Reconstruction of cultural heritage object utilizing its paper model for augmented reality

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Abstract

Augmented reality is nowadays one of the most expanding fields of the computer graphics and the popularity of the cultural heritage AR applications increases as well. This project presents the reconstruction of the historical event with the augmented reality information added to the paper model of the heritage site. The application presents the fire of the Bojnice castle. The hardware used in the project consists of the web cam which records the scene with the castle and the computer which receives the record and produces the augmented experience. The two methods for the registration of the real model and the future work needed are presented.

Categories and Subject Descriptors (according to ACM CCS): I.5.5 [Computer Graphics]: Pattern Recognition—Implementation

1. Introduction

Since the 1997 when Azuma published the first survey of augmented reality (AR), this area has become one of the most watched fields of the computer graphics and has become popular among young generations. This is one of the reasons why researchers try to bring AR to museums, galleries and cultural heritage sites. Most applications add textual or visual (2D or 3D) information to the exhibits. This project enriches the real object with virtual 3D information. Our goal is to present a selected historical event (the fire in the Bojnice castle) to the audience through the augmentation of the virtual fire on the paper model of the castle. We use a camera which takes a video of the castle and a computer to present the augmented experience (For the scheme see Figure 1). The paper model of the castle is available for purchase in toyshops what allow us to create a similar web AR application for all purchasers. In this work-in-progress paper we briefly discuss the method of creating the 3D model of the castle and focus on the registration of the paper model in the camera recording. We describe two possible methods for the registration and present the goals of the future work.

2. Related Work

The field of the augmented reality museum applications is mostly focused on extending the information about exhibits with virtual textual or visual information, displayed in the handheld display or projected on the exhibit itself. The Interactive museum guide from Bay et al. [BFVG06] uses the tablet PC as a tool to provide the user with the museum guide with textual information about exhibits detected by affine transformation invariant local features (in this case SURF [Bt08]). The Phoneguide developed by Föckler et al. [Ft05] uses the neural networks for the recognition of exhibits and camera equipped smartphone to provide user with the textual information. The work by Bimber et al. [Bt05] augments the visual information to the exhibits (in this Michelangelo's drawings). The extension of the exhibit

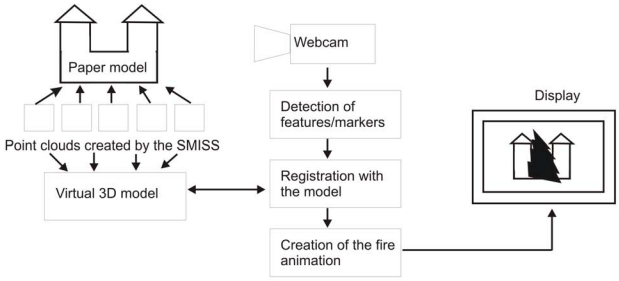

Figure 1: *Scheme of the proposed method*

with 3D information have been done in The Virtual Showcase [Bt06]. The real dinosaur's skeleton was coated with the virtual layers of muscles.

3. Construction of the model

The first task in the project has been the creation of the paper model and then the construction of the virtual 3D model. The size of the paper model is 30 x 30 x 25 centimeters and the virtual 3D model has been created from the paper model in two steps. Firstly we scan the model and create point clouds using the Scalable Multifunctional Indoor Scanning System (SMISS) created by T. Kovacovský [Kov10]. SMISS is the contactless optical 3D scanner composed from a digital projector and a camera. The system matched points between the camera and the projector images to create the point cloud representation of the model (see Figure 2). We needed four side views and one view from the top to completely cover the paper model with all towers and patios by points. Merging of the point clouds from views was done manually in the 3D modeling software. The construction of the 3D model is necessary for the proper registration of the fire animation.

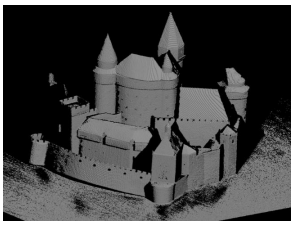

Figure 2: *Point cloud created with the SMISS device*

4. Registration

In the registration phase we decided to explore two different techniques. The first one uses traditional black and white printed markers attached to the base of the castle for the estimation of the position of the camera. The second method is based on the affine transformation invariant features. In both methods we assume to have precalibrated camera with known intrinsic parameters, and to estimate the extrinsic parameters (the position of the camera relative to the model) we need to detect four coplanar corners of the marker or at least three nonlinear points with the second method. The marker based method was firstly used in the work of Rekimoto [Rek98]. In our approach the ARToolkit has been used. The good arrangement and count of the markers in the base are crucial within the method. It is essential for the correct registration, that in each video frame, at least one complete marker is visible. We decided to put markers only on the base desk of the castle not on the model itself so we estimated that the distance of the camera from the center of the model must be at least 0.6 meter. The advantage of the marker method is its robustness, smaller complexity and fast execution. The biggest disadvantage is the fact that the markers are quite disturbing in the model of the castle from the 18th century and their accurate placement needs a lot of experiments. The second approach uses the matching of the features from the video frame with the features from the created database of the key objects. The database consists of descriptors (SIFT or SURF) of interesting points detected on photographs of selected castle parts with known position on the virtual 3D model (the corresponding position was estimated manually). The matching process includes the detection and the description of the keypoints in the video and of the matching phase. We decided to use two different techniques, SIFT [Low02] (Scalable invariant feature transform) and SURF [Bt08] (Speeded up Robust features). Both methods were primarily developed for offline matching, but have been broadly used in the augmented reality applications in the last few years. The advantage of this approach is the fact that it could be used on the castles built from the same pattern without the addition of any markers or signs. The disadvantages are the complexity and the urge of the creation of the database of the key objects.

5. Future Work and Acknowledgments

In the next phase of the project we are going to produce complete application for the reconstruction of an augmented historical event on the paper model of the castle. The complex validation of proposed registration algorithms and the choice of the best one is necessary. The creation of the animated flame (the animation will not be physically based) and its registration is also planed for the future work.

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