STEAM SCENARIOS FOR AR CAPTURING USING ROBOTIC SYSTEMS

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STEAM СЦЕНАРИИ ЗА AR ЗАСНЕМАНЕ С ПОМОЩТА НА РОБОТИЗИРАНИ СИСТЕМИ

Abstract

Possibilities for capturing photos with augmented reality (AR) are considered, based on a trail left by a light source in a darkened space. Some options for using robotic systems to create a "trail" are presented. Examples of the participation of a person as a photographer and creator of AR are given. The conditions and some problems encountered in the process of creating AR photos in closed spaces, as well as outdoors, are described. The given examples of scenarios for application of AR technologies can be used in Mathematics, Information Technologies, Computer Modeling, Fine Arts classes, in STEM centers, during extracurricular activities.

Keywords: *AR; STEAM; Interactive Technologies; Digital Competence; Robotic Systems; Creativity.*

INTRODUCTION

Many mobile applications with augmented reality (AR) require familiarization with the surrounding environment and finding a suitable surface for visualizing an inserted digital object [1]. This is often done by markers or by turning on the camera and rotating it within a well-lit room/space until a sufficiently large smooth surface is detected on which to overlay a grid [2], [3]. AR applications often includes interactive tasks and game elements that encourage experimentation and self-discovery of solutions, for different consumer groups, including through visually "bringing to life" creative elements and projects [4], [5], [6].

In contrast to these applications, here we will consider several scenarios for capturing an AR photo based on a trail left by a light source in a darkened space. Some of the first known shots in this style were taken by the artist Pablo Picasso.

Here we will present ideas for capturing an AR photo using a phone camera as a light source, without the need to install a mobile application. We will also use robotic systems that will create models through a trail of light. The examples of scenarios for application of AR technologies can be used in Mathematics, Information Technologies, Computer Modeling, Fine Arts classes, in STEM centers, during extracurricular activities. Some of the ideas were presented in 2023 during the National Seminar on Mathematics Education at the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences [7].

AR Photo Using Build-in Camera Settings

Creating an image in the "Long exposure" style is available to consumers on a global scale, due to technical advances in many of the latest models of mobile devices. To create the AR photos, a Xiaomi 11T, Android mobile device was used. In the used version of the phone in the "Long exposure" mode of the camera, there are ready-made built-in settings that allow taking a photo based on continuous tracking of the movement of light sources. They are "Neon trails", "Light painting", "Starry sky" and "Star trails" (Fig. 1).

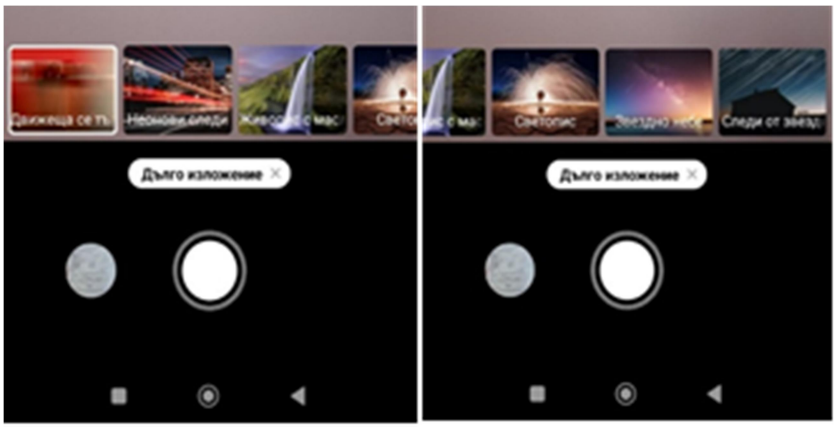

Fig. 1. Available settings for filming in the "Long Exposure" mode

To start in any of the listed modes, one must press and hold the round button in the middle during the video recording. After stopping it, the image is automatically generated. Fig. 2 shows several examples of creating AR Christmas trees using the "Neon trails" setting. The trails of the three trees were made by a person in the following steps: rotation around its axis with one light source; in full-face with one light source; full-face with two light sources.

Fig. 2. An AR Christmas tree made by: a) rotation around its axis; b) full-face with one light source; c) full-face with two light sources

When getting acquainted with the technology of creating an AR photo using a light source, it is appropriate to consider examples demonstrating movements of varying complexity. For example, consumers can be tasked with viewing different videos and guessing what will be depicted in the AR photo. One such task is available at the address https://www.youtube.com/watch?v=XJuml83YLPQ (last view: 01-08-2025) (Fig. 3), showing the process of creating one of the Christmas trees in Fig. 2.

Fig. 3. Example of a task for guessing AR photos

AR PHOTO USING ROBOTIC SYSTEMS

For better accuracy in the contour of the models, robotic systems can be used. For example, in the mobile application for working with an educational Photon Robot [8] it is possible to set a trajectory of a free figure [9], [10]. The length of each of its steps can be adjusted. In this case it is preset to 10 cm. It was worked with one Photon robot, which was tasked with making a model of a snowdrop, letter "T" and a Christmas tree "in one breath". The robot has two antennas that can change color. With activated colors, it is tasked with building: a green leaf and a stem with white petals for the snowdrop; a letter "T" entirely in purple; a Christmas tree with a yellow top, red and blue Christmas toys, and an orange stump (Fig. 4).

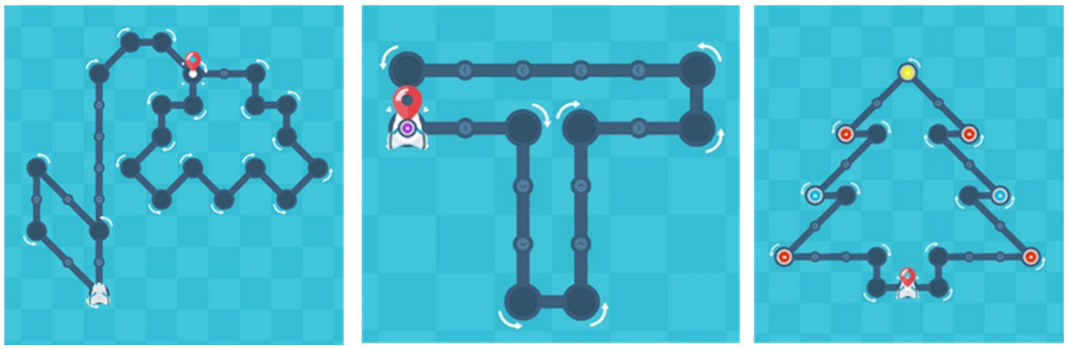

Fig. 4. The programmed figures in the Photon Coding application, Photon Draw (Beginner Level)

The finished AR photos and videos of the trails left by the Photon Robot's movement are shown in Fig. 5. The two antennas form a double line when the robot moves. One of the luminous elements can always be hidden if the goal is to have only one line in the final AR photo.

Fig. 5. AR photos of a snowdrop, letter "T" and a Christmas tree, based on a trail of Photon Robot

The video from the process of creating the AR photos is available at address https://www.youtube.com/watch?v=PvaWAitxRi4 (last view: 01-10-2025) (Fig. 6). Unlike the figures drawn by a person, when following the path of the Photon Robot, the camera phone is several meters above the ground in order to fully capture the figures.

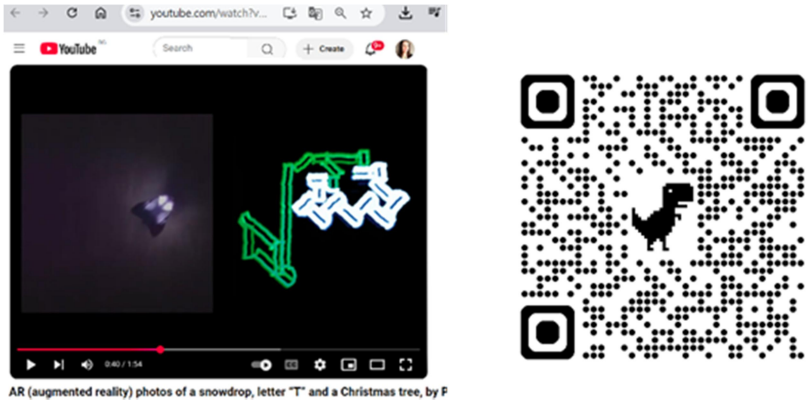

Fig. 6. Process of creating AR photos using Photon Robot

DISCUSSION

Fig. 7 presents AR photos of models "drawn" by a person, which represent an analogous reading of the three figures - snowdrop, the letter "T" and a Christmas tree.

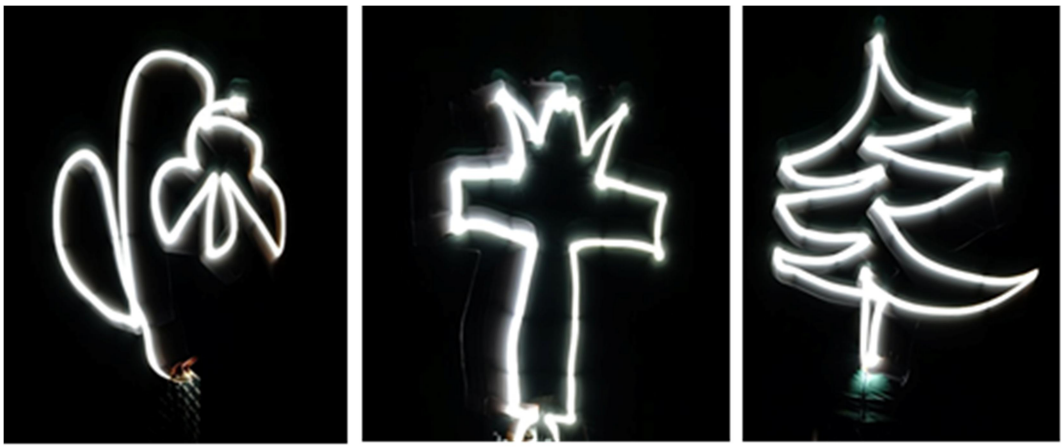

Fig. 7. AR trail made by a person using a phone flashlight

They were filmed with a mobile phone using the already familiar setting "Neon trails". Unlike the figures made by Photon Robot, here no preliminary preparation of the terrain is required for its movement. The accuracy of the letter "T" is noticeable, since two light sources were used and symmetry helped in building the contours. Accordingly, for the Christmas tree and the snowdrop, only one light source was used and the precision of the models is based on the visual estimation of the person drawing.

It is appropriate to organize visits to spaces demonstrating the use of light sources for the creation of original artistic works in dark spaces. For example, during the "LUMINA Park" in the Botanical Garden of the Bulgarian Academy of Sciences, in 2024 in Sofia city, several AR models were made demonstrating the available works - a spiral, a snail and flowers (Fig. 8). The strong wind and low temperatures affected the person drawing and the and the person taking the picture - the mobility of the device was not kept in the required rest the entire time.

Fig. 8. AR photos during the "LUMINA Park" in the Botanical Garden of the Bulgarian Academy of Sciences in Sofia, 2024

When recording the video from which an AR photo will be automatically generated, it is necessary for the mobile device to remain still. A tripod or other means allowing the camera be held still for an extended period of time can be used, especially if filming outdoors. The next step is the use of unmanned robotic systems to film larger scenarios, including in inaccessible places. It is also appropriate to consider the possibility of using a drone as a "drawing" actor to be filmed.

CONCLUSION

The presented ideas for the application of AR technologies can be used in Mathematics, Information Technology, Computer Modeling, Arts classes, in STEM centers, during extracurricular activities. When reviewing the presented resources during training and/or STEM classes, they can be compared with other similar videos according to: accuracy of the trails; possibility of using a different color scheme; space required to perform a figure; quality of the frames; duration of filming, etc.

When preparing a field, it is good to take into account: a period of time (battery) during which technical devices can be worked with (camera, mobile phone; (unmanned) robotic system, etc.); weather conditions (if filming will be done in nature); scenography.

Similar STEAM scenarios for AR filming are also suitable for inclusion in activities in museums, galleries and other interactive spaces. Through them, visitors can explore and experience the process of creating an AR photo, create their own author's model, which they can perform and photograph - independently and/or collectively.

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