

A Data Hiding Scheme based on Voronoi Diagram

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Abstract. In this paper, we propose a novel image steganographic technique based on the Voronoi diagram. The basic idea is to generate a Voronoi diagram of a graph transformed from cover image; that is, the Voronoi points correspond to every two consecutive pixels in the cover image. According to the secret bits to be embedded, every Voronoi point will either be replaced by one of its neighbors or keep its original value. As a result, this scheme does not need any extra information, such as indicators, to extract the secret data. Furthermore, the experimental results show that the proposed scheme can achieve greater data hiding capacity with less distortion compared to related schemes.

Keywords: Steganography, data hiding, voronoi diagram, delaunay triangulation, PSO

References

- [1] R. Davis, "The Data Encryption Standard in Perspective," *IEEE Communications Society Magazine*, Vol. 16, pp. 5-9, 1978.
- [2] R. L. Rivest, A. Shamir, L. Adleman, "A Method for Obtaining Digital Signatures and Public-key Cryptosystems," *Communications of the ACM*, Vol. 21, No. 3, pp. 120-126, 1978.
- [3] R.Z. Wang, C.F. Lin, J.C. Lin, "Image Hiding by Optimal LSB Substitution and Genetic Algorithm," *Pattern Recognition*, Vol. 34, No. 4, pp. 671-683, 2001.
- [4] C.C. Chang, J.Y. Hsiao, C.S. Chan, "Finding Optimal Least-significant-bit Substitution in Image Hiding by Dynamic Programming Strategy," *Pattern Recognition*, Vol. 36, No. 7, pp. 1583-1595, 2003.
- [5] D.C. Wu and W.H. Tsai, "A Steganographic Method for Images by Pixel-value Differencing," *Pattern Recognition Letters*, Vol. 24, No. 9-10, pp. 1613-1626, 2003.
- [6] H.C. Wu, N.I. Wu, C.S. Tsai, M.S. Hwang, "Image Steganographic Scheme Based on Pixel-value Differencing and LSB Replacement Methods," *IEE Proceedings of Vision, Image and Signal Processing*, Vol. 152, No. 5, pp.611-615, 2005.
- [7] J. Mielikainen, "LSB Matching Revisited," *IEEE Signal Processing Letters*, Vol. 13, No. 5, pp.285-287, 2006.

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- [8] C.H. Yang, S.J. Wang, C.Y. Weng, "Analysis of Pixel-value-differencing Schemes with LSB Replacement in Steganography," in *Proceedings of Third International Conference on Intelligent Information Hiding and Multimedia Signal*, Kaohsiung, Taiwan, ROC, pp. 445-448, 2007.
- [9] C.M. Wang, N.I.Wu, C.S. Tsai, M.S. Hwang, "A High Quality Steganographic Method with Pixel-value Differencing and Modulus Function," *Journal of Systems and Software*, Vol.81, No. 11, pp. 150-158, 2008.
- [10] J.Y. Hsiao and C.T. Chang, "An Adaptive Steganographic Method Based on the Measurement of Just Noticeable Distortion Profile," *Image and Vision Computing*, Vol. 29, No. 1, pp. 155-166, 2011.
- [11] R. Descartes, *Principia Philosophiae*, Ludovicus Elzevirius, Amsterdam, 1644.
- [12] G. L. Dirichlet, "Über Die Reduktion Der Positiven Quadratischen Formen Mit Drei Unbestimmten Ganzen Zahlen," *J. Reine Angew. Math.*, Vol. 40, pp. 209-227, 1850.
- [13] G. F. Voronoi, "Deuxieme Memoire: Recherches Sur Les Paralleloedres Primitifs," *J. Reine Angew. Math.*, Vol. 136, pp. 67-181, 1909.
- [14] G. F. Voronoi, "Nouvelles Applications Des Parametres Continus A La Théorie Des Formes Quadratiques, Deuxieme Memoire, Recherches Sur Les Paralleloedres Primitifs," *J. Reine Angew. Math.*, Vol. 134, pp. 198-287, 1908.
- [15] J. Kennedy and R. Eberhart, "Particle Swarm Optimization," in *Proceedings of IEEE International Conference on Neural Networks*, Perth, WA, pp. 1942-1948, 1995.
- [16] Y. Shi and R. Eberhart, "A Modified Particle Swarm Optimizer," in *Proceedings of IEEE International Conference on Evolutionary Computation*, Anchorage, AK, USA, pp. 69-73, 1998.
- [17] J. Kennedy, "The Particle Swarm: Social Adaptation of Knowledge," in *Proceedings of IEEE International Conference on Evolutionary Computation*, Indianapolis, IN , USA, pp. 303-308, 1997.
- [18] Standard PSO, <http://www.particleswarm.info/Programs.html>, 2007.