The Image Processing Group encompasses a variety of projects representing diverse applications of advanced signal and image processing and pattern recognition technologies. In 2003 we carried out basic and applied research in the following areas:

- Document image analysis and recognition: text extraction from low quality documents, data compression, layout analysis and character recognition.
- Human face animation: automated generation of facial expressions.
- Biometric verification: human identification based on face, signature and fingerprint images.
- Image compression: improvement of image quality and compression ratio.
- Image segmentation: extraction of objects from background.

We have published 12 journal papers and 6 conference papers during the year 2003.

**Research Projects**

**Document Imaging**

We have developed a technique for the extraction of text areas in a document image based on the Delaunay triangulation. By representing the location of connected components in a document image with their centroids, the page structure is described as a set of points in the two-dimensional space. When imposing Delaunay triangulation on these points, the text regions in the Delaunay triangulation will have distinguishing triangular features from image and drawing regions. For analysis, the Delaunay triangles are divided into four classes. The study reveals that specific triangles in text areas can be clustered together and identified as text body. Using this method, text regions in a document image containing fragments can also be recognized accurately. Experiments show that the method is also very efficient. We have also developed advanced algorithms for segmentation and layout analysis of large newspaper images.

**Human face animation**

Computer facial animation is a challenging but very important area. We have proposed a novel method in which the non-uniform rational B-spline (NURBS) curve is used as a control mechanism to model and animate human facial expressions. A geometric similarity measure between the modification of NURBS curves and the movement of facial muscles is developed. Based on the geometric similarity, NURBS curves are constructed so that modifying these curves can closely simulate the movement of facial muscles. The control points of the NURBS curves are positioned according to facial anatomy and the NURBS curves are geometrically associated with a generic polygon mesh representing the face. The weights can then be changed or the control points repositioned to simulate various facial expressions. The proposed method performs better than existing facial
animation methods and represents a new approach in geometric modelling for computer graphics.

**Signature verification**

Stability and style variation are important characteristics in handwriting analysis and recognition. We have developed a stability modelling technique of handwriting in the context of on-line signature verification. With this technique, the stability and style-variation characteristics of the reference samples are deduced from the dynamic warping relationship between the sequences of basic handwriting strokes. Reliability measures of the extracted signature features are incorporated into the signature segmentation, model building, and verification algorithms, so that stable handwriting features are emphasized in the signature matching process, while style variations for less stable features are tolerated. The generated signature model consists of a structure description graph of the handwriting components and their stability information. A signature is accepted by the model if it is close to a permissible path within the weighted graph. A novel feature of the technique is its ability to refine the correspondence relation of the handwriting during model building and signature verification. This ability enables the verification and partial correction of segmentation errors to reduce the number of false rejections while maintaining the system security level and keeping the number of reference samples manageable.

**Image compression**

We have investigated computer methods for reducing blocking artefacts in compressed images coded by the block discrete cosine transform (BDCT). The theory of projection onto convex sets (POCS) is applied. Two adaptive constraints are used. The first constraint corresponds to a model that simulates an image before compression using a Delaunay triangular mesh. The mesh is constructed by dividing each block into a set of triangles. The number of triangles in a block is determined by the local block activity. The second constraint is a narrow quantization constraint, where the bound of a BDCT coefficient is also determined by the local block activity. The block activity is measured by the ac components of the BDCT coefficients by incorporating the human visual system model. Our technique produces significantly improved results after a single iteration, and compares favorably with existing methods.

**Image segmentation**

We have developed an adaptive spatial fuzzy c-means clustering algorithm for the segmentation of three-dimensional (3-D) magnetic resonance (MR) images. The input images may be corrupted by noise and intensity non-uniformity (INU) artefact. The proposed algorithm takes into account the spatial continuity constraints by using a dissimilarity index that allows spatial interactions between image voxels. The local spatial continuity constraint reduces the noise effect and the classification ambiguity. The INU artefact is formulated as a multiplicative bias field affecting the true MR imaging signal. By modelling the log bias field as a stack of smoothing -spline surfaces, with continuity enforced across slices, the computation of the 3-D bias field reduces to that of finding the B-spline coefficients, which can be obtained using a computationally efficient two-stage algorithm.

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**Staff**

**Academic Staff**

Prof. Hong Yan  
A/Prof. David Levy

**Postgraduate Students**

Yan Chang  
Rong He  
Kai Huang  
Ding Huang  
Philip Mitchell  
Savant Karunaratne  
Teewoon Tan  
Yi Xiao  
Zhanggui Zeng  
Qinzi Zhang  
Mansuo Zhao

**Research Funding**


**Publications**

**Refereed Journal Papers**


**Refereed Conference Papers**


