

Hardware Implementation of Road Network Extraction Using Simplified Gabor Wavelet in Field Programmable Gate Array

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Abstract

Automatic detection of road networks from the satellite and aerial images is the most demanded research area, and it is used for various remote sensing applications. The Simplified Gabor Wavelet based approaches are used to extract the road network automatically. In this paper, a field programmable gate array architecture designed for automatic extraction of road network using Simplified Gabor Wavelet is proposed. The hardware implementation results are compared with software implementation results. The performance measures such as completeness, correctness and quality are calculated. In the software implementation, the average value of completeness, correctness, and quality of various images are 91%, 98%, and 89% respectively. In the hardware implementation, the average value of completeness, correctness, and quality are 89%, 97%, and 87% respectively. The performance of the proposed algorithm is also proved in noisy images. These measures prove that the proposed work yields road network very resembling to reference road map.

Keywords: road network extraction, simplified Gabor wavelet, field programmable gate array, connected component

References

- [1] J. Guan, Z. Wang, and X. Yao, "A new approach for road centerlines extraction and width estimation," 10th IEEE International Conf. Signal Processing, pp. 924-927, December 2010.
- [2] T. Chen, J. Wang, and K. Zhang, "A wavelet transform based method for road centerline extraction," Photogrammetric Engineering & Remote Sensing, vol. 70, no. 12, pp. 1423-1431, December 2004.
- [3] C. Zhu, W. Shi, M. Pesaresi, L. Liu, X. Chen, and B. King, "The recognition of road network from high-resolution satellite remotely sensed data using image morphological characteristics," International Journal of Remote Sensing, vol. 26, no. 24, pp. 5493-5508, 2005.
- [4] O. Tuncer, "Fully automatic road network extraction from satellite images," Proc. the 3rd IEEE International Conf. Recent Advances in Space Technologies, pp. 708-714, August 2007.
- [5] V. Parthasarathi and D. Y. Pushpamitra, "Real-time implementation of automatic road extraction for high resolution satellite images using FPGA," Global Journal for Information Technology and Computer science, vol. 1, no. 1, pp. 1-6, 2012.
- [6] S. Udomhunsakul, "Road extraction using stationary wavelet transform," International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering, vol. 7, no. 8, pp. 1038-1040, 2013.
- [7] J. J. Hao, Q. Jiang, J. W. Wei, and L. Mi, "Research of edge detection based on Gabor wavelet," Proc. the IEEE International Conf. Measuring Technology and Mechatronics Automation, pp. 1083-1086, 2010.
- [8] W. Jiang, K. M. Lam, and T. Z. Shen, "Efficient edge detection using simplified Gabor wavelets," IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, vol. 39, no. 4, pp. 1036-1047, 2009.

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- [9] J. Hu, A. Razdan, J. C. Femiani, M. Cui, and P. Wonka, "Road network extraction and intersection detection from aerial images by tracking road footprints," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 45, no. 12, pp. 4144 - 4157, December 2007.
- [10] X. Jin and C. H. Davis, "An integrated system for automatic road mapping from high-resolution multi-spectral satellite imagery by information fusion," *Inform Fusion*, vol. 6, no. 4, pp. 257-273, December 2005.
- [11] W. Shi, Z. Miao, Q. Wang, and H. Zhang, "Spectral-spatial classification and shape features for urban road centerline extraction," *IEEE Geoscience and Remote Sensing Letters*, vol. 11, no. 4, pp. 788-792, April 2014.
- [12] X. Huang and L. Zhang, "Road centreline extraction from high-resolution imagery based on multiscale structural features and support vector machines," *International Journal of Remote Sensing*, vol. 30, no. 8, pp. 1977-1987, 2009.
- [13] R. Maurya, P. R. Gupta, and A. S. Shukla, "Road extraction using k-means clustering and morphological operations," *Proc. the IEEE International Conf. Image Information Processing*, pp. 1-6, 2011.
- [14] J. B. Mena and J. A. Malpica, "An automatic method for road extraction in rural and semi-urban areas starting from high resolution satellite imagery," *Pattern Recognition Letters*, vol. 26, no. 9, pp. 1201-1220, July 2005.
- [15] P. P. Singh and R. D. Garg, "Automatic road extraction from high resolution satellite image using adaptive global thresholding and morphological operations," *Journal of the Indian Society of Remote Sensing*, vol. 41, no. 3, pp. 631-640, September 2013.
- [16] Z. Miao, B. Wang, W. Shi, and H. Wu, "A method for accurate road centerline extraction from a classified image," *IEEE Journal of Applied Earth Observations and Remote Sensing*, vol. 7, no. 12, pp. 4762-4771, December 2014.
- [17] M. Dalla Mura, J. A. Benediktsson, B. Waske, and L. Bruzzone, "Morphological attribute profiles for the analysis of very high resolution images," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 48, no. 10, pp. 3747-3762, October 2010.
- [18] B. Ergen, "A fusion method of gabor wavelet transform and unsupervised clustering algorithms for tissue edge detection," *The Scientific World Journal*, vol. 2014, pp. 964870-1-964870-13, 2014.
- [19] C. Sujatha and D. Selvathi, "An optimal solution of image edge detection using simplified Gabor wavelet," *International Journal of Computer Science Engineering and Information Technology*, vol. 2, no. 3, pp. 99-115, June 2012.
- [20] "Satellite images from Satellite Imaging Corporation (SIC)," <http://www.satimagingcorp.com>.
- [21] "Satellite images from Apollo Mapping," <https://www.apollomapping.com>.
- [22] T. A. Abbasi and M. U. Abbasi, "A proposed FPGA based architecture for SOBEL edge detection operator," *Journal of Active & Passive Electronic Devices*, vol. 2, no. 4, pp. 271-277, 2007.
- [23] B. G. C. Kumar and M. H. Rajvee, "Image edge detection based on FPGA," *International Journal of Image Processing and Vision Sciences*, vol. 1, no. 2, pp. 7-9, 2012.
- [24] V. K. Sundari, M. Manikandan, and P. Prakash, "FPGA implementation of Sobel edge detector," *International Journal of Advances in Science and Technology*, pp. 255-259, 2012.
- [25] F. A. Ferhat, L. A. Mohamed, O. Kerdjidj, K. Messaoudi, A. Boudjelal, and S. Seddiki, "Implementation of SOBEL, PREWITT, ROBERTS edge detection on FPGA," *Proc. the International Conf. Image Processing, Computer Vision, and Pattern Recognition*, pp. 1-4, 2013.
- [26] S. Singh, A. K. Saini, and R. Saini, "Real-time FPGA based implementation of color image edge detection," *International Journal of Image, Graphics and Signal Processing*, vol. 4, no. 12, pp. 19-25, 2012.
- [27] K. C. Sudeep and J. Majumdar, "A novel architecture for real time implementation of edge detectors on FPGA," *International Journal of Computer Science Issues*, vol. 8, no. 1, pp. 193-202, January 2011.
- [28] D. Sangeetha and P. Deepa, "FPGA implementation of cost-effective robust Canny edge detection algorithm," *Journal of Real-Time Image Processing*, pp. 1-14, March 2016.