Chapter 25
3D Watermarking Approach Using Particle Swarm Optimization Algorithm

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ABSTRACT

This work proposes a watermarking approach by utilizing the use of Bio-Inspired techniques such as swarm intelligent in optimizing watermarking algorithms for 3D models. In this proposed work we present an approach of 3D mesh model watermarking by introducing a new robust 3D mesh watermarking authentication methods by ensuring a minimal surface distortion at the same time ensuring a high robustness of extracted watermark. In order to achieve these requirements this work proposes the use of Particle Swarm Optimization (PSO) as Bio-Inspired optimization techniques. The experiments were executed using different sets of 3D models. In all experimental results we consider two important factors: imperceptibility and robustness. The experimental results show that the proposed approach yields a watermarked object with good visual definition; at the same time, the embedded watermark was robust against a wide variety of common attacks.

INTRODUCTION

The basic principle of watermarking approaches is to add copyright information into a multimedia object, with the aim of broadcast monitoring, access control, copyright protection etc. The object may be a 2D image, 3D image, video or audio. The watermark does not prevent a user from listening to, viewing, examining, or manipulating the media content. Watermarking can be used in many applications such as owner identification, copyright protection, and Digital Rights Management (DRM) (Gaber & Zhang, 2011; Gaber, 2013). Digital watermarking aims to fulfill simultaneously a set of requirements such as: non visibility, robustness, high bit capacity and crypto-security. It is well known that a watermarking

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method improving on any of these requirements can limit its performance with respect to all the others. In general, good watermarking techniques require a few characteristics. These characteristics apply to watermarking schemes for with the purpose of the watermarking, for example, in copyright protection, the watermarking system should be as robust as possible, but for authentication applications, robustness is not required (Ghali, El Bakrawy, & Hassanien, 2011). Unfortunately, the invisibility and robustness requirements create a contradictory situation for watermarking development. If significant modifications are introduced to the host object media either in spatial or transform domain, greater robustness, in general, can be obtained. However, such modifications are distinguishable and hence do not satisfy the requirement of transparency (invisibility). The design of an optimal watermarking for a given application always involves a trade-off between these competing criteria. Thus, watermarking problem can be formulated as an optimization problem (Soliman, Hassanien, Aboul & Onsi, 2014).

In mathematics, or mathematical programming, optimization, refers to choosing the best element from some set of available alternatives. More generally, it means finding best available values of some objective function given a defined domain, including a variety of different types of objective functions and different types of domains. Recently, Bio-inspired intelligence techniques have been used in multimedia processing for variety of applications with different modifications (Hassanien, Aboul, Kacprzyk, & Abraham, 2008). Bio-inspired intelligence technique such as particle swarm have been employed to solve the watermark problem optimally.

Although there are many proposed approaches of watermark insertion and extraction either in spatial or frequency domain, but most of these methods had a limitation of enhancing either robustness or invisibility. Digital watermarking of 3D objects remains a challenging problem. One of the reasons is the fact that there is no unique representation of 3D objects, e.g. there are 3D mesh objects, and 3D objects represented using parametric surfaces such as 3D NURBS (Non-uniform Rational B-Spline surfaces) or 3D model data combined with texture information (Soliman, Hassanien, Aboul, & Onsi, 2013). The state of research of watermarking 3D models is still in its infancy as compared to published work in image and video watermarking. This situation is mainly caused by the difficulties encountered while handling the arbitrary topology and irregular sampling of 3D meshes, and the complexity of possible attacks on watermarked meshes.

This work proposes a watermarking approach using Bio-Inspired optimization techniques. We develop such a watermarking approach by considering watermarking problem as an optimization problem. Such optimization problem has the goal of achieving the best values of two competing requirements: imperceptibility of underling model and watermarked model robustness against different types of attacks. The proposed system can by divided into two sub-systems. The proposed approach is concerning with designing a watermarking approach for 3D model with mesh models used as 3D image representation.

we present two approaches of 3D mesh model watermarking focuses on introducing a new robust 3D mesh watermarking authentication approaches by ensuring a minimal surface distortion at the same time ensuring a high robustness of extracted watermark. In order to achieve these requirements this work proposes two Particle Swarm Optimization (PSO) as Bio-Inspired optimization technique.

This chapter includes 6 sections. Section 2 provides a brief review of essential concepts and definitions of digital media watermarking. It also provides a survey of the recent research work in the field of watermarking security for 3D mesh watermarking. Section 3 presents the proposed watermarking approach for 3D mesh models using Particle Swarm Optimization (PSO) algorithm. Section 4 explores and discusses the results of the implementation and test of the proposed methods. Finally, section 5 discusses the conclusion and the future work.