From Image Quality Assessment to Perceptual Quality Preserved Image Restoration: A Perceptual Transform Learning Approach (**PI: Dr. Zhang Lei; 2013/14)**

Image restoration (IR) is a fundamental problem in image processing and computer vision. With the ubiquitous use of digital imaging devices, the perceptual quality of outputted images is becoming one of the most important concerns of users. One popular approach to IR is the variational method, where the desired image is reconstructed by minimizing an energy functional that usually consists of a data fidelity term and several regularization terms. Though these regularizers exploit the prior information of high quality natural images, the reconstructed image may not be perceptually pleasant because its perceptual quality is not optimized explicitly by these variational models. From the research of image quality assessment, it is well-known that a small mean-square-error does not mean a good perceptual quality of the reconstructed image, and metrics such as SSIM have been developed to measure the image perceptual quality consistently with human subjective evaluation. It is highly expected that one can design new variational models which is easy to minimize and could explicitly optimize the image perceptual quality, leading to visually more pleasant IR outputs. Unfortunately, few such models have been proposed, despite their high significance to the study of IR.

In this project, we propose a novel approach to perceptual quality preserved IR. Specifically, we will learn a series of linear transforms to characterize the nonlinear human subjective perception of image quality, and use these transforms to design perceptual regularization terms and perceptual fidelity terms under a variational framework, which could optimize explicitly the perceptual quality of the desired image. The following key issues will be deeply investigated. First, with the current research outputs on image quality assessment, we will study how to generate the

training data to learn the desired perceptual transforms. Second, with the constructed dataset we will study the transform learning for perceptual quality regularization and present the corresponding variational models for IR. Third, the transform learning for perceptual nonlocal regularization will be studied to exploit the image nonlocal self-similarity perceptually. Fourth, more interestingly and challengingly, we will introduce the concept of perceptual fidelity and investigate how to learn the transform for perceptual fidelity preserved IR. Our preliminary results are very encouraging, validating the feasibility of this project and its great potential. The research outputs of this project will initiate new directions of IR, and will have high impact in the field of image processing and low level vision.