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A New Watermarking For 3D Models Based On Integral Invariants

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ABSTRACT: In this paper, we propose a new semi-fragile watermarking algorithm for the authentication of 3D models based on integral invariants. To do so, we embed a watermark image by modifying the integral invariants of some of the vertices. Basically, we shift a vertex and its neighbors in order to change the integral invariants. To extract the watermark, test all the vertices for the embedded information, and combine them to recover the watermark image. How many parts can the watermark image be recovered would help us to make the authentication decision. Experimental test shows that this method is robust against rigid transform and noise attack, and useful to test purposely attack besides transferring noise and geometrical transforming noise. An additional contribution of this paper is a new algorithm for computing two kinds of integral invariants.

I.**INTRODUCTION**

Digital watermarking has been studied over many years for digital content copyright protection and authentication. As 3D models are used in a wide variety of fields, the necessity to protect their copyrights becomes crucial. Theoretically, there are two categories of watermarking algorithms, spatial domain methods and frequency domain methods. Spatial domain methods embed the watermark by directly modifying the position of vertices, the colour of texture points or other elements representing the model. The frequency domain methods embed the watermark by modifying the transformation coefficients. There is no unified standard to test which algorithm is better. There are some applications where one method is found to be best suited than the other.

Watermarking algorithms are usually characterized with the four following properties: Validation, Invisibility, Capacity and Robustness. Robust watermarking of 3D models has been widely researched in recent years, and great developments have been achieved in both frequency domain algorithms and spatial domain algorithms. Although the problems have been well defined by researchers working on image watermarking, fragile watermarking has not been researched abundantly until recently. This kind of watermarking scheme focuses on finding where and how the models have been modified or attacked. For many applications, this watermarking scheme is often too restrictive to be usable, as model compression and format conversion are not permitted. It is desired that the hidden data be robust to unintentional changes like model compression, rigid transformation and random noise originating from format **conversion.**

II. LITERATURE SURVEY

The first article on 3d model watermarking was published in 1997 by Ohbuchi et al. Several years passed, and a lot of new algorithms were developed. Theoretically, there are two categories of watermarking algorithms, spatial domain methods and frequency domain methods. Spatial domain methods embed the watermark by directly modifying the position of vertices, the color of texture points or other elements representing the model. The frequency domain methods embed the watermark by modifying the transformation coefficients. There is no unified standard to test which algorithm is better. There are some applications where one method is found to be best suited than the other. Nevertheless, watermarking algorithms are usually characterized with the four following properties: - Validation: the watermark can be fully extracted from the original model. - Invisibility: watermarked models should look similar to the original model. - Capacity: this corresponds to the amount of information that can be embedded in the models. - Robustness: the watermark should survive different types of noise attacks.

Spatial domain algorithms work on certain 3D model invariants, like TSQ, TVR, AIE, etc. to embed the watermark. But most of them are very sensitive to noise. Frequency domain algorithms provide better robustness ability by using wavelet analysis, Laplace transforms and other transforms. Nevertheless, the 3d model distortions fail to be invisible, or extraction routines require the original watermarked model to obtain hidden information.

In this paper, we propose a new semi-fragile spatial domain watermarking algorithm for the authentication of 3D models based on integral invariants. It can survive under rigid transforms and certain noise attacks. Our idea mainly comes from other spatial domain algorithms like. Since we wish to embed the watermark with geometrical invariants, we introduce integral invariants to achieve this. Based on the good character of integral invariants that have proven useful in parameterization, registration and classification applications, we believe they can also be put to use in our problem. First, we calculate the current integral invariant of the vertex that will undergo watermarking. We then change these values slightly to embed the watermark image parts. Finally, we modify the position of the vertices and their neighbors in order to change the integral invariants to the new value. The extraction routine is the inverse process of the insertion routine. We compute the integral invariants for all the vertices and try to match the embedded information. Once matched, we extract the embedded information at each vertex from two integral invariants and combine this data to form the extracted watermark. By analyzing the false-positive probability, we finally make the authentication decision.

III. SYSTEM DESIGN

3.1 INTRODUCTION

Software design is an interactive process through which requirements are translated into a “Blueprint” for constructing the software. Throughput the design process, the quality of the evolving design is assessed with a series of formal technical reviews or design walkthroughs.

System design deals with planning and designing of the system. It mainly deals with form design, screen design. It is the transition of user oriented document-to-document oriented programmers.

3.2 DATA FLOW DIAGRAM

Data Flow Diagram (DFD) is the way of expressing system requirement in graphical form. A Data Flow Diagram is also known as “Bubble Chart” has the purpose of clarifying system requirement and identifying major transformation that will become programs in system design. It is the starting form of design phase that functionally decomposes the requirement specification down to the lowest level of details.

In a Data Flow Diagram, there are four symbols:

- A Square defines the source or destination of system data.
- An Arrow identifies data flow.
- A Circle represents a process that incoming data flow into outgoing data flow.
- An open Rectangle is a data store

IV. MODULE DESCRIPTION

4.1. Embeded watermark image using invariants

Integral invariants for curves in a plane,such an invariant is the area invariant.. This is obviously a way to estimate curvature on a scale defined by the kernel radius r. The superior performance of this and other integral invariants on noisy data, especially for the reliable retrieval of shapes from geometric databases. They introduced integral invariants for surfaces with the integral of a local neighborhood in 3D space .

4.2 Implementation of algorithm for Invariants

1) Find the vertices around point p, divide them into 3 classes: inner, cross, and outer. Vertexes of class inner are in the ball $Br(p)$, and all of their direct neighbors (there is an edge between them) are in the ball. Vertexes of class cross are in the ball $Br(p)$, but at least one of their direct neighbors is out of the ball. Vertexes of class outer are out of the ball $Br(p)$.

2) For all the edges that have a vertex of class outer and a vertex of class cross, compute the intersect point of the edge and sphere $Sr(p)$. Notice that these points construct a ”circle”, and we name the assembly of these points as $Pr(p)$.

3) For each point in $Pr(p)$, compute its spherical angle between its two adjacent points, and sum them to $AGr(p)$.

4) Compute $SAr(p) = AGr(p)$ ¡ (n ¡ 2)¼, where n is the number of points in $Pr(p)$.

5) For each facet whose three vertices are of class inner or cross, compute the volume of the tetrahedron constructed by the facet and point p, and sum them to $V\,Ir(p)$. Notice that the volume can be negative.

6) For each facet that cross the sphere $Sr(p)$, compute volume of the pyramid construct with the inner part of the facet and point p, and sum them to $V\,Or(p)$. Notice that the volume can be negative.

7) Compute $V\,r(p) = AGr(p)$ ¢ r=3 + $V\,Ir(p) + V\,Or(p)$

4.3 Area & Volume invariant

If the neighbor surface is a taper the formula giving the area of the spherical intersection is S = 2¼Rh, where S is the area, R is the sphere radius, and h is the height of the cap. Thus, to change the area invariant, we have to change the value of h.

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Further, if we only have part of a taper , we reach the same conclusion for the area of the partial cap with the vertex at the top: we have to change the value of h.
For any 3D surface the area of spherical intersection can be approximated by a number of partial caps like in the last step. So if we change the value of h for every cap,
we change the spherical area.
Therefore, in order to change the area invariant of a 3D mesh model, we can approximately change the value of h of all outer and cross vertices
The basic idea is to move the vertex along the direction of N. Notice that for inner vertices if we move them along the direction of N a certain distance, the influence to the volume can be easily calculated.
That shift is independent of the movement of other vertices of the same type. As a result, if we specify how many vertice we move and by how much they are moved along the direction
of N
4.4 Performance Evaluation
Our project shows this method is suitable to determine whether the model is attacked through this embedding capacity currently limited two to integral invariants.

V.CONCLUSION

Thus" A new watermarking method for 3D model based on integral invariant" has presented a semi-fragile watermarking method based on integral invariants. It is a spatial domain method robust against rigid transforms and noise attacks. Experimental tests show that this method is suitable to determine whether a model was attacked. . It can survive under rigid transforms and certain noise attacks. The idea mainly comes from other spatial domain algorithms like. Since the intension is to embed the watermark with geometrical invariants, integral invariants are introduced to achieve this. Based on the good character of integral invariants that have proven useful in parameterization, registration and classification applications, we believe they can also be put to use in the problem.

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