Abstract

Title: Enhancement of Image Quality for Improving Scene Content Representation

Adverse environmental conditions and device constraints result in poor visibility and reduced scene details in images. Such degradations hinder proper visual experience for human users and impair effective vision-based decision-making by autonomous systems. Thus, enhancement of image quality targeted towards the improvement of scene content representation in images is an essential computer vision task. This thesis investigates quality improvement of images degraded due to a couple of environmental conditions, namely, haze and low-illumination, and due to constraints that result in low resolution and regional focus. It contributes novel approaches for single image dehazing, low-light image enhancement, multi-focus image fusion and image super resolution. The dehazing approaches include novel hazy image classification and color correction procedures, which are based on new hazy image priors, namely, haze hue prior (HHP) and haze saturation prior (HSP). The proposed approaches estimate the parameters of the Koshmieder's light scattering model to achieve dehazing. For low-light image enhancement, 'exposedness' estimation is performed to produce a pixel-level map signifying the required degrees of enhancement at image pixels. This map is subsequently used in an enhancement function with a few favorable properties to generate the enhanced image. Before the enhancement, inherent image noise is diminished employing a detail-preserving low gradient magnitude suppression method. Further, a hardware-friendly and computationally-simple technique that fuses multi-focus images in discrete cosine transform (DCT) domain is proposed. The technique uses a relation between the eigendecomposition of a second difference matrix with proper boundary conditions and its decomposition on the DCT basis, which is exploited to propose a focus measure. For image super resolution, a technique that performs interpolation exploiting a novel concept called 'process similarity' is proposed. Process similarity refers to the resemblance between decompositions of the image at two different scales quantifying the corresponding structural relation. The complementary natures of discrete and stationary wavelet transforms are leveraged in the method to perform the interpolation. Subjective and quantitative analysis of results on a wide variety of images from standard databases demonstrate that the proposed approaches produce state-of-the-art performance in all the tasks considered.

Keywords: Image dehazing; Low-light image enhancement; Multi-focus image fusion; Super resolution.

- Sobhan Kanti Dhara (15EC91R02)