Implementation of Grayscale Image Segmentation Based on FPGA

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ABSTRACT

An automatic multilevel thresholding algorithm called HVEM (Histogram-based Valley Estimation Method) based on field programmable gate array (FPGA) is presented for segmenting an image into multiple regions with a similar gray-level distribution. The proposed method is computationally efficient so that it can be easily implemented on an FPGA circuit. A method for determining cluster number is also introduced to automatically choose the proper number of thresholds by estimating all possible valleys in a histogram.The proposed method was compared with the Otsu method on a large number of images. In contrast to HVEM, Otsu ’ s method has a serious drawback when extending to a multi-threshold version that is very time consuming and also difficult to be implemented on FPGA. Timing simulations show that the designed hardware can run at a speed of 191 MHz (or 1,457 frames per second) for a 256?e256 gray-level image. This result confirms that the proposed FPGA architecture can achieve the requirements for a real-time image processing system.

Keywords : Otsu ; HVEM ; FPGA ; Multi-Threshold ; Segmentation

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REFERENCES

[1] A. Zainal Arifin , A. Asano “ Image segmentation by histogram thresholding using hierarchical cluster analysis ” Pattern Recognition Letters 2006 pp.1515 – 1521 [2] F. Samopa ,A. Asano “ Hybrid Image Thresholding Method using Edge Detection ” IJCSNS International Journal of Computer Science and Network Security, 2009 ,VOL.9 No.4, pp.292-299 [3] A.T. Abak, U. Baris, B. Sankur, “ The performance evaluation of thresholding algorithms for optical character recognition ”, Proceedings of the Fourth International Conference on Document Analysis and Recognition,1997, pp.697-700.

[4] F. Yan, H. Zhang, C. Ronald Kube, ” A multistage adaptive thresholding method ”, Pattern Recognition Letters 2005, pp.1183-1191.

[5] D. Aiteanu, D. Ristic, A. Graser, “ Content based threshold adaptation for image processing in industrial application ”, International Conference on Control and Automation (ICCA2005), 2005, pp.1022-1027.

[6] H. Ng, “ Automatic thresholding for defect detection ”, Pattern Recognition Letters 2006, pp.1644-1649.

[7] E.P. Ong, B.J. Tye, W.S. Lin, M. Etoh, “ An efficient video object segmentation scheme ”, Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP2002), 2002, pp.IV-3361-IV-3364.

[8] G. Jing, D. Rajan, C. Eng Siong, " Motion Detection with Adaptive Background and Dynamic Thresholds " , Fifth International Conference on Information, Communications and Signal Processing, December 2005,pp.41-45.
[9] C. Su, A. Amer, " A Real-Time Adaptive Thresholding for Video Change Detection " , IEEE International Conference on Image Processing, 2006, pp.157-160.
[10] O. Sukmarg, K.R. Rao, " Fast object detection and segmentation in MPEG compressed domain " , Proceedings of TENCON ,2000, pp.364-368.
[11] D. Zhang, G. Lu, " Segmentation of Moving Objects in Image Sequence " , A Review, Journal of Circuits, Systems, and Signal Processing ,2001,pp.143-183.
[12] A. Amer, " Memory-based spatio-temporal real-time object segmentation " , Proc. SPIE Int. Symposium on Electronic Imaging, Conf. on Real-Time Imaging (RTI), 2003,pp.10-21.
[13] S. Y. Chien, Y. W. Huang, B. Y. Hsieh, S. Y. Ma, L. G. Chen, " Fast video segmentation algorithm with shadow cancellation " , global motion compensation, and adaptive threshold techniques, IEEE Transactions on Multimedia,2004, pp.732-748.
[14] M.S. Atkins, B.T. Mackiewich, " Fully Automatic Segmentation of the Brain in MRI " , IEEE Transactions on Medical Imaging ,1998,pp. 98-107.
[15] P.K. Saha, J.K. Udupa, " Optimum Image Thresholding via Class Uncertainty and Region Homogeneity " , IEEE Transactions on Pattern Analysis and Machine Intelligence,2001, pp.689-706.
[16] C.K. Lee, F.W. Choy, H.C. Lam, " Real-time thresholding using histogram concavity " , Proceedings of the IEEE International Symposium on Industrial Electronics, Xian, China, 1992,pp. 500-503.
[17] S.E. El-Khamy, M. Lotfy, N. El-Yamany, " A modified Fuzzy Sobel edge detector " , Seventeenth National Radio Science Conference, Minufiya University, Egypt, February ,2000, C32,pp. 1-9.
[18] J. Fan, W. G. Aref, " Mohand-Said Hacid, Ahmed K. Elmagarmid, Animproved automatic isotropic color edge detection technique " , Journal of Pattern Recognition Letters ,2001,pp. 1419-1429.
[19] D. Zhang, G. Lu, " Segmentation of Moving Objects in Image Sequence: A Review " , Journal of Circuits, Systems, and Signal Processing ,2001, pp.143-183.
[20] S. Yang, Y. Han, C. R. Wang, X. W. Wang, " Fast selecting threshold algorithm based on one-dimensional entropy " , Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, Guangzhou, China, August,2005,pp.4554-4557.
[21] N M. Hussein and A. Barriga, " Hardware Implementation of a Soft Computing Technique for Edge Detection " ,Proceedings of the World Congress on Engineering ,2008 ,pp.2 - 4.
[22] W. X. Kang, Q. Q. Yang, " Run-Peng Liang The Comparative Research on Image Segmentation Algorithms " , Education Technology and Computer Science, ETCS . First International Workshop on Volume 2,2009, March pp.703 - 707 [23] C. T. Johnston, K. T. Gribbon, D. G. Bailey, " Implementing Image Processing Algorithms on FPGAs " , Proceedings of the Eleventh Electronics New Zealand Conference, 2004.
[24] K. Ratnayake , A. Amer, " AN FPGA-BASED IMPLEMENTATION OF .PATIO-TEMPORAL OBJECT SEGMENTATION " ,2006.
[25] K.T. Gribbon, D.G. Bailey, and A. Bainbridge-Smith, " Development Issues in Using FPGAs for Image Processing " ,Proceedings of Image and Vision Computing New Zealand,2007, pp. 217 – 222 [26] R.L. Rosas, A. de Luca, F.B. Santillan, " SIMD architecture for image segmentation using Sobel operators implemented in FPGA technology " , The 2nd International Conference on Electrical and Electronics Engineering (ICEEE) and XI Conference on Electrical Engineering, Mexico City, Mexico, 2005, pp.77-80.
[27] N. Otsu, " A threshold selection method from gray-level histogram " , IEEE Transactions on System, Man, and Cybernetics, SMC-9 ,1979,pp. 62-66.
[28] L. Dong , G. Yu , " An Optimization-Based Approach to Image Binarization " Proceedings of the Fourth International Conference on Computer and Information Technology ,2004.
[29] E. Ashari , R. Hornsey, " FPGA Implementation of Real-Time Adaptive Image Thresholding " , Proceeding of SPIE.Vol.SPIE-5578 ,2004,pp. 410-419.
[30] Z. K. Huang1, K. W. Chau, " A New Image Thresholding Method Based on Gaussian Mixture Model " , Applied Mathematics and Computation, Vol. 205, No. 2, 2008, pp. 899-907 [31] P.S. Liao, T.S. Chen, P.C. Chung, " A fast algorithm for multilevel thresholding " , Journal of Information Science and Engineering ,2001, pp.713 – 727.
[32] R.C. Gonzalez, R.E. Woods, " Digital image processing, 2nd edition " , Prentice Hall, Upper Saddle River, New Jersey, 2002.
[33] Z.Wang, A .C. Bovik, H.R. Sheikh ,and E.P. Simoncelli, " Image quality assessment form visibility to structural similarity " , IEEE Transactions on image Processing ,2004, pp.600-612 [34] Shiekh H R,Bovik A,C. " Image information and visual quality assessment based on structural " IEEE Transactions on image Processing ,2006,pp.430-444.
[35] http://www.eecs.berkeley.edu/Research/Projects/CS/vision/bsds/