Geometric Modifications Applied To Real Elements In Augmented Reality

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Abstract—augmented reality applications overlap virtual objects over a real scene considering the context. Today, more advanced applications also make use of diminished reality, which removes real objects from a scene. This paper describes a novel approach that combines augmented reality and diminished reality techniques to modify real objects in augmented reality applications. The proposed approach removes an object and replaces it with its purposely-modified replica. The solution uses dynamic texture techniques and inpaint to enhance the visual response of the performed modification. The results are promising considering both realism of the modified real object and performance of the application.

Keywords-augmented reality, mixed reality, physically-based simulation.

I. INTRODUCTION

Augmented Reality (AR) applications insert virtual objects into a real scene. AR scenes are visible by projection [1], by using a monitor [2] or a Head Mounted Display (HMD) [3]. Diminished reality (DR) applications remove objects from a real scene to show information covered by the removed objects [4].

Still according to [4], the information used to remove an object can be obtained from multiple cameras or from a single one using information from previous frames. In [5], we see an approach that makes use of an Inpaint technique as heuristics to synthesize background images, using only information from the current frame.

In [6], a study about realism in AR applications is conducted. According to the author, to obtain good results in realistic AR applications, three aspects must be enforced when inserting virtual objects: shape, appearance and behavior. Shape can be respected by keeping the object’s proportions according to the scene proportions where it is inserted. The objects appearance is realistic if it reproduces the real scene illumination, using Bidirectional Reflectance Distribution Functions (BRDFs) and Image Based Lighting (IBL) for example. And, finally the object’s behavior is realistic if its interaction with the scene is coherent, in relation to occlusion, shadows generated from the virtual objects on real objects, and to collision interactions among real and virtual objects.

The focus of this work is on the realistic behavior aspect of AR applications. It is developed a system capable of performing modifications in real objects, in real time, aiming at providing realistic means of interaction among real and virtual objects. A virtual replica of the real object is superimposed onto it, with an acceptable level of realism, so that the user cannot identify it as a replica. A possible application that can take advantage of the proposed approach would be a game, where the introduced virtual objects could interact with modifiable real objects, by deforming them. That can be achieved, for example, with the aid of a physics engine. Such interaction enhances the realism in a game, as the virtual object would be interacting in a coherent way with the real scenery in a way that only real objects could do.

The rest of the paper is organized as follows. Section 2 describes some work related to the topics mentioned in this paper. Section 3 introduces the technique, presenting how it works in general. In Section 4 the implemented technique is presented in detail, discussing in depth each step. Section 5 presents and discusses the results. Finally, Section 6 presents the conclusions and suggestions for future work.

II. RELATED WORK

The most common way of interaction between real and virtual objects in AR consists in modifying the virtual objects only. An example of such interaction can be seen in [7], where a real castle occludes virtual elements and, at the same time, virtual objects collide with it. In order to accomplish such levels of interaction, the application takes advantage of the fact that the real object pose is known and its structure is described by a 3D model (see red lines in Fig. 1 (left)). The 3D model is used by the physics simulation and by the visibility algorithm, but it is not overlaid on the image (only the remaining virtual elements are overlaid, as seen in Fig. 1 (right)). In contrast, the work presented in the current paper handles the reverse problem, which is the modification of a real object behavior caused by the interaction with virtual elements.

The approach of [8], which makes use of an Inpaint technique to remove the markers that were originally painted in a tissue, should also be highlighted. In this paper, the authors aim to project an image over a cloth, with realistic illumination. For that, they use a cloth with a number of