

Combined Classifier versus Combined Feature Space in Scale Space Texture Classification

Citation for published version (APA):

Gangeh, M., Haar Romenij, ter, B. M., & Eswaran, C. (2007). Combined Classifier versus Combined Feature Space in Scale Space Texture Classification. In *Proceedings of the International Conference on Robotics, Vision, Information and Signal Processing (ROVISP2007) 28-30 November 2007, Penang, Malaysia*

Document status and date:

Published: 01/01/2007

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Combined Classifier versus Combined Feature Space in Scale Space Texture Classification

Mehrdad J. Gangeh^{1,2}, Bart M. ter Haar Romeny², C. Eswaran³

¹Faculty of Engineering, Multimedia University, 63000 Cyberjaya, Malaysia
Tel: +603-83125435, Fax: +603-83183029, E-mail: mehrdad@mmu.edu.my

²Biomedical Image Analysis, Department of Biomedical Engineering, Eindhoven University of Technology,
5600 MB Eindhoven, the Netherlands
Tel: +31-40-2474752, Fax: +31-40-2472740, E-mail: {M.Gangeh, B.M.terhaarRomeny}@tue.nl

³Faculty of Information Technology, Multimedia University, 63000 Cyberjaya, Malaysia
Tel: +603-83125831, Fax: +603-83125264, E-mail: eswaran@mmu.edu.my

Extended Abstract

Multiresolution techniques become more and more important in texture classification due to the intrinsic multi-scale nature of textures. Hence, scale space theory is a natural framework to construct multi-scale textures by deploying multi-scale derivatives up to certain order. The main issue in multiresolution techniques is the large feature space generated (multi-scale, multi-resolution, multi-derivative order). The common trend in the literature, which is the fusion of the features generated from different scales to come up with one feature space to be fed to the classifier, makes the problem even more serious. The large feature space generated is hampered by the ‘curse of dimensionality’. To tackle this problem typically severe feature reduction is applied in multiresolution techniques, e.g. by calculating moments of the histogram [1] or calculating the energy [2]. However, the performance of the classifiers trained using this reduced feature space depends on how good these features can represent the data in the particular application.

Recently, an alternative solution was proposed by the authors using combined classifiers [3]. Using combined classifiers alleviates the problem of generating a large feature space, as the features generated from each scale/derivative are directly fed to a base classifier. In this approach, instead of concatenating features generated from each scale/derivative, the decision made by the base classifiers are combined in a two-stage combined classifier.

In this paper, the performance of the proposed classification system is first compared against the combined feature space for only the zeroth order Gaussian derivative at multiple scales (Fig. 1). The results clearly show that the proposed system using combined classifiers outperforms the classical approach of the combined feature space. The significance of the parameters, especially the fraction of variance maintained after applying PCA (principal component analysis) is also discussed (Fig. 1-right graph).

Next, the performance of our proposed texture classification system using combined classifiers is compared against multiresolution histograms [1]. In multiresolution histograms, after construction of multi-scale textures using scale space theory, the moments of the histograms are calculated for each scale/derivative. These moments are then concatenated to construct a combined feature space. The performance of this system for four textures of the well-known Brodatz Album, i.e. D4, D9, D19, and D57 (Fig. 2, the same textures as used in [2]) is shown in Fig. 3 (right graph) using learning curves.

The performance of the proposed technique is also shown in Fig. 3 (left graph) using the same textures for comparison. The results suggest that our proposed technique can significantly improve the performance for both small and large training set sizes.

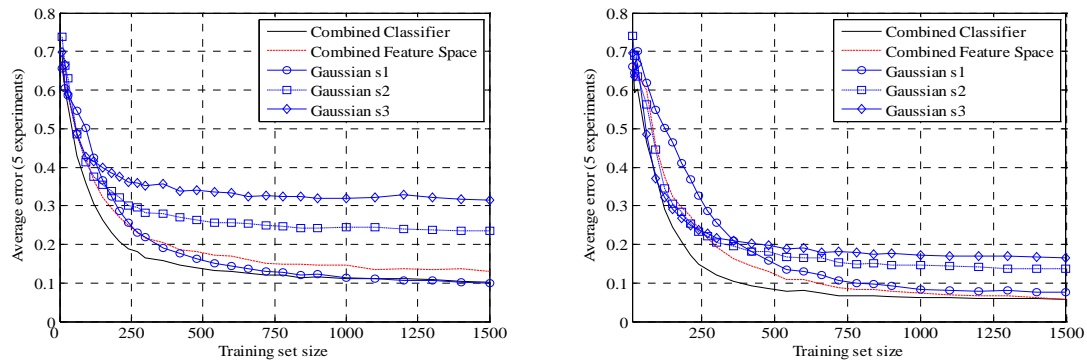


Fig. 1- Learning curves obtained using the combined classifier and the combined feature space methods for the zeroth order derivative with regularization of classifier in scale 1 and for the combined feature space with fraction of variance retained for PCA equivalent to 95% (*left graph*) and 99% (*right graph*).

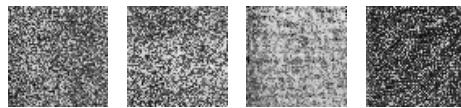


Fig. 2- Textures D4, D9, D19, and D57 from Brodatz Album used in the experiments

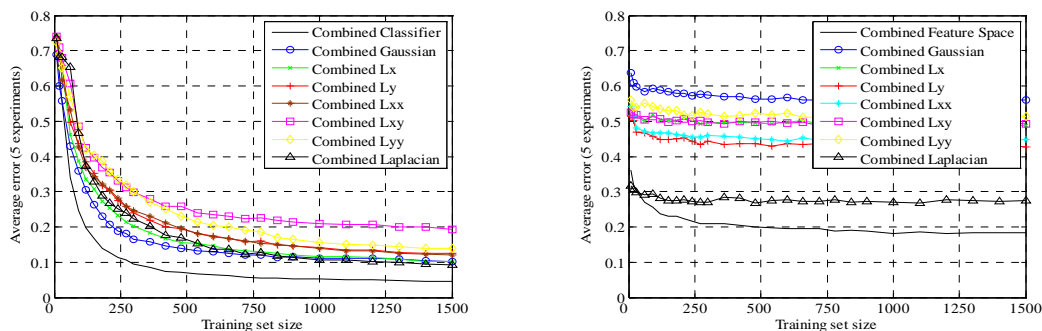


Fig. 3- Learning curves for the classification of 4 textures from the Brodatz album at multiple scales of single and multiple derivative orders using combined classifiers (*left graph*) and using multiresolution histograms (*right graph*).

References:

1. B. van Ginneken, B. M. ter Haar Romeny, "Multi-scale Texture Classification from Generalized Locally Orderless Images", *Pattern Recognition*, Vol. 36 (2003) 899-911.
2. T. Randen, J. H. Husoy, "Filtering for Texture Classification: A Comparative Study", *IEEE Trans. on PAMI*, Vol. 21 (1999) 291-310
3. M. J. Gangeh, B. M. ter Haar Romeny, and C. Eswaran, "Scale Space Texture Classification Using Combined Classifiers", *Lecture Notes in Computer Science*, Vol. 4522 (2007) 324-333.