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MATCHING ICP FOR RECONSTRUCTION OF 3D OBJECTS WITH LASER SCAN

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ABSTRACT

This paper presents a part of the development of a complete system (both hardware and software) for the reconstruction of 3D objects from 2D images, using low-cost laser technology. The reconstruction process consists of three stages, the first part is the surface registration, followed by a filtering and cleaning, to finally do the matching of the registered surfaces to rebuild the whole object. The matching process was performed with the ICP algorithm (Iterative Closest Point). With which various tests were made matching by minimization and optimization, to finally give them texture and.visualize the results by MeshLab.

Keywords: matching, ICP algorithm, 3D reconstruction.

INTRODUCTION

Three-dimensional models have many applications in computer graphics, mixed reality, medical science, reverse engineering, robotics, etc. Several techniques including stereo, structured light and laser detection depth are used to obtain 3D images of an object. A 3D image surface is represented by a point cloud. However a single 3D image surface is not enough to build a 3D model of the entire object.

Along with the surface registration techniques, others appear and allow joining the sides or sectors of the scanned object, this process is known as matching of scanned surfaces. Among the most cited techniques are those based on points oriented to join surfaces and thus achieve a good reconstruction of objects [1], otherwise it will eventually have improved these techniques in which its main drawback is its time complexity. The most recent proposal considers an initial hypothesis and from it a speedy matching of surfaces. For example, S. Winkelbach et al. [2] propose an efficient method to generate a probable hypothesis using a turntable.

D. Akca [3], proposes a method by Least Squares 3D Surface Matching (LS3D), where estimates the 3D transformation parameters between two or more fully 3D surface patches, minimizing the Euclidean distances between the surfaces by least squares. This formulation gives the opportunity of matching arbitrarily oriented 3D surface patches. For V. Dominguez et al. [4] the matching process is performed using the algorithm ICP proposed by P.J. Besl, and N.D. McKay [5]. In an assisted version, initially performed, approximate transformation based on the identification of at least 3 points on both surfaces. This is sufficient to place the coupled surfaces of the reference system on the first view point, with the objective of creating whole 3D models of sculpture pieces, which also allows texture to the reconstructed digital object.

This paper presents the results obtained using ICP algorithm as matching of 3D surface images, process to conform a 3D reconstruction of objects, considering the approaches proposed in A.S. Mian [6], in regards of finding the closest points from one surface to another, and the consideration of the methodology of the reconstruction system reported in C. Zhongjie and C. Shou-Yu [7]. Which allow achieving an efficient and fast matching.

SYSTEM ARCHITECTURE

The system uses image capture through a fixed camera, previously calibrated by observing the environment, and the scanning via a laser beam to capture the depth and a better reconstruction of the scanned object. The laser line is used to track the object and is controlled by a step motor, which is synchronized with the capture rate of the camera. This allows achieving the object tracking and indirectly by computer vision techniques the reconstruction of the 3D objects. Fig. 1 shows a diagram of system hardware.

The computer vision techniques being used takes advantage of the process of triangulation in Fig. 1, which is the intersection of laser layers, object surface and the center of the camera's projection. Once the 3D point cloud is obtained, there will be a cleaning and filtering process for a more optimal result of the scanned object. Finally a process of matching ICP (Iterative Closed Point) (Mian et al. [6]) is done to form the total volume of 3D object. Each matching process receives two scanned surfaces as input. This process is repeated until all registered surfaces belonging to an object are united.

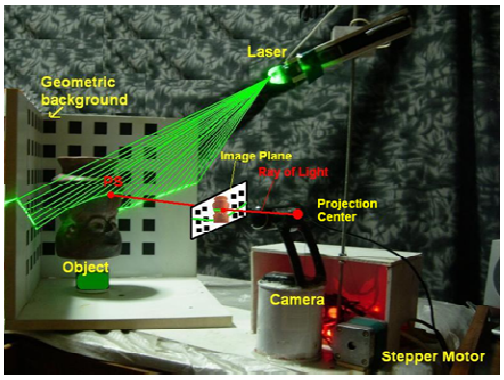

Fig. 1 - 3D Reconstruction System

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