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Features of the Formation of Guilloche Rosettes

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Abstract:

Geometric structures play an important role in exploring and studying the world around us. These designs are present both in nature and in technical solutions implemented by man. At the same time, these structures help influence various processes that are important to humans. One of the tools for implementing such designs and their implementation in various areas of cognition is guilloche. At the same time, the construction of guilloche is largely determined by the area of its application. Based on this, the work pays special attention to the peculiarities of the formation of guilloche rosettes.

Key words: Rosette, Guilloche, Ornament, Features, Geometric Figure

Introduction

Various models and approaches are widely used in various fields of research [1]-[9]. Among such tools, one should highlight both logical structures and structures based on a certain mathematical formalization, where geometric structures should be highlighted. These models and approaches allow solving specific problems and can be used in conjunction with other tools. This combination makes it possible to consider new conditions for solving more complex problems.

One example of interesting mathematical formalizations that can be used to solve various problems is the use of the apparatus for constructing geometric figures using guilloche rosettes [10], [11]. This technique allows you to: ensure the protection of information in the financial sector [12]-[14]; create decorative patterns or be used in image analysis [15], [16]; enter additional information in printing production [17], [18]; provide new technologies for the production of boards [19], etc.

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The expansion of the capabilities of guilloche and, as a consequence, the areas of their use is largely determined by the conditions for which such guilloche is used. These conditions ultimately determine the features of the formation of various geometric structures.

Thus, the main goal of this work is to consider the features of guilloche formation, taking into account the area of its use. This involves a preliminary review of related research and formalization methods to describe the process of constructing individual geometric structures.

Related works

The creation and use of guilloche rosettes is one of the areas of research. These issues have been given attention in many works by researchers and practitioners.

P. Albenda explores the peculiarities of the formation and use of guilloche rosettes in the art of the Assyrian Empire [20]. The author reveals in detail the technique of constructing guilloche rosettes and using it for various decorations and interior design. There are many specific drawings, geometric plots, where various guilloches are used.

M. Nassar and Z. Al-Muheisen explore geometric mosaics using the guilloche technique [21]. The work notes the skill of constructing such ornaments, the art of their creation. At the same time, the special geometry of such a mosaic is noted. The article also examines the significance of the non-figurative nature of this mosaic and other church artifacts of similar date in Lebanon and Syria [21].

S. Usilin, D. Nikolaev and D. Sholomov consider in detail the guilloche technique for making passport pages [22]. In particular, the authors use this experience to recognize individual guilloche elements. For these purposes, a morphological filtering technique is used for pre-processed images using the Viola-Jones detector. This approach is general and can be used to form more secure geometric structures based on guilloche.

D. Bansal, S. Malla, K. Gudala and P. Tiwari explore issues of combating counterfeiting [23]. For these purposes, the feasibility of using guilloche is considered. Therefore, the work pays due attention to the technique of constructing guilloche. The authors note that this technique makes it possible to create various protection

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technologies, both explicit and hidden. In general, this allows you to monitor the effectiveness of guilloche in this area.

B. Yoon, J. Lee, I. S. Park, S. Jeon, J. Lee, and J. M. Kim also analyze the latest anti-counterfeiting techniques [24]. Therefore, special attention is paid to guilloche and the technique of its implementation. For these purposes, an appropriate strategy for protecting and preventing the spread of counterfeits must be built. In doing so, the authors concentrate on colorimetric and fluorimetric approaches that use guilloche. This allows you to create active authentication and use molecular imaging methods [24].

H. Forcinio in his study emphasizes that it is guilloche that provides an effective fight against counterfeits [25]. At the same time, the work notes that it is necessary to take into account the features of such guilloche and use appropriate techniques for forming geometric structures.

D. W. K. Neo, A. S. Kumar and M. Rahman analyze the possibilities of using guilloche in various technological processes [26]. In particular, the use of guilloche for the manufacture of a polygonal array of Fresnel lenses is considered. The proposed technology also makes it possible to solve other problems of eliminating production barriers when processing free-form surfaces with complex curvature [26].

The above discussion allows us to conclude that the guilloche technique is used in different tasks. Moreover, such a technique assumes the possibility of taking into account individual features of its use to solve individual problems. Therefore, the formation of geometric structures using guilloche is an urgent task.

Guilloche elements as functional description

Guilloche, as a unique way of forming geometric structures, can be considered in the form of several separate components. Each component has its own characteristics of formation and connection into a single whole. Thus, it should be noted that guilloche is a special technology based on the composition of guilloche elements placed on a surface that is protected [25]. At the same time, guilloche elements are called small ones with a large number of vertical thin lines, tasks, including mathematical formulas [26]. Therefore, to construct guilloche, you can use the appropriate mathematical formalization. At the same time, the principle of guilloche elements is based on the use and superimposition of standard functions, such as sine and cosine [11].

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As an example, we can cite the following analytical generalizations [11], [27]:

$$\rho = a^2\left[\left(1+\frac{1}{n}\right)^2+\left(\frac{1}{n}\right)^2-2\left(\frac{1}{n}\right)\left(1+\frac{1}{n}\right)\cos(n\varphi)\right],$$

where φ is the polar angle, and n is the parameter of the shape of the curve (epitrochoides),

or

$$x=(R+r)\cos(mt)+(r+p)\cos\left(\frac{m(R+r)}{r}t\right)+Q\cos(mt);$$

$$y=(R+r)\sin(mt)-(r+p)\sin\left(\frac{m(R+r)}{r}t\right)+Q\sin(mt),$$

where t is a parameter, and other letters indicate “secret” parameters that are embedded in the geometric shape of the socket outlets.

Then, by changing the parameters, you can get a family of guilloche rosettes. By imposing restrictions on these types of geometric designs, it is also possible to form their color scheme. These sockets can be placed within certain frames of their construction. This also creates new types of guilloche. Below we consider some constructions of such sockets.

Some examples of forming guilloche rosettes

Let's consider one type of guilloche task using the following formula:

$$x=a\cos(t)+\frac{1}{2}\cos(bt)+\frac{1}{3}\sin(ct),$$

$$y=a\sin(t)+\frac{1}{2}\cos(bt)+\frac{1}{3}\cos(ct),$$

t – some parameter that determines the boundaries of the pattern change,
other parameters determine the geometric shape of the outlet.

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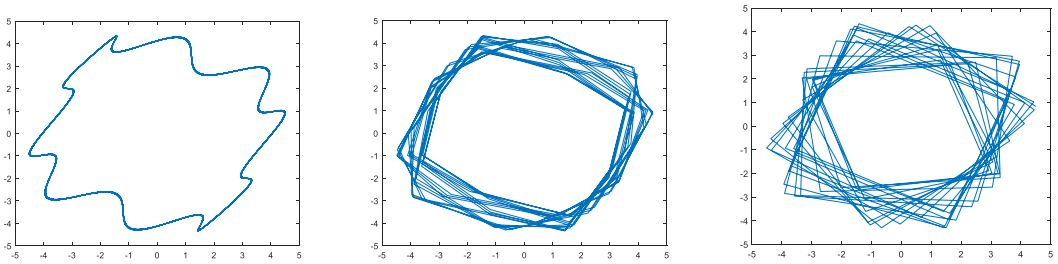
By changing the range and step of changing the guilloche, you can get completely different images. Examples of such constructions are shown in Figure 1. In Figure 1a, the smallest step of changing the guilloche lattice nodes is specified, in Figure 1c – the largest step of changing the guilloche lattice nodes. The remaining parameters are unchanged.



a) b) c)

Figure 1: An example of constructing a guilloche with different iteration steps of its nodes

Next, let's look at an example of changing color schemes when creating guilloche.

To do this, consider the construction of guilloche in accordance with the formula:

$$x = (2 + sin(a1 * t1)/2) * (cos(t1 + sin(b1)/c1)),$$
$$y = (2 + sin(a1 * t1)/2) * (cos(t1 + sin(b1 * t1)/c1)),$$

t1 – some parameter that determines the boundaries of the pattern change,
other parameters determine the geometric shape of the outlet.

The corresponding geometric figure is shown in Figure 2. Here we also change the iteration step of the guilloche knots.

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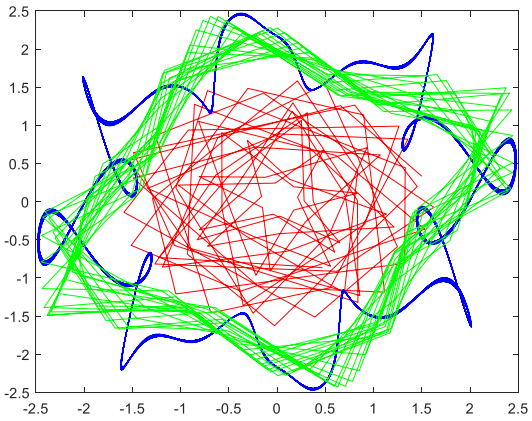
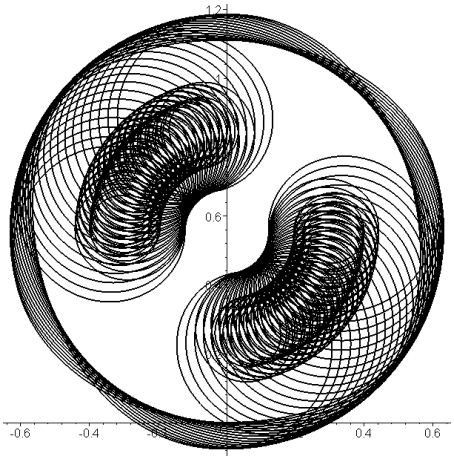


Figure 2: Color representation of guilloche by changing the iteration step of its nodes

It is also possible to obtain more complex geometric objects if you specify a complex mathematical formalization. Some examples are given below.



a) $[1+p\arccos(\cos(s))]^w$ **(w=1,** $p = 0{,}785$**)**

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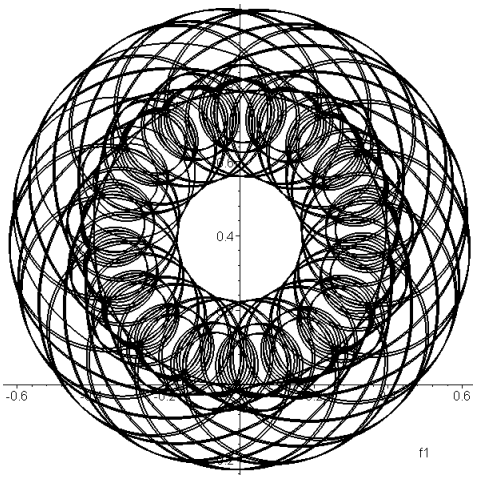

b) $[1+p\arccos(\cos(s))]^w$ **(w=1,** p = 0,804**)**

Figure 3: Complex form of defining guilloche rosettes

Thus, by specifying the analytical guilloche formula, various types of rosettes can be formed.

Conclusion

The paper examines the features of the formation of geometric structures using guilloche. Attention is paid to various areas of using such structures in practice. This made it possible to pay attention to the features of the formation of such structures: from simple to complex. Among such features, the article highlights the guilloche parameters and the iteration step for determining the nodes for their construction. Attention is also drawn to the possibility of changing the color scheme of guilloche. The results of constructing such guilloches are presented using specific examples.

References:

1. Sotnik, S., Matarneh, R., & Lyashenko, V. (2017). System model tooling for injection molding. International Journal of Mechanical Engineering and Technology, 8(9), 378-390.

2. Khan, A., Joshi, S., Ahmad, M. A., & Lyashenko, V. (2015). Some Effect of Chemical Treatment by Ferric Nitrate Salts on the Structure and Morphology of Coir Fibre Composites. Advances in Materials Physics and Chemistry, 5(1), 39-45.

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023 SJIF(2023)-3,778 Volume-1, Issue-12

3. Al-Sherrawi, M. H., Lyashenko, V., Edaan, E. M., & Sotnik, S. (2018). Corrosion as a source of destruction in construction. International Journal of Civil Engineering and Technology, 9(5), 306-314.

4. Nevliudov, I., Yevsieiev, V., Baker, J. H., Ahmad, M. A., & Lyashenko, V. (2020). Development of a cyber design modeling declarative Language for cyber physical production systems. J. Math. Comput. Sci., 11(1), 520-542.

5. Lyashenko, V., Deineko, Z., & Ahmad, A. (2015). Properties of wavelet coefficients of self-similar time series. International Journal of Scientific and Engineering Research, 6(1), 1492-1499.

6. Abu-Jassar, A. T., Al-Sharo, Y. M., Lyashenko, V., & Sotnik, S. (2021). Some Features of Classifiers Implementation for Object Recognition in Specialized Computer systems. TEM Journal: Technology, Education, Management, Informatics, 10(4), 1645-1654.

7. Baker, J. H., Laariedh, F., Ahmad, M. A., Lyashenko, V., Sotnik, S., & Mustafa, S. K. (2021). Some interesting features of semantic model in Robotic Science. SSRG International Journal of Engineering Trends and Technology, 69(7), 38-44.

8. Abu-Jassar, A. T., Attar, H., Yevsieiev, V., Amer, A., Demska, N., Luhach, A. K., & Lyashenko, V. (2022). Electronic User Authentication Key for Access to HMI/SCADA via Unsecured Internet Networks. Computational Intelligence and Neuroscience, 2022, 5866922.

9. Abu-Jassar, A. T., Attar, H., Lyashenko, V., Amer, A., Sotnik, S., & Solyman, A. (2023). Access control to robotic systems based on biometric: the generalized model and its practical implementation. International Journal of Intelligent Engineering and Systems, 16(5), 313-328.

10. Kardash, O., & Chelombitko, V. Didgital-art цінних паперів. Theory and practice of design, (23), 105-114.

11. Zhanna, D., Tetyana, S., & Vyacheslav, L. (2023). Guilloche rosette as an element of building complex geometric structures. Journal of Universal Science Research, 1(10), 526-534.

12. Слюніна, Т. Л., Бережний, Є. Б., & Ляшенко, В. В. (2007). Розвиток вітчизняної мережі банківських установ: особливості та регіональні аспекти. Вісник ХНУ ім. В. Н. Каразіна. Економічна серія, 755. 84–88.

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023 SJIF(2023)-3,778 Volume-1, Issue-12

13. Ляшенко В. В. (2007). Интерпретация и анализ статистических данных, описывающих процессы экономической динамики. Бизнес Информ, 9(2), 108-113.

14. Vasiurenko, O., & et al.. (2020). Spatial-Temporal Analysis the Dynamics of Changes on the Foreign Exchange Market: an Empirical Estimates from Ukraine. Journal of Asian Multicultural Research for Economy and Management Study, 1(2), 1-6.

15. Lyubchenko, V., & et al.. (2016). Digital image processing techniques for detection and diagnosis of fish diseases. International Journal of Advanced Research in Computer Science and Software Engineering, 6(7), 79-83.

16. Lyashenko, V., Matarneh, R., & Kobylin, O. (2016). Contrast modification as a tool to study the structure of blood components. Journal of Environmental Science, Computer Science and Engineering & Technology, 5(3), 150-160.

17. Winklhofer, M., Dumas, R. K., & Liu, K. (2008). Identifying reversible and irreversible magnetization changes in prototype patterned media using first-and second-order reversal curves. Journal of Applied Physics, 103(7).

18. Chaganty, N. R. (2003). Analysis of growth curves with patterned correlation matrices using quasi-least squares. Journal of statistical planning and inference, 117(1), 123-139.

19. Lee, H. C., & et al.. (2020). Multiaxially-stretchable kirigami-patterned mesh design for graphene sensor devices. Nano Research, 13, 1406-1412.

20. Albenda, P. (2022). Ornamental wall painting in the art of the Assyrian Empire (Vol. 28). Brill.

21. Nassar, M., & Al-Muheisen, Z. (2010). Geometric Mosaic Pavements of Yasileh in Jordan. Palestine exploration quarterly, 142(3), 182-198.

22. Usilin, S., Nikolaev, D., & Sholomov, D. (2011, August). Guilloche elements recognition applied to passport page processing. In Proceedings of the 8th Open German-Russian Workshop “Pattern Recognition and Image Understanding” OGRW-8-2011 (pp. 303-306).

23. Bansal, D., Malla, S., Gudala, K., & Tiwari, P. (2013). Anti-counterfeit technologies: a pharmaceutical industry perspective. Scientia pharmaceutica, 81(1), 1-14.

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023 SJIF(2023)-3,778 Volume-1, Issue-12

24. Yoon, B., Lee, J., Park, I. S., Jeon, S., Lee, J., & Kim, J. M. (2013). Recent functional material based approaches to prevent and detect counterfeiting. Journal of Materials Chemistry C, 1(13), 2388-2403.

25. Forcinio, H. (2002). Technology advances anticounterfeiting options. Pharmaceutical technology, 26(6), 26-34.

26. Neo, D. W. K., Kumar, A. S., & Rahman, M. (2015). An automated Guilloche machining technique for the fabrication of polygonal Fresnel lens array. Precision Engineering, 41, 55-62.

27. Liakhovych, O., & Riznyk, V. (2011). Investigation of information technologies for creating guilloches. Liakhovych O., Riznyk V, 97-100.