Image Super-Resolution using Convolutional Neural Network

ABSTRACT

In this modern era of technology, a modern image sensor is usually either a charge-coupled device (CCD), or a complementary metal-oxide-semiconductor (CMOS) active-pixel sensor. In order to increase the resolution of the image captured, the size of each individual pixel sensor must be reduced to obtain higher sensor density, which is a challenge in terms of the cost of fabrication. Hence, a post-processing technique is introduced to tackle the image degradation problem, which commonly referred as super resolution reconstruction. Super-Resolution, generally speaking, is the process of recovering a high-resolution (HR) image from single or multiple low-resolution (LR) images.

A framework for image super resolution using Convolutional Multilayer Perceptron (conv. MLP) is developed. The system is implemented using Python Theano and trained with samples from various categories, i.e. flowers, buildings, animals, vehicles and etc. By using the adaptive nature of neural network, some filters are pre-trained with common image degradation whereby they inherit the noise reduction and motion blur reduction features. As a result, the system can perform super-resolution on degraded low resolution image, giving a high-resolution image with motion blur or noise reduced.

The system is benchmarked with Multilayer Preceptron (MLP), as well as some other non-learning based algorithms, i.e. Nearest Neighbour, Bicubic Interpolation, New Edge Directed Interpolation (NEDI), Iterative Curvature-Based Interpolation (ICBI) and Fast Curvature-Based Interpolation (FCBI). Quantitative results are measured using Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM). Images processed by the system yields high accuracy results when provided with adequate training samples, giving very high PSNR and SSIM readings.