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Keio University

Thesis Abstract

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Thesis Title

Improvement of Image Denoising with Interpolation and RAISR

Digital images are frequently contaminated by noise due to different sources such as transmission errors, malfunctioning pixel elements in the camera sensors, faulty memory location and timing errors in analog-to-digital conversion. Some undesirable effects such as image degradation and distortion of some important image features may occur in the digital images due to the noises. Therefore, image denoising has been recently become an essential step in many subsequent image processing applications. The purpose of this thesis is to improve the denoising performance of the image with interpolation and RAISR without deteriorating the image details.

Chapter 1 provides a brief introduction to background theory of image denoising, a variety of noise commonly encountered in the digital images in the real world, the causes of noise in the digital images, main issues in the removal of mixed noise and Gaussian noise, the principal objectives to tackle these problems, the methodology used in this research and organization of this thesis.

Chapter 2 presents the characteristics and methodology of some state-of-the-art nonlocal-based Gaussian noise removal methods and convolutional neural network (CNN)-based denoising methods.

Chapter 3 describes the removal of mixed-noise composed of Additive White Gaussian Noise (AWGN) and Random-Valued Impulse Noise (RVIN) by utilizing interpolation technique based on multi-surface fitting for single frame. Directional Weighted Median (DWM) filter is used to remove RVIN, and Block Matching and 3D filtering (BM3D) is utilized to suppress GN. The core of this research is the addition of interpolation before the detection of impulse noise of DWM filter to reduce the impulse noise rate and to improve the accuracy of impulse noise detection.

Chapter 4 describes the improvement of nonlocal-based denoising methods for Gaussian noise by employing Improved Rapid and Accurate Image Super-Resolution (IRAISR) with less number of filters. There are two processes in this approach. The first process is to remove noise by using benchmark Gaussian noise removal methods such as BM3D and Weighted Nuclear Norm Minimization (WNNM). The second process is to enhance the denoising performance by utilizing an Improvement of RAISR as a post-processing step. Two improvements of RAISR which are the minimization of the classes for the gradient angle by geometric conversion and the reduction of the classes for the strength are also contributed in this research.

Chapter 5 explains an overall conclusion of this thesis, some limitations and further extensions of image denoising methods.