Efficient lossless compression of RAW images using the reversible denoising and lifting steps (RDLS) method

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1. Scope of research topic

Because of large and constantly growing sizes and quantities of acquired images, compression has become a mandatory element of picture archiving and communication systems. The proposed topic concerns the compression of RAW images, i.e., is images containing raw data from the photosensitive matrix of a digital camera. In this topic, we assume that the primary color filters of the abovementioned matrix are placed in front of the sensors in the so-called Bayer pattern (RGGB). The PhD student's primary task will be to modify one or several existing lossless image compression algorithms by applying reversible transformations constructed using the RDLS method to the RAW images.

2. General description of the research topic

Reversible transforms used in lossless compression algorithms, while performing their primary task (e.g., reducing the correlation of color image components), cause side effects—namely, they increase the noise contamination of the data being transformed (e.g., by propagating noise between transformed components), which in turn worsens the compression ratios. To solve this problem, we proposed a method of reversible denoising and lifting steps (RDLS) which, with the help of denoising filters, constructs a new reversible transform that has a number of properties that are interesting from a theoretical and practical standpoint. The new transform prevents the noise propagation inherent in the original transform, while retaining its other desirable effects and properties (such as component correlation reduction or perfect reversibility). By applying RDLS, we obtain a more general transform that may be adapted to the data being processed by selecting denoising filters. The method connects domains that until now were separate: lossless compression and irreversible denoising. We have successfully applied RDLS to several color space transforms and DWT. It may be applied to any transform that is based on so-called lifting steps, also beyond the image compression domain.

Highly promising results can be expected from employing RDLS in the lossless compression of RAW images. The obvious premise is that RAW images are noisy—RDLS was originally proposed for such data. As a result of previous research, among other things, it was found that the best effects of RDLS-modified color space transforms were obtained for images of characteristics similar to RAW files—for large images at acquisition device resolutions that have undergone little to no further processing. Furthermore, RAW files contain image acquisition parameters that can be used for virtually cost-free adaptive selection of denoising filters (using the Detector Precision Characteristic method)—for both the RDLS-modified color space transforms and transforms, such as DWT, applied to individual image components. Improving the effects of lossless compression of RAW images is important in practice because these images are large, lossy compression should not be applied to them, and they require efficient storage in resource-constrained devices (such as digital cameras).

Further reading on issues related to the proposed topic: image processing [1], image compression algorithms [2-4], DWT and the lifting technique [5,6], color space transforms [7-9], RDLS [10-16], techniques (histogram packing and detector precision characteristic, etc.) that may be useful for compression of RAW data employing RDLS [16-20].

3. Scientific discipline in which a doctoral dissertation will be prepared

Technical Informatics and Telecommunications / Applied Computer Science

4. Promoter contact details

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