Application of the reversible denoising and lifting steps (RDLS) method to improve lossless compression of RAW images

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1. The scope of research topic

The large and constantly growing sizes and quantities of acquired images have made compression a mandatory element of many picture archiving and communication systems. The proposed topic concerns the compression of RAW images, i.e. 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 task will be to modify one or several existing lossless image compression algorithms by applying reversible transformations constructed using the RDLS method for the RAW images.

2. General description of research topic

The reversible transforms exploited in lossless compression algorithms while performing their basic task (e.g., reducing of correlation of components of color images) cause side effects, namely 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 new reversible transform that has a number of properties that are interesting from a theoretical and practical standpoint. The new transform prevents noise propagation of the original transform while retaining its other desirable effects and properties (like the component correlation reduction or the transform 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: the 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.

Very good effects of employing RDLS in lossless compression of RAW images can be expected. 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 in resolutions of acquisition devices that were not subject to further processing or processed in a minimal extent only. Furthermore, RAW files contain image acquisition parameters that can be used for virtually costless 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 storing in devices with limited resources (like a digital camera).

Further reading on issues concerned with 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 [16-21].

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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