inflorescence, cement and so on. Whether Fibonacci spiral curve inward contraction vertex from which to start the rectangle. It's finishers in its diagonal and away from the apex of the golden section point to the intersection of the other vertices cable, Shown in Figure 3 left; this point there are a total of four, with the use of the Grid "Rule of Thirds" dividing line is very similar.

By Figure 3 we can intuitively find: This position is not YY 'line, which is 0.618 which is the golden rectangle line length; rough estimate, this location is relatively close to the screen almost two edges of 2/3 that is 0.667. Perhaps it is because of this reason, many scholars believe that the Grid of Nine Box average split is the "Rule of Thirds" is in line with the principle of the golden section, and even Eastern and Western art is an ancient culture in the amazing fit; but this is not accurate.

3.2 VISUAL CHARACTERISTICS OF THE HUMAN EYE - PHYSIOLOGY PRINCIPLES OF KEY OF VISUAL

The geometric center in the human visual range, most can cause visual attention point is not the screen, but they are four points each intersection by the formation of binocular vision. Visual physiology through a lot of statistics found that each monocular visual range (statistical average) is an eccentric oval, its visual range is:

Right eye visual range: above 50°, below 70°, left 60°, right 100°. Similarly, the left eye: above 50°, below 70°, right 60°, left 100°. If the eyes while watching the visual center of perspective that is reachable range is above 40°, below 50°, left and right 55°. Moreover, the center axis of each eye is not within the visual center of its visual range, but at the right of the partial 60% for the right eye, the left eye is at the left side of the 60% of the [6]; shown in Figure 4 [7].
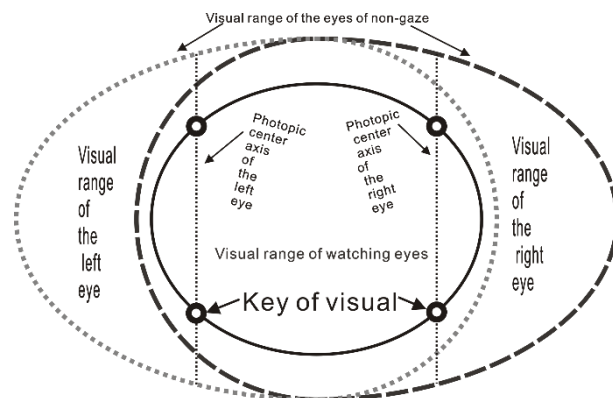

FIGURE 4 Illustration of monocular vision scope and the Visual interest centers when the eyes while viewing

In Figure 4, the thin dashed circle represents the visible range of the left eye, the right eye virtual coarse coil; elliptical solid line represents the visual field when the eyes gaze. As long as the two eyes of the same vision, the ellipse is symmetrical elliptical labyrinth ratio of 9:11. However, in the eyes of non-watching a visual range, the

left and right eye by the superposition of the visual range is formed, which includes the dashed line in Figure 4 the entire range, which form a lateral angle reaches 200 °, the longitudinal direction 110 °, labyrinth ratio of 5: 3 oval.

Figure 4 four small dots that is the Key of visual, they are subject to two eyes due to watching the visual attention, while at the center of one of the visual axis of the eye, so they become the visual center of gravity; that is visually ergonomic principles focus on the screen.

3.3 THE TWO ARE COINCIDENT BETWEEN KEY OF VISUAL AND SCREEN FIBONACCI SPIRAL CURVE CONTRACTION POINT

In the visual physiology, on the human visual range is based on statistical experimental measurement data, if we put the most commonly used TV frame ratio: 3:4, 2:3 and 9:16, and then increase 0.618: the golden ratio screen 1. By the same height as the left according to Figure 3, but of different widths, the location of Key of visual drawn through the drawing, and then compared with Figure 4, the results shown in Figure 5 [7].
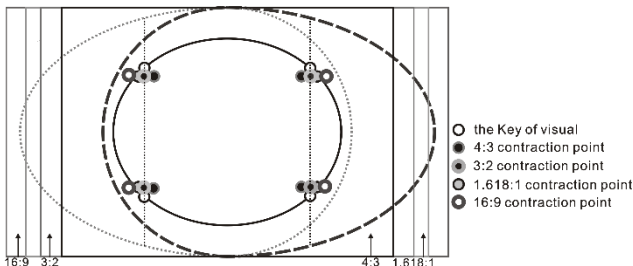

FIGURE 5 Contrast icon on different frame Fibonacci spiral contraction point and the Key of visual

We can intuitively be seen from Figure 5, the position of the different aspect ratio of the picture frame center of interest (that is, the Key of visual) at high frame remains unchanged, the wider the more to the sides; If the aspect ratio of format is 4:3, the Key of visual on the inside, when the two coincide exactly 3:2, and in the outside of the 16:9, but their positions are very close. This fully shows that the human eye in the center of visual interest on the screen is the golden principle of Fibonacci spiral point contraction in the picture.

3.4 GEOMETRIC POSITIONING THE LOCATION AND SCALE OF DIVIDING LINE

Has been fully demonstrated in front of the demonstration, Grid dividing line should pass through the Fibonacci spiral contraction point on the screen, rather than the "rule of thirds", so that we come to Key of visual of the screen to comply with the human eye visual habits. Thus, as long as we calculate the four-point position on the screen, starting deed Fibonacci spiral curves, you can easily locate the location and distribution of the ratio of the dividing line. From Figure 2 and Figure 3 that, at the bottom left of the screen, Fibonacci spiral curve starting position is two lines

cross, a diagonal rectangle, and the other one is left on the vertex to the adjacent side recently the golden section point line. Assuming the picture height is a, width b, to the lower left corner of the screen as the origin of coordinates, known coordinates of the top left corner (0,a), coordinates of the lower left side of the gold point ([1-0.618] b, 0), and the coordinates of the upper right corner of (b,a); shown in Figure 6 [7]:
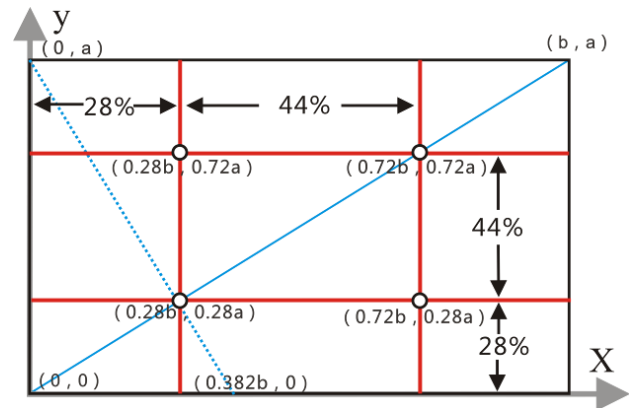

FIGURE 6 Geometric coordinates the position shown on the Style Box of the grid dividing line

Two intersecting straight line equation are:

$$y = \frac{a}{b} x ,\qquad(1)$$

$$\frac{x - 0}{(1 - 0.618)b - 0} = \frac{y - a}{0 - a} .\qquad(2)$$

Solutions to the above equation can be derived intersection coordinates:

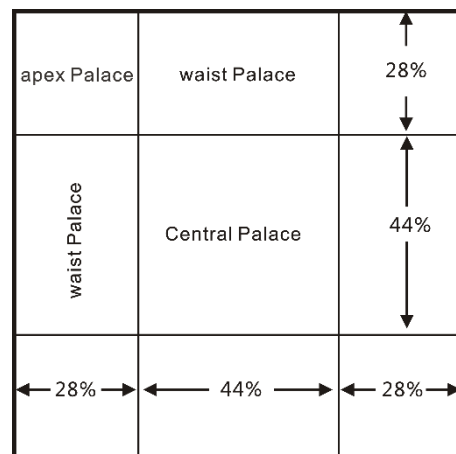$$x \approx 0.28b ; \ y \approx 0.28a\qquad(3)$$

FIGURE 7 The Golden Section Grid icon

In the same way, we can find the coordinates of the other three. Use parallel with the border line segment connecting these four points, and then extended to the border of the screen, we obtain new grid dividing line which meets the golden section principle. From Figure 6,

we can visually see that the distribution ratio Grid dividing line in any ratio screen are: 28: 44: 28; rather than sharing. By this kind of division, the nine cells in the Style Box, their size is no longer the same, but the largest center Box, followed by four weeks, the minimum of the four corners; shown in Figure 7 [7].

As a result of the golden section principle to the dividing line on the Grid rigorous and precise positioning, so will be named: "The Golden Section Grid", to distinguish it from the traditional Style Box which has nine of the same size grid. In The Golden Section Grid, the area ratio of three different sizes Box full compliance with the golden section; assume three different Box area were: S1 (four top grid), S2 (four waist Palace), S3 (the central Box); geometry mathematics can prove three kinds Box area ratio is: S1:S2:S3=0.618:1:1.618 [7].

The Golden Section Grid in three sizes Box area is still the golden ratio, can prove the reverse of the previous assumption holds that the human eye in the center of visual interest on the screen is the Fibonacci spiral in the picture contraction point in the golden section principle.

4 Philosophical meaning and practical application of the Golden Section Grid

4.1 THE PHILOSOPHY OF MATHEMATICS SIGNIFICANCE FOR THE CENTRAL BOX IS GREATER THAN OTHERS EIGHT

Why Grid gossip about King Wen is in accordance with: "Nine-palace of justice, law with turtle, 2,4 for the shoulder, 6,8 for the foot, Left 3, right 7, head 9, shoe 1, 5 living the central" arranged in such a way that instead of the other way, such as small to large. Ancients interpreted as: Siyu 8,6,2,4 is even an overcast, four positive 9,1,3,7 odd yang, and gossip has eight count, Grid are nine grid, the inevitable one more; 5 that central Palace, so Grid either horizontal, is vertical, or diagonal three Palace and are the same as 15.

Can be proved mathematically, 1 to 9 will fill nine Box, to meet the horizontal, vertical, diagonal and all the same there are eight kinds of ways, but only into the 5 to set up the central Palace. [8] and 5 is not included in the positive odd because, "5" in the Chinese pronunciation of that through "no", which means "empty"; but "empty" it means that the space needs to be large enough to accommodate the Quartet. So among the five nine palaces, which live in the central palace, large but not the performance on the area and shape, which also confirms the concept of TCM's: "holding the central, transportation all around" [9].

The central Palace needs "empty" and "big" concept has long been widely used in architectural design, whether it is the previously mentioned 'ya', 'Jing' font Chinese traditional layout, or Western architecture typical round dome.

4.2 THE VIDEO EQUIPMENT VIEWFINDER FROM "RULE OF THIRDS" TO THE GOLDEN SECTION GRID

Now almost all digital cameras have both cameras feature the same digital camera can also take still pictures. To facilitate framing, in their viewfinder or LED screen provides almost all of the "Rule of Thirds" dividing line. However, in recent years, with the popularity of wide screen, many photographers began to feel that the camera viewfinder dividing line within the window can not provide help for composition. Because if you press the viewfinder grid lines inside the intersection of symmetrical dynamic display screen to focus, shooting out of the picture will make people feel full, especially for delicate characterization, showing portraits of close-range, close-up; because the body close to the net after the grid lines, blank on the back too much. So in order to overcome this phenomenon, some TV cameraman when shooting close-ups of a single anchor man picture, simply put the host in the middle of the screen; blunt the screen is divided into two parts.

And in the actual shooting, photography and imaging frame aspect ratio is not the same for photography 3:2,4:3 and 16:9 are, but when recorded is more of 4:3 and 16:9. Such viewfinder fixed "Rule of Thirds" grid lines cannot be applied to the needs of different video frame composition; example, usually SLR viewfinder aspect ratio of 3:2, grid lines also by three: two to the average distribution. When the need to shoot the video, the face of 16:9 format, the camera viewfinder provides grid lines entirely superfluous. Similarly, the camcorder viewfinder aspect ratio of 16:9 mainly for shooting 4:3 static picture, such a composition dividing line has lost its meaning. In the digital age, if you want to design a moving mesh dividing line with the aspect ratio salvo in the viewfinder, technically is not a big problem. Such as imaging equipment manufacturers in a long and high is 16:9 viewfinder design a different frame when switching automatically move around the grid lines (upper and lower two fixed and two moving left and right), and so the distribution frame according to press 28:44:28 ratio of [7], which will be carried out more quickly and help photographers framing. To this end, I have applied for a Chinese patent and has been authorized (the viewfinder used in camera and video recorder, patent No.: 201320178018.1, authorization date: 2013-09-25).

4.3 THE GOLDEN SECTION GRID HAS CONVENIENT THAN EXISTING COPYBOOK WRITING HIEROGLYPHIC CHARACTERS LIKE THIS

Many Chinese primary school language teachers found that low-years period students to write Chinese characters as a whole and some word big, too small and some are not unified, that is not beautiful and norms when they are in the existing copybooks this (Tian word lattice, small

squares or m word format) in writing. The main reason is that they are not allowed to look at the writing position, only the feel, including began to write, writing process and the end; because copybooks grid being used are not succinctly tell beginners, various kinds of radicals in the copybook specific placeholder where? What position should the started to write, the pen moves and pen collection?

Chinese invention patents declared my latest "The Golden Section Grid copybook" (dividing a square lattice copybooks into The Golden Section Grid proportional 28:44:28, the Note: the application has been submitted, received patent number: 201410018954.5, but also unauthorized) can solve the above problems and quickly; shown in Figure 8.
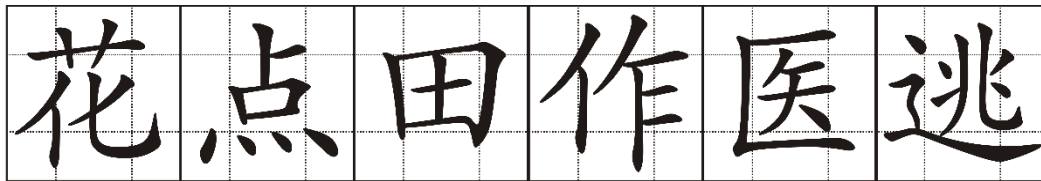

FIGURE The Golden Section Grid copybook

In the Golden Section Grid copybook, Shrinkage strokes, such as short horizontal, horizontal fold, short, vertical, etc., they all started to write and ending near the center of the palace or the palace to the dividing line, the length to the width of the palace long as the reference. Divergent strokes such as "apostrophe", "flick" such as in long horizontal and vertical started to write in the house, outside the palace at the end, "the next four small point" started to write on the outside and tighten the eight palace to the central Palace. While penetrating strokes, such as long horizontal, vertical long, vertical bend fishing, walking the bottom so they will run through three Box, started to write in the middle of the waist Palace, palace through the central grid to reach the middle of the other side of the waist or top Palace, or started to write in the middle of the top Palace. Character has surrounded the structure, peripheral structural part (half surrounded or enclosed) were to surround the outer shape in the center of Gong, surrounded by the inner part of living in the Central Palace.

The Golden Section Grid copybook can fully reflect the ancient Chinese calligrapher Bao Shichen said: "Where the word regardless of the density ramp at the positive, must pull knot of spirit, is the central Box of character." This is the calligrapher respected "tighten toward the central palace". However, the former Central palace is too small; related to The Golden Section Grid copybook specific application method in calligraphy, I will discuss other details of the paper.

5 The conclusion

Grid previous segmentation approach, which is "Rule of Thirds" is not the golden section, no rigorous geometry basis. The Golden Section Grid, not only contains the central palace is greater than the other palace round about philosophical sense, will also play a very important role in the split screen, the new split grid lines can be applied to any aspect ratio of the picture composition, including Chinese characters copybooks posts and viewfinder of video equipment.

Acknowledgments

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