Graphic Design using Cartesian Geometric Transformation Based STEM Education

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Abstract: This paper presents the use of STEM education concept of the research in mathematics for textile design, where firstly the nature of the problem is proposed by using the scientific concept, then the technology is formed in terms of a graphic design, the mathematic concern is interpreted, finally, the use of the design is used to form the pattern for engineering usage, where the Geometer's Sketchpad (GSP) is a tool to design artworks from Cartesian coordinate products. The simple mathematic formation is given and described. The objective of this work is the use of the STEM technique for graphics design based on theCartesian geometric transformation. The obtained result has shown that the Cartesian product is set in the square, converging segment, the Kaleidoscopic and circular gridsby using the geometric transformations, which are rotation, reflectionandtranslation. Byusing the GSP scan for modifying the grid size, color and pattern, the created geographic figures and many more beautiful patterns can be obtained for the required applications.

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Keywords: STEM education; Graphic design; Cartesian product; Geometric transformation, Geometer sketchpad (GSP)

1. Introduction

Graphic design based on mathematic method has been widely used in various applications, where the use of nonlinear of light called bifurcation was also implemented, especially, for textile design. The computer graphic design is recognized as an excellent tool for the modern designers, where there are two different levels of the design involved, for instant, 2D and 3D, which depends on the designer requirements. Principally, there are the one of the coordinate systems, from which the Cartesian coordinate can also be applied, where the integration of technology with mathematics and art resulting in the creation of works of art such as the artistic design of the table(grid), plus, multiplier, modulo [1] using the geometer sketchpad (GSP) [2] adopting addition and multiplication on the clock to design a work of art designs and stitch using Cartesian product [3], in which research is to present the artistic design of the Cartesian product into different grids to create a master pattern and the conversion feature geometric rotation of the mirror and parallel, which is from prototype design to achieve diversification in the production. In this paper, mathematic knowledge is used for textile pattern design using the STEM components [4-8], where the STEM is stand for science, technology, engineering and mathematics, which is a popular technique for research and investigation in various countries[9-12], especially, in United State of America and United Kingdom for a decade. Till date, the researches, investigation and education based on STEM have been used in many countries including Thailand. By using the STEM components, the knowledge of science, technology, mathematics and engineering is applied using the order pair in the Cartesian coordinate, where finally the colorful patterns are obtained, which can be called a pixel in the computer graphic design, from which all details of each pixel in the design grid can be made by the mathematical operations in terms of rotation, reflection and translation, where finally, the required graphic design is obtained. There are various graphic design results in this work, which will be seen in the following section. The mathematical description of the method is also reviewed and given.

2. Methodology

The tools used for designing the artwork from multiplication of Cartesian coordinate. The GSP program was used in the design and geometry of the design. The creation of patterns can be created from within the tool such as draw a straight line, circle, line, color, arc through three points and areas within the building. The grid is made up of each tool, then moves the plot along and created the segment and can make a significant piece of geometric transformation using the rotation, reflection and parallel rotation.The methods are as follows: (1) design grid squares from the 1 on the size of the grid squares in size by allowing each channel to have a square from the two design grids compression by squares will look to reduce the size of the width of the square next to it, from which the right to just 50. % of the width of the box to the left like this by vertical (length) is the same as the width of three images Kaleidoscope design grid size. The grid will look like a camera, where the Kaleidoscope has its focal point at the bottom right hand, in which the look of the table with two diagonal lines and the adjacent corner. The bottom-right dividing point ratio and a unit 2a sequentially from the fourth grid design is a circular grid that resembles a grid Kaleidoscope. The focal point is at the bottom right hand corner, which features a diagonal arcs of circumference, (2) defines a set of by a member of the same size as the grid size. Find multiple Cartesian's set genuine small difference, (3) shading the couple's first multiple Cartesian in the second set, and (4) determine the pattern to put it in the shaded grid Then the patterns can be decorated using GSP and apply geometric transformations to design prototypes for a variety of beautiful designs.

3. Experiment and Results

Shading the multiple pairs of Cartesian in the second set,this set will be put into the shade the grid then the pattern that has been refurbished.

The scientific thought is now established, the use of technology can be used to make the textile patterns, which is modeled before the pattern being implemented, from which in the design, where the involved mathematical detail is given as following.

Given $\mathrm{U}=\{1,2,3,4,5,6,7,8,9\}$ and defined subset genuine and has a multiplier effect Cartesian $A=\{1,9\}, B=\{1,2,8,9\}, C=\{2,8\}$, $D=\{1,9\}$, $E=\{3,7\}$, $F=\{4,5,6\}, G=\{4,6\}$, $H=\{3,4,6,7\}$ and $I=\{5\}$, the Cartesian product isgiven by

$$A\times B = \{(1,1),(1,2),(1,8),(1,9),(9,1),(9,2)\ (9,8),(9,9)\}$$
$$C\times D = \{(2,1),(2,9),(8,1),(8,9)\}$$
$$E\times F = \{(3,4),(3,5),(3,6),(7,4),(7,5),(7,6)\}$$
$$G\times H = \{(4,3),(4,4),(4,6),(4,7),(6,3),(6,4),(6,6),(6,7)\}$$
$$I\times E = \{(5,3),(5,3)\}$$
$$I\times I = \{(5,5)\}$$

Shading the multiple pairs of Cartesian coordinates, then $(A\times B)\cup(C\times D)\cup(E\times F)\cup(G\times H)\cup(I\times E)\cup(I\times I)$ into the grid square9x9, which is given by the following order pairs, where the pattern in Figure 6(a) is given by $\{(1,1),(1,2),(1,8),(1,9),(2,1),(2,9),(8,1),(8,9),(9,1),(9,2),(9,8),(9,9)\}$ and the subset pattern in Figure 6, where the result in pattern in Figure 6(b) is given b $\{(3,4),(3,5),(3,6),(7,4),(7,5),(7,6),(4,3),(4,4),(4,6),(4,7),(6,3),(6,4),(6,6),(6,7),(5,3),(5,3)\}$ and the subset pattern in Figure 6(c) is given by
$\{(5,5)\}$

In Figure 7, they were obtained from the original image in grid square 9x9 to geometric transformation using the rotation, parallel and reflection, which is the same image that Figure 8 in the grid compression 9x9 using the rotation and reflection, where the rotation and reflection have the same image. The results from the use of geometric transformation by moving parallel in Figures9 and10 were obtained by dividing the original image in the 9x9 Kaleidoscope gridsto apply geometric transformations, where the rotation and reflection were used. The same image using geometric transformation by moving parallel in Figures 11 and 12 were obtained by dividing the original image in a circular grid. 9x9 to geometric transformation by rotation and reflection have the same image using geometric transformation by moving parallel rotation in Figure 13 by sliding parallel to notice that the rotation and reflection have identical photos depending on the pattern master. If you change the master may cause pattern unique to Figure 14, which shows the original image in a circular grid using the rotating images in Figure 15, which is shown the original image in a circular grid. The reflection and image display in Figure 16 models in sizes 9x9 grids circle the parallel is evident that these three images to three different images.

4. Conclusion

This work was conducted by the students from Suan Sunandha Rajabhat University, Thailand, where the concept of STEM components was implemented and achieved, which were applied for graphic design for textile pattern usage. By using the art design from the multiple Cartesian with GSP program, which can be used the mathematics to design using knowledge, where the multiple Cartesian and programs set by the GSP program allows the design, which is simple yet elegant and can be presented as animated as well. The results can be used as a pattern on textile products, porcelain tile pattern, which pattern design, which can create a piece of conversion. The obtained results have shown that the Cartesian coordinate transformations in terms of rotation and reflection based on mathematics is operated and the required pattern obtained, from which the adopted outputs for textile design is achieved.

Acknowledgment

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Figures:

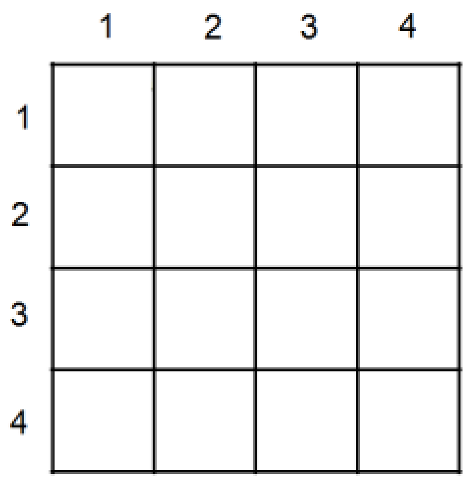


Figure 1: A 4×4 grid

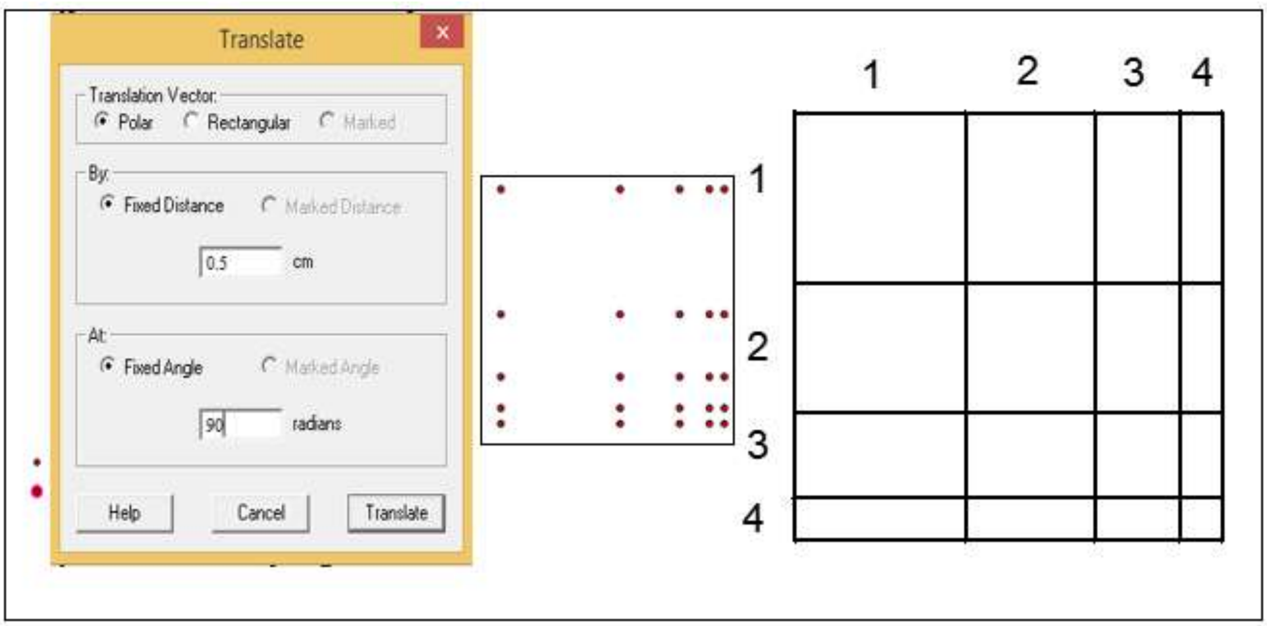


Figure 2: A 4×4 compressiongrid

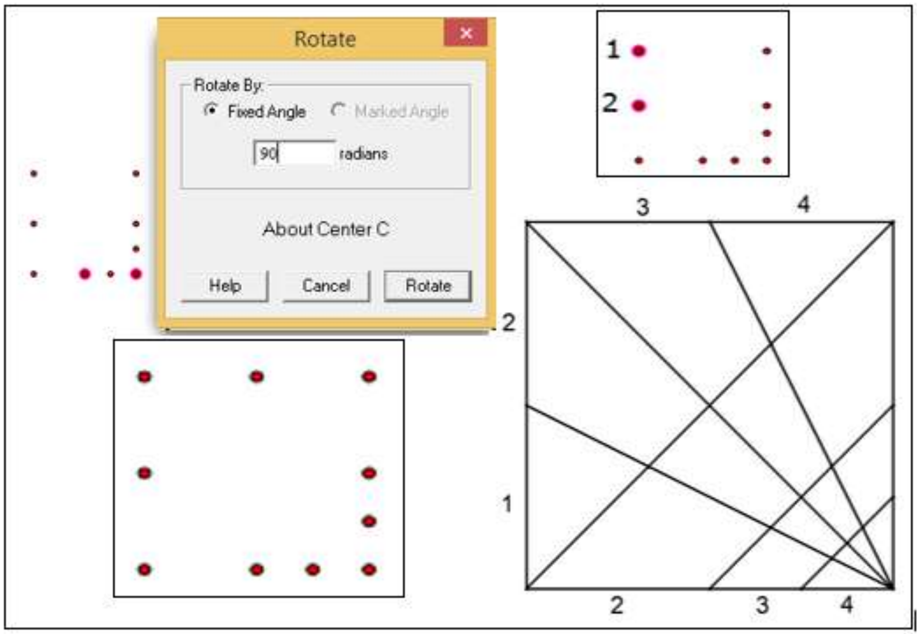


Figure 3: A 4×4 Kaleidoscopic grid

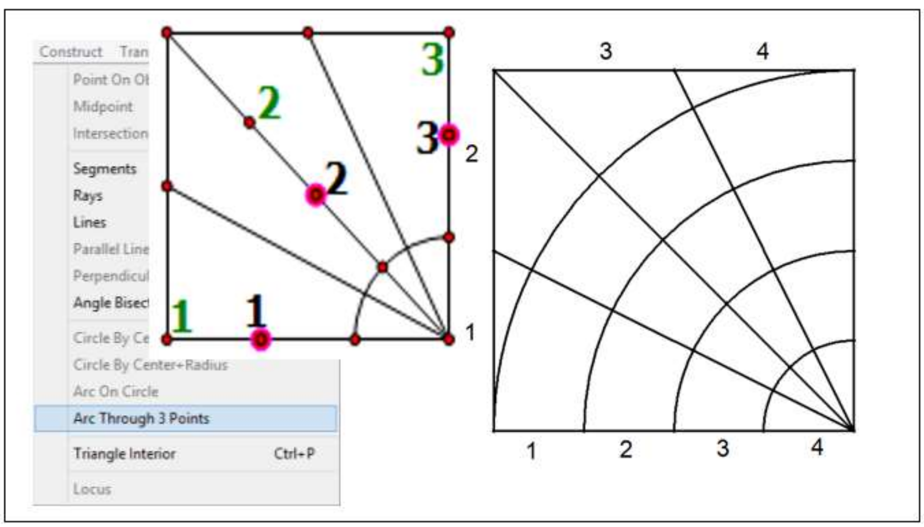


Figure 4: A 4x4 circular grid

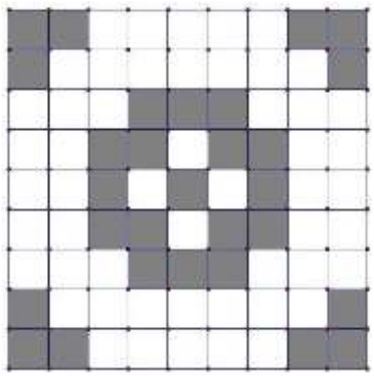
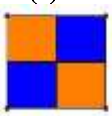
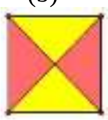


Figure 5: The shedding pixel of 9x9 a square Cartesian grid

(a)



(b)



(c)

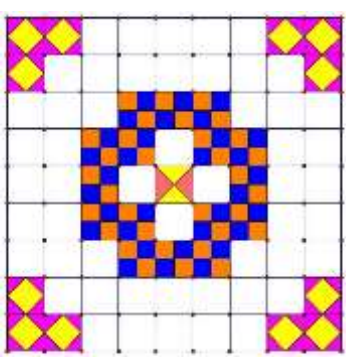
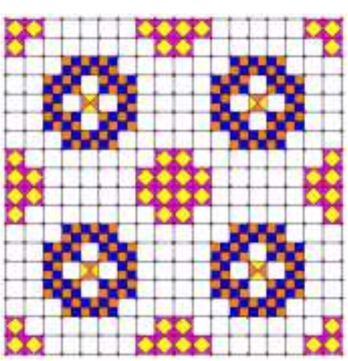


Figure 6: A 9×9 square grid prototype



(d)

Figure 7: A 9×9 prototype grid for rotation

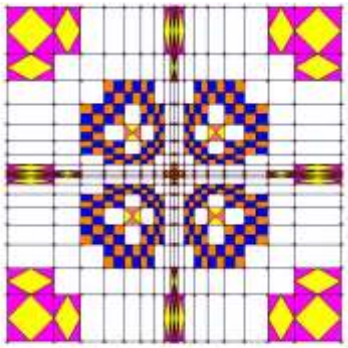


Figure 8: A 9×9 prototype grid for rotation and reflection

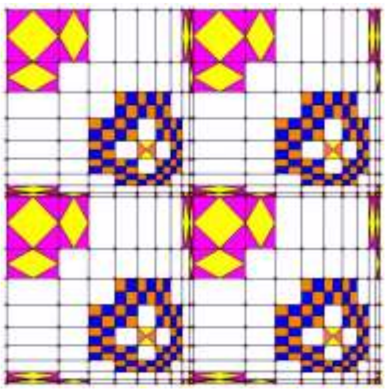


Figure 9: A 9×9 compression grid prototype for transformation

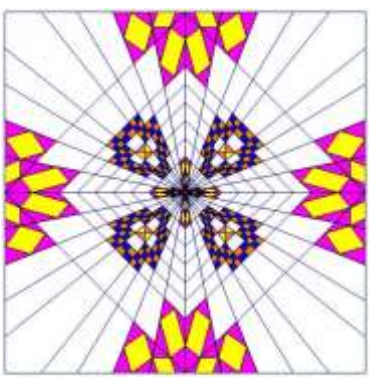


Figure 10: A9x9 Kaleidoscopic prototype grid for rotation and reflection

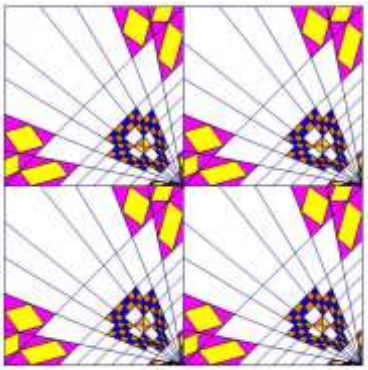


Figure 11: A9x9 Kaleidoscopic prototype grid for transformation

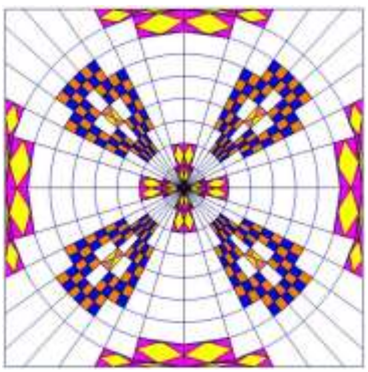


Figure 12: A9x9 Kaleidoscopic prototype grid for rotation and reflection

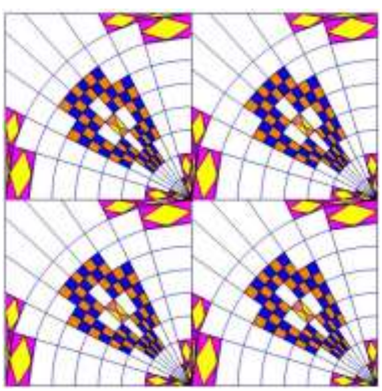


Figure 13: A9x9 circular grid prototype for transformation

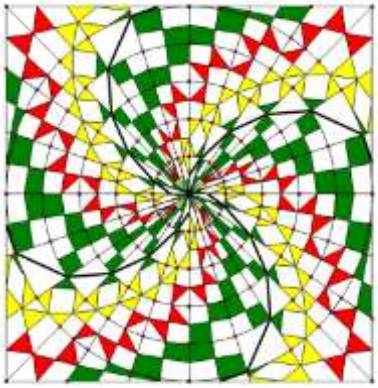


Figure 14: A 6×6 circular grid prototype for rotation

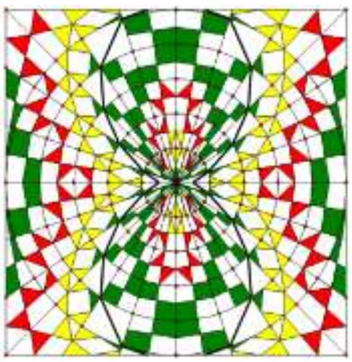


Figure 15: A 6×6 circular grid prototype for reflection

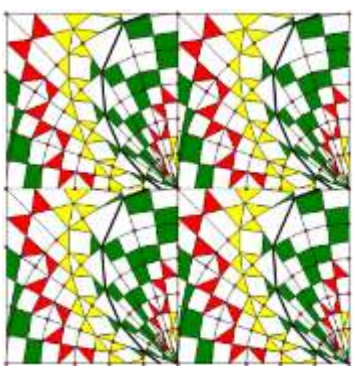


Figure 16: A 6×6 circular grid prototype for transformation

10/2/2025