DOI: http://dx.doi.org/10.1016/j.infrared.2016.03.021
Reference: INFPHY 1989

To appear in: *Infrared Physics & Technology*

Received Date: 28 January 2016
Revised Date: 29 March 2016
Accepted Date: 30 March 2016

Please cite this article as: Y. Qi, R. He, H. Lin, Novel Infrared Image Enhancement Technology based on the Frequency Compensation Approach, *Infrared Physics & Technology* (2016), doi: http://dx.doi.org/10.1016/j.infrared.2016.03.021

Novel Infrared Image Enhancement Technology based on the Frequency Compensation Approach

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Abstract: A novel infrared image enhancement method has been proposed in this paper. Our aim is to develop a detail enhancement method which is focused on the frequency feature of the image. The proposed method is following the most popular strategy of enhancing the infrared images nowadays, but concentrating on the frequency domain. Firstly, the original image is separated by a guided image filter into detail layer and the base layer. Quite unlike the traditional methods, we use the guided image filter to eliminate most of the noise and weak signal of the scenario. Then, by a designed iteration process, the higher frequency of the scenario will be calculated back and add to the detail layer. The noise will not be enhanced because the iteration is only focused on the leftover scenario frequency. We run many tests on the raw data captured by the 320 × 256 HgCdTe cooled thermal imager, and make a comparison between our approach with the previous method of bilateral filtering digital detail enhancement and guided image filtering digital detail enhancement. Figures and analytical data show that our method is better than the previous proposed researches. Our method could effectively process the infrared image with less noise and artifacts, which has potential applications in testing, manufacturing, chemical imaging, night vision, and surveillance security.

Keywords: infrared image enhancement; frequency compensation; noise reduction;

1 Introduction

Contrast enhancement for infrared images has been widely investigated in recent years. Many researchers focus on how to fully display the minor details hidden in the high dynamic range (HDR) infrared images. Since the raw sensor data can be within the range of 12 to 14-bit level that exceeds the usual display device or the human vision. The state-of-the-art procedure of enhancing an infrared image could be characterized into two main aspects: the global procedure of an image and the local procedure of an image. To the best of our knowledge, most of these procedures are conducted in the gray-intensity level. For example, there are methods based on histogram equalization [1,2,3,4,5], by which the intensity distribution are normalized using the cumulative distribution function to uniform the distribution of the intensity. After that came the adaptive histogram equalization, and the contrast limited adaptive histogram equalization [6,7,8], which chose the local histogram mapping function to reduced undesired noise amplification. Meanwhile, some researchers focused on the image fusion via gradient transfer and total variation minimization approach, and great progress have been made [20]. In recent years, a useful approach occurs. This approach separates the raw image into two different layers called the detail layer and the base layer. The separation is done by introducing the edge-preserving filters like the bilateral filter