A multi-channel illumination compensation mechanism for brightness invariant image retrieval

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Shiv Ram Dubey, Satish Kumar Singh and Rajat Kumar Singh

Indian Institute of Information Technology, Allahabad

Introduction

- The matching of two images of similar scene is very challenging in case of drastic illumination differences.
- In this work, an illumination compensation mechanism is introduced which compensates the effect of illumination.
- It basically converts the image from RGB color space to illumination reduced $R_{IC}G_{IC}B_{IC}$ color space.
- The proposed mechanism is generic in nature and can be used with any of the existing descriptor.
- The proposed method is tested for over uniform and non-uniform databases with state-of-the-art descriptors.
- The proposed approach outperforms the existing illumination compensation approaches.
- The performance of illumination invariant descriptor is also boosted with proposed illumination compensation mechanism.

Illumination Compensation Mechanism

The flowchart of the illumination compensation is illustrated in the Fig. 6.1. The mechanism operates in two phases (1) color intensity reduction and (2) contrast mapping. Color intensity compensation is performed using Red, Green, Blue and Intensity channels of the RGB and HSI color space of the image. A new illumination compensated color space $R_{IC}G_{IC}B_{IC}$ is created. The $R_{IC}G_{IC}B_{IC}$ color space is composed of the three channels, namely illumination compensated Red (R_{IC}), illumination compensated Green (G_{IC}) and illumination compensated Blue (B_{IC}).

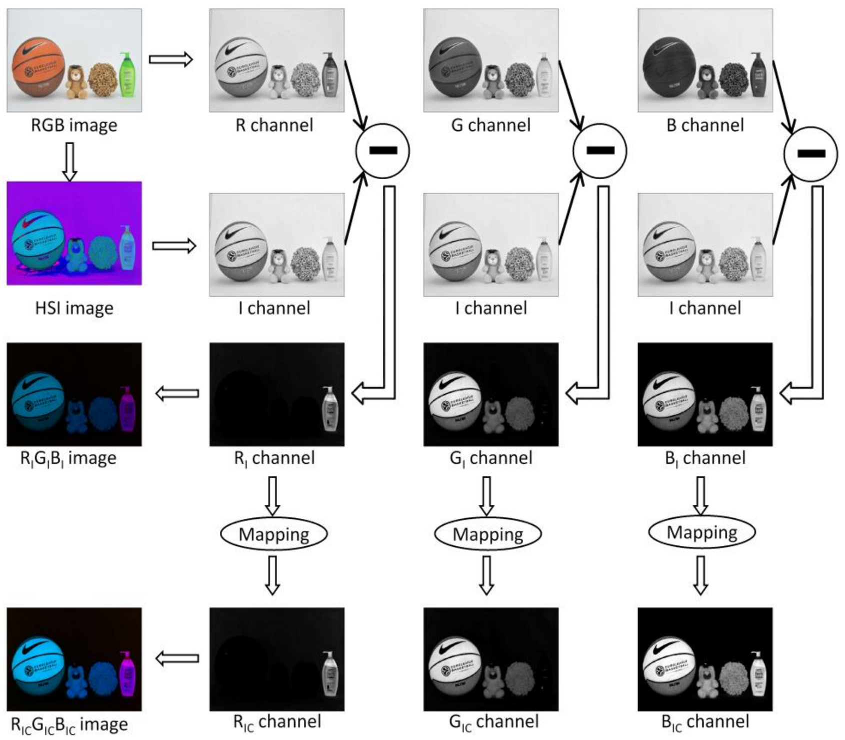

Fig.1. Workflow of illumination compensation in $R_{IC}G_{IC}B_{IC}$ color space.

Fig.2. Visualization of the illumination compensation steps: original images having uniform illumination differences (1st row), intensity subtracted images (2nd row), and contrast stretched images (3rd row). This example image is taken from the Phos database [5].

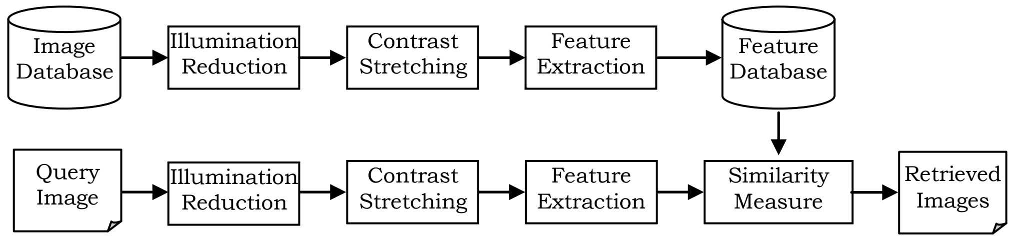

Fig.3. Image retrieval using illumination compensation mechanism.

The illumination reduced and compensated image is displayed in Fig. 2 for the images having uniform illumination differences. Fig. 3 shows the image retrieval framework using illumination compensation. Six different color or texture features, namely Color Coherence Vector (CCV) [1], Border-Interior Classification (BIC) [2], Color Difference Histogram (CDH) [3], and Structure Element Histogram (SEH) [4] are considered for the experiments. We refer BIC, CDH, and SEH features extracted over illumination compensated image as BIC_{IC}, CDH_{IC}, and SEH_{IC} respectively.

Experiments and Results

A standard Phos natural illumination database is used for image retrieval. The Phos database consists of the 15 different categories with 15 images per category having different degrees of uniform (9 images) and non-uniform illumination (6 images) [5]. The results are reported in terms of average retrieval precision (ARP) vs average retrieval rate (ARR) plot in the Fig. 4 over phos database. The Corel-non-uniform database is also synthesized from original Corel-1k database [6]. The five degrees of different non-uniform illumination is adopted to generate 5 images of original image including original one. The comparison with existing illumination compensation over Corel-non-uniform database is carried out in Fig. 5.

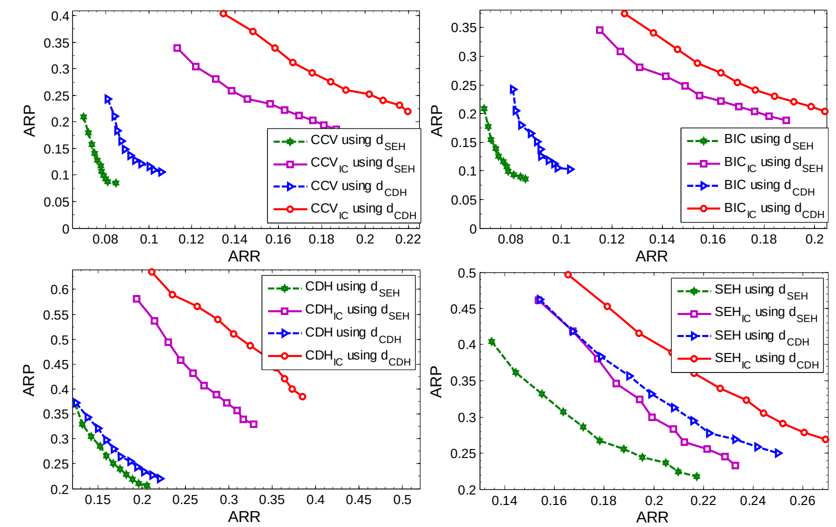

Fig.4. Results in terms of ARP and ARR curves for different features with and without illumination compensation using d_{SEH} [4] and d_{CDH} [3] similarity measures over Phos illumination benchmark dataset.

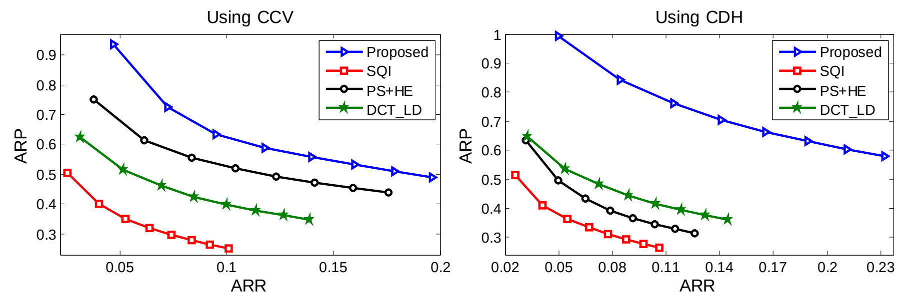

Fig.5. Comparison between proposed illumination compensation method and existing illumination compensation methods such as self-quotient image SQI [7], plane subtraction and histogram equalization (PS+HE) [8-9] and discrete cosine transform in the logarithmic domain (DCT_LD) [10], over Corel-non-uniform dataset using CCV and CDH feature descriptors.

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