Future Research Plans

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My research interests and research projects are described in "Research Statement". And I believe that the biologically inspired methods will be the future research direction for image analysis, machine learning, and pattern recognition. Hereby I briefly depict my future research plans.

Future Research – Track 1: I proposed an orientation-based ***face recognition*** method under the framework of Gabor wavelet transform (GWT) and Hamming distance (HD), which results a set of face patterns, face pattern word (FPW), face pattern byte (FPB), face pattern nibble (FPN). The face recognition experiments prove that the proposed method is very promising (up to 97.92% of identification rate) compared with the classical methods like PCA, LDA, and EBGM. Even more surprisingly the recognition performance can be further boosted to 100% of identification rate using a score-level fusion technique. Specifically, the experiments were conducted on a multispectral (LWIR and RGB) face database from 96 subjects; the face scores were computed with FPB, EBGM and LDA method; and the fusion methods include mean fusion, classifier-based fusion, and HMM fusion. This research project can be further investigated in the following aspects: (1) Simplify the face patterns and increase the processing speed to meet the needs of real-time face recognition applications; (2) Enhance the face score fusion by using different modalities of face images (NIR, MWIR), variant recognition methods, and different fusion methods (HMM, GMM); (3) Integrate/combine with other human identification methods (fingerprint, iris, voice) to further improve the system accuracy and reliability.

Future Research – Track 2: I proposed a CAD (***computer-aided detection***) method using Gabor features that achieved an overall high performance in detecting both masses and calcifications, and even in detecting early-stage cancerous lesions with digitized mammograms. Segmentation (circular Gaussian filter), feature extraction (Gabor filtering plus edge histogram descriptor), and classification (fuzzy C-mean plus KNN) were well integrated into one research project. This CAD method can be further developed and adapted to similar applications such as breast cancer detection using (multi-view) digital mammograms, lung cancer detection using x-day images or CT/MRI images.

Future Research – Track 3: It turns out that ***information fusion*** is a powerful tool to further enhance a system performance. Information fusion includes signal/image fusion, feature fusion, score fusion, and decision fusion. I will try to apply the score level fusion to a CAD system like breast cancer detection with the scores from different CAD algorithms and from several image modalities (x-ray, MRI, ultrasound), respectively.

Future Research – Track 4 (long-term): ***Bio-inspired image processing*** will be one of my long-term research plans. *Compressive sensing* is an active research field due to its potential benefits to medical imaging, machine vision, data transmission/storage, etc. While retinal imaging in the human eyes provides us many clues in the areas of optical system design, compressive sensing (photoreceptors to nerve fibers≈ 100:1), multilayer network (photoreceptors, bipolar & ganglions), and image representation and understanding. It is worth of the time to investigate and simulate some functions of retinal imaging although not all retinal functions are well understood.