Animar: Augmenting the Reality of Storyboards and Animations

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***Abstract*—This paper presents Animar, a mobile application to create short animations that uses augmented reality to aid the sketching. This application was conceived using design methods and its characteristics were used to create the interface and form of interaction. The user draws each frame on a specific paper with empty rectangles and a few patterns. The software extracts the frames and rectifies the perspective distortion using image processing techniques. To help the user, Animar tracks the pattern to show a virtual onion skin of a chosen frame over another one. The animation is generated by combining all the frames extracted from the paper. Animar was developed for Android and supports multiple screen sizes from cellphones to tablets and its concept won an international contest on problem solving with augmented reality.**

***Keywords*-mobile augmented reality; drawing; animation**

I. Introduction

Mankind always had a strong relationship with drawings. For instance, that is considered men's first method of writing [1]. Throughout the years, it developed itself to turn into one of the most important expressions of art. Additionally, several forms of drawings are used for entertainment. One of them is the flipbook. It is a primitive way to create animations that use the concept of persistence of vision to produce the illusion of motion [2]. In a similar way, the basic concept of flipbook is spread all over the Internet as animated GIFs.

During the years, several techniques were developed to help people create smooth animations. One of them is the onion skinning [3], which consists on using a semi-transparent paper to draw the current frame. This paper lies on top of the previous frame so the animator can have hints to draw the new one.

In this context, this work presents Animar. It is a mobile augmented reality application designed to help people create their own short animation and share it easily. Animar uses image processing techniques to extract and rectify the frames in order to compose them into an animation. Moreover, it uses augmented reality to generate a virtual onion skin. To the best of the authors' knowledge, there are no other solutions in the literature that possess these features.

This paper is organized as follows: Section 2 shows the related works. Section 3 presents the concept and the architecture of Animar. Section 4 discusses the implementation and the results obtained. Finally, Section 5 presents conclusions and future directions for this work.

II. Related Works

Today we have a vast number of software whose features combine drawing assistance followed by animation creation. Analyzing the computer aided drawing feature, we have applications that propose step-by-step tutorials as well as onion skinning techniques. On the other hand we have animation generating software that uses digitally drawn art as frames of the animation.

Art Academy Lessons For Everyone [4] for Nintendo's 3DS is an example of a software that offers art lessons and tutorials with a complete set of digitalized art tools. It also adds a lifelike feel enabled by the platform's stylus and touch screen. The game also lets you take pictures to use as reference or background for future paintings. Similar applications are Disney Creativity Studio [5] and Learn to Draw [6].

Focusing on applications that handle significant feedback there is The Drawing Assistant [7]. This software uses computer vision algorithms to automatically extract regions, block-in lines, skeletons, alignments and proportions from the model photograph. Drawing steps of the image are generated by the algorithms and after each step the software gives corrective feedback.

It's important to emphasize how some people prefer the classic pencil to paper drawing than finger or stylus on touch screens and pads. An augmented reality example with physical pen-and-paper creation is PapARt [8]. It is a system that allows users to visualize, manipulate and finally trace a scene which is projected onto a sheet of paper. This technology needs a good number of hardware pieces.

There are also software that generate animations as the final output. An example is Do Ink [9], its features include key-frame animation and onion skinning techniques. The user can make the drawing and edit vectors independently using a combination of the two features mentioned before.

III. Animar

This work presents Animar, a mobile application that uses augmented reality, or simply AR, for creating storyboards

978-1-4799-4261-9/14 $31.00 © 2014 IEEE
DOI 10.1109/SVR.2014.40

and short animations. The process to conceive and develop this application is described as follows.

A. Conception

Animar was created through a brainstorming [10] session conducted by a group of 6 people, among computer scientists and designers. The aim was to generate alternatives for an AR application focusing areas such as games and arts. In total, 18 alternatives were generated at the brainstorm section that lasted one hour. After that, the ideas were organized and then evaluated.

For the evaluation stage, each alternative was scored between zero and five. Each evaluator rated the ideas individually in order to ensure impartiality among the evaluations. The criteria for the evaluation were innovation, capability of implementing and use of AR appropriately. After that, the average was calculated and the best rated alternative was an application for drawing and creating animations through the onion skinning technique using the device's camera that was later called Animar.

Animar was designed to be used on tablets because their wider touch area helps in the drawing process. It makes the user experience more comfortable, since he does not need much effort to see the content that is being created. It also allows us to create a simple and organized interface that takes advantage of the large area available, using large and stylized graphics. However, the interface was also adapted to be used in small devices, such as cellphones, to attend a broader audience.

One of Animar's features is to make it possible the use of the onion skin technique on digital devices. For that, the application uses AR to overlay a semi-transparent frame on top of the one the user is currently drawing, as shown in Figure 1. It allows the creation of a more natural interaction because he can draw smoothly using the tablet's display as an onion skin paper.

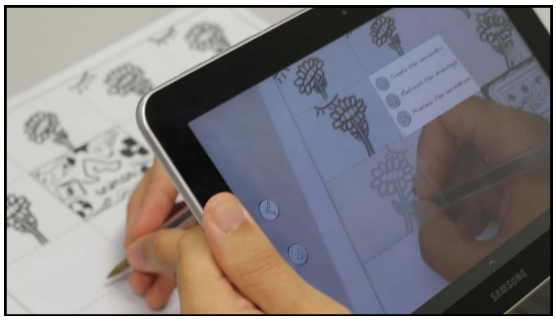

Figure 1. The user holds the device, showing a virtual onion skin of a previous frame overlaying a new one.

A paper template using AR markers was designed in order to do the tracking. The designed template consists of two makers on the center of the paper, avoiding the occlusion from user hands and allowing an appropriate tracking.

B. Application

Animar aims helping people make short animations and share them easily. In order to do that, the user has to draw on a paper grid in which each rectangle represents a frame in the final animation. The paper has two patterns that are tracked by the application. Based on the position of these patterns, Animar automatically extracts the drawings inside each frame of the storyboard paper.

However, the device's camera will capture the paper with perspective distortion, as shown in Figure 2. In order to remove such distortion, Animar applies some image processing techniques to automatically rectify the frames to create the animation.

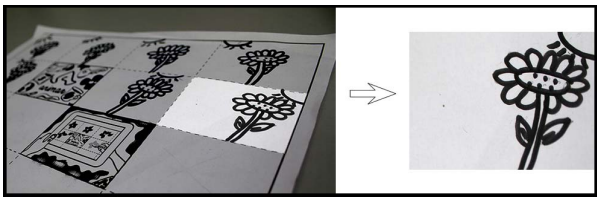

Figure 2. On the left it is possible to see the image captured by the camera with one of its frames highlighted. The same frame after the rectification process is shown on the right.

Aiming to make it easier to draw a smooth animation, Animar uses augmented reality to create a virtual onion skin from any previous frame. In fact, the authors could not think of another form of interaction to do this on real paper without the help of AR. The user virtually selects the frame he wants to use as base and then select which frame to draw on. After this, the application overlays the selected frame, as shown in Figure 1.

When the user finishes the storyboard, the application will create an animation that combines every frame in order to share it with friends or customers.

C. Architecture

As mentioned in the previous subsection, Animar aims to extract frames from a grid-based storyboard and compose them as an animation. This is done using predefined image-targets on the paper. These frames are sub-images of the paper and can be used later to create onion skins or combined together to create an animation. Having said that, the basic architecture of the system is rather simple and composed of just a few modules that can be seen in Figure 3.

1) ARBasicModule: The ARBasicModule is the base class of this system and controls the initial setup with the augmented reality environment. One of its roles is to register callbacks for I/O and user interaction, such as providing animation previewing controls, overlaying created onion skins on paper and registering screen's touch detection. Also, it is responsible for controlling the drawing loop, which

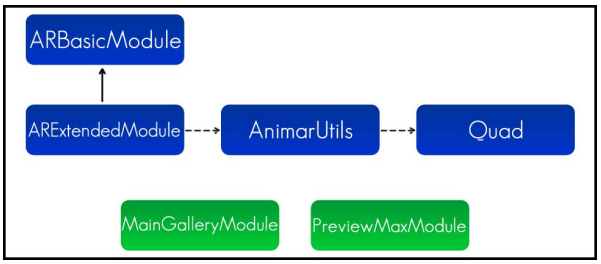

Figure 3. A simplified diagram of Animar's architecture.

tracks the camera image frame by frame and renders the 3D elements over it. Therefore, this class can be seen as one of the main components of the system.

2) ARExtendedModule: The ARExtendedModule class is a subclass of the ARBasicModule. The system behavior it implements is responsible for loading the required initial assets, setting the tracking configuration for the predefined targets, handling geometry touches and extracting the frame sequence used for creating animations and onion skins. Excluding the frame extraction, the details of each of the other steps are not going to be described in greater detail, as they can be considered just boiling plate steps.

The frame extraction task has three steps. First, it passes a sliding window extracting each sub-image contained inside of it. In general, these sub-images will be distorted due to the different camera positions. Now, since the actual size and position of each grid square is known, it is possible to use a reference square to compute the homography transformations [11]. These transformations are used to rectify the perspective distorted sub-images. Thus, in the second step, all sub-images are rectified using that procedure. The third step saves the extracted and rectified sub-images on disk, making them available to be used as onion skins or combined to create animations.

3) Quad: The Quad class represents a quadrangle. Instances of this class are used during the frame extraction procedure. They represent the limits of each further extracted sub-image, which was described in the ARExtendedModule.

4) AnimarUtils: The AnimarUtils class contains basic functionalities regarding the frame extraction step described before. It has functions responsible for passing a sliding window, a Quad instance for example, from an initial position to the end of the paper grid. The result is a set of Quads that can be used later to extract each desired sub-image.

5) MainGalleryModule: The MainGalleryModule class is responsible for displaying all animations created by the user. It displays these animations in a grid view fashion and provides extra functionalities for playing them.

6) PreviewMaxModule: The PreviewMaxModule class is the module which displays a selected animation. Inside the Animar application, whenever the user selects to play or preview an animation, this module is started. It also enables the user to delete the current displayed animation.

As described before, these were the modules used in the Animar system development. They are the basic modules responsible for conveying all the functionalities of the application. The system design is simple, result of a more complex conception design and further refinements.

D. Implementation

Animar was implemented aiming the Android platform since it is today's most used operational system for mobile devices [12] [1]. The patterns in the paper were tracked using the Metaio SDK [13]. It was also used to render the Animar's augmented reality content. The OpenCV library was used for manipulating images and removing their distortion [14].

Several augmented reality platforms were evaluated in order to choose the most suitable to track the patterns on the paper. Metaio SDK was chosen because it provides a tracking technique that showed to be robust for Animar. It is also easy to implement with and offers a free license for several platforms, including Android.

As mentioned before, the device's camera captures the paper with a perspective distortion. The OpenCV was used to rectify this image. The main reason to choose this library was because it has several data structure and basic functions to simplify and optimize the image rectification. Moreover, OpenCV has a fast and stable version for Android that is free to use.

IV. Results

During the development of Animar we faced the challenge of supporting different screen sizes. The solution to this problem was to develop the graphical user interface elements according to the screen's resolution. For example, an element can be created to cover a horizontal half of the screen, so that on 800x600 and 1280x720 resolutions the same element would have 400x600 and 640x720, respectively. Using the proportions of the GUI elements we can check the screen resolution and adapt the layouts at runtime before showing them to the user. The application was executed in several devices having different screen sizes and proportions, as well as configurations. Among them are the cellphones LG L3 II, L5 I, Nexus 5, Samsung Galaxy S3 and the tablets Samsung Galaxy Tab 10.1 and Galaxy Note 2014 10.1.

As explained earlier, Animar's art creation flow consists of drawing each frame with the help of augmented reality and then creating the animation using the undistorted images. Figure 4 shows Animar's augmented reality scene at runtime, where all possible onion skins are shown to the user so he can pick one before drawing.

In order to evaluate the potential of this application, we submitted Animar to the Metaio International Developer

[1]The source code is available at https://db.tt/dtGLc0kf

Figure 4. Animar at runtime showing all possible onion skins.

Contest [15]. This competition tried to stimulate the competitor's creativity to develop applications with relevant use of augmented reality. Among the various categories the software was submitted to "Got HeARt?", which proposed the development of systems in which augmented reality plays an important role on the solution of a personal or social problem. According to Metaio, there were hundreds of entries from over 40 countries for this competition and Animar conquered the 1st place on its category.

During the awards event Animar was put available for the audience. Excellent feedbacks were given, mostly positive. The main concern was that some did not feel comfortable holding the device while drawing. People also considered the tablet used on that occasion, the Galaxy Tab 10.1, heavy to hold while drawing. However, there are many lighter tablets available in the market.

V. Conclusion

This work presented Animar, a mobile application that combines augmented reality aided drawings with automatic animation creation. It presents an innovative way for people to draw and share their animation frame by frame using devices that are largely available nowadays.

Animar was conceived using design techniques and its features and interface were created especially for its purpose. The storyboard paper has two patterns that are used to extract the user's drawings. These patterns are tracked using the Metaio SDK. OpenCV library is also used to rectify the camera's perspective distortion.

The application was submitted to an international contest and conquered 1st place. During the demonstration at the event, Animar received good feedbacks from people that had the opportunity to use it, even though some were not comfortable on holding the device while drawing.

A. Future Works

To solve the concern regarding holding the device while drawing, one possible improvement would be the development of a support to hold the device, making it easier for the user to visualize the onion skin without having to always hold it. The idea is to use the device as a see-through screen. One other plan consists on exploring the possibility of using Animar with a Google Glass. The use of a see-through device in this case is more comfortable for the users.

VI. Acknowledgments

The authors would like to thank CNPq (processes number 13015479, 381714/2014-4, 381424/2014-6, 140898/2014-0 and 381712/2014-1) for partially funding this research.

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