Editorial

Introduction to the Special Issue on Recent Developments in Multimedia Watermarking Using Machine Learning

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1 Introduction

In the digital information age, multimedia contents, such as text, image, audio, video, and 3D computer graphic models, can be easily copied, manipulated, and distributed over the Internet. It emerges from the fact that many innovative techniques to protect the data transmission, storage, sharing, and processing of multimedia contents have been recently developed and used. The prime motive behind attacks can be to alter, modify, or even delete the multimedia contents to illegally claim ownership or to prevent the information transfer to intended recipients. Therefore, addressing these challenges has been an interesting problem for researchers in the field. Digital watermarking is a data hiding technique for inserting multimedia information, also known as watermark, into a multimedia data, which can be later extracted or detected for a variety of purposes, including identification and authentication in many applications. Robustness, imperceptibility, capacity, security, and computational cost are important characteristics for the general watermarking system. However, there exist some tradeoffs between the robustness, imperceptibility, and capacity characteristics of the watermark. Therefore, some optimization techniques are required to balance these characteristics. In recent years, different machine learning methods are used as an optimization technique to offer the optimal balance between imperceptibility and robustness. In addition, to enhance the robustness and security of the watermark, researchers are using machine learning methods.

2 Summary of the Accepted Papers

The objective of this Special Issue is to concentrate on all aspects and future research directions, major trends and challenges, state-of-the-art techniques and approaches, methodologies, and most recent developments related to this specific area. More than 25 submissions were received, virtually covering all aspects of the area. After review, nine of these high-quality papers were found suitable for inclusion in the Special Issue. Below, we briefly summarize the highlights of each paper.

The paper “Medical image reliability verification using hash signatures and sequential square encoding,” authored by Ranjani and Babu, presents a data hiding framework to verify the integrity of medical images. The integrity of medical images is verified by embedding hash signatures using the sequential square embedding technique. This technique is as efficient as the diamond encoding technique but with increased payload capability. During the data hiding stage, the hash signatures are embedded in randomly chosen pixel pairs in the signature block using the sequential square encoding (SSE) technique. In the experimental results, the data hiding capacity of the proposed SSE technique is verified in terms of the peak signal-to-noise ratio (PSNR). The medical image integrity is substantiated by comparing the L2 Norm between computed and extracted hash signatures. Results demonstrate that the proposed algorithm provides a secure framework for medical image integrity verification.

The paper “An efficient medical image watermarking technique in E-healthcare application using hybridization compression and cryptography algorithm,” authored by Aparna and Kishore, presents an efficient

medical image watermarking technique in E-healthcare application using the hybridization of compression and cryptography algorithm. Watermarking by combining lossless data compression and encryption techniques and the scattered embedding of the watermark bits in the embedding region make it an effective technique. The experimental result is carried out on different medical images with electronic health record (EHR), and the effectiveness of the proposed algorithm is analyzed with the help of the PSNR and normalized correlation (NC). Experiments are also reported to compare the proposed methods to other existing methods.

The paper "Multiple watermarking for healthcare applications," authored by Zear et al., presents an algorithm for multiple digital watermarking using combination discrete wavelet transform (DWT), discrete cosine transform (DCT), and singular value decomposition (SVD) for healthcare applications. The robustness enhanced by back-propagation neural network is applied to the extracted watermarks to reduce the effects of different noises applied on the watermarked image. Experimental results illustrated that the proposed method is able to withstand a variety of signal processing attacks. Experiments are also reported to compare the proposed methods to other existing methods. The visual quality of the proposed method is also evaluated by a subjective method.

The paper entitled "Combining Haar wavelet and Karhunen-Loeve transform for robust and imperceptible data hiding using digital images," authored by Sharma et al., presents an introduction of digital image watermarking followed by important characteristics and potential applications of digital watermarks. Recent state-of-the-art watermarking techniques as reported by the noted authors are discussed in brief. It includes the performance comparison of reported transform/spatial domain-based watermarking techniques presented in tabular form. The authors developed a robust watermarking technique using the fusion of DWT and Karhunen-Loeve transform for digital images. In addition, the visual quality of the watermarked image is enhanced using different image denoising techniques. Various experiments are performed and results prove the effectiveness of the proposed technique.

The paper entitled "A parallel algorithm for wavelet transform based colour image compression," authored by Singh et al., presents a parallel algorithm for calculating convolution-based wavelet transform of red, green, and blue intensity components simultaneously in color images, which can run on commonly used processors. This means that it needs no extra hardware. The results are also compared to the nonparallel algorithm based on compression time, mean square error, compression ratio, and PSNR. Experiments on complexity analysis are also reported to compare the proposed methods to other existing methods.

The paper "Machine learning based robust watermarking technique for medical image transmitted over LTE network," authored by Rai and Singh, presents a secure watermarking technique using a machine learning algorithm. The propagation of the watermarked image is simulated over a 3GPP/LTE downlink physical layer. The watermark data is scrambled and a transform domain-based hybrid watermarking technique is used to embed this watermark into the transform coefficients of the host image and transmitted over orthogonal frequency division multiplexing (OFDM) downlink physical layer. Support vector machine (SVM) is used as a classifier for the classification of non-region of interest (NROI) and region of interest (ROI) in medical images. Various experiments are performed and results prove the effectiveness and efficiency of the proposed technique as acceptable for clinical applications.

The paper entitled "An image authentication algorithm using combined approach of watermarking and vector quantization," authored by Tiwari and Sharma, presents a two-stage watermarking technique for image authentication adapting advantages of vector quantization (VQ). In the proposed algorithm, robust watermark and semifragile watermark are embedded independently in two successive stages. Robust watermark and VQ enhances the security of the system by providing double protection to the designed system, whereas semifragile watermark helps in authenticating the received image. Experimental results demonstrate the capabilities of the method in classifying attacks and correctly locating the tampered area. It is possible to detect and determine tamper with very high sensitivity. The proposed technique outperforms previous algorithms regarding imperceptibility, attack classification criteria, robustness feature, and tamper detection feature.

The paper "Novel relevance feedback approach for color trademark recognition using optimization and learning strategy," authored by Pinjarkar et al., develops a relevance feedback system embedded with

optimization and unsupervised learning technique as preprocessing stage for trademark recognition. The search space is reduced using particle swam optimization (PSO) for the optimization of the database feature set, which is further followed by clustering using self-organizing map (SOM). The relevance feedback (RF) technique is implemented over the preprocessed feature set. Experimentation is done using FlickrLogos-32 PLUS dataset. Experimentally, it is noticed that the proposed technique is invariant to various transformations with significant performance.

The paper "A novel scene-based video watermarking scheme for copyright protection," authored by Shukla and Sharma, presents an approach to digital video watermarking for copyright protection using two different algorithms, whereby the successive estimation of a statistical measure is used to detect scene boundaries and watermark is embedded in the detected scenes with DWT. Experimental results demonstrate better visual imperceptibility and improved performance in terms of NC and bit error rate. Comparative analysis with existing schemes proves the improved robustness, better imperceptibility, and reduced computational time of both proposed algorithms.

The contributions of these nine selected articles in this Special Issue can provide a concise overview of the current state-of-the-art techniques and disseminate some of the new and interesting ideas and approaches that the authors have expressed in their papers. We hope they can provide a solid foundation for future new approaches and applications.

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