3D Animation Watermarking Using PositionInterpolator

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Abstract. For real-time animation, keyframe animation that consists of translation,
rotation, scaling interpolator nodes is used widely in 3D graphics. This paper
presents 3D keyframe animation watermarking based on vertex coordinates
in CoordIndex node and keyvalues in PositionInterpolator node for VRML
animation. Experimental results verify that the proposed algorithm has the robustness
against geometrical attacks and timeline attacks as well as the invisibility.

1 Introduction

The watermarking/fingerprinting system for the copyright protection and illegal copy
tracing have been researched and standardized about digital contents of audio, still
image, and video [1],[2]. Recently the watermarking system for 3D graphic still
model has become an important research focus to protect the copyright [3]-[6]. 3D
computer animation has been very fast growing in 3D contents industry, such as
3D animation movie, 3D computer/mobile game and so on. On the other hand, many
3D contents providers are damaged by the illegal copy of 3D character animation. We
proposed the watermarking system for copyright protection of 3D animation.

An animation in 3D graphics is known as moving objects including mesh or texture
in 3D space. The animation methods be widely used in 3D graphics are as follows; 1. Vertex animation: As similar as morphing, this method stores the positions of
animated vertices in each frame and generates these vertices by using interpolator. 2
Hierarchical animation: An articulated body of human or character consists of a hier-
archical structure. This method divides a character into several mesh models, inherits
to the relation of parent-child, and store transform matrices of translation, rotation and
scaling in each frame or transformed frame. 3 Bone based animation: This method,
which is an extension hierarchical animation, makes bones with 3D data similar as
bone in human body and sticks meshes as child in bones. 4 Skinning: This method is
to prevent the discontinuity of articulations that occurs at hierarchial and bone
based animation by using the weighting method of bones. 5 Inverse kinematics:

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This method is to adopt the applied mechanics in physical science or mechanical engineering.

For real-time animation, keyframe animation that applies the above methods is used widely in 3D graphics. This is a method that registers the animated key values in the important several frames among the entire frames and generates the rest frames by interpolator using the registered key values. Generally PositionInterpolator and Orientation-Interpolator can be used to implement simple keyframe animation.

This paper presents the watermarking for the wide-use keyframe animation in VRML. The proposed algorithm selects randomly the embedding meshes, which are transform nodes among the entire hierarchical structure. Then the watermark is embedded into vertex coordinates in and keyValues of PositionInterpolator in the selected transform node. Experimental results verify that the proposed algorithm is robust to geometrical attacks and timeline attacks that are used in general 3D graphic editing tools.

2 Proposed Algorithm

The block diagram of the proposed algorithm is shown as Fig. 1. The watermark is used as the binary information in this paper. The meshes in hierarchical structure are called as the transform nodes from now.

2.1 Geometrical Watermarking

All unit vectors $\hat{v}_{i\in[0,N_{TR_i}]}$ of vertices $v_{i\in[0,N_{TR_i}]}$ in a selected transform node $TR_i$ are projected into 2D coordinate system $(X_{local}, Y_{local})$ within the unit circle. The unit circle is divided equally into $n$ sectors so that can embed $N$ bits of watermark in a transform node. Namely, a bit of watermark is embedded into a sector that a center point $c_{k\in[1,n]}$ of vectors that are projected into a sector. A center point $c_{k\in[0,n]}$ is moved toward the target point $o_{w=1}$ of right side if a watermark bit $w$ is 1 or the target point $o_{w=0}$ of left side if a watermark bit $w$ is 0, as shown in Fig. 4. From the viewpoint of the robustness, the target points $\{ o_{w=0}, o_{w=1} \}$ must be determined to the