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Lossless color image compression using double level RCT in BBWCA

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Abstract

A new lossless image compression scheme for natural color images which is based on double level Reversible Color Transform(RCT) and Bi-level Burrows Wheeler Compression Algorithm(BBWCA) is proposed. The first level RCT from RGB to HSV provide higher reduction in number of unique hue components, thus gives higher compression in case of natural images. The first level RCT followed by the second level RCT from HSV to YUV helps to yield small number of unique Y component values. DC level shifting and twos complement operation will be applied as preprocessing steps to second level RCT. The result of double level RCT is used as the input to BBWCA, in which row-wise BWT followed by column-wise BWT is applied. The compressed image data is formed by using move-to-front(MTF), Run-length-encoding and Entropy coding. The proposed method using double level RCT with BBWCA results in high compression by taking advantage of reduction in hue components of natural images. Among the different color space compared, the proposed method achieves better compression and is well suited for small and large size natural images. Proposed method make use of a double level RCT on the existing BBWCA algorithm and resulted in improving the compression ratio by 46 percentage.

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Keywords: BWCA,Double level RCT,Lossless Compression,Y Component

1. Introduction

Presentation of images without losing information while compression remain as a great challenge for research community. Lossless image compression algorithm allows the original image data to be perfectly reconstructed from the compressed data. Lossless image compression is used in cases where it is important that the original and the decompressed images must be identical, like medical industry, satellite imagery, remote sensing etc. Raster map compression and information hiding domains make use of lossless compression techniques[6,7]. Color images, especially high resolution images, like medical images or satellite images prefer lossless compression algorithms[1−4]. As these compression techniques mainly dependent upon redundancy between image pixels[18], it is very difficult to preserve its quality while reducing the image data. In most of the cases images are transformed into various domains to increase

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the redundancy.

Conversion of images into different color spaces provides more characteristics of that image. Various linear and nonlinear transformations [9–11] of the RGB and tri-stimulus color spaces can be used to describe the color image via a transformed plane. Such transformations help to bring out perceptual redundancy that are present in the image pixels and can thus improve the compression rate. Digital images which are represented in device-dependent RGB color space can be easily transformed[9] into various color space using the transformation formulas[9].

RCT are totally reversible integer color transforms and are used in both lossless and lossy compression methods by JPEG2000[8,19]. HSV and YUV are such RCTs which helps to increase the redundancy in images and thus enhance compression.YUV transformation before encoding helps to reduce the entropy of the images and thus achieves higher compression[11]. A new lossless color image compression scheme is developed by using this property of YUV in Bi-level BWCA[1]which is a variant of Burrows Wheeler Compression Algorithm(BWCA)[12]. Here row-wise and column-wise BWT is applied on YUV transformed image data which produce better compression than single level BWTs. HSV can be used in natural image compression where the hue components shows great reduction in the number of unique symbols[5]. In the proposed work, the above mentioned two compression techniques for color images are combined to achieve better compression of natural color images through a double level RCT scheme in BBWCA. Double level RCT gives much better compression rate than any other single level RCTs in case of natural color images.

The following sections describes the proposed double level RCT-based BBWCA. Analysis of the different stages and their effects on image data are presented in section 3. The experimental results for test images are given in section 4 followed by concluding remarks in section 5.

2. Proposed Method

Most of the conventional compression methods fails to provide better compression rate without loosing information. Even though many works have been reported in the literature, those can be still enhanced to obtain less number of unique symbols to achieve better compression ratio. Utilizing the double level reversible color transformation, we have experimentally proved that around 46 percentage of improvement can be made in the compression ratio compared to the existing methods.

Our proposed method utilizes the characteristics of double level RCT in BBWCA methodology which is introduced by Aftab khan et al.[1] We have experimentally proved that, applying double level RCT on images provide better compression than any single color transformation. The proposed method is designed for compressing natural color images, where the number of unique hue component symbols can be substantially reduced. Since the hue component shows great redundancy, we use HSV as the first level RCT. YUV is used as the second level RCT which shows tremendous reduction in the number of unique symbols in the Y component. The output of double level RCT is given as the input to bi-level BWCA[1] which helps to yield high compression rate. Figure 1 shows the schematics of the data flow and processing steps in the proposed lossless image compression using double level RCT in BBWCA.

2.1. First Level RCT

For natural images if we take hue components, it has limited number of unique values. The proposed method is designed for natural images exploiting this scenario. So the first level RCT comprises of converting the source image or the original image into HSV color space. Fig 2: shows the original image of Kodim22.png which is taken from natural image dataset Kodak[16] and it's transformed HSV Image.

H and S components are converted into unsigned integer format since they are in normalized form in HSV color model. After conversion, each component of HSV(hue, saturation and value) are in the range of 0-255. The DC Level shifting[20] operation is performed in each component to make it in the range of -128 to +127. For that we deduct 2^n from those pixels whose values are greater than +127. Since we are dealing with digital images, each gray level pixel