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PII: S1350-4495(17)30861-7
DOI: https://doi.org/10.1016/j.infrared.2018.04.005
Reference: INFPHY 2537

To appear in: *Infrared Physics & Technology*

Received Date: 22 December 2017
Revised Date: 9 April 2018
Accepted Date: 11 April 2018

Please cite this article as: M. Jiang, Edge enhancement and noise suppression for infrared image based on feature analysis, *Infrared Physics & Technology* (2018), doi: https://doi.org/10.1016/j.infrared.2018.04.005

Edge enhancement and noise suppression for infrared image based on feature analysis

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Abstract: Infrared images are often suffering from background noise, blurred edges, few details and low signal-to-noise ratios. To improve infrared image quality, it is essential to suppress noise and enhance edges simultaneously. To realize it in this paper, we propose a novel algorithm based on feature analysis in shearlet domain. Firstly, as one of multi-scale geometric analysis (MGA), we introduce the theory and superiority of shearlet transform. Secondly, after analyzing the defects of traditional thresholding technique to suppress noise, we propose a novel feature extraction distinguishing image structures from noise well and use it to improve the traditional thresholding technique. Thirdly, with computing the correlations between neighboring shearlet coefficients, the feature attribute maps identifying the weak detail and strong edges are completed to improve the generalized unsharped masking (GUM). At last, experiment results with infrared images captured in different scenes demonstrate that the proposed algorithm suppresses noise efficiently and enhances image edges adaptively.

Keywords: infrared image; feature analysis; shearlet transform; denoising; edges enhancement.

1. Introduction

As the detection mean helping human visual system to be sensitive to infrared radiations, infrared sensor outcomes infrared images which can reflect temperature differences of objects in scene. The infrared sensors take advantage of passive imaging and all-weather operations. As a result, they are widely employed in scientific research [1], military detection [2], fire monitoring [3], fault diagnosis [4], medical analysis [5] and remote sensing [6]. In general, with the factors including the principles of infrared imaging technology, external environmental distortion and thermal motion of sensors itself, infrared images suffer from low resolution, edge blurring, details loss, low image contrast and background noise [7-9]. To prevent the drawbacks that restrict developments of infrared imaging technology, it is imperative to suppress the background noise and enhance the details and edges.

To enhance the details for infrared images, there are many algorithms proposed by researchers. These enhancement algorithms can be divided into two categories: histogram-based method and unsharped masking (UM). Changing the distribution to be equal, histogram equalization improves infrared image contrast by making gray levels clear [10]. Meanwhile, this global process over-enhances images and easily courses details loss. Different from histogram equalization, contrast-limited adaptive histogram equalization (CLAHE) manipulates on local regions, not the entire image. Each local region is enhanced by making sure that the histogram of local region in output matches the designed histogram.