Chapter 7

A Robust Embedding Scheme and an Efficient Evaluation Protocol for 3D Meshes Watermarking

Saoussen Ben Jabra
University of Tunis El Manar, Tunisia

Ezzeddine Zagrouba
University of Tunis El Manar, Tunisia

ABSTRACT

This paper proposes two main contributions. In the first one, a 3D mesh watermarking using Maximally Stable Meshes detection and multi-signatures embedding is presented. The originality of this scheme is to detect the attack type applied on marked mesh. In plus, it is robust against numerous attacks, blind and invisible. The proposed scheme uses the Maximally Stable meshes (MSMs) to insert signature. After MSMs detection using an extension of Maximally Stable Efficient Regions, three MSMs are selected to be marked. Then, three different signatures are embedded using three different watermarking schemes. This embedding allows knowing the type of the applied attack by detecting which of the signatures resisted. In more, it maximizes robustness by profiting from advantages of every scheme. The second contribution is a new evaluation protocol for 3D watermarking which allows generating a performance score for 3D mesh watermarking schemes. This protocol is based on six criteria having different weights in performance score computing. Finally, this protocol is used to evaluate the proposed watermarking scheme and to compare it with other algorithms. The obtained results verified the good performances of the proposed algorithm which presents the highest score.

DOI: 10.4018/978-1-4666-3906-5.ch007
INTRODUCTION

The recent decade has seen the emergence of 3D meshes in industrial, medical and entertainment applications. Therefore, their protecting from piracy and illegal use has attracted more and more attention in both the research and industrial domains. Many 3D models used for online commerce or entertainment are examples of contents that developers and owners can’t distribute without control over piracy. However, due to the complexity of 3D objects, 3D watermarking is far from the maturity of watermarking algorithms dedicated to audio, image or video watermarking. Basically, watermarking process consists to embed a signature into data and to try to detect it after any manipulation done on marked data. Usually, signature must be robust against the malicious attacks; this type of watermarking is designed to copyright protection applications. The watermarking can also be fragile for authentication applications. Robustness is often measured in terms of the number of watermarking attacks categories the watermark is able to resist. Most common categories of attacks are RST transformations (Rotation, Translation, Scaling), geometrical attacks (noise addition, surface smoothing), resampling attacks (connectivity modifications such as simplification, and remeshing) and cropping (i.e. cutting part of the 3D model by a plane). Watermarking can be blind or non blind depending on whether the original digital image is needed at extraction, or not.

This paper is organized as follows: an overview of mesh watermarking techniques is provided first. The proposed watermarking scheme is described, and the proposed evaluation protocol for 3D watermarking methods is presented. Experimental results and evaluations are given along with conclusions and perspectives.

MESH WATERMARKING OVERVIEW

Recently, 3D meshes have been widely used in virtual reality, medical imaging, video games and computer aided design. A 3D mesh is a collection of polygonal facets targeting to constitute an appropriate approximation of a real 3D object. It possesses three different combinatorial elements: vertices, edges and facets. From another viewpoint, a mesh can also be completely described by two kinds of information. The geometry information gives the positions (coordinates) of all its vertices, while the connectivity information provides the adjacency relations between the different combinatorial elements. Although there are many other 3D representations, such as cloud of points, parameterized surface, implicit surface and voxels, 3D mesh has been a standard of numerical representation of 3D objects thanks to its simplicity and usability. Furthermore, it is quite easy to convert other representations to 3D mesh, which is considered as an effective model. This fact partially explains why much of the work in the area of 3D watermarking deals with 3D triangle meshes. Although some schemes have been proposed to watermark NURBS (Lee, 2002) and point-sampled surfaces (Cotting et al., 2004), existing techniques concerning 3D meshes can be classified in two main categories, depending on whether the watermark is embedded in the spatial domain (by modifying the geometry or the connectivity) or in the frequency domain (by modifying some kind of mesh transformation like spectral decomposition or wavelet transformation).

Spatial Schemes

These can be classified in two main categories: geometric schemes which modify vertices coordinates and topologic schemes which modify vertices connectivity.
Related Content

Parallel Segmentation of Multi-Channel Images Using Multi-Dimentional Mathematical Morphology
www.igi-global.com/chapter/parallel-segmentation-multi-channel-images/4846?camid=4v1a

A Framework for Interactive 3D Rendering on Mobile Devices
www.igi-global.com/article/a-framework-for-interactive-3d-rendering-on-mobile-devices/115837?camid=4v1a

A Semi-Supervised Metric Learning for Content-Based Image Retrieval
www.igi-global.com/article/semi-supervised-metric-learning-content/59878?camid=4v1a

Future Trends in Coronary CT Angiography
www.igi-global.com/chapter/future-trends-coronary-angiography/61092?camid=4v1a