AUTHOR COMMENTARIES - From Special Topics

Face Recognition - April 2009
Interview Date: May 2009

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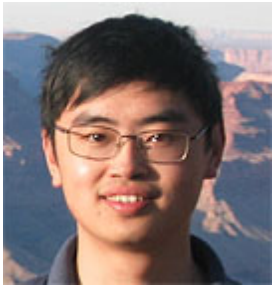


Xiaofei He

From the Special Topic of Face Recognition

According to our Special Topics analysis of face recognition technology over the past decade, the paper "Face recognition using Laplacianfaces" (XF He, et al., IEEE Trans. Patt. Anal. Mach. Int*. 27[3]: 328-40, March 2005) ranks at #14 on the list of most-cited papers over the past decade. It is also a core paper in the Research Front Map on Face Recognition, and a Highly Cited Paper in the field of Engineering in* Essential Science Indicators℠ *from Thomson Reuters.*

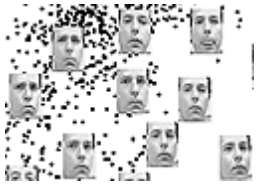
This month, ScienceWatch.com *talks with lead author Professor Xiaofei He, who hails from the College of Computer Science at Zhejiang University in China, about this paper and its impact on the field.*

SW: Would you please describe the significance of your paper and why it is highly cited?

Our paper is the first to introduce manifold learning techniques to the face recognition field. We were exploring the geometrical and topological structures through a graph model. We found a set of basis functions, called Laplacianfaces, which are linear approximations to the eigenfunctions of the Laplace-Beltrami operator on the face manifold. The Laplacianface approach allows more accurate estimation of face variations, such as expression, illumination, and pose.

In addition, our paper systematically discusses the connection between our approach and canonical approaches, such as Eigenface and Fisherface, and shows that these approaches can be unified into a graph-embedding framework. The presented framework of analysis leads to further research and discussions. Our work provides experimental evidence that the intrinsic manifold structure can significantly improve the recognition rate.

Figure 1:



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SW: How did you become involved in this research, and were there any particular successes or obstacles that stand out?

I did my B.S. in computer science at Zhejiang University, China, and my Ph.D. in computer science at the University of Chicago.

I have been working on manifold learning and face recognition since my Ph.D. study. Since 2000, there has been a lot of interest in geometrically and topologically motivated approaches to data analysis. After noticing the close relationship between manifold learning methods and canonical dimensionality reduction methods (such as Principal Component Analysis and Linear Discriminant Analysis) which have been applied to face recognition, I immediately started to think about how to use manifold structure to improve face recognition performance. This eventually led to this highly cited publication.

SW: Where do you see your research and the broader field leading in the future?

In November 2007, I moved from Yahoo! Research Labs in Burbank, where I was a research scientist, to Zhejiang University in China, where I have accepted a position as a full professor at the College of Computer Science. I am currently leading a research group and continuing to work in the field of face recognition and manifold learning.

"The Laplacianface approach allows more accurate estimation of face variations, such as expression, illumination, and pose."

It is now a general belief that the images of human faces lie on low-dimensional manifolds. The broader direction is thus discovering more complex geometrical and topological properties of the face manifold, such as curvature and homology group, from limited random samples. Furthermore, it would be interesting to study how to use differential operators to explore the meaningful structure of the functional space on the face manifold from which we are looking for the optimal classifier.

These efforts would improve our understanding of the face recognition problem from a geometrical perspective and may lead to a more accurate and robust recognition algorithm, which is invariant to pose, illumination, and expression.

SW: What are the implications of your work for this field?

The results of our research have significant implications for face recognition, pattern classification, and manifold learning. With regard to face recognition, we showed that the local manifold structure could better describe the face variations. We also presented a graph embedding framework and a novel linear manifold learning algorithm—Locality Preserving Projections (LPP), which impacts our view of canonical dimensionality reduction algorithms, such as Principal Component Analysis and Linear Discriminant Analysis. LPP is a general tool for exploratory data analysis and has been applied by other researchers to a wide range of problems such as human age estimation, human action recognition, and graph pattern matching.

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Figure 1:

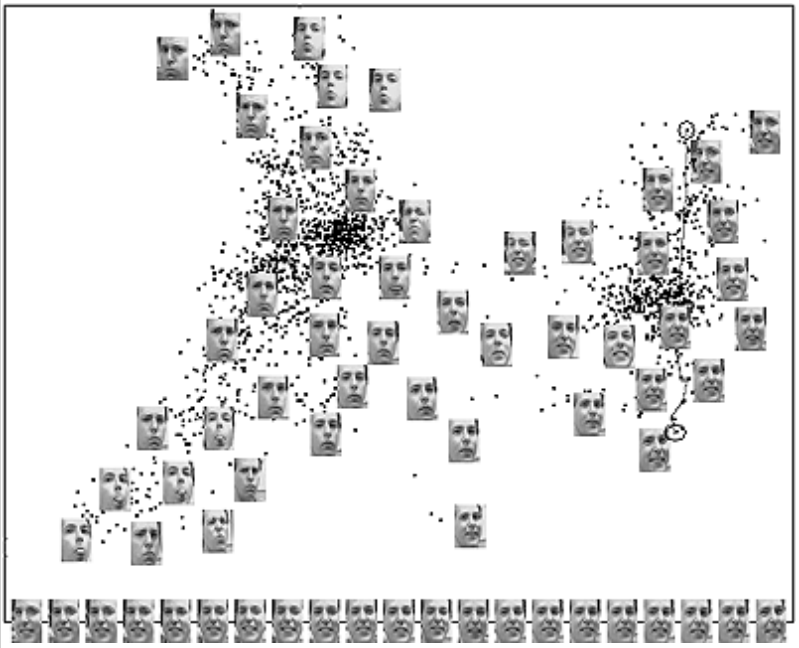

Figure 1:

Two-dimensional linear embedding of face images by Laplacianfaces. As can be seen, the face images are divided into two parts, the faces with open mouth and the faces with closed mouth. Moreover, it can be clearly seen that the pose and expression of human faces change continuously and smoothly, from top to bottom, from left to right. The bottom images correspond to points along the right path (linked by solid line), illustrating one particular mode of variability in pose.

Click for a larger view of figure.

Xiaofei He's current most-cited paper in *Essential Science Indicators*, with 110 cites:

He XF *et al.*, "Face recognition using Laplacianfaces," *IEEE Trans. Patt. Anal. Mach. Int.* 27(3): 328-40, March 2005. Source: *Essential Science Indicators* from Thomson Reuters.

Keywords: FACE RECOGNITION, LAPLACIANFACES, MANIFOLD LEARNING TECHNIQUES, POSE, EXPRESSION, FACE VARIATIONS, ILLUMINATION, GRAPH EMBEDDING FRAMEWORK, PATTERN CLASSIFICATION.

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