

# 基於Gabor 特徵與支持向量機之車胎紋路辨識

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## 摘要

在交通事故處理方面，胎痕跡證是調查交通事故現場中重要的蒐集項目之一。傳統上，採集輪胎印痕與後續胎痕跡證鑑別均需仰賴大量的人力，因此為了有效解決人工作業方式耗時與高成本之缺點，本研究發展胎痕樣式自動識別系統。本系統提出有效的胎痕紋路特徵表示(feature representation)、特徵擷取(feature extraction)、與特徵識別(feature recognition)等，藉以加速後續胎痕跡證鑑識及車輛歸屬判定工作之進行。本研究利用自行開發的輪胎印痕辨識系統自動識別其相對應之廠牌型式。一般說來，車胎紋路(tire texture)設計之目的，是為了使輪胎具有較好的抓地性與排水性，因此各廠家均有其獨特的專利與設計概念，所以各車胎紋路常會因廠牌的不同，而產生極大的差異。本研究影像前處理部份，主要結合二值化與快速八連通方法來進行分割區域連通與雜訊之濾除，同時採用Gabor feature做為車胎紋路特徵描述的方法，利用主分量分析法(principal component analysis; PCA)做為特徵擷取之方式，最後再應用歐氏距離(Euclidean distance; ED)、餘弦距離(cosine distance; CD)以及支持向量機(support vector machine; SVM)等3種不同的分類器來進行車胎紋路識別。本研究利用所提方法進行15類的車胎紋路辨別，其中採用SVM分類器可以高達83%左右的識別率。

關鍵詞：車胎紋路、主分量分析法、支持向量機、Gabor特徵

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## 參考文獻

- [1]王瑩璋、林昭男,剎車胎痕自動偵測模式之建立,交通學報,第四卷,第二期,頁15-27,民國九十三年十二月.
- [2]林昭男,“以影像處理技術為基礎之胎痕識別系統,”大葉大學車輛工程研究所碩士論文,2004.
- [3]Y.W. Wang, “A Tire-mark Identification Scheme for Suspected Vehicle Detection in hit and run Accident,” Journal of the Eastern Asia Society for Transportation Studies, Vol.6, pp. 3441-3452, 2005.
- [4]Y.W. Wang, “A Tire Mark Localization Method for Forensic Image Analysis,” Journal of the Eastern Asia Society for Transportation

Studies, Vol. 7, pp. 2881-2890, 2007.

- [5]M.Y. Kalinkin, Usanov, D.A., and A.V. Skripal, " Recognition of tire pattern on its trace by computer video technology, " Proceedings of SPIE, Vol.5772, pp.199-202, 2004.
- [6]M.J. Thali, M. Braun, W. Br?¶chweiler, and R.Dirnhofer, " Matching tire tracks on the head using forensic photogrammetry, " Forensic Science International, Vol. 113, pp 281-287, September 2000.
- [7]W. Br?¶chweiler, M. Braun, R. Dirnhofer, and M.J. Thali, " Analysis of patterned injuries and iniury-causing instruments with forensic 3D/CAD supported photogrammetry (FPHG): an instruction manual for the documentation process, " Forensic Science International, Vol.132, pp 130-138, 2003 [8]U. Buck, N. Albertini, S. Naether, and M. J. Thali, " 3D documentation of footwear impressions and tyre tracks in snow with high resolution optical surface scanning, " Forensic Science International, Vol. 171, pp 157-164, Sep. 2007.
- [9]S.W. Jung, S.W. Bae, and G.T. Park, " A design scheme for a hierarchical fuzzy pattern matching classifier and its application to the tire tread, " Fuzzy Sets and Systems, Vol. 65, pp 311-322, Aug. 1994.
- [10]D. Colbry, D. Cherba, and J. Luchini, " Pattern recognition for classification and matching of car tires, " Tire Science and Technology, Vol. 33, pp 2-17, Jan. 2005.
- [11]P. McDonald, " Tire Imprint Evidence, " Elsevier series in Practical aspects of criminal and forensic Investigation, New York, 1989.
- [12]P. Moreno, A. Bernardino, J. S. Victor, " Gabor parameter selection for local feature detection, " Proceedings of IbPRIA2005, Lecture Notes in Computer Science 3522, pp. 11-19, 2005.
- [13]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.
- [14]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.
- [15]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.
- [16]J. Wang, K. N. Plataniotis, and A. N. Venetsanopoulos, " Selecting discriminate eigenfaces for face recognition, " Pattern Recognition Letters, Vol. 26, pp. 1470-1482, 2005.
- [17]J. Wang, K. N. Plataniotis, and A. N. Venetsanopoulos, " Selecting discriminate eigenfaces for face recognition, " Pattern Recognition Letters, Vol. 26, pp. 1470-1482, 2005.
- [18]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.
- [19]L. Bing, Z. Yun, and P. Y. Hong, " Face recognition based on wavelet transform and svm, " IEEE International Conference on Information Acquisition, pp. 373-377, Hong Kong and Macau, China, 2005.
- [20]G. Guodong, S. Z. Li, and C. Kapluk, " Face recognition by support vector machines, " Proceedings of IEEE Conference on International Automatic Face and Gesture Recognition, pp. 196-201, Grenoble, France, 2000.
- [21]J. Qin, and Z. S. He, " A SVM face recognition method based on Gabor-feature key points, " Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, pp. 5144-5149, Guangzhou, China, 2005.
- [22]K. Jonsson, J. Kittler, Y. P. Li, and J. Matas, " Support vector machines for face authentication, " Proceedings of British Machine Vision Conference Nottingham, pp. 543-553, Nottingham, 1999.
- [23]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.
- [24]V. N. Vapnik, " Statistical Learning Theory, " John Wiley & Sons, Inc., New York, 1998.