EXHIBITION WITH AUGMENTED REALITY "PYTHAGOREAN TREE"

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ИЗЛОЖБА С ДОБАВЕНА РЕАЛНОСТ „ДЪРВОТО НА ПИТАГОР"

Abstract

Here are presented paintings with augmented reality from an exhibition, the purpose of which is to provide a user experience when presenting content about the fractal "Pythagorean Tree", to encourage creativity and experimentation, to motivate for deeper study. The exhibition includes paintings with elements of an image of a Pythagorean Tree, with augmented reality to each of them. The augmented reality is an animation with a fractal "Pythagorean Tree", respectively: a symmetrical tree with a small number of iteration; animation with a change in the angle of the rectangular triangle, using only the contours of geometric objects, changing colors and the degree of transparency, using a regular pentago; a regular hexagon; m including different angles of rectangular triangles. Each of the paintings is used as a marker of the augmented reality. An ease of use and an immersive experience that stimulates curiosity are provided. The pilot presentation showed a high level of satisfaction and evaluation of the experience as useful.

The exhibition is temporary and prepared for gallery space, but can be transformed into a mobile exhibition with presentation in science museums, interactive centers, STEAM centers; at scientific conferences and on stands at popularization forums.

Keywords: *Augmented Reality, AR; Pythagorean Tree; Galleries; Museums; STEAM; Creativity; Interactivity.*

INTRODUCTION

The exhibition is a powerful tool for spreading messages and ideas, for providing pleasure to a large group of people in a short time. XR and interactive technologies allow to improve the possibility of providing an experience for visitors. Examples of interactive presentation of photos using dynamic software are presented in [1]. Some ideas of interactive presentation of objects using a holographic pyramid, as well as its implementation in the context of STEAM education are discussed in [2].

Simone Brasili and Johan Gielis point out that Pythagorean concepts, reflecting the influence of ancient mathematical thought in modern symmetry studies, can be seen as "a transversal principle that connects logic, creativity, design, culture, and information. Whether derived from ancient means or modern digital tools, symmetry continues to be a beautiful language for interpreting and shaping our world" [3]. There are a number of visual proofs of the Pythagorean Theorem and visualizations related to it, Pythagorean means – arithmetic, geometric, and harmonic, some of which also inspire artistic creativity [4], [5], [6], [7] as to "new forms in algebraic geometry, with potential applications in visualization, mathematical art, and education" [8]. The interest in the fractal "Pythagorean Tree" does not decrease, especially when its related to the use of information technologies. An opportunity for an interactive presentation of the fractal "Pythagorean Tree" is presented in [9], by including a QR code in a picture, which provides a link to a short video. Possibilities for research and

design applications of using dynamic software GeoGebra [10], allowing switching to augmented reality mode, are demonstrated in [11].

Here we will describe an exhibition of paintings with elements of an image of a Pythagorean Tree, with augmented reality to each of them, ensuring ease of use and an immersive experience that stimulates curiosity.

THE EXHIBITION "PYTAGOREAN TREE"

The exhibition includes paintings with elements of the image of the Pythagorean Tree, with augmented reality to each of them. The augmented reality is an animation with the fractal "Pythagorean Tree". Each of the paintings is used as a marker of the augmented reality.

In the first model of the fractal "Pythagorean Tree", the rectangular triangle is isosceles and are used squares. Several successive iterations of the fractal are shown through animation, i.e. the "growth" of the Pythagorean Tree is observed (Fig. 1).

Fig. 1. "Pythagorean Tree" fractal model with an isosceles rectangular triangle

The following figure shows a model, for the making of which are used only contours. It shows both growth and movement by changing the angle of the rectangular triangle (Fig. 2).

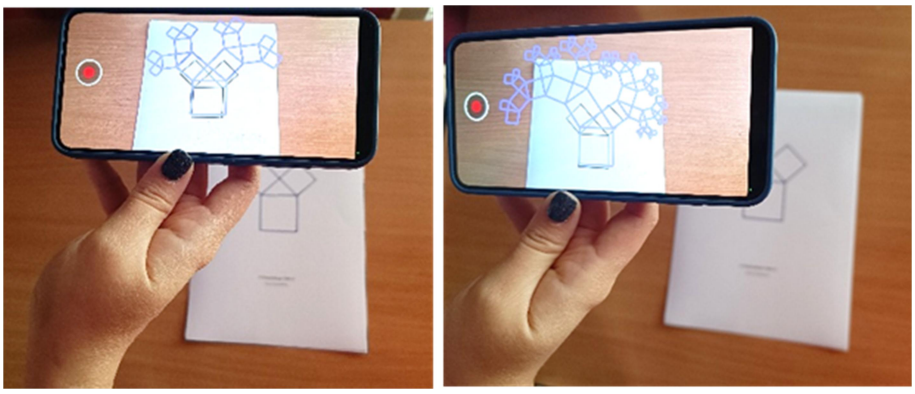

Fig. 2. Fractal model "Pythagorean Tree" with contours

For the next model, the number of iterations increases, the colors of the squares change, as well as the value of the angle of the rectangular triangle. The animation is also associated with oscillation, i.e. the growth and decrease are observed (Fig. 3).

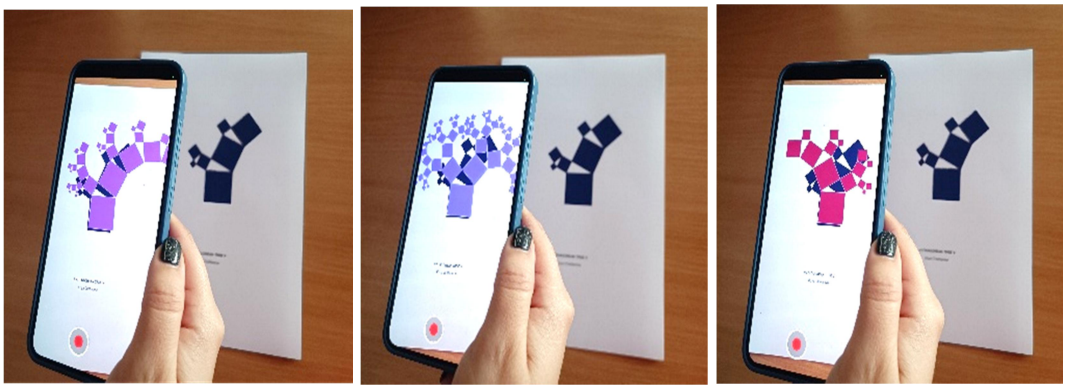

Fig. 3. Model of the fractal "Pythagorean Tree" with oscillation, change of angle and color

A model with a larger number of iterations is presented in Fig. 4. It is convenient to use as a way to illustrate a key characteristic of the fractal – self-similarity.

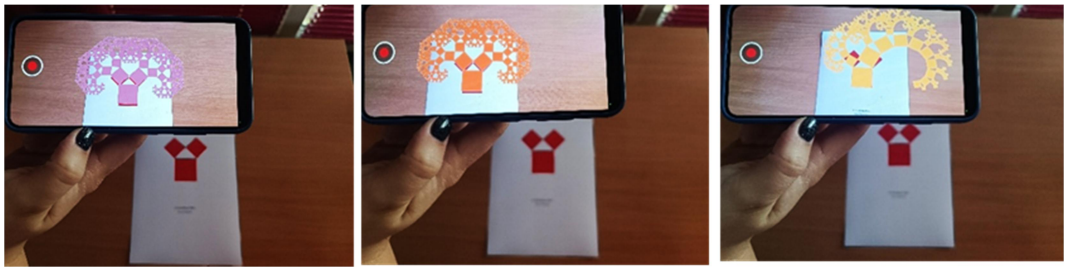

Fig. 4. "Pythagorean Tree" fractal model with a larger number of iterations

In the following models, instead of a square, a regular pentagon and a regular hexagon are used (Fig. 5). The animation is related to both changing the shape (by changing the angle of the rectangular triangle), and changing the fill colors, contours, and the degree of transparency (by changing the corresponding parameters).

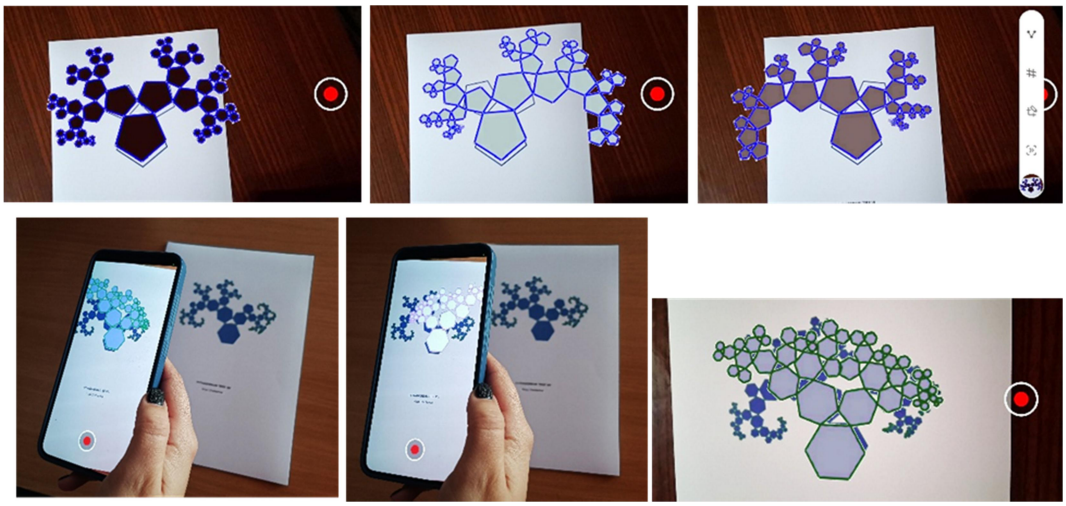

Fig. 5. Models of the "Pythagorean Tree" fractal with a pentagon and a hexagon

Fig. 6 presents a model in which the rectangular triangles have different angles.

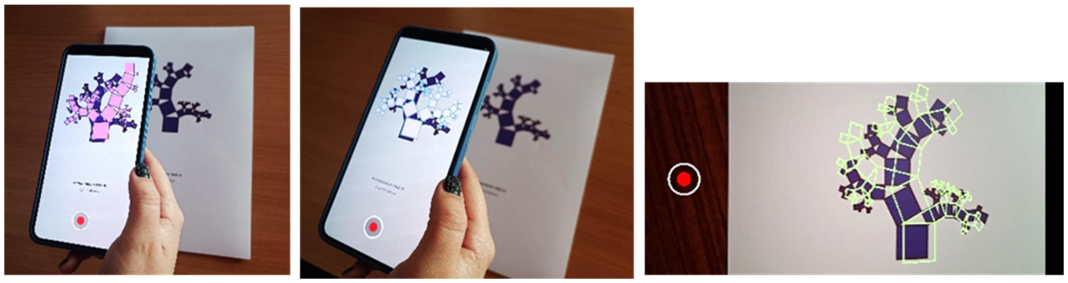

Fig. 6. "Pythagorean Tree" fractal model with different rectangular triangles

DISCUSSION AND CONCLUSION

A number of studies related to exhibitions have focused on communication and technology [12]. Kim and Lee are considering the exhibition as a communication tool or communication environment research, propose methods for displaying information for effective communication with visitors by attracting their attention, focusing on the use of the architectural surface as an extended presentation interface [13]. The role of the exhibition in overcoming challenges in interdisciplinary communication is explored in [14]. The exhibition is seen as an interdisciplinary communication tool that is expected to increase impact when applied together with other tools and serving as a means to promote higher-quality discussions, ongoing research and partnerships. In [15] fundamental factors of the exhibition are examined, focusing on the communicative relationship between people and exhibitions. Technologies like virtual reality, augmented reality, mixed reality, multi-touch systems, sensors, that enable interactive designs in exhibitions are also discussed, as well as "storytelling that services to immerse audiences for better long-term memories than general exhibition types". Emphasis is placed on exploring audience responses as experience, emotion, and behavior [16].

The pilot presentation of the exhibition with augmented reality "Pythagorean tree" showed a high level of satisfaction and evaluation of the experience as useful. During the measurement, the longest time was spent in front of the augmented reality of the last painting, in which on the one hand there is a challenge, and on the other hand – the "dance" of the tree is more lively and provides an easier emotional experience. Therefore, when curating, it is appropriate for that painting to occupy a place through which it can arouse interest, and then with the other paintings to be shown the overall message and provide an understanding at a basic level of the essence of the fractal under consideration.

The discussed exhibition is temporary and prepared for a gallery space, but it can become a mobile exhibition with a presentation in science museums, interactive centers, STEAM centers; at scientific conferences and at stands during promotional forums. In the context of STEAM, the exhibition covers three areas – mathematics, technology and art, i.e. it is realized STEAM(3) [17].

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