Artikel

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Visualization of polygon topology in R2 by dividing the outer plane of the polygon

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Abstract. In geometric topology, it is very interesting to develop especially related to the visualization of similar polygons to show the existence of each topology in a two-dimensional plane (R2). The aim to be achieved is to evaluate the conceptual application through the application of the development of the theory of polygon duplication images that are similar with the aided triangle and rectangle. The method chosen in this study is basic research for aiming at discovering new knowledge that had not been previously known. of a visual illustration of a polygon where the number of duplications can be determined and the R2 field. The instrument used is a validated assessment sheet. The validity test result is 2.68 so it is included in the valid category. The visualization of polygon topology on R2 can determine the number of polygons produced by dividing the number of corner points (n) into 2 parts, namely even and odd. The phenomenon of the research result shows that the odd and even n shows an arithmetic sequence. With this division, the formula for the total polygon topology $\sum P_n$ is obtained using the formula for (Un) in the arithmetic sequence.

1. Introduction

Geometry topology is one of the three main branches of topology besides topology in algebra [1]. Deepening the concept of geometry is very necessary in everyday life. Its implementation is widely used in several aspects, for example in building construction by making illustrations using dimensions 2 (R2) or dimensions 3 (R3). With an illustration of this capability will facilitate the implementation of building construction and its application in a development. Another thing that is certainly no less interesting in terms of art, visualists from geometric shapes that generally give the name polygon is an interesting thing [2]. One example in the field of design. If we look closely, the designs made by the designers are an approximation of polygons with various special treatments. Many even apply polygon topology in fabric designs and paintings [3]. This is what makes it interesting to discuss the basic concepts that are easy to implement about the geometric topology of a polygon. In a simple and easy way but rooted in the concept, it will be very easy to find duplicate polygons with their topology.

In the history of batik in several regions, as well as the results of research [4], it shows that in the illustration, if we observe, there are duplications of polygons with their geometric topology. Thus, there are many ways to be able to make a variety of designs from polygons that can be developed.

In duplicating a polygon that has the same properties or topology, you can use various methods. Researchers are interested in carrying out research by making polygene duplications in 2 dimensional space (R2) by utilizing several very simple and easy to do geometric shapes. Then choose the geometric shape of a right triangle and a quadrilateral (square or rectangle). The choice of 2 shapes

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takes into account the properties of right triangles and rectangles which are very easy to understand and easy to calculate by anyone. For example, to determine the length of the side and the size of the angle, we can easily find it. This is the advantage or advantage of this method because it uses media that is easy to use, understand and apply [5].

This basic concept is not many researchers who carry out research, but there are several previous studies that include the creative digitization of motifs in a world design style that is packaged in a book. The research entitled "Calculating Angle Size of Polygons with the Assistance of Field Division and Cross-sectional Polygon Duplication and Approximation of Polygon Extensions with the Assistance of Triangular Constraints" [6] is a complete discussion, but the difference has not yet discussed the number of topologies that can be generated. In addition, in his research entitled [7] Generation of Pythagorean Tree Fractals Using the Iterated Function System, he also uses a topological system which in anonymous language is called a fractal. From the various studies and studies above, this research can show how to determine the polygon duplication and the number of polygon duplications which is called geometric topology which can be obtained with the help of right triangles and rectangles.

2. Research methods

The method used in this research is basic research according to Ubaidillah [7] argues that basic or pure research is research that aims to find new knowledge that has not previously been known.

This research was conducted in several stages including the following:

a) An n-sided polygon is drawn with the n value used, $n > 2$
   The polygons used in this research start from P_3, P_4, P_5, ... , P_n because it is in accordance with the definition that at least 3 points can be made exactly one plane.

b) The outer division of the polygon with the help of a rectangular area
   This step is done by drawing a straight line out of the polygon plane from each polygon corner. Then you can find a rectangle outside the polygon that positions the polygon inside the rectangle

c) Decompose the outer division plane with the right triangle and quadrilateral
   From step 2, the results of the division of the outer plane, there are several shapes including right triangles, rectangles, squares, and trapezium. Furthermore, from each of these shapes it is converted into the form of right triangles, squares and rectangles by drawing a straight line at several corner points on the trapezoid.

d) Calculate the ratio of the angle of the outer angle and the angle in the polygon
   After you can see that there are only right triangles and rectangles, we can easily determine the polygon angles

e) Calculate the ratio of the side of the polygon point to the side formed
   To get the position of the polygon vertices, we use side comparisons. The length of the side through which the vertex traverses can be found with the help of the similarity of the triangle or the Pythagorean formula. Then the ratio of the polygon points to the sides can be determined.

f) Duplicate the polygon into its topology inside the rectangle resulting from dividing the outer plane of the polygon
   Generated various kinds of polygon topologies that are only in the rectangle that are on the outer plane of the polygon

g) Calculate the number of polygon topologies that have been found
   To find how many topologies and polygon duplications, you can use the arithmetic sequence formula of U_n

The steps that have been written above are tested repeatedly for different values of n so that they are divided into n = even and n = odd to make it easier to find the general formula.

3. Calculation methods

Some of the formulas used in the calculation are the nth term in the arithmetic sequence [8].

$$U_n = a + (n-1)b \qquad (1)$$

4. Analysis and discussion

In the process of finding the duplication of this polygon conceptually as we create a fractal which we usually encounter in several batik design models [8]. Basically the concept of repeating the form we get [9]. Like making a fractal in geometry [10], the result of this research formula becomes very easy and simpler.

Steps taken to obtain the results of the treatment are as follows. For polygons with a value of n divided into 2 parts

$$n > 2 \begin{cases} n = odd, n = 3, 5, 7, \dots \\ n = even, n = 4, 6, 8, \dots \end{cases} \qquad (2)$$

The resulting polygon duplication is a polygon topology inside the rectangular shape in the outer area of the polygon. For the number of duplicated polygons $(\sum P_n)$ using the arithmetic sequence formula.

At $n = odd$ the following results are obtained.

$$
\begin{aligned}
n = 3 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_3 = 7 \\
n = 5 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_5 = 9 \\
n = 7 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_7 = 11
\end{aligned} \qquad (3)
$$

The pattern that is formed leads to the usual arithmetic sequence at n so that it can be calculated for $n = odd$ then $U_n = a + (n-1)b$, where a = the first term of the nth term arithmetic sequence, b = difference.

While the number of polygon duplications using $\sum P_n = U_n = a + (n-1)b$ where a = the first term in the number $(\sum P_3)$ and b = difference $(\sum P_{n+1} - \sum P_n)$

At $n = even$ the following results are obtained.

$$
\begin{aligned}
n = 4 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_4 = 8 \\
n = 6 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_6 = 10 \\
n = 8 \quad &\dots\dots\dots\dots\dots\dots\dots \sum P_8 = 12
\end{aligned} \qquad (4)
$$

The pattern that is formed leads to the usual arithmetic sequence at n so that it can be calculated for $n = even$ then $U_n = a + (n-1)b$, where a = the first term of the nth term arithmetic sequence, b = difference.

While the number of polygon duplications using $\sum P_n = U_n = a + (n-1)b$ where a = the first term in the number $(\sum P_4)$ and b = difference $(\sum P_{n+1} - \sum P_n)$.

5. Conclusion

Research conducted on the visualization of polygon topology on R2 can determine the number of polygons produced by dividing the number of corner points (n) into 2 parts, namely even and odd. The phenomenon of the research result shows that the odd and even n shows an arithmetic sequence. With this division, the formula for the total polygon topology $\sum P_n$ is obtained using the formula for (Un) in the arithmetic sequence.

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