

## A PCA AND PERTURB BASED FRAGILE WATERMARKING SCHEME FOR 3D MODELS

JEN-TSE WANG<sup>1,2</sup>, PENG-CHENG WANG<sup>3</sup> AND SHYR-SHEN YU<sup>1,\*</sup>

<sup>1</sup> Department of Computer Science and Engineering  
National Chung Hsing University  
250 Kuo-Kuang Road, Taichung 402, Taiwan

<sup>2</sup>Department of Digital Media Design  
Hsiuping Institute of Technology  
11 Gungye Road, Daily City, Taichung 412, Taiwan

<sup>3</sup>Department of Information Management  
Hsiuping Institute of Technology  
11 Gungye Road, Daily City, Taichung 412, Taiwan

\*Corresponding author: pyu@nchu.edu.tw

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**ABSTRACT.** *In this paper, a new fragile watermarking scheme that enables the verification of 3D models for detecting unauthorized alterations is presented. The principal component analysis (PCA) is adopted to produce the PCA coordinate system and make the system robust to similarity transformation attacks. Before watermark embedding, the coordinates of illegitimate intervals are slightly perturbed to ensure all intervals legitimate. In order to control distortion, a special quantization technique is proposed to watermark a legitimate interval. Experimental results show that 100% vertices of the cover model can be embedded and extracted in the proposed method. Moreover, the distortion of the stego model is insignificant and under controlled by quantization step setting. Finally, the proposed method is immune to the causality, convergence and embedding holes problems.*

**Keywords:** Fragile watermarking, Three dimensional (3D) models, Principal component analysis (PCA), Verification, Tampering detection

1. **Introduction.** Digital watermarking is a technique that embeds a watermark into an object which can be a still image, a video clip, an audio clip, or a 3D model. According to the insertion space, two categories broadly classify these watermarking techniques: spatial domain [1-6] and transformation domain based watermarking schemes [7-18]. The least-significant-bits (LSB) method [1] was one of the most frequently used techniques in the spatial domain. Furthermore, watermarking techniques can be classified into robust watermarking [19-24] and fragile watermarking [25-28] according to the applications. The main goal of robust watermarking is to make embedded watermarks detectable against attacks. On the other hand, fragile watermarking is applied to verify the slightest unauthorized alteration and locate the changed regions.

Among different media types, watermarking of 3D objects is comparatively difficult inherently. Initially, Ohbuchi *et al.* [19-22] proposed a large variety of techniques for embedding data into 3D polygonal models. Recently, a considerable progress has been made in the area of robust watermark schemes for 3D polygonal meshes. But only a few fragile watermarking algorithms have been proposed. Yeo and Yeung [25] firstly proposed a fragile watermarking algorithm for authenticating 3D polygonal meshes. Lin *et al.* [26] proposed a similar fragile watermarking scheme. Chou and Tseng [27] proposed a blind fragile watermarking scheme based on the sensitivity of vertex geometry for 3D model