A New Kind of High Capacity and Security Reversible Data Hiding Scheme

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ABSTRACT

A novel high capacity and security reversible data hiding scheme is proposed in this article, in which the secret data is represented by different orthogonal spreading sequences and repeatedly embedded into the cover image without disturbing each other in the light of Code Division Multiple Access (CDMA) technique, and thus the embedding capacity is enlarged. As most elements of orthogonal spreading sequences are mutually canceled in the process of repeated embedding, it keeps the distortion of the embedded image at a low level even with high embedding capacity. Moreover, only the receiver who has the spreading sequence and the embedding gain factor the same as the sender can extract the secret data and achieve the original image exactly, thus the proposed scheme achieves high embedding security than other schemes. The results of the experiment demonstrates that the CDMA based reversible data hiding scheme could achieve higher image quality at moderate-to-high embedding capacity compared with other state-of-the-art schemes.

KEYWORDS

Capacity, Code Division Multiple Access (CDMA), Data Hiding, Reversible

1. INTRODUCTION

Reversible data hiding (RDH) is a kind of distortion-free data embedding method, it allows one to hide the secret data into an image in such a way that the original image can be reconstructed completely from the marked image after the embedded data having been extracted correctly. For some sensitive applications, such as military and medical imaginary, the cover image is so important that even a very slight change of pixels is unacceptable. In this case, any changes may affect the intelligence of the image that always require access to the original data, and thus the reversible data hiding is highly desired is such scenery.

Many reversible data hiding schemes have been developed in recent years. Early reversible data hiding schemes were mainly based on lossless compression techniques, in which certain bits of an image pixel are compressed to create vacancies for data embedding losslessly (Fridrich, Goljan, & Du, 2002; Celik, Sharma, Tekalp & Saber, 2005). Fridrich et al. proposed a reversible data hiding method by compressing the least significant bit planes of the host image and embedded the secret data into the saved space. Celik et al. enhanced Fridrich et al.’s approach and presented a high-performance scheme through compressing quantization residues with more efficient compression technique, however, these schemes often suffer from large distortion with low embedded capacity and lack of...
safety control algorithm. Later on, many efficient algorithm shaving been proposed that emphasize on increasing data embedding capacity at low image distortion.

Ni et al. (Ni, Shi, Ansari & Su, 2006) proposed an efficient reversible data hiding solution named histogram shifting scheme, in which a gap is created near the highest histogram bin by shifting image gray levels with one position, and the embedded bits are encoded by using the highest bin of pixels. From then on, many histogram modification schemes are proposed. Lee et al. (Lee, Suhand & Ho, 2006) employed the difference-image to embed more data than Ni et al.’s scheme. Yang et al. (Yang & Tsai, 2010) proposed an interleaving prediction method and increased the number of prediction errors as many as the pixels, by which the embedding capacity is improved effectively. Xuan et al. (Xuan, Tong, Teng, Zhang & Shi, 2012) embedded data into image prediction-errors with histogram pair method, and four thresholds are introduced for performance optimization, by which they achieved excellent results at low-to-moderate embedding capacity. Recently, Li et al. (Li, Zhang, Gui & Yang, 2013) proposed an adaptive reversible data hiding scheme to enhance the embedding performance at high embedding payload.

Difference expansion is another fruitful research direction introduced by Tian (Tian, 2003), in which the pixel differences are expanded and the secret data are added to the expansion created space furtherly. Thodi and Rodriguez (Thodi & Rodriguez, 2007) enhanced the difference expansion technique with a method called prediction-error expansion, which exploits the correlation inherent in the neighborhood of a pixel than the difference-expansion scheme, and thus the distortion of the cover image is reduced after data embedding. Sachnev et al. (Sachnev, Kim, Nam, Sures & Shi, 2009) presented a prediction-error expansion method-based scheme without using a location map in most cases, it allows to embed more data into the image with less distortion. Li et al. proposed to embed 1 or 2 bits into expandable pixels adaptively according to the local complexity with prediction-error expansion method.

Although most schemes try to exploit ample small prediction errors for data hiding so as to lighten the image distortion, but a lot of big-value prediction errors would still be involved for data hiding when the payload is high, and the image quality drops rapidly with the increase of embedding capacity. In this paper, a CDMA based high performance reversible data hiding scheme is presented for reversible data hiding. The secret data are represented by different orthogonal spreading sequences and embedded repeatedly into the cover image to enlarge its embedding capacity, as most elements of different spreading sequences are mutually canceled in the process of the repeated data embedding, that keeps the image in good quality even at high embedding capacity. Moreover, according to the speciality of the proposed scheme, only the receiver who has the spreading sequence and the embedding factor the same as the sender can extract the secret data and achieve the original message exactly, which improves the security of the system.

The rest of the paper is organized as follows. Section 2 introduces the CDMA based data hiding method in detail. In section 3, a CDMA based reversible data hiding scheme is provided, the experimental results are provided and discussed in section 4. The conclusions are drawn in section 5.

2. CDMA BASED REVERSIBLE DATA HIDING

Code Division Multiple Access (CDMA) is a kind of spectrum spreading technique for signal transmitting, in which various signals are represented by different orthogonal spreading sequences and transmitted together in a single channel and thus the frequency resource is saved (A data hiding scheme can also be viewed as a communication system, in which the massage is the secret data and the transmission channel is the cover image). The principle of a CDMA based data transmitting scheme is as follows:

Suppose \( S = (s_n)_{n=1}^m \) is a zero-mean sequence with size of \( 1 \times m \) and satisfies the following conditions:
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