Yufeng Zheng **Research Statement** 3/6/2012

My research interests are focused on image processing, pattern recognition, and computer vision. I have led many research projects such as multisensory image fusion and night vision colorization, thermal face recognition, breast cancer detection, landmine detection, glaucoma detection, and etc. The common techniques involved in these projects are image analysis and pattern recognition. I believe that the future of pattern recognition shall be built on the integration of statistical models and the simulation of biological functions. Click http://www.r2image.com/TRS_Demo/ for a demo.

Multisensory image fusion can combine multispectral images (like visible, near IR and far IR) into one fused image that can provide more comprehensive information for target recognition; while night vision colorization can render multispectral images (taken at nighttime) with colors and produce a day color resembled image for human observation. The image fusion and colorization processes can be achieved automatically, which will greatly enhance machine vision and human vision. I have developed a prototype and demonstrated the feasibility of this technique. My experimental results showed that the fused image is informative and clear, and the colorized image appears realistic and natural. It is anticipated that the proposed fusion and colorization approaches for multispectral imagery will help improve target recognition and visual analysis, especially for nighttime operations. Army, air force and navy are major users of such a technology; while DOD is primary fund agency to support this type of research.

Compared to fingerprint and iris recognition, face recognition is an ideal biometric option for homeland security applications since it offers non-intrusive identification of human subjects at a distance without their cooperation. Furthermore thermal face recognition analyzes the long wave IR (thermal) images to accomplish face identification, which makes this technique applicable to both daytime and nighttime operations (or under poor illumination). My preliminary experiments proved that thermal face recognition is comparative to visible face recognition in terms of accuracy and efficiency. I have filed a provisional patent for the proposed thermal face recognition technique, and it is in progress to apply for a full utility patent. DHS has the great interest to sponsor such a research.

The current lifetime risk of developing breast cancer among American women is 13.4% (one in seven), exceeded only by lung cancer. With digital mammograms computer-aided detection (CAD) has proven to be a very useful tool for radiologists. I proposed a CAD method using Gabor features that achieved an overall high performance in detecting both masses and calcifications, and even in detecting early-stage cancerous lesions. Of course, hospitals are interested in such a CAD application, and NIH has the fund opportunities for such a research proposals.

In the future, I will deepen my research work in multispectral image synthesis, biometrics, and CAD; meanwhile will expand my research to biologically inspired image analysis. For example, to process visual signals, human retina functions like a complex multiple layer network, which consists of vertical signal pass way (from photoreceptors, to bipolar cells and then ganglion cells) and lateral process network (horizon calls and amacrine cells). The functions on such a thin retina (0.5mm) are so complicated, which may include signal sampling, filtering/processing, extraction/selection, and compression. It is clear that simulation of retinal imaging and processing will benefit image sensing, image analysis, and pattern recognition. NSF and DARPA are greatly interested in sponsoring such an advanced research.

My future research work will follow the direction of Bio-inspired Computer Vision. Relevant research lab equipment may include multispectral/hyperspectral imaging cameras, and medical imaging devices like microscope, ultrasound, CT or MRI, etc. I am willing to collaborate with multidiscipline experts in human vision, brain science, statistical analysis, & mathematical modeling. The bio-inspired sensing/analysis/cognition techniques can be widely applied to biometrics, computer vision, information fusion, medical imaging, bioinformatics, and also compressive sensing.