Hand Gesture Recognition Based on Statistical Learning Method Under Complex Environment

莊頌祥、黃登淵

E-mail: 9806488@mail.dyu.edu.tw

ABSTRACT

Hand gesture recognition technique has become a challenging topic of research due to the increasing demands for human-computer interaction (HCI) in recent years. Gesture recognition based on visual perception has many merits compared with devices such as Genius mice, keyboards or electronic gloves. This technique provides the users an intuitive means to directly use their hands to interact with a computer. The hand is truly a deformable object with a variety of degrees of freedom (DOF), which causes the recognition of hand gestures a more difficult task. Moreover, when gestures are used to define a vocabulary or a symbol in an HCI ’s application, the simplicity and easiness for gestures are critically important. Other applications can be easily found in a virtual reality environment, image/video coding, content-based image/video retrieval, and video games.Orientations on hand gesture recognition are definitely significant. In this research, we proposed a module called hand orientation evaluation and correction, which can be used as a preprocessing unit to correct the hand gestures with large angles to an acceptable small angle effectively. For the proposed method, we first utilized Gabor wavelets as a discriminative hand gesture feature, and then used principal component analysis (PCA) for feature extraction to reduce the dimensionality of the Gabor features. Finally, three classifiers including Euclidean distance, cosine distance, and support vector machine (SVM) are employed for hand-gesture classifications.Extensive experimental results show that the recognition rates of Gabor filtered images are higher than those of raw images. Among the three classifiers used, the SVM has the highest recognition rate for both with and without Gabor filters convoluted images. In still images with various hand orientations, the combination of Gabor filtered images with SVM has the highest recognition rate of up to 96.06% with -vi103 feature vectors used. However, the recognition rate is only 86.36% when no Gabor filter is used.We also implemented a dynamic video system for hand gesture detection and recognition, which can effectively identify the hand gestures with varying orientations. The processing time is around 250ms for each frame in a video sequence testing. Moreover, the recognition rates of hand gestures can reach 94% and 90.8% when wearing long- and short-sleeve clothes, respectively.

Keywords : hand gesture recognition, Gabor feature, PCA, SVM

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REFERENCES

[1]J. Triesch and C. von der Malsburg, “ Robust classification of hand postures against complex backgrounds, ” In: Proceedings of the IEEE Int. Conf. on Automatic Face and Gesture Recognition, pp. 170-175, Killington, Vermont, USA, Oct. 1996.
[2]J. Triesch and C. Von Der Malsburg, “ A system for person-independent hand posture recognition against complex backgrounds, ” IEEE transactions on pattern analysis and machine intelligence, Vol. 23, No. 12, pp. 1449-1453, 2001.
[3]Y. T. Chen, and K. T. Tseng, “ Multiple-angle hand gesture recognition by fusing svm classifiers, ” In: Proceedings of IEEE conference on Automation Science and Engineering, pp. 527-530, Scottsdale, AZ, USA, Sep. 2007.
[4]Y. T. Chen, and K. T. Tseng, “ Developing a multiple-angle hand gesture recognition system for human machine interactions, ” In: Proceedings of the 33rd Annual Conference of the IEEE Industrial Electronics Society (IECON), pp. 489-492, Taipei, Taiwan, Nov. 5-8, 2007,.
[5]Q. Chen, N. D. Georganas, and E. M. Petriu, “ Real-time vision-based hand gesture recognition using haar-like features, ” In: Proceedings of IEEE Instrumentation and Measurement Technology Conference Proceedings, pp. 1-6, Warsaw, Poland, May 1-3, 2007 [6]Q.Chen, N. D. Georganas, and E. M. Petriu, “ Hand gesture recognition using haar-like features and a stochastic context-free grammar, ” IEEE Transaction on Instrumentation and Measurement, Vol. 57, No. 8, Aug 2008.
[7]F. S. Chen, C. M. Fu, and C. L. Huang, “ Hand gesture recognition using a real-time tracking method and hidden markov models, ” Image and Vision Computing, Vol. 21, No. 8, pp. 745-758, Aug. 2003.
[8]M. A. Amin, H. Yan, “ Sign language finger alphabet recognition from gabor-pca represention of hand gestures, ” In: Proceedings of the Sixth International Conference on Machine Learning and Cybernetics, Hong Kong, August 19-22, 2007 [9]P. Moreno, A. Bernardino, J. S. Victor, “ Gabor parameter selection for local feature detection, ” In: Proceedings of IbPRIA2005, Lecture Notes in Computer Science 3522, pp. 11-19, 2005.
[10]H. Y. Chen, C. L. Huang, and C. M. Fu, “ Hybrid-boost learning for multi-pose face detection and facial expression recognition, ” Pattern Recognition, Vol. 41, pp.1173-1185, 2008.
[11]A. M. Martnez, and A. C. Kak, “ Pca versus lda, ” IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 23, No. 2, pp. 228-233, 2001.
[12]J. Wang, K. N. Plataniotis, and A. N. Venetsanopoulos, “ Selecting discriminate eigenfaces for face recognition, ” Pattern RecognitionLetters, Vol. 26, pp. 1470-1482, 2005.
[13]P. N. Belhumeur, J. P. Hespanha, and D. J. Kriegman, “ Eigenfaces vs. fisherfaces: recognition using class specific linear projection, ” IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, pp. 711-720, July 1997.
[14]J. Wang, K. N. Plataniotis, and A. N. Venetsanopoulos, “ Selecting discriminate eigenfaces for face recognition, ” Pattern Recognition Letters, Vol. 26, pp. 1470-1482, 2005.
[15]Z. Shaoyan and Q. Hong, “ Face recognition with support vector machine, ” In: Proceedings of IEEE International Conference on Robotics, Intelligent Systems and Signal Processing, Vol. 2, pp. 726-730, Changsha, China, 2003.
[16]G. Guodong, S. Z. Li, and C. Kapluk, “ Face recognition by support vector machines, ” In: Proceedings of IEEE Conference on International Automatic Face and Gesture Recognition, pp. 196-201, Grenoble, France, 2000.
[17]K. Jonsson, J. Kittler, Y. P. Li, and J. Matas, “ Support vector machines for face authentication, ” In: Proceedings of British Machine Vision Conference Nottingham, pp. 543-553, Nottingham, 1999.
[18]J. Qin, and Z. S. He, “ A svm face recognition method based on gabor-feature key points, ” In: Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, pp. 5144-5149, Guangzhou, China, 2005.
[19]L. Bing, Z. Yun, and P. Y. Hong, “ Face recognition based on wavelet transform and svm, ” In: IEEE International Conference on Information Acquisition, pp. 373-377, Hong Kong and Macau, China, 2005.
[20]M. Safari, M. T. Harandi, and B. N. Araabi, “ A Svm-based method for face recognition using a wavelet pca representation of faces, ” In: International Conference on Image Processing, Vol.2, pp. 853-856, Singapore, 2004.
[21]V. N. Vapnik, “ Statistical Learning Theory, ” John Wiley & Sons, Inc., New York, 1998.
[22]R. L. Hsu, M. A. Mottaleb, and A. K. Jain, “ Face detection in color image, ” IEEE Transactions on Pattern Analysis and Machine

Intelligence, Vol. 24, No. 5, pp. 696-706, 2002.
[23]C. Garcia, and G. Tziritas, “ Face detection using quantized skin color regions merging and wavelet packet analysis, ” IEEE Transactions on Multimedia,Vol. 1, No. 3, pp. 264-277, 1999.
[24]D. Chai, and A. Bouzerdoum, “ A bayesian approach to skin color classification in ycbcr color space, ” In: Proceedings of TENCON, Vol. 2, pp. 421-424, 2000.
[25]M. Soriano, B. Martinkauppi, S. Huovinen, and M. Laaksonen, “ Skin detection in video under changing illumination conditions, ” In: Proceedings of the 15th International Conference on Pattern Recognition, Vol. 1, pp. 839-842, 2000.
[26]L. M. Bergasa, M. Mazo, A. Gardel, M. A. Sotelo, and L. Boquete,"Unsupervised and adaptive gaussian skin-color model, ” Image and Vision Computing, Vol. 18, pp. 987-1003, 2000.
[27]J. Yang and A. Waibel, “ A real-time face tracker, ” In: Proceedings of the IEEE Workshop on Applications of Computer Vision, pp. 142-147, Sarasota, Florida, USA, 1996.
[28]J. Y. Xu, “ Face detection and recognition technology research in complex background, ” In: Proceedings of M.S. thesis, Shandong university of technology, pp. 22-24, China, 2007.
[29]E. Y. Lam, “ Combining gray world and retinex theory for automatic white balance in digital photography, ” In: Proceedings of the Ninth International Symposium on Consumer Electronics, pp.134-139, Macau, 2005.
[30]H. T. Lin, and C. J. Lin, “ A study on sigmoid kernels for svm and the training of non-psd kernels by smo-type methods, ” In: Proceedings of Master thesis, Department of Computer Science and Information Engineering, National Taiwan University, 2003.
[31]A. Caplier, L. Bonnaud, S. Malassiotis, and M. Strintzis, "Comparison of 2d and 3d analysis for automated cued speech gesture recognition," In: Proceedings of the 9th International Workshop on Speech and Computer (SPECOM '04), Saint-Petersburg, Russia, September 2004.