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GUEST EDITORIAL

Special Issue: Real-Time Data Hiding and Visual Cryptography

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1 Introduction

Data hiding (DH) may embed secret data, copyright information, and annotation into various media such as image, audio, video, or text. The embedded data should be invisible to a watchdog, and meanwhile the secret data have to stay hidden in a cover signal without detection from steganalysis tools. For this reason, we should retain the good visual quality of an image with the high embedding data. However, trade-offs exist between the embedding capacity and the degree of quality to cover media modification. That is, as one increases, the other must decrease. Thus, according to our need, we choose the best way to implement DH. Reversible DH (RDH) was derived from DH for sensitive applications such as military and hospital since 10 year ago. Recent research on RDH has been focused on encrypted domains.

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Another topic of this special issue is visual cryptography scheme (VCS). In the last two decades, investigations on VCS were widely conducted. A basic model of VC was firstly proposed by Naor and Shamir. They demonstrated VCS, where an image was divided into a number of shared images so that only participants in the qualified set could decrypt the secret image, while participants in the non-qualified set have no information about the secret. In VCS, the appealing property is that the decoding process can be performed directly by the human eyes without any complicated cryptographic computation. This "stacking-to-see" property of VCS provides many intended applications, e.g., information hiding, access control, watermarking, authentication, identification, and transmitting passwords.

This special issue (SI) of the Springer Journal of Real-Time Image Processing (JRTIP) entitled Real-Time DH and VCS highlights the latest research results on various image, pattern recognition, and signal processing algorithms and technologies for real-time approaches in DH, RDH, and VCS based on various multimedia. This SI addresses both theoretical and practical problems along with the real-time theme of JRTIP. It includes fast schemes and hardware implementations, as well as software/hardware co-design based on DH/RDH and VCS.

The call for papers resulted in 29 submissions. For each submission, at least two reviewers examined its quality, together with the guest editors and editor-in-chief. Finally, 19 papers were accepted for this special issue. The selected papers outlined below can be divided broadly into the following themes.

The first theme involves VCS and image secret sharing schemes to support real-time algorithms. Six papers fall into this theme. The second theme involves DH, RDH, and steganography for high capacity and good image quality with fast encoding algorithm, and another nine papers fall into this theme. The third theme has two papers and consists of watermarking and reversible watermarking implemented with FPGA for supporting real-time processing techniques. The fourth theme has two papers including steganalysis and authentication.

In the following section, we present a brief overview of each manuscript and then conclude this guest editorial.

2 Real-time data hiding and visual cryptography

A summary of the papers is outlined below:

In the paper entitled "A real-time secret image sharing with fairness" by Lee et al. [1], the authors proposed a method to hide the verification value at the random coefficient of polynomial to solve fairness problem and the time complexity. As a result, the proposed scheme not only satisfies the fairness, but also is suitable for the real-time process.

The paper entitled "Participants increasing for threshold random grids-based visual secret sharing" by Yan and Lu [2] presents the new participants increasing issue only from the n original shadow images generated by previous existed (k, n) threshold random grids-based visual secret sharing (RGVSS), which is possibly to join the new participants in existed secret sharing.

In the paper entitled "Visual secret sharing scheme for (k, n) threshold based on QR Code with multiple decryptions," by Wang et al. [3], they proposed a VSS scheme based on QR code, which can visually reveal secret image with the abilities of stacking and XOR decryptions as well as scan every shadow image by a QR code reader.

In the paper entitled "A Novel Two-in-one Image Secret Sharing Scheme Based on Perfect Black Visual Cryptography" by Li et al. [4], a novel two-in-one image secret sharing (TiOISS) scheme based on perfect black visual cryptography scheme (PBVCS) was proposed for supporting real-time computation, where grayscale secret images can be recovered quickly with a few Boolean operations.

The paper entitled "A Novel Mapping-Based Lossless Recovery Algorithm for VSS" by Liu et al. [5] presents a novel mapping-based lossless recovery algorithm (MbLRA) for VSS to solve complex computation, where secret image can be reconstructed losslessly by using additions only. The MbLRA was proved to be the least number of the shadow images which can recover the secret losslessly by analyzing the Hamming weight of adding all n shadows.

In the last paper of the first theme entitled "An enhanced threshold visual secret sharing based on random grids" by Yan et al. [6], a new threshold random grids (RG)-based VSS scheme is presented to improve the visual quality of the previewed image. Compared with previous schemes, they proposed that a scheme can gain better visual quality in the reconstructed images as well as (k, n) threshold.

The first paper of the second theme entitled "Sequential Multiple LSB Methods and Real Time Data Hiding: Variations for Visual Cryptography Ciphers" by Papadopoulos et al. [7], a general model approach of real-time DH and watermarking for image, video, and audio communications is proposed.

The paper entitled "Portable Real-Time DCT Based Steganography Using OpenCL" by Poljicak et al. [8] presents steganographic method with increased robustness to unintentional image processing attacks. The method is based on a discrete cosine transform (DCT) where the values of DCT coefficients are modified in order to hide data. Results show that the proposed method is very robust to image compression, scaling, and blurring.

In the paper entitled "Lossless Data Hiding for Absolute Moment Block Truncation Coding Using Histogram Modification" by Kim et al. [9], a lossless DH for absolute moment block truncation coding (AMBTC) images, which is very sensitive to change small pixels. Nevertheless, to improve the hiding capacity, they presented an efficient extension of the histogram modification technique by counting the coefficients of the bit planes.

The paper entitled "Secure Medical Images Based on Data Hiding Using a Hybrid Scheme with the Hamming Code, LSB, and OPAP" by Kim et al. [10] presented a DH to prevent forgery of a patients medical image (e.g., X-ray and CT) in hospitals. In addition, DH can help patients avoid mistakes of doctors or nurses who confuse patient X-rays or CT scans. For that purpose, they applied a mixed scheme composed of Hamming code and LSB with an optimal pixel adjustment process (OPAP) algorithms.

The paper entitled "Data hiding scheme improving embedding capacity using mixed PVD and LSB on bit plane" by Jung [11] presented a mixed method composed of pixel-value differencing (PVD) and least significant bit (LSB) techniques. First, one bit plane is used for PVD scheme to embed secret bit stream. Second, the other bit plane is applied the LSB substitution scheme which is to provide high embedding capacity.

In the paper entitled "Reversible Data Hiding Scheme with Edge-Direction Predictor and Modulo Operation" by Kim et al. [12], a RDH scheme with edge-direction predictor and modulo operation (MO) was proposed for improving the performance of histogram shifting (HS) method with three cases. Traditional histogram shifting-based schemes often utilized pixel difference values for improving hiding capacity. But these techniques have to overcome the limitation. They proposed a new HS method by using modulo operation with difference values which given a higher hiding capacity than previous HS-based methods. By using the MO, the height of peak point increases.

The paper entitled "Adaptive Real-Time Reversible Data Hiding for JPEG Images" by Yang et al. [13] presented adaptive real-time RDH for JPEG images using successive zero coefficients in zigzag sequences of discrete cosine transformation (DCT) blocks. The contribution of this scheme successfully enhances the hiding capacity while the image quality of stego-image is maintained.

In the paper entitled "High-capacity reversible data hiding method using block expansion in digital images," Jung [14] presents neighboring interpolation and pixel-value differencing on block expansion for RDH. A consecutive embedding technique for a sub-block maintains a higher embedding capacity and good visual quality in stego-images.

In the last paper of the second theme entitled "Separable Reversible Data Hiding and Encryption for HEVC Video" by Long et al. [15], one can encrypt the signs and amplitudes of motion vector differences (MVD) and the signs of residual coefficients with an encryption key by using RC4, while another can hide data into nonzero AC residual coefficients with a hiding key. For the decoding phase, one can decrypt the HEVC video and obtain a HEVC video similar to the original one if he only has the encryption key; he can extract the hiding data without knowing the HEVC video content if he only has the hiding key; he can extract the hiding data and recover the original HEVC video if he has both the encryption key and hiding key.

The first paper in the third theme entitled "Two Zero-Watermark methods for XML documents", by Wen et al. [16], designed and tested two zero-watermarking methods for XML documents. One is XSLT-related method which is designed with embedding extra codes in XSLT file to serve as sort of copyright function. Another uses the functional dependency of XML file as feature for zero-watermarking. The proposed zero-watermarking scheme can resist selection attacks, alteration attacks, reorganization attacks, and compression attacks.

In the last paper of the third theme entitled "FPGA Implementation of Semi-Fragile Reversible Watermark by Histogram Bin Shifting for Real-Time" by Hazra et al. [17], field programmable gate array (FPGA) implementation of reversible watermarking (RW) algorithm based on histogram bin shifting (HBS) that can be used for real-time applications of medical and military images has been presented. The embedding and extracting procedures involved in the proposed scheme are implemented using Xilinx system generator. The device for the proposed scheme is practically viable. They showed that a watermarking scheme can be implemented by the FPGA.

For the first paper in the fourth theme entitled "High accurate real-time image steganalysis based on GPU", by Xia et al. [18], discrete cosine transform residual (DCTR) and spatial rich model (SRM) of Fridrich et al. are proposed and implemented on the GPU device to exploit the parallel power of the GPU and some optimization methods are presented, because it is required the huge time cost for steganalysis tools. Although computing the four-dimensional co-occurrences, it is possible to improve the performance of the proposed scheme as them are converted into one-dimensional histograms, because it is more suitable for parallel computing.

In the last paper entitled "Real-time Adult Authentication Scheme for Digital Contents using X.509 Certificate in Ubiquitous Web Environment" by Lee et al. [19], they proposed a certification method using X.509 with real-time performance when people attempt to access specific digital content, e.g., blue movies.

3 Conclusions

Finally, we would like to thank both the editors-in-chief of the Journal of Real-Time Image Processing, Nasser Kehtarnavaz and Matthias F. Carlsohn, and the entire editorial staff for their valuable support throughout the preparation and publication of this special issue. We would like to thank all authors for their contributions to this issue and reviewers for their extensive help in reviewing the manuscripts. We hope that this special issue will have a broad impact on real-time data hiding, visual cryptography, watermarking, and steganalysis for copyright, secret communication, and detection technique of steganography, especially of benefit to the academic and industrial communities involved in the DH (or RDH) and VCS technologies.

References

1. Lee, G.J., Yoon, E.J., Kim, C., Yoo, K.Y.: A real-time secret image sharing with fairness. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-015-0558-7
2. Yan, X., Lu, Y.: Participants increasing for threshold random grids-based visual secret sharing. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0639-2
3. Wan, S., Lu, Y., Yan, X., Wang, Y., Chang, C.: Visual secret sharing scheme for threshold based on QR code with multiple decryptions. J. Real Time Image Process. (2017). https://doi.org/10.1007/s11554-017-0678-3
4. Li, P., Yang, C.N., Kong, Q.: A novel two-in-one image secret sharing scheme based on perfect black visual cryptography. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0621-z
5. Liu, X., Wang, S., Sang, J., Zhang, W.: A novel mapping-based lossless recovery algorithm for VSS. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0644-5
6. Yan, X., Liu, X., Yang, C.N.: An enhanced threshold visual secret sharing based on random grids. J. Real Time Image Process. (2015). https://doi.org/10.1007/s11554-015-0540-4

7. Papadopoulos, N.A., Psannis, K.E.: Sequential multiple LSB methods and real-time data hiding: variations for visual cryptography ciphers. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0630-y
8. Poljicak, A., Botella, G., Garcia, C., Kedmenec, L., Prieto-Matias, M.: Portable real-time DCT-based steganography using OpenCL. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0616-9
9. Kim, C., Shin, D., Leng, L., Yang, C.N.: Lossless data hiding for absolute moment block truncation coding using histogram modification. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0641-8
10. Kim, C., Shin, D., Kim, B.G., Yang, C.N.: Secure medical images based on data hiding using a hybrid scheme with the Hamming code, LSB, and OPAP. J. Real Time Image Process. (2017). https://doi.org/10.1007/s11554-017-0674-7
11. Jung, K.H.: Data hiding scheme improving embedding capacity using mixed PVD and LSB on bit plane. J. Real Time Image Process. (2017). https://doi.org/10.1007/s11554-017-0719-y
12. Kim, D.S., Yoon, E.J., Kim, C., Yoo, K.Y.: Reversible data hiding scheme with edge-direction predictor and modulo operation. J. Real Time Image Process. (2015). https://doi.org/10.1007/s11554-015-0548-9
13. Yang, C.N., Kim, C., Lo, Y.H.: Adaptive real-time reversible data hiding for JPEG images. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-015-0555-x
14. Jung, K.H.: High-capacity reversible data hiding method using block expansion in digital images. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0618-7
15. Long, M., Peng, F., Li, H.Y.: Separable reversible data hiding and encryption for HEVC Video. J. Real Time Image Process. (2017). https://doi.org/10.1007/s11554-017-0727-y
16. Wen, Q., Wang, Y., Li, P.: Two Zero-Watermark methods for XML documents. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0647-2
17. Hazra, S., Ghosh, S., De, S., Rahaman, H.: FPGA implementation of semi-fragile reversible watermarking by histogram bin shifting in real time. J. Real Time Image Process. (2017). https://doi.org/10.1007/s11554-017-0672-9
18. Xia, C., Guan, Q., Zhao, X., Zhao, C.: Highly accurate real-time image steganalysis based on GPU. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0600-4
19. Lee, J., Jeon, I., Kwon, H., Shin, D., Shin, D.: Real-time adult authentication scheme for digital contents using X.509 certificate in ubiquitous Web environment. J. Real Time Image Process. (2016). https://doi.org/10.1007/s11554-016-0601-3