Experiences on the Implementation of a 3D Reconstruction Pipeline

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Abstract—3D reconstruction from 2D images aims recovering models that represent accurately and in three dimensions features of interest of objects in a scene. This is the subject of the so called TechPetro project with the purpose of developing engineering solutions based not only on 3D reconstruction but also on markerless augmented reality. While the first allows the automatic 3D reconstruction of complex scenes captured from the real world, markerless augmented reality augments users’ perception through the use of an interface that integrates in real-time 3D virtual information into the real world scene visualized by the user. In this paper experiences made on the definition and implementation of a 3D reconstruction pipeline are presented, together with some preliminary results.

Index Terms—3D Reconstruction, Pipeline, Real-time, Markerless Augmented Reality.

I. INTRODUCTION

Markerless Augmented Reality (MAR) [1] and 3D Reconstruction (3DR) [2][3][4][5] are two evolving research areas that show an impressive increase in sophistication and complexity of their applications. MAR consists in a particular branch of Augmented Reality (AR) [6] in which the need for fiducial marks is dismissed [7] in order to use the surrounding world as a marker. The fundamental intent of AR (taking advantage of users knowledge and familiarity with their own environment to perform tasks) can be actually achieved, after all, fiducial markers are intrusive objects needed only by the application that uses them, but never by the users. Although, the development of MAR techniques to deal with basic AR tasks (tracking and registration) becomes much more complex and demands higher computational power.

3DR is a research field that involves several techniques with the purpose of recovering models that represent accurately and in three dimensions features of interest (shape, structure, texture etc.) of a specific object or a set of them. In this context, there are techniques that interfere in the environment in order to achieve their goals (active techniques) as structured light, infrared and sonar based techniques, and also the ones that do not interfere (passive techniques) as the one called Structure from Motion (SIM) [8][9].

Passive techniques are often more complex, but have more flexibility because do not demand especially prepared or controlled environments. On the other hand, active techniques are not too complex, but depend on certain constraints of the reconstructed environment, object or equipment (object size, closed spaces, projection of light on a room or surface etc.) that harms their applicability in some environments without this level of control. The natural consequence of the differences between passive and active techniques is the need for knowing in detail the problem to be solved before assigning one of them as the best.

Despite of other necessary considerations, it is reasonable to accept that the use of optical sensors has a higher utilization potential, due to their popularity, easiness of handling and reduced cost (in comparison with other types of sensors).

Lately, MAR and 3DR applications became more sophisticated and complex due to the popularization of these technologies, which became from merely academic experimentation to commercial systems with costumers mainly in medical, industrial inspection, training, merchandising, and entertainment segments. The popularity of such systems is also due to another important factor: the increase of computation power. With a set of resources that are more adequate to the demands of applications developed using MAR and 3DR technologies, it became possible to immerse users meanwhile they utilize the systems in a manner very close to the one imagined since it became possible to immerse users. Despite a recent past, this requirement had not been achieved completely.

Initially, systems that applied MAR and 3DR technologies faced the barrier of resource restriction and were only able to reach less than satisfactory or workable levels. With higher computation power, response time decreases and visual quality increases in a manner that new and more complex demands rise (real-time responses, high accuracy, independency of operator etc.), turning early reputable applications into naive ones.

Rigorously, MAR and 3DR are independent fields that count on their specific techniques for solving the proposed challenges of each area. However, considering the fundamental question of application usage, it means, thinking about how the tasks could be performed and taking into account that the results are as good as the user’s handling, the need of choosing techniques able to deal with a simple way of interaction is