A High Capacity Data Hiding Algorithm for Point-Sampled Geometry

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Abstract. This paper proposes a high capacity data hiding algorithm for point-sampled geometry. We introduce the unit length as the quantizer to generate an embedding order list as well as an embedding index list. Our algorithm considers every two elements in the embedding order list as the order pair, and we embed 3 bits of secret message into the index pair associated with the order pair. The message embedding is very efficient requiring, at most, adding 1 to, or subtracting 1 from, the index pair. This reflects a slight perturbation of a point's coordinates where the magnitude of the perturbation is no greater than one unit length. Our algorithm achieves a high embedding capacity, being 4.5 times the number of points in the cover models. The capacity magnitude is 50% higher than that of the current state of art algorithms, but the model distortion is similar to our counterparts. Our scheme is robust against translation, rotation, and uniformly scaling operations, and it is simple to implement. Our algorithm belongs to the blind manner: the message can be extracted without referring to the original cover model. We believe our scheme is appropriate for most point-sampled models.

Keywords: data hiding, point-sampled geometry, capacity, quantization

References

[1] N. Aspert, E. Drelie, Y. Maret, T. Ebrahimi, "Steganography for Three-Dimensional Polygonal Meshes," in *Proceedings of SPIE 47th Annual Meeting*, pp. 705-708, 2002.

[2] A. Bogomjakov, C. Gotsman, M. Isenburg, "Distortion-Free Steganography for Polygonal Meshes," *Computer Graphics Forum*, Vol.27, No.2, pp. 637-642, April 2008.

[3] F. Cayre, and B. Macq, "Data Hiding on 3-D Triangle Meshes," *IEEE Transactions on Signal Processing*, Vol.51, No.4, pp. 939-949, 2003.

[4] C.H. Chang, C.M. Wang, Y.Y. Tsai, Y.M. Cheng, "A Novel Data Hiding Algorithm Using Normal Vectors of 3D Model," in *Proceedings of Computer Graphics*, Vol.4035, pp. 231-241, 2006.

[5] B. Chen and G.W. Wornell, "Quantization Index Modulation: A Class of Provable Good Methods for Digital Watermarking and Information Embedding," *IEEE Transactions on Information Theory*, Vol.47, No.4, pp. 1423-1443, 2001.

[6] Y.M. Cheng and C.M. Wang, "A High-Capacity Steganographic Approach for 3D Polygonal Meshes," in *Proceedings of Pacific Graphics*, Vol.22, No.9, pp. 845-855, 2006.

[7] Y.M. Cheng, C.M. Wang, Y.Y. Tsai, "A Data Hiding Algorithm for Point-Sampled Geometry," in *Proceedings of International Conference on Computational Science and its Applications*, Vol.3980, pp. 181-191, 2006.

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[8] Y.M. Cheng, C.M. Wang, Y.Y. Tsai, C.H. Chang, P.C. Wang, "Steganography for Three-Dimensional Models," in *Proceedings of Computer Graphics*, Vol. 4035, pp. 510-517, 2006.

[9] Y.M. Cheng and C.M. Wang, "An Adaptive Steganographic Algorithm for 3D Polygonal Meshes," *The Visual Computer*, Vol. 23, No. 9-11, pp. 721-732, 2007.

[10] C.M. Chou and D.C. Tseng, "Affine-Transformation-Invariant Public Fragile Watermarking for 3D Model Authentication," *IEEE Computer Graphics and Applications*, Vol.29, No.2, pp.72-79, 2009.

[11] M. Gross and H. Pfister, *Point-Based Graphics*, Morgan Kaufmann, San Francisco, 2007.

[12] N.F. Johnson and S. Jajodia, "Exploring Steganography: Seeing the Unseen," *IEEE Computer*, pp. 26-34, 1998.

[13] L. Kobbelt and M. Botsch, "A Survey of Point-Based Techniques in Computer Graphics," *Computers & Graphics*, Vol.28, No.6, pp. 801-814, 2004.

[14] H. Luo, J.S. Pan, Z.M. Lu, H.C. Huang, "Reversible Data Hiding for 3D Point Cloud Model," in *Proceedings of Intelligent Information Hiding and Multimedia Signal Processing*, pp. 487-490, 2006.

[15] Y. Maret and T. Ebrahimi, "Data Hiding on 3D Polygonal Meshes," in *Proceedings of Multimedia and Security Workshop*, pp. 68-74, 2004.

[16] J. Mielikainen, "LSB Matching Revisited," *IEEE Signal Processing Letters*, Vol.13, No.5, pp. 285-287, 2006.

[17] F.A. P. Petitcolas, R.J. Anderson, M.G. Kuhn, "Information Hiding - A Survey," *Proceedings of IEEE, Special Issue on Protection of Multimedia Content*, Vol.87, No.7, pp. 1062-1078, 1999.

[18] H. Provos and P. Honeyman, "Hid and Seek: An Introduction to Steganography," *IEEE Security and Privacy*, Vol.1, No.3, pp. 32-44, 2003.

[19] A.C. Rencher, *Methods of Multivariate Analysis*, 2nd Edition, Wiley, New York, 2002.

[20] Y.Y. Tsai, C.M. Wang, Y.M. Cheng, C.H. Chang, P.C. Wang, "Steganography on 3D Models Using a Spatial Subdivision Technique," in *Proceedings of Computer Graphics International*, Vol.4035, pp. 469-476, 2006.

[21] C.M. Wang and Y.M. Cheng, "An Efficient Information Hiding Algorithm for Polygon Models," in *Proceedings of EUROGRAPHICS 2005*, Vol.24, No.3, pp. 591-600, 2005.

[22] C.M. Wang and P.C. Wang, "Data Hiding Approach for Point-Sampled Geometry," *IEICE Transactions on Communications*, Vol.E88-B, No.1, pp. 190-194, 2005.

[23] C.M. Wang and P.C. Wang, "Steganography on Point-sampled Geometry," *Computers and Graphics*, Vol.30, No.2, pp. 244-254, 2006.

[24] H.T. Wu and Y.M. Cheung, "A Reversible Data Hiding Approach to Mesh Authentication," in *Proceedings of IEEE/WIC/ACM International Conference on Web Intelligence*, pp. 774-777, 2005.

[25] H.T. Wu and Y.M. Cheung, "A High-Capacity Data Hiding Method for Polygonal Meshes," in *Proceedings of Information Hiding*, Vol.4437, pp. 188-200, 2007.

[26] P.C. Wang and C.M. Wang, "Reversible Data Hiding for Point-Sampled Geometry," *Journal of Information Science and Engineering*, Vol.23, No.6, pp. 1889-1900, 2006.

[27] P.C. Wang, K.C. Wu, C.M. Wang, "A Reversible Steganographic Algorithm for Point-Sampled Geometry," in *Proceedings of Eighth International Conference on Intelligent Systems Design and Applications*, Vol.3, pp. 296-301, 2008.