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Information Hiding Scheme on Modified Least Significant Bits Using Bit Position and Bit Count in Medical Images

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Abstract: Information hiding techniques are related to hiding the secret information in digital media without distortion. In this study, a new information hiding scheme using bit position and bit count in the pixel is proposed to provide high embedding capacity. The proposed method divides one pixel into two regions high and low region and counts the number of 1's value on bit position for each region to decide the length of embedding secret bits. The proposed embedding algorithm hides the secret bit depending on the bit count. The experimental results show that the proposed method has strength on embedding capacity without distortion to the human visual system.

Key words: Information hiding, data hiding, steganography, least significant bit, position, distortion

INTRODUCTION

Multimedia data such as image, audio and video are being produced gradually and becomes easily spread over internet in recent years. Information hiding technique is one of information security technologies that can conceal the existence of secret information from third party (Khan *et al*., 2014; Subhedar and Mankar, 2014; Jung and Yoo, 2015). Information hiding techniques can divide into irreversible data hiding and reversible data hiding methods whether the cover-object can recover from the stego-object or not. The least significant bit substitution and pixel-value differencing schemes are well known in irreversible data hiding and histogram shifting and difference expansion schemes are general techniques in reversible data hiding. The least significant bit replacement is a general technique that can hide the secret bit into right bits of a pixel within permitting image distortion to the human visual system. Wu and Tsai (2003) proposed the pixel-value differencing to hide the secret bit more on the edge area by calculating the difference of two consecutive pixels. Tian proposed a reversible data hiding based on difference expansion to provide high embedding capacity and low image distortion (Tian, 2003). Ni *et al*. (2006) proposed histogram shifting based reversible data hiding where zero and peak points on the histogram graph was used.

Additionally, there are many kind of works based on least significant bit replacement techniques (Khodaei and Faez, 2012; Ker, 2005; Mielikainen, 2006; Chan and Cheng, 2004; Chang *et al*., 2002; Wang *et al*., 2001; Xu *et al*., 2016; Thien and Lin, 2003). The least significant bit matching is that one bit value is added or subtracted randomly when the embedding secret bit does not match. The revisited least significant bit matching was proposed to improve the image quality by minimizing the number of modification. In addition, the optimal least significant bit substitution, the genetic algorithm based least significant bit substitution and the modulus least significant bit replacements were proposed to improve the image quality. In this study, a new information hiding scheme using bit position and bit count in the pixel is proposed to differentiate the length of embedding bits by calculating the number of 1 on most significant bits in one pixel rather than traditional least significant bit based data hiding methods have.

Literature review: The least significant bit replacement is a basic technique to hide the secret bits in some bits of each pixel of the cover image (Jung and Yoo, 2015). Suppose that the k-bit of the secret data can be embedded into the k-right most least significant bits of the cover image. For a pixel value $p_i = (b_7b_6b_5b_4b_3b_2b_1b_0)_2$ and the secret bit stream s_i a new pixel value p'_i is calculated by Eq. 1:

$$p_i^{'} = p_i - \left(p_i \bmod 2^k\right) + \sum_{i=0}^{k-1} s_i \quad (1)$$

The secret bits can be extracted from the new pixel value directly by Eq. 2:

$$s_i = p_i^{'} \bmod 2^k \quad (2)$$

For example; $s_i = 100_2$ and $p_i = 115$ are given for the length of embedding bits k = 3. A new pixel value

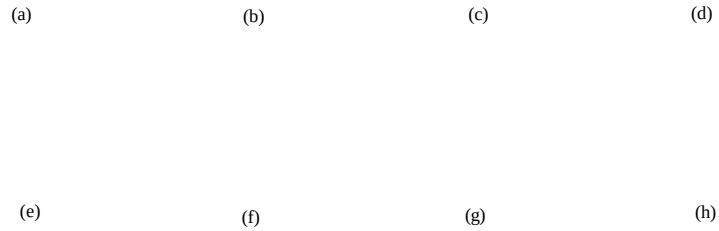

Fig. 2: Cover images: a) Image 1; b) Image 2; c) Image 3; d) Image 4; e) Image 5; f) Image 6; g) Image 7 and h) Image 8

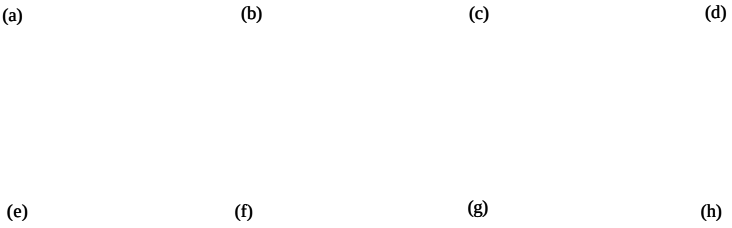

Fig. 3: Stego-images: a) Image 1; b) Image 2; c) Image 3; d) Image 4; e) Image 5; f) Image 6; g) Image 7 and h) Image 8

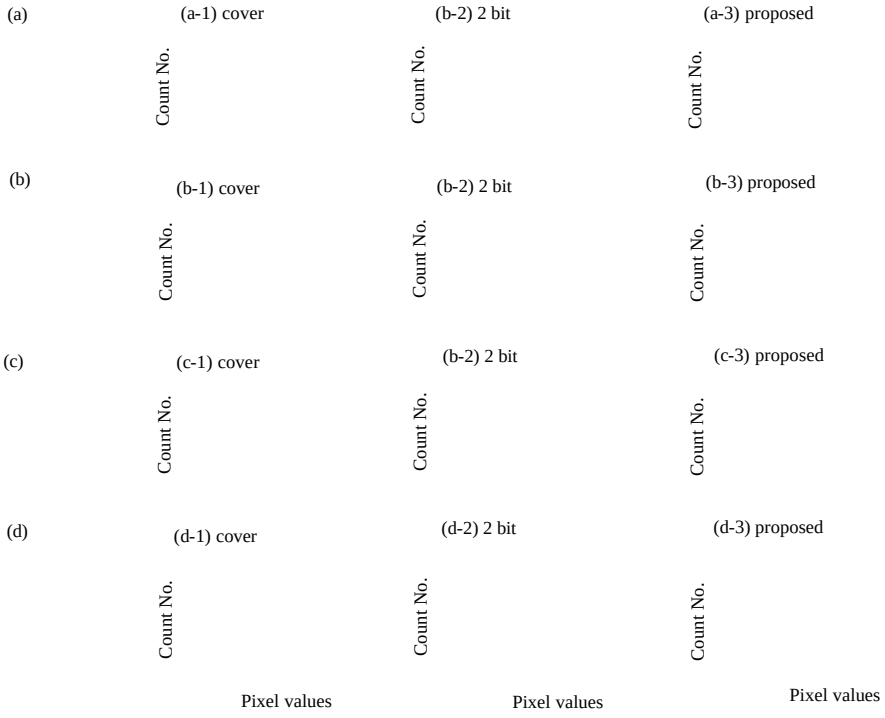

Fig. 4: Histogram comparison: a) Image 1; b) Image 2; c) Image 4 and d) Image 8

Table 1: Comparisons of the embedding capacity and the PNSR

	2 bit least significant bit scheme		The proposed scheme	
Cover images	Embedding capacity (bits)	PNSR (dB)	Embedding capacity (bits)	PNSR (dB)
1	524.288	45.65	551.914	31.10
2	524.288	44.65	566.467	30.88
3	524.288	43.31	536.736	30.91
4	524.288	45.22	555.537	30.98
5	524.288	44.45	551.680	30.09
6	524.288	44.05	616.087	29.57
7	524.288	45.90	539.289	32.83
8	524.288	44.00	564.861	30.46
Average	524.288	44.49	560.698	30.81

The histogram of 2 bit least significant bit replacement and the proposed scheme is shown in Fig. 4. For four cover images, histogram of a cover image, 2 bit least significant bit replacement and the proposed stego-images are compared. The proposed scheme can hide the secret bits from two bits to four bits, so, the variance of histogram is larger than previous research. In general, least significant bit based data hiding methods are vulnerable to RS histogram attack which shown in Fig. 4.

CONCLUSION

In this study, a new information hiding scheme using bit position and bit count in the pixel has been proposed. The proposed scheme divided one pixel into high and low region to decide the length of embedding bits, where the proposed scheme used the bit count by calculating the number of 1 on high region in the pixel. The proposed method could embed the secret bits in the low region and the length of embedding bits was different on each pixel. The experimental results showed that the proposed method maintained 30.81 dB and 560,698 bits on average without distortion to the human visual system.

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