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A NOVEL REVERSIBLE DATA HIDING SCHEME

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Abstract. *A novel reversible data hiding scheme based on an improved difference expansion (DE) method, which introduces the companding technique into traditional DE, is proposed in this paper. The method focuses on largely increasing the number of the differences to be expanded. The location map recording these expanded positions can be efficiently compressed due to significant difference between possibilities for expanded and non-expanded differences. Thereby, the hiding capacity is largely increased. We compress large differences into smaller values, and then expand these values. Hence, the higher PSNR value can be achieved than that caused by directly expanding large differences. As revealed in the experimental results, the proposed scheme outperforms traditional DE, in terms of embedding capacity and visual quality, as expected.*
Keywords: Reversible watermarking, DE, Companding technique

1. **Introduction.** Digital watermarking refers to the process of embedding some labels or signatures into digital media without introducing perceptible artifacts. Watermarking schemes can be classified as either robust or fragile. Robust watermark is generally designed to resist unmalicious or malicious attacks such as scaling, cropping, lossy compression, and so forth. For example, Lu *et al.* proposed two counterfeiting attacks on two robust watermarking schemes [1]. In contrast, fragile watermark is designed to detect any tiny alternation to the original digital content. As one kind of fragile watermark, reversible watermarking has drawn extensive attention from researchers especially in some fields such as the law enforcement, medical and military image systems, as it can restore the original image without any distortions after the watermark is extracted.

The concept of reversible watermarking firstly appeared in the patent owned by Eastman Kodak [2]. Honsinger *et al.* utilized a robust spatial additive watermark combined with modulo addition to achieve reversible data embedding [2]. Fridrich *et al.* losslessly compressed high level bit-planes to make space for the embedded data in the spatial domain [3]. Macq employed the patchwork algorithm, proposed by Bender *et al.* [4], and modulo addition to reversibly embed the watermark bits into the host image [5]. The above algorithms [2, 3, 5] aimed at the authentication, so their amounts of hiding data were limited. The following algorithms [6, 7, 8, 9, 10] can achieve higher hiding capacity. Goljan *et al.* proposed a two cycle flipping permutation to assign a watermark bit in each pixel group [6]. Celik *et al.* presented a high capacity, reversible data-embedding algorithm with low distortion by compressing quantization residues [7]. Xuan *et al.* embedded