

# Traditional Romanian Egg Decoration in Augmented Reality with 3D Printing

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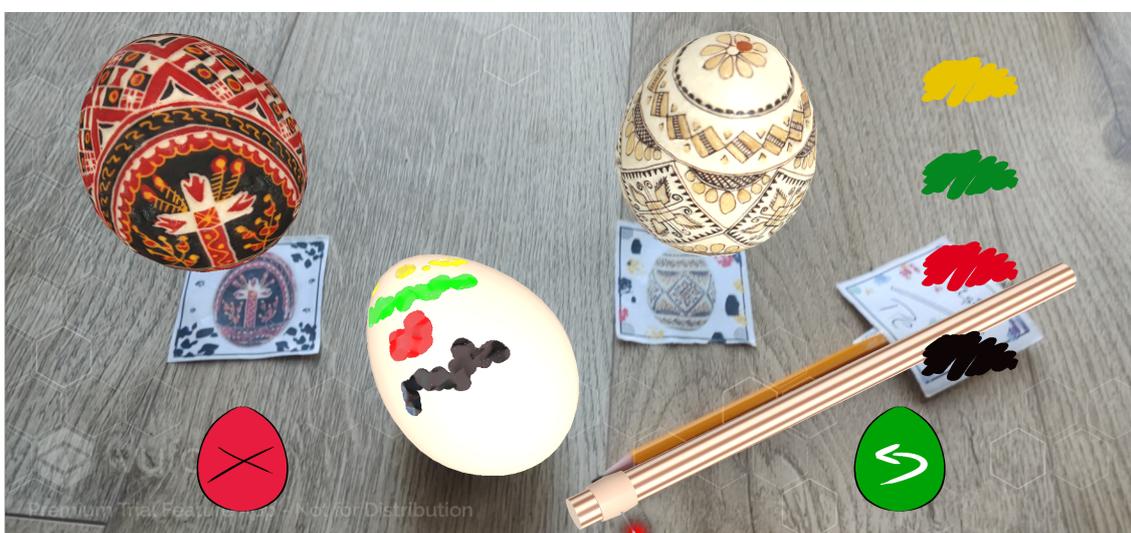


Figure 1: Screenshot of the Easter Egg decoration AR app prototype.

## Abstract

The folk art of decorating Easter eggs is an important part of Romania's intangible cultural heritage. We have developed a prototype for a mobile Augmented Reality (AR) app that allows users to virtually decorate Easter eggs, using a 3D printed egg as a physical AR marker to allow tangible interaction with the egg, mimicking the decorating process.

## 1. Introduction

The tradition of Easter Egg decoration in Romania [Ciu12], similar to Easter traditions in other Eastern European countries, is an example of threatened intangible heritage and folk art. It is a slowly fading tradition, as it is an activity that requires a steady hand and a lot of patience – decorating a single egg can take several hours, even for the most experienced artists. It is therefore not unexpected that youths and young adults of Generation Z, born and raised in the era of the internet and the instant gratification provided by social media and on-demand entertainment, show little interest in old traditions and heritage crafts.

For them, the integration of the heritage craft into interactive digital media and mobile apps can serve as a bridge to revitalisation of

these activities, as they have the potential to attract younger demographic groups. This is what our project tries to achieve, attempting to entice members of Generation Z to engage in a traditional activity by using a medium that they are familiar with.

We are developing an Augmented Reality (AR) application that aims to recreate the experience of Easter Egg decoration with wax in Augmented Reality as an entertaining means of introducing traditional Romanian egg decorating patterns to children as well as adults who are interested in novel approaches to explore folk art traditions. Unlike the traditional 2D markers used in AR applications we are using 3D markers to enhance the user's experience with tactility, mimicking the weight of the real object in the process. Our 3D markers are egg-shaped, chicken egg sized models with a black-

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**Figure 2:** Different stages of the egg decorating process (artwork by folk artist Ileana Hotopilă): This is the traditional method for decorating Easter eggs, where the motif/pattern for the egg is created in several stages, during each of which pure beeswax is applied to the egg as a mask before the egg is dipped into a dye, building up the motif/pattern layer by layer. After the final stage the wax is removed by melting it off slowly to reveal the final motif/pattern.

and-white pattern that are created by using 3D printing technology and the pipeline suggested by Mann et al. [MF19]. Our aim is to create an affordable alternative to VR painting methods that usually require expensive equipment. Users must have a smartphone to run the application, the 3D printed egg marker and a 2D marker for the pen/brush (Figure 1). The phone serves as a portal between the real world and the 3D space, allowing the user to freely paint on the egg by moving the pen (with the 2D marker attached to it). The simple UI provides a small colour palette consisting of the most commonly used colours in Romanian Egg decoration.

## 2. Related Work

In recent years, there have been various projects that have successfully employed new media technologies, such as serious games [MCB\*14] or AR [HDZ\*21] or combinations of these (i.e. AR serious games [AML\*10]), to preserve and present cultural heritage, with AR predominantly being applied to tangible heritage, employing virtual environment infrastructure systems like the Unity game engine [Oik16] in combination with a AR plug-ins, such as Vuforia [CCL\*21], ARToolkit [BPCRLV19], Unity ARKit [KKK\*19] or similar.

Other new technology and AR applications have focused on intangible heritage [ABKT\*17]. For example, the “Tortellino Xperience” [RSM11] uses hand tracking and gesture recognition in an application that teaches people the traditional method for preparing the Tortellini Pasta in a fun and engaging way.

The affordability, ready availability and proliferation of modern mobile devices, such as smartphones, has led to an increase in the development of mobile apps for cultural heritage, which have found different uses, such as companion apps for museums and/or exhibitions [RRM14], or – in the context of cultural tourism – outdoor heritage sites [CC13], where AR games have been found to provide an engaging mechanisms for the dissemination of cultural heritage information [EV18].

More recently AR has been used in intangible cultural heritage contexts, e.g. to present heritage crafts [ZMP\*20], as well as to teach these crafts to users [Hal21]. Applications such as these can be further enhanced through the use of digital fabrication techniques, particularly 3D printing, by creating 3D printed AR markers that add a tactile dimension to AR heritage applications, allowing replicas of heritage objects to be used in Mixed Reality scenarios [MF19].

## 3. Decorated Easter Eggs in Romania

Coloured, painted and otherwise decorated eggs are a long-standing Christian Easter tradition [Bra11] with pre-Christian origins [Bar66]. In Central and Eastern Europe, Easter egg decoration has evolved into folk art employing numerous variations and approaches, e.g. using onion skin, plants and wax to decorate eggs [New65].

The decorated Easter eggs found in Romania belong to the traditions associated with the Eastern Orthodox Church and feature a set of distinctive patterns and motifs [Mur09], and the techniques employed in their creation are part of the country’s body of intangible cultural heritage crafts.

The more traditional application methods, colour schemes, patterns and motifs for the decoration of Easter eggs are mainly found among rural communities [GI3b], where the decoration of these eggs is an Easter custom for women and children, involving complex combinations of colours and patterns or motifs applied to the egg in layers of wax (Figure 2) with regional distinctions in terms of colours and patterns [GI3a].

## 4. An AR Application for Experiencing the Romanian Easter Egg Decoration Heritage Craft

Our solution for preserving the Romanian folk art of Easter egg decoration is a simple game-like AR app (Figure 1) that employs



**Figure 3:** 3D printed (chicken egg size) AR target egg model.

a 3D printed egg (Figure 3), created using the method by Mann and Fryazinov [MF19], which is used as an AR marker onto which users can virtually apply decorations. To serve as inspiration for users, using 2D markers, the AR app also displays two digitised hand-decorated Easter eggs by the folk artist Ileana Hotopilă (Figure 4), providing authentic examples for traditional Egg decoration patterns.

We developed the core application with Unity Engine<sup>1</sup>, employing the Vuforia<sup>2</sup> plugin for Augmented Reality integration. The assets were created using off-the-shelf software [AJM<sup>+</sup>20], i.e. Autodesk Maya<sup>3</sup> for 3D models, Adobe Photoshop<sup>4</sup> for textures and Meshroom<sup>5</sup> for the generation of egg models from photogrammetry.

The black-and-white pattern on the surface of the 3D marker was converted into two solid models, one of black colour and one of white colour, and the resulting model was 3D printed in two colours by using an Ultimaker 3 machine. We would like to note that any multi-material 3D printer is suitable for the fabrication process and the Ultimaker was chosen because they are widely available and relatively inexpensive for dual-material 3D printers.

The two exemplar Easter eggs in the AR app were digitised using photogrammetry, employing a standard DSLR to take about 250 pictures of each of the eggs. To reduce the rendering load, a lower resolution egg model with fewer polygons was generated onto which the textures for both eggs were projected in Meshroom,

<sup>1</sup> <https://unity.com>

<sup>2</sup> <https://developer.vuforia.com/>

<sup>3</sup> <https://www.autodesk.com/products/maya/overview>

<sup>4</sup> <https://www.adobe.com/products/photoshop.html>

<sup>5</sup> <https://alicevision.org/#meshroom>

allowing the same model to be used in the app by simply swapping the texture map.

## 5. Results and Discussion

Our prototype AR app allows users to freely draw/paint on the 3D printed egg. The user can see authentic traditional 3D scans of Romanian Easter Eggs and even create their own using different colours inside the AR app. The experience involves both tactile and visual interactions, as the user can hold the egg and the pen and look through their smartphone's screen to see the results. It has been tested on Windows and Android, where for the latter it requires as a minimum Android 9 for Vuforia to run.

There are some limitations regarding the AR tracking of the 3D printed egg, as the simplicity of the shape of the egg causes tracking to be lost occasionally, resulting in the AR engine apparently detecting the egg somewhere where it is not. A more complex shape would not have blended as easily with complex backgrounds, however, the egg performs well with plain backgrounds. A consequence of the lack of AR tracking accuracy in the current prototype is that it becomes difficult to draw on the egg, which can be overcome by increasing the size of the brush bigger, making it easier to control its tip. Another possibility would be to see if the use of a different AR engine than Vuforia would result in more accurate tracking of the 3D printed egg.

## 6. Conclusions and Future Work

We have developed a proof-of-concept prototype for a mobile AR app for the virtual decoration of Easter eggs. Our project, which is work-in-progress, uses a 3D printed egg as a physical AR marker to facilitate tangible interaction, and users can virtually draw/paint on the egg. The use of the 3D printed egg as one of the AR markers provided a simple and elegant solution for making use of the app as similar to the real-world heritage craft that it emulates as closely as possible, but this also has potential drawbacks; Users of the app would require access to a 3D printer to fabricate the egg. Also, apart from being less accessible, the egg object created with the Ultimaker 3 3D printer that we used does not feel smooth to the touch, meaning that the stylus/brush does not glide on it without resistance, breaking the illusion. This could possibly be solved by using a different (higher resolution) 3D printer or even a different fabrication method.



**Figure 4:** Two digitised decorated Easter eggs in our AR app (original eggs by Ileana Hotopilă).

The current work-in-progress prototype leaves a lot of room for improvement. We plan to implement some extensions to the app and hope to trial others in the future. The first step will be to extend the app to more closely mimic the manner of the Romanian egg decoration tradition, i.e. to draw masks onto the egg instead of paint, also integrating traditional egg decoration patterns. A potential progression of this, to more closely mimic the real experience of Egg decorating with wax, could be the use of a timer to simulate the brush drying up, simulating the paint stroke becoming thinner as time passes, and therefore requiring wax to be reapplied to the brush by virtually 'dipping' it into liquid wax. Although this would increase the realism of the experience, it would also make using the app more difficult, so different usage modes, i.e. levels of difficulty, could be added to the app.

Another task for the future, once the AR tracking stability of the prototype has been improved, would be to do more extensive usability testing and to conduct a user study to evaluate whether our AR app can be used to successfully convey the skills of the Romanian folk art of Easter egg decoration to the app's users.

## 7. Acknowledgments

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