An Analytical Survey on Image Compression

Pranali Dahiwal
Department of Technology,
SPPU, Pune India
pranali.da@gmail.com

Anagha Kulkarni
Cummins College of Engineering for Women, Pune, India
anagha.kulkarni@cumminscollege.in

***Abstract*— There has been a significant increase in the number of smartphones and other devices that have been highly useful as a means of communication and entertainment. Therefore, there is a need to secure such devices as the majority of the smartphones that are being sold have been equipped with inbuilt biometric authentication system. Facial features are very diverse and have some kind of similarity with features in other people's faces, especially relatives and siblings. Therefore, there is a need to offload the facial authentication system and the recognition images to the cloud platform for computation. To this end, this research article has analyzed the past works based on the facial image compression paradigm for their improvements and limitations to assist in the implementation of a fast and effective facial image compression technique that will be discussed in detail in the upcoming publications.**

***Keywords*— Image Compression, Facial Features, Face Compression.**

I. INTRODUCTION

Biometric authentication has attracted immense attention over the past few years. This is due to the fact that security and privacy have been highly debatable topics that have been trending all over the world. With the introduction of the internet paradigm, it has facilitated a lot of different services from the platform that has been highly crucial in increasing the convenience of the users by a large margin.

Biometric authentication has been on the rise recently as more and more researchers have been utilizing this platform for enabling robust and secure security to various different applications. This process has been improved with the introduction of biometric sensors in Smartphones and other mobile devices have led to the proliferation of this technology with the common people [1].

Therefore, in such applications, there is a need to reduce the size of the data that is used to maintain a facial recognition system. Due to the system being on the cloud server, we need to actively maintain the space complexity of the server intact [4]. This is due to the fact that the facial recognition data is in the form of images that can take a lot of space when not optimized or compressed which could quickly cover up the entire space of the cloud server. There is a growing need for the creation of efficient Compression algorithms specifically for the maintenance of facial recognition images. As the increase in the amount of the data would be detrimental to maintaining a high latency of the cloud server and would, in turn, affect the other services reliant on the cloud.

Biometric facial authentication has also found an application in improving civil security by utilizing CCTV camera footage to identify individuals using facial image recognition [5]. Such a technique if applied to uncompressed images would highly cripple a system as it can not handle large resolution of facial image files due to the fact that the images with high resolution take up a lot of storage.

Therefore, there is a need for an innovative, robust and scalable facial image compression technique that can allow for the compression of facial images without any loss in the quality as well as the facial recognition performance. There are a lot of techniques that focus on the extraction of Principal Component Analysis (PCA) or other statistical methods that utilize Karhunen Loeve Transform (KLT) for efficient image compression [2]. These techniques effectively compress the image as compensation between image quality, compression ratio and the computational complexity that is associated with the compression of an image. This trade-off is highly debatable and a poorly compressed image would be useless as the facial features would difficult to ascertain in such a compressed image.

Therefore, there is a need to create a facial Image Compression technique that would allow us to use the facial images for the purpose of easily authenticating an individual. Such a concentrated technique was utilized in [3]. The authors used facial frontal images for the purpose of compression, these images had the full-face frontal view with all the features of the face easily distinguishable. This is a highly innovative technique, but the whole process of decompression using a master code for an individual compiled of thirteen facial features did not allow for efficient and secure authentication to be carried on such images. The technique effectively produced an image that is visually appealing and there is a need for a technique that can achieve facial image compression with minimal drawbacks and tradeoffs.

978-1-7281-6823-4/20/$31.00 ©2020 IEEE

In this paper, section II is dedicated for the literature review of past work, section III is discussion and finally, section IV concludes this paper.

II. RELATED WORKS

This section analyzes the past works related to facial image compression in-depth and tries to understand their technique and flaws as described below.

D. Marpe et. al. presented a novel technique for image encoding [6]. The researchers proposed utilizing the widely used wavelet-based methods to be used for lossy image compression. The presented results demonstrate higher efficiency than conventional methods.

P. Wong and N. Memon describes a scheme to watermark images for easier authentication and verification [7]. The researchers have designed a scheme to watermark images, which can be either visible or invisible, with a key. A key is necessary to perform both the extraction and insertion process.

Z. Liu et. al. proposes a technique for compression of chromosome images, established on a significant characteristic of the images such as a region of interest to cytogeneticists for their diagnosis and evaluation [8]. For the chromosome ROIs, the compression is achieved by executing a differential operation on the chromosome for DE correlation, accompanied by the integer wavelet transforms. The researchers utilized the self-modified SPHIT algorithm to develop individual embedded bitstreams for both ROIs and remaining images that permit lossless-to-lossy compression of both.

S. Lo et. al. explores a specific image processing task based on a neural-network framework, developed to forage an optimal wavelet kernel [9]. The researchers aim to increase the compression efficiency of image recognition in Computed Tomography (CT) and calcifications in mammograms by utilization of a linear convolution neural network. Through the examination of tap-4 wavelets on Magnetic Resonance Images (MRI), Mammograms, Lena images, and Computed Tomography, revealed that the compression with the highest efficiency can only be produced by Daubechies wavelet with an infinitesimal mean-square-error for microcalcification and general image textures in mammograms. This optimization approach has been validated to perform with a significantly higher degree of precision.

Y. Zhao et. al. introduces a compression technique for cultural heritage images with the addition of a watermark for authentication [10]. The researchers utilized a data hiding framework incorporated with a digital watermark. The watermark consists of two constituents, a chrominance watermark for increasing the compression efficiency and augmented with a soft-authenticator watermark for tamper and authentication assessment of the image. The authors developed the watermark by utilizing the various domains and their orthogonal nature such as watermark insertion, color decomposition, and authentication. The proposed algorithm, named as DCT-DWT dual-domain algorithm for compression and protection of images, has been simulated to perform exceptionally.

Z. Chen et. al. proposes a technique for compression of Positron Emission Tomography (PET) images in the temporal and spatial domains relying on cluster analysis and Optimal Sampling Designs (OSD) [11]. The proposed algorithm accomplishes a staggering data compression ratio that even exceeds 80:1. The algorithm has not been tested experimentally on clinical data, therefore, in Dynamic PET data, the distinguishable groups are highly critical.

J. Park and H. Park explores stereo images and their disparity map based on a mesh representation [12]. The technique is central to the application concerned with stereo image compression and interpolation. To achieve a relatively high image quality in compression and interpolation of stereo images, the researchers propose a prediction error and view-interpolation error. The Errors are dependent on the gradient as well as the view-interpolation of the stereo images. The mesh representation, which is triangular in nature, is responsible for minimizing the prediction and interpolation errors.

V. Velisavljevic et. al. introduces the sparse representation of smooth images that can be achieved by 2-D Wavelet Transformation (WT), which is limited due to the fact that infuses contours or edges and is unable to capture the 1-D discontinuities efficiently [13]. This is implemented by a compression algorithm called Space Frequency Quantization (SFQ) which utilizes direction lets. The presented algorithm has been simulated and produced outstanding results.

V. Sanchez et. al. presents a fully lossless and efficient compression method for 4-D medical data [14]. The researcher utilized H.264/AVC advanced video coding scheme and its advanced features to develop a differential coding algorithm for the motion vectors. The suggested technique makes the data redundancy in 4-D to achieve a greater degree and quality of compression. A differential coding algorithm is designed by the authors to enhance the compression performance which exploits the correlations between the motion vectors. The proposed system was quantitatively evaluated on large medical datasets and the yielded results outperformed the conventional methods by a huge margin.

S. Miaou et. al. proposes a new lossless encoding method for the encoding of medical images [15]. The existing methods rely on intra-coding to compress a single image, such as JPEG-LS that has an exceptional coding implementation. But it fails to utilize the correlations between the frames among the pictures. Therefore, the authors present an innovative technique that implements both, the interframe coding with the motion vectors and JPEG-LS to improve the compression of the images. The technique was tested extensively on capsule endoscopy images and the results were relatively better than utilizing just the JPEG-LS independently.

W. Sun et. al. introduces a novel technique for rendering images in High Dynamic Range (HDR) and Texture Compression (TC) [16]. The conventional method DHTC is a flexible and robust method to generate HDR textures compressed at different bit-rates, as it is a joint-channel framework. The researchers develop two texture formats for HDR, the 4 bpp format that is of acceptable quality, whereas the heavier 8 bpp format is of the highest quality providing almost lossless quality. Thus, the paper defines a logical solution for the compression of HDR and LDR with the help of alpha maps.

Z. Mai et. al. introduces the utilization of inverse tone-mapping on a compressed Low Dynamic Range (LDR) to generate HDR content that is backward compatible [17]. The researchers propose an aggregation of compression and tone-mapping that estimated the distortion of the combination by developing a statistical model. The model is utilized to minimize the expected Mean Square Error (MSE) by locating the tone-curve through a formulated numerical quantization problem. The authors also present a simple model that generates a closed-form solution and minimizes the complex computations of the optimization problem. The framework was evaluated against the pre-existing methods and has demonstrated to procure higher quality images relatively.

C. Charrier et. al. explores the assessment of images after compression, as it has been traditionally done by humans, the authors interject that an optimized technique can be developed that reduces human error in the assessment [18]. Therefore, the researchers propose a calibration method that isn't subjective. Maximum Likelihood Difference Scaling (MLDS) is utilized to calculate perceived image quality. This technique ameliorates the drawbacks experienced in other rating methods and provides exceptional performance upgrade over the MS-SSIM method.

I. Tabus et. al. describes a technique for compression of depth map images [19]. The researchers utilize three different types of representation, firstly, the depth value over every region, secondly, the constant depth regions enclosed, thirdly, the crack edges. The authors utilized the mutual exclusiveness and natural smoothness of depth variation in the neighboring regions, to encode the depth values of a certain region. The approach was tested against conventional methods and achieved entropy and compression of extraordinary levels.

S. Kim and N. Cho presents a compression algorithm for lossless color images relying on the context-adaptive arithmetic coding and hierarchical prediction [20]. Initially, the image is encoded through a conventional grayscale compression and its y component is added to the RGB image DE correlated by a reversible color transformation. The researchers define a context model that is utilized for error prediction. The technique has been tested on images and produces exceptional results and reduced bit rates, in comparison to the conventional techniques.

W. Hu et. al. proposes an innovative compression algorithm for Piecewise Smooth images which utilizes GFTs, Graph Fourier Transforms that minimize the cost of total signal representation of each block of pixels, keeping the compactness and transform coefficients in consideration [21]. The researchers utilize GFT for a block of pixels at a time, because discrete cosine and other fixed transforms aren't capable of this process. As GFTs have high computational complexity, the authors implement two methods to reduce it, initially, to apply LR-GFT, a low-resolution pixel block is generated by down-sampling a High-resolution and utilizing a low-pass filter. Secondly, to preserve the sharp object boundaries, the authors employ up-sampling and interpolation at the decoder along the High-Resolution boundaries utilizing arithmetic edge coding.

Y. Dar et. al. introduces a method for the reduction of artifacts introduced in the image due to compression [22]. The proposed system is evaluated extensively and is proven to have an exceptional improvement in quality for the conventional compression algorithms.

L. Lucas et. al. describes a highly efficient technique for compression of medical images. The researchers employ lossless compression on the volumetric sets relying on the concept of Minimum Rate Predictors (MRP) [23]. The proposed algorithm has been demonstrated to be highly effective in comparison to conventional methods, such as JPEG-LS, CALIC, etc.

Y. Gao and T. Blumensath Explores the fundamentals of Computed Tomography such as inversion of linear systems [24]. As only one instance can be kept in the memory of a system at a time to invert large linear systems. To ameliorate these effects parallel computation is utilized with the help of newer architectures and GPUs. The researchers propose an algorithm for parallelization of the CT image construction, the system is applied to the reconstructed volume and arbitrary partial subsets of the data. The authors guarantee the frequent selection of dense matrices, by developing a homogenously randomized selection criterion, which maximizes the information flow. The proposed algorithm has been tested against conventional techniques and is proven to perform faster than the predecessors.

Y. Lin explains that there has been an increase in focus on the increasing the quality of the images after compression. It becomes highly difficult to easily compress an image that can be used effectively by a computer to perform various tasks without any degradation [25]. Therefore, the authors in this paper propose an effective task-based compression technique based on the JPEG 2000 framework that achieves significant improvement in machine-based tasks.

G. Akkad states that there has been a significant increase in the quality of images that are being produced nowadays. There are sensors being developed every year that improve the details of capturing the image. This leads to an overall increase in the size of the images that require significantly more storage space [26]. Hence, the authors in this approach have implemented an innovative approach towards solving this problem by utilization of watermarking and hamming code along with the stereoscopic image compression technique to achieve considerable reduction in the image size. The main drawback of the proposed methodology is that the presented technique is highly computation extensive.

T. Leung discusses the problems faced while compression of medical images for storage and transmission. Various approaches have been stipulated such as the MRI scan, the CT scan that produce high resolution images of the internal body parts for the doctor to spot an anomaly [27]. The authors in this approach define an effective and visually lossless compression technique based on the JPEG 2000 encoding paradigm. The experimental results indicate an extensive improvement over the traditional compression and encoding algorithms.

A. Bouida elaborates on the various approaches towards achieving the compression of images that can be utilized for enabling biometric authentication for various purposes. The authors state that most of the image compression approaches reduce the quality of the images that leads to a loss of detail that can render the image useless for the purpose of biometric authentication. Therefore, the authors have presented an innovative approach for the purpose of compression of the iris images using wavelet transformation and SPIHT coding that ensures that the finer details of the image are not lost [28]. The main drawback of this methodology is the increased time complexity observed.

D. Samai introduces the paradigm of biometric authentication as it is one of the most innovative and approaches that also is very hard to replicate. This is highly useful in various scenarios but as the image quality and size required for the biometric database is quite high it becomes a highly difficult task to achieve [29]. Thus, the authors in this approach have implemented an effective biometric system that utilizes the palmprint which is stored through the use of the progressive image compression that utilizes encoding through SPIHT coder to achieve reliable improvements. The main drawback of the proposed methodology is the lack of performance evaluation through feature extraction approaches.

S. Lim states that the PCA or the Principal Component Analysis is one of the most useful approach that can linearly and statistically transform a collection of variables. The authors in this publication utilize this novel concept to aid in the compression of the images effectively through the use of the block storage facilities [30]. The main drawback of this methodology is that the medical experts are not consulted in the evaluation of the compression results.

A. Al-Fayadh narrates that there has been a considerable increase in the utilization of medical images for the diagnostic purposes [31]. But the increase in the size of the images introduces a plethora of problems that need to be ameliorated. To ameliorate these effects the authors have proposed an effective and secure hybrid image compression approach through the use of a gradient approach. The resultant images have been compared using the JPEG 2000 encoding standard which was passed with flying colours.

S. Chandra explains that there has been a considerable shift towards the medical imaging paradigm as it allows for an early diagnosis of the ailment. This is a highly useful approach that eliminates the risk associated with operation and surgery to understand any anomaly in the patient's internal workings or organs. But the problem with this approach is that the medical images are extremely large that require enormous amounts of storage [32]. To reduce this dependence a lossless image compression approach is preferred for legal reasons.

B. Koc introduces the concept of gene activity identification and monitoring that allows for an effective presumption of the expression of certain genes. For this purpose, the entropy coders or the generic image compression encoders are generally used to compress these microarray images through which quite low-quality results are obtained [33]. To ameliorate this effect the authors in this approach present an inversion coding technique that effectively achieves an improvement of over 25% in the compression performance.

M. Mansour states that there has been a tremendous growth in the number of researches concerning the image compression paradigm of late. This increasing size is getting highly difficult to store and process which has led to the increase in the various approaches to compress the images by a plethora of researchers that have been implementing to overcome this problem [34]. The authors in this approach compare a variety of popular compression algorithms for their performance for the sensitivity of noise to the various approaches which have indicated a characteristic influence on each of the approaches which leads to an optimal compromise.

J. Taquet elaborates on the paradigm of biomedical images that has been increasing due to increasingly useful technological advancements that are being performed to eliminate the need for cutting open the body for the purpose of investigation. The act of operating an individual is highly dangerous as it involves the loss of significant amount of blood that is not desirable in any circumstance and must be avoided when necessary [35]. Therefore, there is a need for an effective and reliable lossless compression algorithm to compress biomedical images which the authors introduce through the utilization of the hierarchical oriented predictions.

S. Gao discusses that there has been a significant improvement in the brain imaging paradigm that has been a boon for diagnosing various brain related ailments. This type of scanning puts a lot of pressure on the existing techniques for the image compression that would be required to process such large amount of image data in one go [36]. Therefore, the authors in this publication outline an effective implementation of image compression applicable on the 3D High definition brain images. The main drawback of this approach is that the authors have not utilized this technique on other types of medical images.

C. Huang states that there has been a steady increase in the number of lossy image compression techniques that have been implemented in various representations. One of the main issues with this type of compression is that many artifacts are introduced in the image and the color bias is also a big problem with color images which lead to quantization errors [37]. To overcome these issues the authors in this publication propose an effective and deep learning methodology that utilized the YCbCr model to perform color correct compression of the images and reduce the redundant reconstruction and quantization errors noticed in the conventional approaches. The technique has been evaluated on the JPEG 2000 standard with satisfactory results.

J. Maheshwari narrates that there is an increase in the amount of counterfeiting and other illegal activities that have been increased due to the introduction and the supplementation of the internet paradigm. Therefore, the authors in this approach have proposed an effective water marking scheme that utilizes the DCT based pyramid transform along with a JPEG 2000 compression attack [38]. The experimental results indicate that the compression technique achieves significant reduction in the SNR in comparison to the conventional approaches to the image compression paradigm done before.

C. Lee explains that there have been significant improvements in the image sensor technology that can effectively utilize a large detail form which an image can be created. The traditional image compression techniques are not effective for hyper spectral images as they tend to omit the high signal energy obtained in the images which render them unable for use in processing [39]. To ameliorate this effect the authors in this paper define a hybrid compression of such images through the use of Principal Component Analysis along with a Pre-Encoded Discriminant information to preserve the resultant compress image effectively.

S. Mei explains that there has been increased use of the hyper spectral images in various applications. The images are really heavy and the conventional compression approaches such as the JPEG 200 and Principal Component Analysis or PCA although really effective in preserving the information in the hyperspectral image tend to introduce increased computational complexity due to the PCA paradigm [40]. The resultant technique is highly effective and achieves reduced computational complexity.

III. DISCUSSION

The literature review stipulated above demonstrates the ongoing researches that are being performed for facial image compression. There are various biometric features that are considered for the evaluation such as the eye and nose position and shape along with the various distances of the predominant facial features. The compression as well as the transmission rate of the approach is also one of the most important measuring parameters that are examined in this research article.

The distribution of the various research articles detailed in this paper have been segregated according to the type of images used for the image compression methodology. Most of the techniques that have been evaluated for their performance have had some inconsistencies that were identified. Some of the researches have exhibited poor management of the space complexity of the facial image compression technique as reviewed in some research articles like [4], [16], [26], [27], [30] and [32].

IV. CONCLUSION

For the purpose of designing a fast and efficient facial image compression technique, an assorted collection of previous researches on this paradigm has been analyzed with utmost scrutiny. Many researchers have been highly focused on only one aspect of the facial image authentication, such as, compression performance, security, speed of the authentication process, application of the scheme in a variety of approaches, etc. which is a very conservative approach that does not solve underlying problems of the facial image compression paradigm effectively. Therefore, an innovative and useful proposition of an efficient facial image compression technique has been formulated through this thorough analysis which will be augmented in the upcoming editions of this research publication.

For future research, an effective and efficient technique for facial image compression will be developed. The methodology will be designed to achieve a reduction of the size of the compressed image to 1/4th of the size of the original image.

References

[1] M. Chowdhury et al, “Fuzzy Rule-Based Approach for Face and Facial Feature Extraction in Biometric Authentication”, International Conference on Image and Vision Computing New Zealand (IVCNZ), 2016.

[2] Y. Liu et al, “Scalable Face Image Compression Based on Principal Component Analysis and Arithmetic Coding”, IEEE International Conference on Consumer Electronics - Taiwan (ICCE-TW), 2017.

[3] S. Balakrishnan et al, “Performance Study on Facial Image Compression using Master Code”, IEEE World Congress on Computing and Communication Technologies (WCCCT), 2017.

[4] T. He et al, “End-to-End Facial Image Compression with Integrated Semantic Distortion Metric”, IEEE Visual Communications and Image Processing (VCIP), 2018.

[5] Y. Li et al, “Joint rate-distortion optimization for simultaneous texture and deep feature compression of facial images”, IEEE Fourth International Conference on Multimedia Big Data (BigMM), 2018.

[6] D. Marpe, G. Blättermann, J. Ricke and P. Maaß, “A Two-Layered Wavelet-Based Algorithm for Efficient Lossless and Lossy Image Compression”, IEEE Transactions on circuits and systems for Video Technology, Vol. 10, No. 7, October 2000.

[7] P. Wong and N. Memon, “Secret and Public Key Image Watermarking Schemesfor Image Authentication and Ownership Verification”, Vol. 10, no. 10, 2001.

[8] Z. Liu, Z. Xiong, Q. Wu, Y. Wang and K. Castleman, “Cascaded Differential and Wavelet Compression of Chromosome Images”, IEEE Transactions on Biomedical Engineering, Vol. 49, No. 4, 2002.

[9] S. Lo, H. Li and M. Freedman, “Optimization of Wavelet Decomposition for Image Compression and Feature Preservation”, IEEE Transactions on Medical Imaging, Vol. 22, No. 9, 2003.

[10] Y. Zhao, P. Campisi, and D. Kundur, “Dual Domain Watermarking for Authentication and Compression of Cultural Heritage Images”, IEEE Transactions on Image Processing, Vol. 13, No.3, 2004.

[11] Z. Chen, D. Feng, W. Cai, and R. Fulton, “Performance Evaluation of Functional Medical Imaging

Compression via Optimal Sampling Schedule Designs and Cluster Analysis", IEEE Transactions on Biomedical Engineering, Vol. 52, No. 5, 2005.
[12] J. Park and H. Park, "A Mesh-Based Disparity Representation Method for View Interpolation and Stereo Image Compression", IEEE Transactions on Image Processing, Vol. 15, No. 7, 2006.
[13] V. Velisavljevic, B. Beferull-Lozano and M. Vetterli, "Space-Frequency Quantization for Image Compression with Direction lets", IEEE Transactions on Image Processing, Vol. 16, No. 7, 2007.
[14] V. Sanchez, P. Nasiopoulos, R. Abugharbieh, "Efficient Lossless Compression of 4-D Medical Images Based on the Advanced Video Coding Scheme", IEEE Transaction Information Technology in Biomedicine, Vol. 12, No.4, 2008.
[15] S. Miaou, F. Ke and S. Chen, "A Lossless Compression Method for Medical Image Sequences Using JPEG-LS and Interframe Coding", IEEE Transactions on Information Technology in Biomedicine, Vol. 13, No. 5, 2009.
[16] W. Sun, Y. Lu, F. Wu, S. Li and J. Tardif, "High-Dynamic-Range Texture Compression for Rendering Systems of Different Capacities", IEEE Transactions on Visualisation and Computer Graphics, Vol 18, No. 1, 2010.
[17] Z. Mai, H. Mansour, R. MAntiuk, P. Nasiopoulos, R. Ward and W. Heidrich, "Optimizing a Tone Curve for Backward-Compatible High Dynamic Range Image and Video Compression", IEEE Transactions on Image Processing, Vol. 20, No. 6, 2011.
[18] C. Charrier, K. Knoblauch, L. Maloney, A. Bovik and A. Moorthy, "Optimizing Multiscale SSIM for Compression via MLDS", IEEE Transactions on Image Processing, Vol. 21, No. 12, 2012.
[19] I. Tabus, I. Schiopu and J. Astola, "Context Coding of Depth Map Images Under the Piecewise-Constant Image Model Representation", IEEE Transactions On Image Processing, Vol. 22, No. 11, 2013.
[20] S. Kim and N. Cho, "Hierarchical Prediction and Context Adaptive Coding for Lossless Color Image Compression", IEEE Transactions on Image Processing. Vol. 23, No. 1, 2014.
[21] W. Hu, G. Cheung, A. Ortega, and O. Au, "Multi-resolution Graph Fourier Transform for Compression of Piecewise Smooth Images", IEEE Transactions on Image Processing, Vol. 24, No. 1, 2015.
[22] Y. Dar, A. Bruckstein, M. Elad and R. Giryes, "Post-processing of Compressed Images via Sequential Denoising", IEEE Transactions on Image Processing, 2016.
[23] L. Lucas, N. Rodrigues, L. Cruz, and S. Faria, "Lossless Compression of Medical ImagesUsing 3D Predictors", IEEE Transactions on Medical Imaging, 2017.
[24] Y. Gao and T. Blumensath, "A Joint Row and Column Action Method for Cone-Beam Computed Tomography", IEEE Transactions on Computational Imaging, 2018.
[25] Y. Lin et al, "Task-based JPEG 2000 Image Compression: An Information-theoretic Approach", IEEE Data Compression Conference, 2018.
[26] G. Akkad et al, "FPGA Hardware Architecture for Stereoscopic Image Compression Based on Block Matching, Watermarking and Hamming Code", IEEE International Image Processing Applications and Systems Conference, 2016.
[27] T. Leung et al, "Visually Lossless Compression of Windowed Images", IEEE Data Compression Conference, 2013.
[28] A. Bouida et al, "The improving of biometric image quality compression using Wavelet and SPIHT coding", International Conference on Signal, Image, Vision and their Applications (SIVA), 2018.
[29] D. Samai et al, "Multimodal Biometric System based on Palmprint using Progressive Image Compression", International Conference on Information Technology for Organizations Development (IT4OD), 2016.
[30] S. Lim et al, "Medical Image Compression Using Blockbased PCA Algorithm", IEEE 2014 International Conference on Computer, Communication, and Control Technology (I4CT 2014), September 2014.
4, 2014
[31] A. Al-Fayadh et al, "An Adaptive Hybrid Image Compression Method and Its Application to Medical Images", 5th IEEE International Symposium on Biomedical Imaging: From Nano to Macro, 2008.
[32] S. Chandra et al, "Lossless Medical Image compression in a block-based storage system", IEEE Data Compression Conference, 2014.
[33] B. Koc et al, "Lossless Compression of DNA Microarray Images with Inversion Coder", IEEE Data Compression Conference, 2014.
[34] M. Mansour et al, "Comparative analysis on image compression techniques for chromosome images", 2nd International Conference on Advances in Biomedical Engineering, 2013.
[35] J. Taquet et al, "Hierarchical Oriented Predictions for Resolution Scalable Lossless and Near-Lossless Compression of CT and MRI Biomedical Images", IEEE Transactions on Image Processing, Vol. 21, no. 5, May 2012.
[36] S. Gao et al, "Deep Enhancement For 3D HDR Brain Image Compression", IEEE International Conference on Image Processing (ICIP), 2019.
[37] C. Huang et al, "Multi-Channel Multi-Loss Deep Learning Based Compression Model for Color Images", IEEE International Conference on Image Processing (ICIP), 2019.
[38] J. Maheshwari et al, "Robust Digital Image Watermarking using DCT based Pyramid Transform via image compression", IEEE ICCSP 2015.
[39] C. Lee et al, "Hybrid Compression of Hyperspectral Images Based on PCA With Pre-Encoding Discriminant Information", IEEE Geoscience and Remote Sensing Letters, 2015.
[40] S. Mei et al, "Low-Complexity Hyperspectral Image Compression Using Folded PCA and JPEG2000", IEEE International Geoscience and Remote Sensing Symposium, 2018.