Parameter estimation of image gamma transformation based on zero-value histogram bin locations

Ping Wang, Fenlin Liu, Chunfang Yang, Xiangyang Luo

PII: S0923-5965(18)30160-7
DOI: https://doi.org/10.1016/j.image.2018.02.011
Reference: IMAGE 15338

To appear in: *Signal Processing: Image Communication*

Received date : 26 August 2017
Revised date : 21 December 2017
Accepted date : 22 February 2018

Please cite this article as: P. Wang, F. Liu, C. Yang, X. Luo, Parameter estimation of image gamma transformation based on zero-value histogram bin locations, *Signal Processing: Image Communication* (2018), https://doi.org/10.1016/j.image.2018.02.011

Parameter Estimation of Image Gamma Transformation Based on Zero-Value Histogram Bin Locations

Ping WANG[a], Fenlin LIU[a,*], Chunfang YANG[a], Xiangyang LUO[a]

[a]*Zhengzhou Science and Technology Institute, Zhengzhou, 450001, China*

Abstract

Gamma transformation plays an important role in image processing and image display. However, images may look either bleached out or too dark if transformed with improper parameters. While the value of gamma transformation parameter with which an image was created is not included in the current image standards, it is hard to restore the original image vision without the knowledge of gamma transformation. In this paper, a gamma transformation parameter estimation method is proposed based on Zero-Value Histogram Bin (ZVHB) locations. The method firstly exploits the relationship between the number of ZVHBs and the parameter of gamma transformation to get an approximate value of the parameter and an interval to which the parameter belongs. Then in the interval, the parameter is searched from the approximate value by matching the ZVHB locations of the investigated image and the reference images transformed with two close parameters. The experimental results validate the effectiveness of the proposed method, which outperforms the state-of-the-art methods. Meanwhile, the improperly transformed images can be restored visually by applying inverse gamma transformation with the estimated parameters.

Keywords: Gamma transformation, image restoration, parameter estimation, zero-value histogram bin

1. Introduction

With the wide usage of the digital media, image manipulation by means of digital computer plays an important role in our daily life. Image manipulations, such as median filtering, contrast changing, rescaling, blurring and compressing, are generally used to improve the visual quality of the image, or save storage space [1]. However, these tools may be utilized by image content tamper to hide the trace of tampering visually, or misused with improper parameters which can reduce image quality. Therefore, it is of great significance for digital image forensics and image processing to carry on the research of image manipulations identification.

At present, the research of image manipulation detection technology has made a lot of achievements, mainly including the detection of median filtering [2, 3, 4, 5, 6], contrast enhancement [7, 8, 9, 10, 11, 12, 13], rescaling [14, 15, 16, 17, 18], blurring [19, 20, 21, 22], JPEG compression [23, 24, 25, 26, 18] and so on [27, 28, 29]. Besides, researchers have developed some universal blind manipulations identification methods which can detect multiclass images [30, 31]. These techniques implicitly assume that no other operations were applied. Considering the cases where multiple operations may be involved, Chu et al. [32] proposed an operations order detection method based on multiple hypotheses testing theory and Chen et al. [33] proposed an method for JPEG-resampling-JPEG operation chain detection.

Among many image manipulations, gamma transformation, also known as gamma correction, which has only one determining parameter, is one of the most wildly used image contrast changing operations. For example, aerial images or medical magnetic resonance images may be contrast enhanced by gamma transformation, and the TV pictures are usually gamma transformed to obtain a better visual effect [1]. However, in order to hide the trace of tampering visually, gamma transformation may be applied to a spliced portion locally to adjust tampered area contrast when the original images are in different contrasts. Aiming at this kind of image splicing tampering, Stamm and Liu [10] exploits the average of high frequency coefficients of image histogram characteristics function to detect gamma transformation and then locates the spliced area precisely. In [12], the number of image histogram gaps is utilized to detect the global gamma transformation, and furthermore, the gap/peak bins are exploited to locate the spliced area. Besides, Qiu et al. [34] applied steganalytic model directly to detect image manipulations including gamma transformation, which has an impressive performance; De Rosa et al. [13] proposed a gamma transformation detection method by investigating the use of second-order statistics based on the co-occurrence matrix of pixels, which is robust to the attack of the universal counter-forensic scheme [35].

However, though these methods are effective to detect image gamma transformation, they could not obtain any knowledge about how the image is transformed. As there is only parameter of gamma transformation which controls the direction and intensity of the transformation, the parameter is important if we are concerning displaying an image accurately on a computer

*Corresponding authors
Email address: liufenlin@vip.sina.com (Fenlin LIU)