MARCH: Mobile Augmented Reality for Cultural Heritage

Omar Choudary, Vincent Charvillat, Romulus Grigoras, and Pierre Gurdjos
IRIT, University of Toulouse
2 Rue Camichel, 31071
Toulouse, France
{firstname.lastname}@enseeiht.fr

ABSTRACT

We present MARCH, a complete solution for enhanced cultural heritage discovery using the mobile phone. Simply point the camera of a mobile device at prehistoric cave engravings. Then MARCH augments the captured images with the expert's drawings, highlighting in real time the animal engravings, which are almost impossible to observe with the naked eye. We have created a mobile augmented reality application which runs at 14 FPS for 320x240 frames on a Nokia N95 smartphone. We describe the optimizations and the requirements needed to obtain these results on mobile devices.

Categories and Subject Descriptors

H.5.1 [**Information Interfaces and Representation**]: Multimedia Information Systems; I.3 [**Computer Graphics**]: Miscellaneous; I.4.3 [**Image Processing and Computer Vision**]: Enhancement—*Registration*

General Terms

Algorithms, Design, Experimentation, Performance

Keywords

Mobile Application, Augmented Reality, Cultural Heritage

1. INTRODUCTION

Public access to prehistoric sites, especially closed ones like caves is often restricted. However, there is a sustained interest among the public in discovering these sites. In such a context augmented reality and mobile devices can prove very efficient in enhancing real site visits and transforming museum visits into close to real experiences.

Augmented Reality [1] has been used in many computer applications to enhance camera input in real time. A difficult task is the registration between the augmentation and the real image. This process was prohibitive for mobile phones at the beginning of this century. Recent research has provided several mobile solutions [2, 4, 6, 8, 9].

We present a mobile application which uses augmented reality in the scope of enhancing the visits of prehistoric caves (Figure 1). MARCH can be used in the context of a real cave as well as in museum-like environments. To the best of our knowledge, this is the first attempt, without using gray-scale obtrusive markers, of a real-time mobile augmented reality application for cultural heritage.

MM'09, October 19–24, 2009, Beijing, China.
ACM 978-1-60558-608-3/09/10.

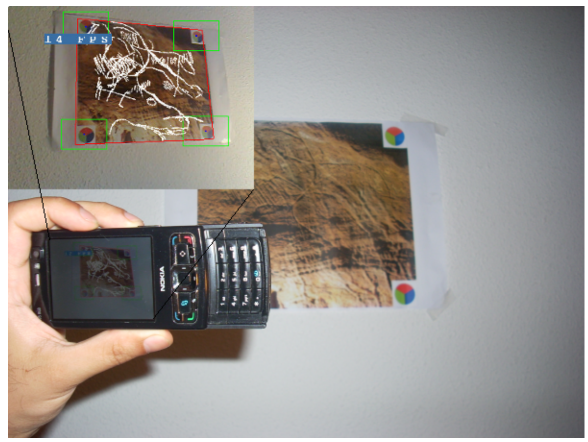

Figure 1: *A snapshot of MARCH in a museum-like environment*

The use of visual markers in the form of color patches was presented in [3]. We have chosen this solution as it uses non-intrusive small color targets. Also, these color targets can be used in the context of a real cave, where other solutions based on SIFT or SURF will probably fail due to illumination conditions. Another important reason for the use of these markers is that they allowed us to create a real time mobile application.

2. SYSTEM IMPLEMENTATION

The Gargas [5] cave organization (French Pyrenées) provided us with several data. This data contains images from caves depicting animal engravings as well as the interpreted drawings of an expert (Figure 3(a)). Our work aims at augmenting our natural photographs with the registered interpretations of the expert.

The system overview is presented in Figure 2. There are two parts: an off-line process and the mobile application.

The off-line part consists of three steps. Firstly, we need the interpreted drawings made by an expert (Figure 3(a)). Secondly a non-rigid transformation is used to register the drawings with the digital images of the cave. Finally, we obtain the transparent layers containing the engravings, which match perfectly the digital images (Figure 3(b)).

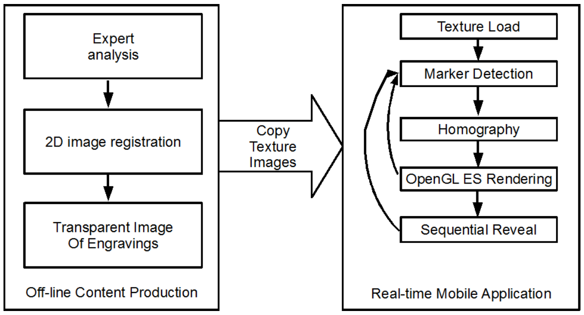

Figure 2: ***System Overview***

(a) (b)

Figure 3: ***Expert Drawings (a) and Alignment with the digital cave image (b)***

The mobile application was developed in Symbian C++ and runs on a Nokia N95. We can switch between a *real-time* and an *animation* mode (Figure 4).

In *real-time* mode, MARCH captures real images using the viewfinder of the mobile phone. Then it detects the visual markers and matches the augmentation (expert animal drawings) with the real image. In this way the user can move freely around the cave image while always getting the correct augmentation of the engravings. We obtain a frame rate of 14 FPS for images with a resolution of 320x240.

While tracking the visual markers in real-time the user can switch to the *animation* mode. In this mode MARCH sequentially highlights the different engravings, in turn, based on the last captured image. There is no detection or match involved in this step as the application uses all the information from the last frame. For this reason we obtain high frame rates, around 30 FPS, for the animation. From this mode the user can switch back to the *real-time* mode.

(a) (b) (c)

Figure 4: ***Mobile application real-time mode, before (a) and after (b) detection, and animation mode (c)***

2.1 Visual Marker Detection

MARCH processes each viewfinder frame to detect the four color patches (See Figure 4). The original algorithm is presented in [3]. We have made several optimizations to improve the algorithm and use it successfully in our solution. The application only scans four sub-areas of the image, called *detection regions*. After the first detection of the markers MARCH dynamically adjusts the size and position of these regions (see Figure 4(b) and Figure 4(c)). For this purpose it uses the coordinates of the detected markers as the new center position of each detection region.

2.2 Registration

The registration basically consists in aligning the transparent augmentation layer with the viewfinder image. Under a planar to planar assumption, this is a bijective mapping, so-called homography. This homography can be computed, after having the four detected markers, using the SVD implementation provided by the *NokiaCV* library [7].

3. CONCLUSION

In this demo we have presented MARCH, a complete multimedia solution for cultural heritage, which can be used to interactively discover prehistoric engravings using the mobile phone. We used visual markers to create a mobile augmented reality application which runs at 14 FPS on a Nokia N95. We have presented the algorithms and the optimizations used to achieve these results.

4. REFERENCES

[1] R. Azuma, Y. Baillot, R. Behringer, S. Feiner, S. Julier, and B. MacIntyre. Recent advances in augmented reality. *Computer Graphics and Applications, IEEE*, 21(6):34–47, Nov/Dec 2001.

[2] E. Bruns, B. Brombach, T. Zeidler, and O. Bimber. Enabling mobile phones to support large-scale museum guidance. *Multimedia, IEEE*, 14(2):16–25, April 2007.

[3] J. Coughlan, R. Manduchi, M. Mutuzaki, and H. Shen. Rapid and robust algorithms for detecting colour targets. In *AIC '05: Proc. of the 10th Congress of the Intl. Colour Association*, pages 328–331. AIC, 2005.

[4] J. Gao. Hybrid tracking and visual search. In *MM '08: Proc. of the 16th ACM intl. conference on Multimedia*, pages 909–912, New York, NY, USA, 2008. ACM.

[5] Gargas. `http://www.gargas.org`.

[6] J.-H. Lim, Y. Li, Y. You, and J.-P. Chevallet. Scene recognition with camera phones for tourist information access. *Multimedia and Expo, 2007 IEEE International Conference on*, pages 100–103, July 2007.

[7] NokiaCV. `http://research.nokia.com/research/projects/`.

[8] D. Wagner, G. Reitmayr, A. Mulloni, T. Drummond, and D. Schmalstieg. Pose tracking from natural features on mobile phones. In *Proc. ISMAR 2008*, 2008.

[9] D. Wagner and D. Schmalstieg. First steps towards handheld augmented reality. In *ISWC '03: Proceedings of the 7th IEEE International Symposium on Wearable Computers*, page 127, Washington, DC, USA, 2003. IEEE Computer Society.