香港浸會大學理學院
HKBU Faculty of Science

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DEPARTMENT OF COMPUTER SCIENCE

PhD Degree Oral Presentation

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Time:	20 August 2010 (Friday) 10:30 am – 12:30 pm (35 mins presentation and 15 mins Q & A)
Venue:	T714, Cha Chi Ming Science Tower, HSH Campus

"Wavelet and Manifold Learning and Their Applications"

Abstract

In the past twenty years there has been significant development in the use of wavelet methods in various areas of information technologies. The wavelet transform is a synthesis of ideas from different fields, such as mathematics and signal processing. Generally, the wavelet transform is a tool that divides up data, functions, or operators into different frequency components and then studies each component with a resolution matched to its scale. Therefore, the wavelet transform is anticipated to provide economical and informative mathematical representation of many objects of interest. Above all, wavelets have been widely applied in such computer science research areas as image processing, computer vision, network management, and data mining.

Wavelets have many good properties, such as vanishing moments, hierarchical and multiresolution decomposition structure, linear time and space complexity of the transformations, decorrelated coefficients, and a wide variety of basis functions. These properties could provide considerably more efficient and effective solutions to solve many problems. In this thesis, we apply wavelet analysis to various fields and obtain the good performance as follows:

Face recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. For this reason, since the early 70's, face recognition has drawn the attention of researchers in the fields from security, psychology, and image processing, to computer vision. Numerous algorithms have been proposed for face recognition. Feature extraction is very important because effectiveness of identification system depend on it. There are many different methods to extract features such as eigenface, Fourier transform etc. We use wavelet transform (WT) to make

features easy and clear in Chapters 3-4. We present a face recognition system based on waveletfaces in Chapter 3, and wavelet packet decomposition in Chapter 4.

Textures are repetitive visual patterns for surfaces of objects and provide important information for object segmentation and identification. Segmentation of a texture image is a difficult task. Many researchers suggest that wavelet analysis is a good method because it can provide the joint space/frequency resolution. In Chapter 5, we propose a novel approach to frequency segmentation using wavelet de composition of pseudo-motion image.

In recent years, the BEM (boundary element method) has been widly used in computation. The most attractive feature of the boundary element for the solution of many problems is to reduce dimension. The discrete compactly supported wavelets have many good features such as orthogonality, compactly supported. So the wavelet-Galerkin methods have been applied to get the numerical solutions of partial differential equations. To solve PDE, we need study the integral equations in depth. The singularity is the difficult problem for integral equations. In Chapter 6, Wavelet-Galerkin algorithm for solving the first kind of weak singular integral equations with the logarithmic kernel is proposed.

Many problems in information processing involve some form of dimensionality reduction. In the Chapters 7-8, we introduce Locality Preserving Projections (LPP), Tensor LPP, and Gabor LPP. LPP should be seen as an alternative to Principal Component Analysis (PCA) -a classical linear technique that projects the data along the directions of maximal variance. When the high dimensional data lies on a low dimensional manifold embedded in the ambient space, the LPP is obtained by finding the optimal linear approximations to the eigenfunctions of the Laplace Beltrami operator on the manifold. As a result, LPP shares many of the data representation properties of nonlinear techniques such as Laplacian Eigenmaps or Locally Linear Embedding. In Chapters 7-8, Tensor LPP and Gabor LPP are presented to reduce dimension in the real examples.

***** ALL INTERESTED ARE WELCOME *****