A Computer Aided Generative System for Polish Traditional Tilings Design

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Abstract
Decorative tilework, known also as tile art, dates back thousands of years. Different types of tiles decorate the world's oldest temples and mausoleums with precise details and eye-catching colors. They are clearly distinctive from mosaic art, which is based on the use of a huge amount of, usually small, irregular elements. In the case of tiling, the elements used are usually larger and much more regular, they can consist of a certain number of tiles or just one. While popular in many cultures, specific tiling patterns with distinctive features developed separately in different parts of the world. During the interwar period in Poland (1918-1939) a distinctive type of tiles called “corset” became very popular. Corsets arranged in intricate patterns form elegant tileworks. The aim of our research is using modern technology to help preserving this unique cultural heritage as many original tileworks disappeared as the result of war, postwar rebuilding and modern urban development. In this paper rules of a visual language that can describe specific tiling patterns characteristic for corset tiling are defined. Then, a system for automatic generation of tile pattern designs, which is based on these rules, is proposed. Using this system the user can design corset patterns taking into account historical context, architectural harmony or artistic imagination. We not only want to preserve the living patterns of heritage, but also to propose them as an element of modern interiors, where they can perform a decorative function and beautifully separate functional spaces in modern open-plan apartments.

Keywords: Generative Design, Rule Systems, Polish Heritage

Introduction

Decorative tilework, known also as tile art, dates back thousands of years. Tiles decorate the world's oldest temples and mausoleums with precise details and eye-catching colors. Tilework should be clearly distinguished from mosaic art, which is based on the use of a huge amount of, usually small, irregular elements. In the case of tiling, the elements used are usually larger and much more regular, they can consist of a certain number of tiles or just one.

During the interwar period in Poland (1918-1939) a distinctive type of tiles called “corset” (Polish “gorsecik”) became very popular. A corset has a shape of a curvelinear quadrangle with two convex and two concave edges (Fig 1a). Despite this simple form corsets allow for the generation of a large number of patterns (Strug et al. 2018). Two, three or multi-coloured arrangements of corsets, which form stripes, chessboards, crosses, slices, and more complicated designs, frequently occurred on the floors of kitchens, bathrooms, verandas, staircases, in cafes and craft workshops. In Fig1b an example of a possible tilework design is depicted, while in Fig.1c a photograph of a part of tiling of the staircase in a building at Okrag 3 Street in Warsaw is shown.

Figure 1: (a) “Corset” tiles in different colours, (b) a tilework pattern, (c) Okrag 3, Warsaw (photo copyright Warszawskie Posadzki)

As the result of war and post-war neglect, and the renovation of old houses, large part of these designs has been either lost or damaged. In recent years there has been a growing interest in saving this part of national culture as well as in adapting it to modern times (Faryna-Paszkiewicz et al., 2013). Inspirations with the aesthetics of the 1920s and 1930s return again in contemporary design of buildings, furniture, and ceramic tiled floors. By adding a bit of modern design to the iconic mosaic shape, we get patterns that can be successfully used in vintage, modernist and modern interiors. Old, renovated tenement houses require interior designers to treat them with sensitivity and respect for the past.

Elegant tileworks arranged in intricate patterns of small "corsets", not only invite interwar design spirit to modern interiors but also can beautifully separate functional spaces. Effective carpet patterns can be conjured up from colorful ceramic "corsets", which originally decorate places with traditions. Corsets in subdued, complementary colors allow for creative interior arrangement experiments. Original tilings will successfully decorate the space of stylish tenement houses as well as common pubs, bars and city restaurant gardens. The universality of tailworks, their technical qualities, durability and excellent quality make them suitable for use in a lot of places where the designer wants to achieve a spectacular aesthetic effect.

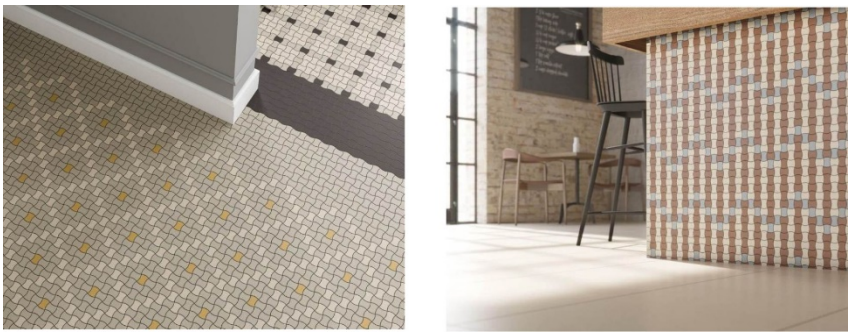

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Figure 2: Patterns composed of corsets on a floor of a renovated tenement house and in a pub in Warsaw

The paper presents the process of automatic generation of tile layout patterns design. In the proposed generative system the user can design corset patterns taking into account historical context, architectural harmony or artistic imagination. The analysis of the still existing traditional tilings indicates that they are usually composed of one or two patterns arranged alternatively or repeating in every second row. The most commonly used motifs are of the size 2x2, 3x3, 4x4, or 5x5 and are composed of tiles in various colours. The described system enables the designer to create a motif/ motifs of the chosen size and select the number of rows and columns in which these motifs are to be arranged. After creating motifs the system uses rules that depend on the type of motifs to arrange them on the plane. Designing of motifs which are not rectangular but have rotating symmetry is also possible. For such motifs the designer selects places on the grid composed of corsets, where they should be located. The spaces between the motifs are filled with corsets in the selected color. In this way a great number of different tiling layouts can be obtained, yet preserving the traditional style of Warsaw's flooring designs.

A Generative System for Tiling Design

A generative system consists of basic shapes, a set of structural schemes for representing potential solutions, and a set of rules for selecting and fitting shapes to schemes. By setting the rules for the arrangement of motifs, the generation system determines a variety of potential solutions for a given design task. In our system there is one basic shape in the form of a corset, which can take various colours. Using this shape different motifs can be created. The structural schemes are specified by determining the number of rows and columns in which motifs should be arranged or by pointing the points on a grid in which motifs are to be located. Rules of fitting shapes are defined by combinations of translations and rotations which allow matching motifs to the schemes.

The process of designing a tilework starts by selecting the size of tile motifs by the user. It can be 2x2, 3x3, 4x4, or 5x5. In the next step the user defines the colour of tiles for one or two motifs of the chosen size and specifies the number of rows and columns in which these motifs are to be arranged. In Fig.3 motifs of different sizes are shown.

Then, the fitting rules for arranging motifs in required way are selected. The rules for fitting motifs are different for motifs with odd and even number of elements. The next motif in the row can be matched to the previous one without rotation or using rotation by 90, 180, 270

degrees for motifs of the size 2x2 and 4x4. For motifs of the size 3x3 or 5x5, the next motif in the row have to be rotated by 90 or 270 degrees. Analogous rules apply when motifs are adjusted in columns. Therefore, when the defined motif with even number of elements is not a symmetrical one, sixteen different patterns composed of this motif can be obtained. In case of motifs with odd number of elements only four different patterns can be generated using the same motif. When rotating motifs, rotation can be applied to the entire motif at once, or all the corsets that the motif consists of can be rotated separately.

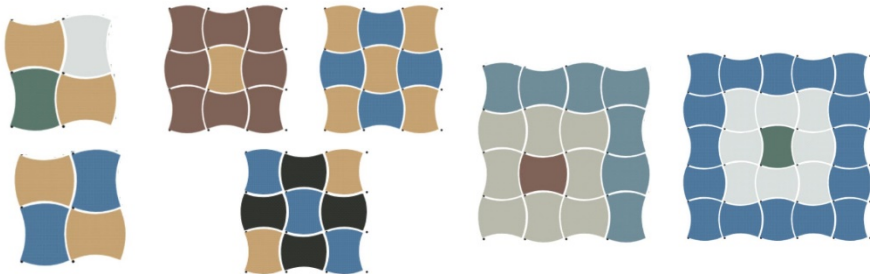


Figure 3: Motifs of sizes 2x2, 3x3, 4x4 and 5x5

Four rules for matching the same motif in a row and in a column are shown in Fig.4. In the rules which add the motif in a row the fitted motif is not rotated or rotated through 90 degrees. In the rules matching motifs in a column the added motif is not rotated or rotated through 270 degrees. Three patterns composed of the same motifs of sizes 5x5, 3x3 and 4x4and obtained using these rules are presented in Fig.5. In the pattern in Fig. 5a every second motif in a row and in a column is rotated through 90 degrees, in the pattern Fig. 5b only motifs in columns are rotated through 90 degrees, while in the pattern in Fig. 5c the matched motifs are not rotated.

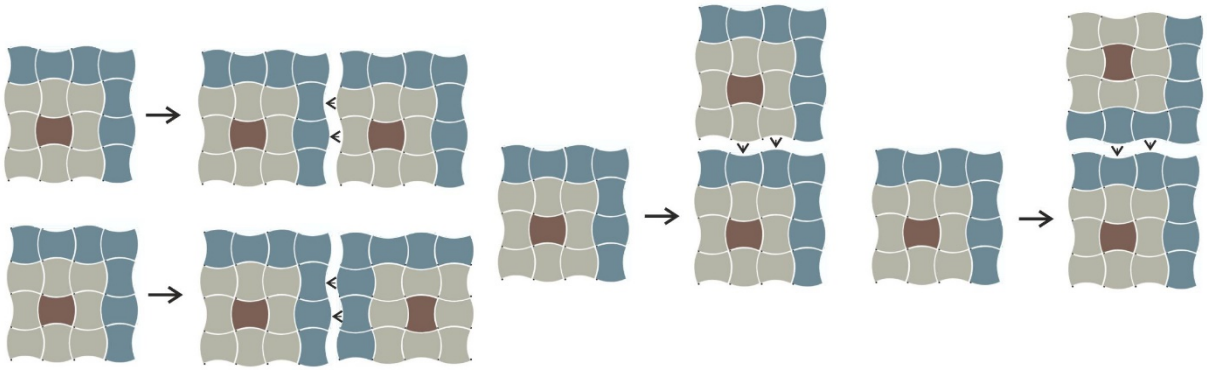


Figure 4: Selected rules for matching motifs in rows and columns

If the patterns composed of two motifs are considered, then motifs in rows are added alternately, and in columns the same motifs can be fitted together or they can be added alternately. The rules for the required angle of rotation for motif matching are the same as for single motif patterns.

Selected rules for matching two motifs of the same size are presented in Fig.6. These rules describe the process of alternately fitting motifs in rows and fitting the same motifs in columns. The motifs in rows and columns can be rotated according to the principles defined above. In Fig.7 four rules of fitting the motifs in columns in the alternate way are shown without rotation or rotated through 90 degrees.

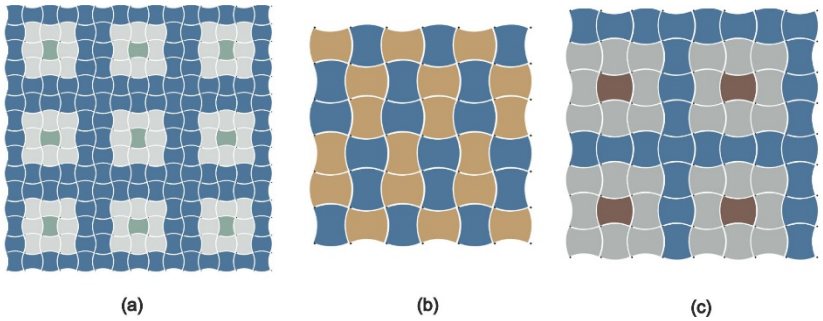


Figure 5: Three patterns composed of the same motifs of sizes 5x5, 3x3 and 4x4

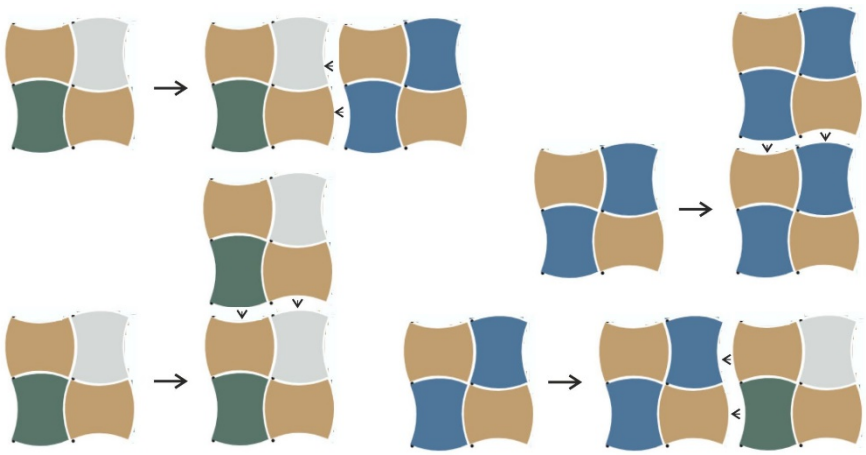


Figure 6: Selected rules for matching two motifs in rows and columns

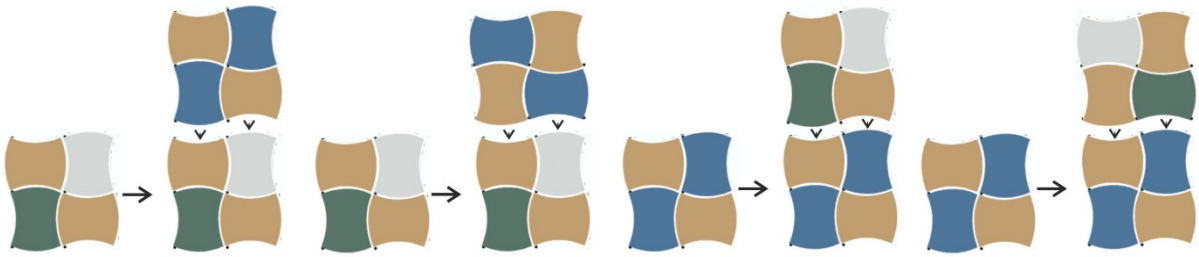


Figure 7: Selected rules for fitting two motifs alternately in columns without rotation or rotated through 90 degrees

Four patterns composed of two tile motifs of sizes 2x2 and 3x3 are shown in Fig. 8. In all these patterns motifs are arranged alternately in rows and columns. In the first and third pattern every second motif up the column is rotated through 90^{o}. In the second pattern motifs are not rotated, while in the fourth one, every second motif up the column is rotated by 270^{o}.

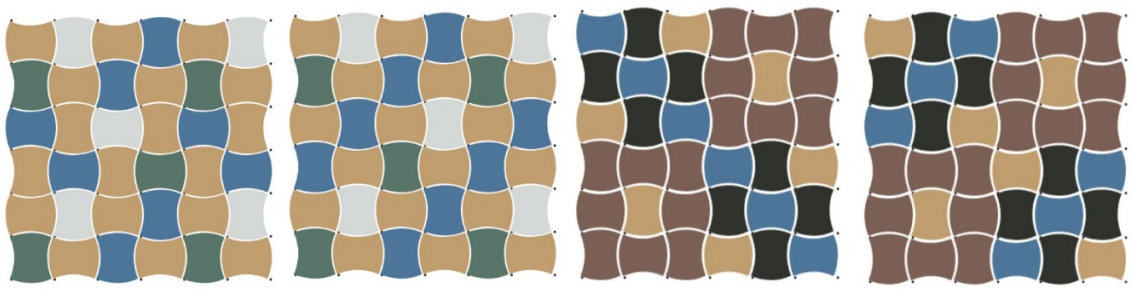


Figure 8: Four patterns composed of two motifs of sizes 2x2 and 3x3, arranged alternately in rows and columns

Another option for creating tileworks is that the designer generates a motif and indicates the places on the grid composed of corsets, where this motif should be located. The spaces between the motifs are filled with corsets in the selected color. In this case the corset grid can be treated as a plane division that becomes a source of inspiration for creating new motifs. An example of a corset grid, a motif and patterns obtained by arranging this motif in marked places is presented in Fig.9. In Fig.9a a corset grid with selected points, where the center of the motif should be placed is shown. In Fig.9a and b a designed motif and pattern obtained by locating it on the grid are depicted. The same pattern after completing it to a square shape and after filling empty places with yellow corsets are illustrated in Figs. 9d and e. The similar pattern obtained as a result of specifying four places for the motif on the grid is shown in Fig. 9f. It should be noted that in this case, as the centres of motifs are located closer in the Fig.9a, the motifs in the second column are rotated through 90^{o}.

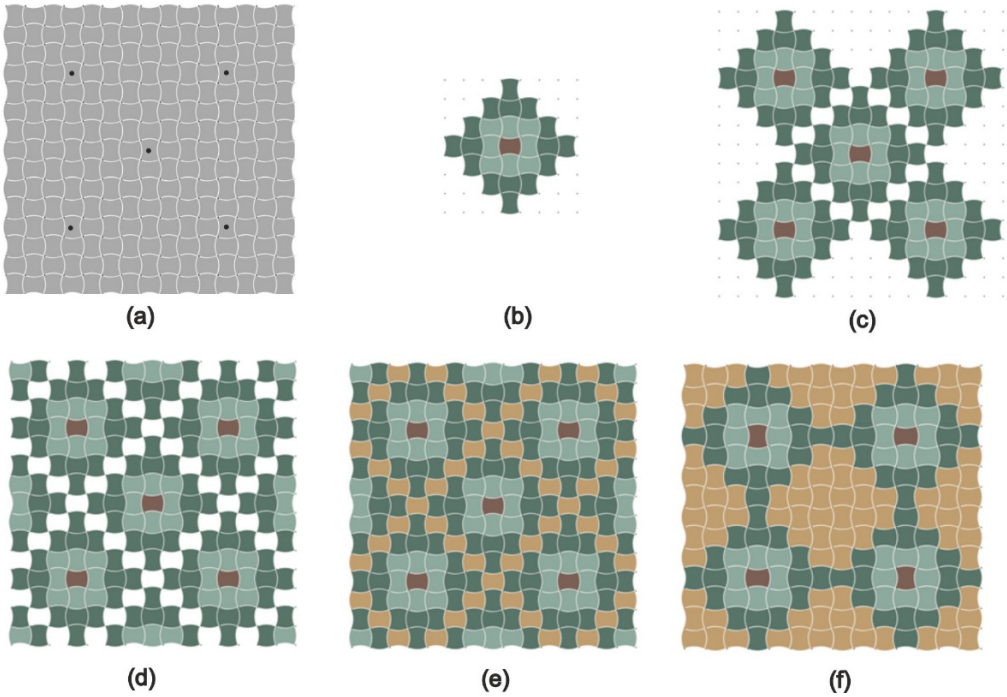


Figure 9: (a) a corset grid with selected locations for motifs, (b) a created motif, (c), (d), (e), (f) patterns obtained by locating a motif in chosen places on the grid

Moreover, the designer can create several motifs with the same shape and combine them to create larger tiles that can be used to fill the plane. Three different motifs and a larger tile composed of them are presented in Fig.10.

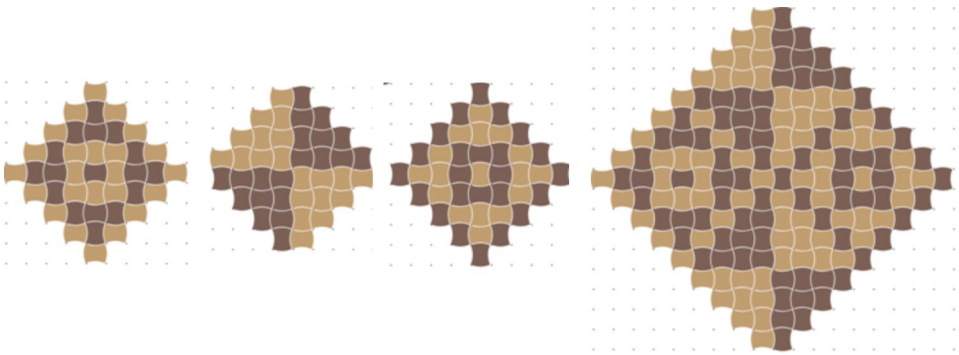
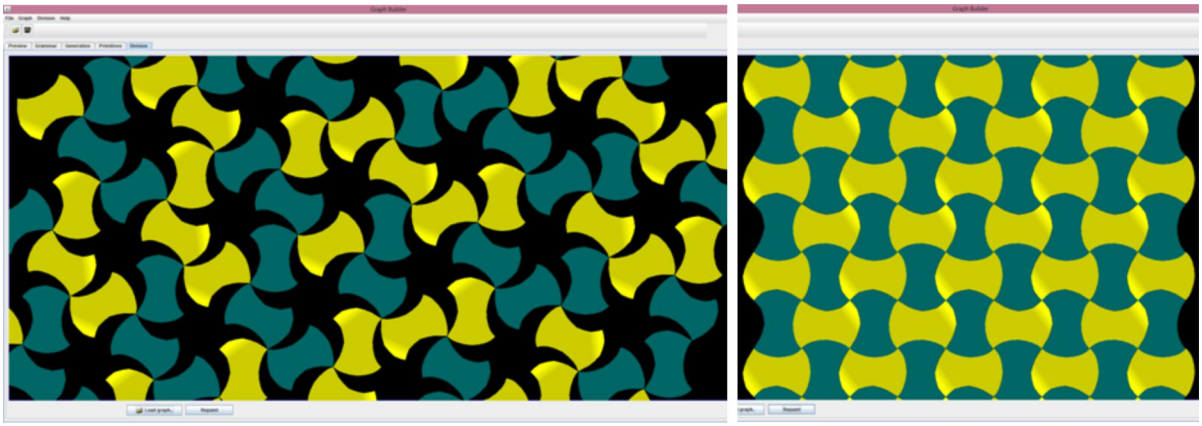


Figure 10: Three corset motif and a tile composed of them

Although traditional Warsaw tailings were created in subdued colors, they can be modernized by introducing corsets in lively colors. An example of a tilework with lively corsets is shown in Fig.11b. Moreover, plane tilings filled by corsets can be based not only on quadrilateral grids but also on triangular grids (Grabska et all. 2001). The example of filling such a grid by two-coloured corsets is shown in Fig.11a. It can be seen that in this case the defined tiles do not fill the whole plane leaving black empty spaces. The emergent black shapes can constitute an inspiration for the designer, who can not only reconstruct the former existing layouts but also create new ones on the basis of the previously existing ones.



(a) (b)

Figure 11: (a) a pattern with emergent stars, (b) a pattern composed of colourful corsets

Conclusions

In this paper a rule-based approach has been proposed to recreate tile patterns. The system not only allows for reproducing traditional designs but also for producing new designs on the basis on the old ones. Moreover, such a system can assist a designer in the conceptual phase of the design process. The automatic design system can also make designing new patterns much easier and help to maintain their use in different situations, not only for floor tilings but for wall decoration, spaces separation or even patchwork design.

In future we plan to extend the proposed system in two ways. The most obvious direction is to add more rules to allow for different ways of combining shapes. While our research is based on the „corset" shape it is also possible to extend the system by modifying the underlaying shape thus obtaining even more variations of tiling patterns.

References

Faryna-Paszkiewicz, H. & Frub, Z. (2013). *Warsaw's disappearing floor tiling* (in Polish:), Nisza, Warsaw.

Grabska, E, Ślusarczyk, G. & Niewiadomska, A. (2001). *Hierarchical graph grammars in graphic prints design and generation*, Machine GRAPHICS and VISION 10 , pp. 519-536.

Strug, B. Ślusarczyk, G. & Grabska, E, (2018). *Using Graph Grammars For Generative Process Recreating Warsaw's Traditional Floor Tiling,* Generative Art 2018: proceedings of XXI Generative Art Conference.

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