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# From stereoscopic images to semi-regular meshes

Jean-Luc Peyrot *, Frédéric Payan, Marc Antonini

*Laboratory I3S - University Nice - Sophia Antipolis and CNRS - UMR 7271, France*

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ABSTRACT

The pipeline to get the semi-regular mesh of a specific physical object is long and fastidious: physical acquisition (creating a dense point cloud), cleaning/meshing (creating an irregular triangle mesh), and semi-regular remeshing. Moreover, these three stages are generally independent, and processed successively by different tools. To overcome this issue, we propose in this paper a new framework to design semi-regular meshes directly from stereoscopic images. Our semi-regular reconstruction technique first creates a base mesh by using a feature-preserving sampling on the stereoscopic images. Afterwards, this base mesh is passed to a coarse-to-fine meshing process to get the semi-regular mesh of the original surface. Experimental results prove the reliability and the accuracy of our approach in terms of shape fidelity, compactness, but also runtime, since many steps have been parallelized on the GPU.



## 1. Introduction

Motivated by the high fidelity and the realism of the numerical models, and supported by the increasing storage capacities, the acquisition devices provide now high resolution meshes, ensuring the preservation of the finest details. Consequently these data are massive, and cannot be easily managed by any workstation or mobile device with limited memory and bandwidth. The semi-regular meshes are a good way to overcome these issues, because of their scalability and their compactness. Indeed, the semi-regular meshes are based on a regular subdivision connectivity, well-suited to display or transmit a mesh at different levels of details. This subdivision connectivity also allows a compact representation since only the connectivity of the lowest level of details is needed to reconstruct the full connectivity. This semi-regular structure is also adapted to multiresolution analysis [10] and wavelet compression [14]. Despite their good properties, the semi-regular meshes are sometimes forsaken by users because they are not provided by current acquisition systems which only provide point clouds. So, if one wants to produce a semi-regular mesh of a specific physical object, the pipeline presented in Fig. 1 must be processed: physical acquisition (creating a dense point cloud), cleaning/meshing (removing redundant points and noise inherent to acquisition process, and creating an irregular triangle mesh), and then semi-regular remeshing [15]. This pipeline is long and fastidious, especially as these three stages are performed independently.

Our original idea is to make the design of semi-regular meshes easier, by simplifying the classical pipeline shown above. This paper, that is an extended version of Peyrot et al. [16], presents a *coarse-to-fine* approach that allows an acquisition system to provide semi-regular meshes as output, thus avoiding a remeshing process. We focused on stereoscopic systems, because stereoscopy is an increasing field of interest in surface reconstruction, due to its rapidity and accuracy.

Our method, depicted in Fig. 2, relies on an analysis of the stereoscopic images to get a base mesh that captures the salient features of the original object, followed by a coarse-to-fine meshing that generates the semi-regular output. The most innovative part of our algorithm is the

* Corresponding author.
*E-mail address:* peyrot@i3s.unice.fr (J.-L. Peyrot).

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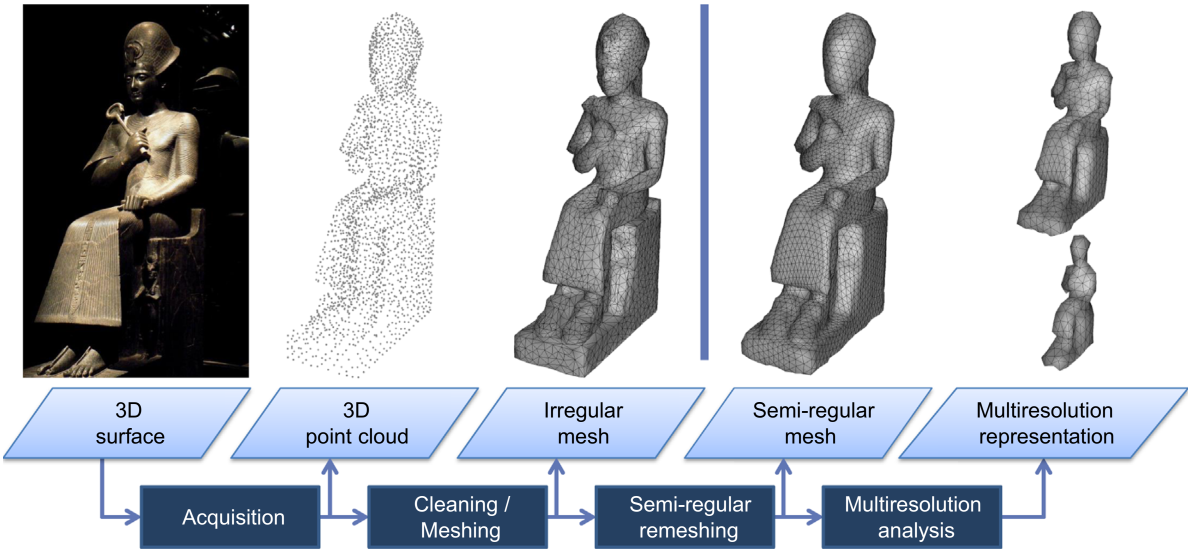


**Fig. 1.** The pipeline to get a semi-regular mesh from a physical object, and its application to multiresolution analysis.

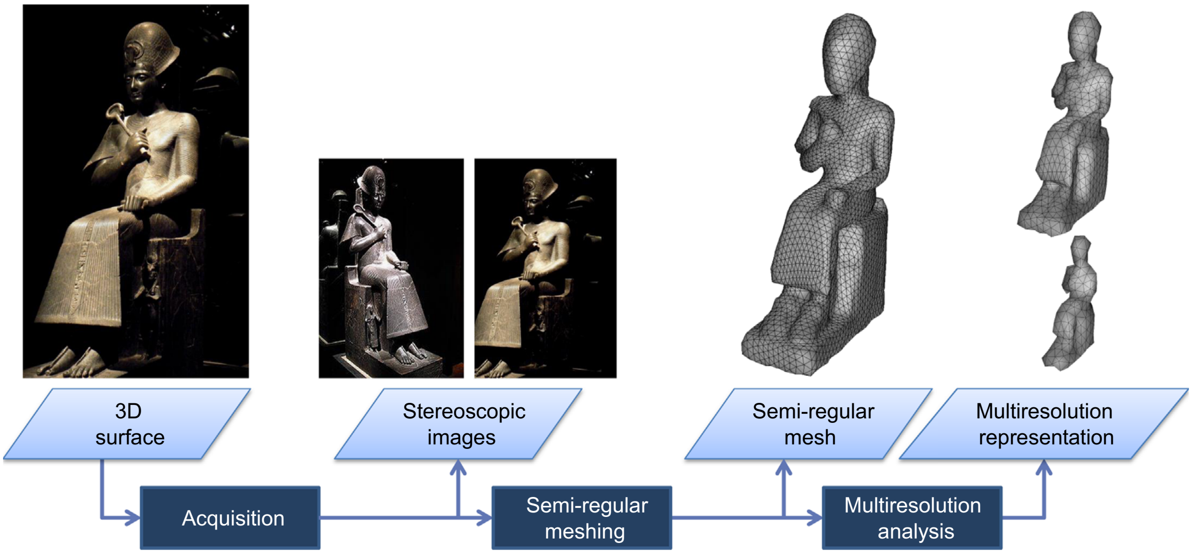


**Fig. 2.** Our 3D reconstruction technique that produces a semi-regular mesh directly from stereoscopic images.

use of the stereoscopic images as parameterization domain to create the semi-regular mesh.

The remaining of the paper is organized as follows. In Section 2, we remind the reader of the basics of semi-regular meshes and briefly review two prior methods of surface reconstruction based on stereoscopy and parameterization. Section 3 presents our semi-regular reconstruction method. Experimental results are presented in Section 4. Finally, Section 5 summarizes our contributions, and proposes future work.

## 2. Background

### 2.1. Semi-regular meshes

A semi-regular mesh $M_{sr}$ is a structured mesh defined by $L$ levels of resolutions (Fig. 3), where all the triangles at a specific level can be merged by fours down to a lower resolution mesh.

This merging process can be applied $(L-1)$ times to $M_{sr}$ until obtaining a base mesh $M_0$ that represents the lowest resolution of $M_{sr}$ ($M_{sr}$ can be seen as $M_{L-1}$). A semi-regular