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Passport Photo Compression: A Review

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ABSTRACT

The demand for electronic -passport photo (frontal facial) images has grown rapidly. It now extends to Electronic Government (E-Gov) applications such as social benefits driver's license, e-passport, and e-visa . With the COVID 19 (coronavirus disease), facial (formal) images are becoming more widely used and spreading quickly, and are being used to verify an individual's identity, but unfortunately–that comes with insignificant details of constant background which leads to huge byte consumption that affects storage space and transmission, where the optimal solution that aims to curtail data size using compression techniques that based on exploiting image redundancy(s) efficiently.

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1. Introduction

Since the COVID19 (coronavirus disease), the need has been made to utilize facial images or referred passport photo images, especially in an e-learning platform, where all worldwide upload their personal facial images for recognition, and authentication. In addition to the need mentioned above for a facial image, it play a vital……role in (E-Gov) applications such submitting of individuals for jobs, paying tax, social benefit, driving license, e-passport and national cards. Basically that comes with a greater storage cost, because of huge bytes consumptions overloaded with image redundancy(s), even all the images overloaded are compressed in the standard-format of well-known efficient JPEG (Joint Photographic Experts Group) techniques, but still suffer from inherited problems of inability to consider image regions independently, and block-based nature[1]-[5]. Passport photo image compression generally represents the significant facial information compactly, while losing insignificant information of redundancy base, in which the techniques mainly classified either according to the redundancy removal of lossless and lossy scheme or the domain of removal that implies spatial coding (SC), Transformation Coding (TC) and Hybrid coding (HC) , figure (1) shows the categorized clearly. For general information about the image compression subject see [6]-[11]. Despite-a vast number of image compression techniques available today, either standard or non-standard, the need to construct an acceptable compression system of facial based urgently increased, where this reviewing paper is majorly concerned.

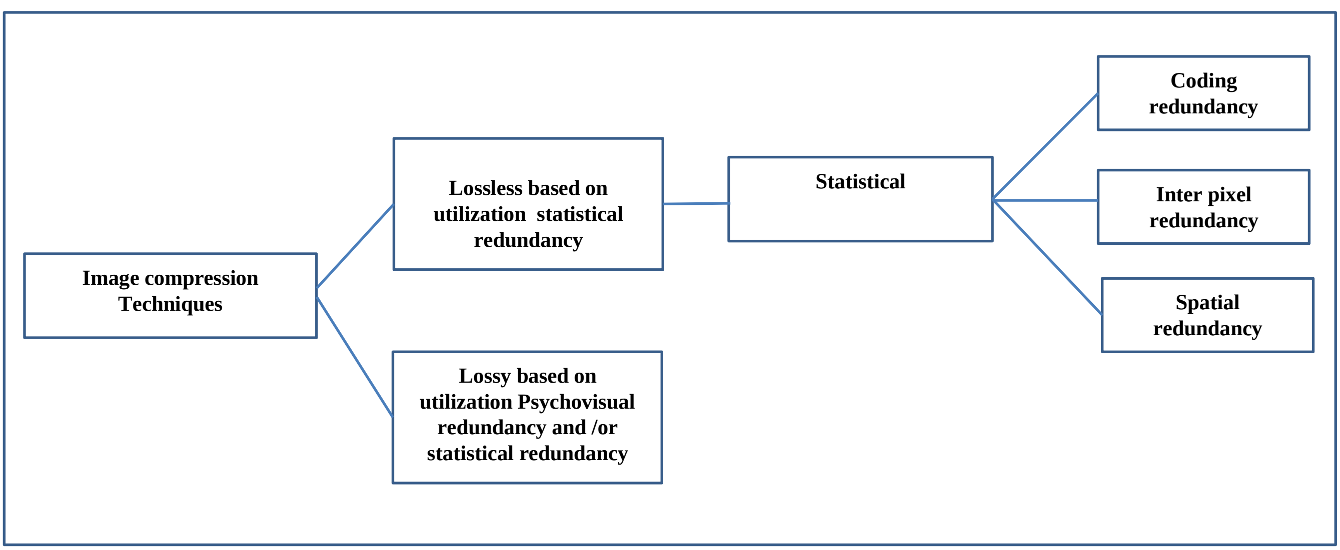

FIGURE 1: IMAGE CLASSIFICATION TECHNIQUES BASED ON REDUNDANCY UTILIZATION

2. Types of Image Compression

There are two main types of image compression, which are as follows: Lossless, lossy.

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2.1 Lossless Compression Techniques: Lossless compression ensures that, upon decompression, the image retains all of its original characteristics. In order to convey data more precisely without sacrificing information, lossless data compression most likely makes use of statistical redundancy . By encoding all the data from the original file, it compresses the image so that when it is decompressed, it perfectly matches the original image .

- Benefits: There is no quality loss, and image file sizes are only slightly reduced.
- Drawbacks: greater file sizes compared to lossy compression.

2.2 Lossy Compression Techniques: As the name implies, lossy compression results in some sort of data loss. The actual image and the decompressed version differ [12]. Multimedia data is most typically compressed using lossy compression. Text and data files, such bank records and text articles, generally need to be compressed without loss. Making a master lossless file that can be used to create compressed files for various reasons is generally advantageous.

- Benefits It is supported by a wide variety of tools, plugins, and applications and has very minimal file sizes.
- the drawback : The quality suffers as the compression ratio rises. After compression, the original cannot be recovered.

3. Literature Review

Baback and Alex [13], presented a fully automatic human facial model system for certain applications of video telephone, image database compression and face recognition. The proposed system is-based-on locating a face of the input grayscale image using Eigen–temples, followed by scaling then normalized it by their standard deviation, where the square root of the eigenvalues computed by the Karhunen-Loeve (KL) expansion and quantized by Lloyd-Max of Gaussian source. The system Was evaluated-using 2,000 images of the FERET(Facial Recognition Technology) faces dataset with variation of illumination(contrast), variances in head scale, and slight head skew, where the reduction in bytes was between 100 to 540 bytes according to image details (characteristics) compared to the standard JPEG of the quality–actor of 2%, with detection face accuracy of 97%, and it takes approximately 15 seconds to reconstructed face images on the modern-computer workstation.

Qiuyu and Suozhong [14], suggested a lossy color personal ID photo compression system of YCbCr color space, where each color band is segmented (divided) into three distinct areas: background, head/shoulder and facial regions, then coded using the JPEG-2000 based Wavelet transform (Daubechies 9/7) filter bank of five levels decomposition with varying quality factors, and the embedded block coding with optimal truncation (EBCOT) technique, where all the high frequencies in background discarded, while the borders of heard/shoulder are encoded using Freeman chain code followed by arithmetic coding, whereas the facial region coded using the shift up one bit in the encoder. The proposed system was evaluated using several non-standard color images of sizes (256x256) pixels with JasPer program, where high compression was achieved compared to the standard JPEG-2000, which converged to 20, with the facial region's Signal to Noise Rate (SNR) quality score was around 26.5dB, compared to 25.6dB for JPEG2000.

Michael et al.[15] ,introduced a lossy facial color compression system of the YCbCr color model, where each color band is coded independently that starts by determining the facial features to isolate the facial region from the background (non-facial region), then partition each image into tiles (blocks) of fixed sizes 8x8 pixels, where the tile content is modeled by clustering (using the K-means algorithm) the same tile with numerous training photos, and constructing a tree of Vector-Quantization (VQ) dictionaries per location of RMSE threshold base. The system was trained on 6000 non-standard images allowing compression rates nearly twice as good as JPEG-2000. However, the main challenge is maintaining VQ dictionaries at the encoder and decoder, which takes about 40 megabytes (MB) and takes about 3.5 seconds for both encoding and decoding processes. The bit rate and quality, such as bit per pixel (bpp=0.014), are used to test the experimental findings on 1000 photos (at various rates). For the JPEG2000 and the suggested system, the peak signal to noise ratio (PSNR) is 14 and 25, respectively, bpp=0.044 PSNR is 27 and 29.

Zhu et al. [16], proposed a lossy formal color compression system of The YUV color model, in which each color band Is coded (compressed) using shape adaptive SPIHT (SA-SPIHT) techniques, that starts by convolving the image with a created binary mask of 5-3 SA-wavelet of contour coding based on the differential chain to isolate the facial from non-facial regions, then utilized SPIHT with different quantization steps followed by arithmetic coding techniques. The system was evaluated using color non-standard and non-square photographs with a size of 126x102 pixels, where each original uncompressed image required (38 KB), the results were compared with standard techniques/non-standard techniques JPEG/ JPEG200/normal SPIHT, in which the attained PSNR= 38.7126 at compression rate (0.078 bpp) compared to JPEG/PSNR=22.4206, JPEG2000/PSNR=30.4706, SPIHT/PSNR=33. 5320.

Jun et al. [17], compressed formal facial color image loosely using the color transformation model of YUV, the system starts by isolating the facial Region of Interest (ROI) region from the non-facial (background) region using linear modeling scheme of non-uniform illumination base, followed by Sobel edge detector, thresholding and morphological filter. The facial (ROI) region is also segmented from the body one using skin detection of local minimum and maximum values, finally the facial region is coded using JPEG2000 with maximum shift (MAXSHIFT), while the background is set to zero values. The system was tested using a non-standard image dataset of roughly 2000 facial images, with better performance than the standard JPEG-2000, where the bitrates achieved between 0.05bpp to 0.625 bpp.

Ram et al. [18], presented a new face compression scheme based on Redundant Tree-Based Wavelet Convert (RTBWT) to transform, where the transform learned from a training set of aligned face images, along exploiting the sparse coding, then quantized uniformly, encoded using Huffman coding, and finally applied post-processing filtering to improve the results. The evaluation of the proposed system was carried out using a dataset of 4515 grayscale images with a size of 221x179 pixels with 8bpp and a test set of 100 aligned images, the results compared with standard techniques JPEG200, in which the attained PSNR= 29.98 dB at Structural Similarity Index Measure (SSIM) (0.84), while the proposed techniques without post processing / with post processing equals (30.32 dB, 0.79) and (31.83 dB, 0.87) with less than 1000 bytes preserving compared to JPEG2000

Tariq and Tawheed [19], exploited an application of DWT to compress passport images efficiently, the proposed system starts by locating namely selecting the face (ROI) automatically based on the color of the skin, then the ROI region is compressed lossless using Huffman coding techniques, At the same time, the non-facial region (Non-ROI) is compressed using SPIHT or EZW (Embedded Zero Tree) transformations to both images, followed by Huffman coding techniques. The experimental results tested on standard India color passport photo measuring 3.5 cmx3.5 cm with pixel resolutions of 512x512 pixel and 256x256 pixel, where EZW demonstrates slightly better results than other methods, in which For 512x512 pixels, the PSNR remains between 37.81dB and 39dB, with a compression ratio of 16.82 to 17.95, while for 256x256 pixels the PSNR was greater than 30 dB, with compression ratios ranging from 7.28 to 13.41.

Reni et al. [20], suggested a full face of frontal view pane background with a compression system referred to as Facial Image Compression Master Code Book (FICMCB), where the input images are read from a source (database), then divided into fixed block sizes of 8x8 pixels, vectored using the VQ process. The index is finally with Huffman coding and stored in a separate database that constitutes a data base of compressed information. The evaluation was applied on standard FERET database, with quality values of PSNR (between 27.45 and 29.72) for block sizes 64 and 16, respectively.

Ameer [21], proposed a lossy frontal facial image compression of gray image base that mixture between near-lossless and lossy compression techniques, the proposed system starts by converting the color images into gray base, then efficiently segmented facial (ROI) region form non-facial (Non-ROI) region using facial features of size, position and orientations, where non-facial region compressed using simple scalar quantization process, while the facial region compressed by utilized near-lossless scheme for residual image of spatial based techniques. The experiments results are based on adopting ten-non-standard square images of sizes 256x256 pixels, with scalar uniform quantizer for background (non-facial) region between 2to 10, with error tolerance of near lossless techniques equals 1, 1, where compression ratio achieved between 7.7 to 13.3 on average with PSNR values between over 40 dB and less 35dB.

Weqar [22], implemented a lossy frontal facial image compression of grayscale images that integrity between lossless and lossy techniques, the segmentation process based on background differencing, followed by median filters and finally automatically selected the global threshold value, for the background region (non-facial) the DWT of Haar base utilized along the hard thresholding techniques to quantize the details subbands, whereas the facial region exploited also the DWT with predictive coding techniques, namely use DWT of hard thresholding for details subbands, while predictive coding exploited for approximation subband. The proposed system tested on ten non-standard square images of sizes 256x256 pixels, with various hard thresholding values for background/subbands details of ROI regions, where compression ratio exceeds 10 with PSNR quality over 40 dB on average.

Abdullah [23], proposed an efficient hybrid photo passport compression system for grayscale images that combined between a novel spatial compression techniques that referred pixel based techniques (PBT) of optimized residual for facial region, along the developed joint photographic experts group (DJPEG) for non-facial region, with segmentation process which exploits facial features-based technique of Center Mass (CM) and Moment of Inertia (MOI), where implementation effective and quickly to crop or segmented the facial part from non-facial part using small number parameters. The experimental results evaluated using 15 images from FERET standard dataset with appreciable the CR and PSNR were between (14.8070 to 20.8183) and between (45.3944 to 42.5594) respectively.

3. Studies description

Description of study In this section, table 1 summarizes the image compression techniques that were previously explained and clarified during the subject review.

Table 1 – summary of subject review

No	Author	Compression Technique	Method	Describe
1.	Baback and Alex[13]	Lossy	Karhunen-Loeve basis.	the proposed system able to fully utilize the power of the KL expansion for encoding differences in facial geometry between different people thanks to ability to normalize extrinsic variations brought on by scale and position misalignment, changes in global illumination (contrast), and contrast changes. This facial detection algorithm can also be used in conjunction with a traditional coding scheme, giving faces and facial features preference when bits are allocated.
2.	Qiuyu and Suozhong[14]	Lossy	hierarchal scheme	The background boundary is described using the freeman chain code and its arithmetic code. The facial region is next biplane-shifted upward. Unfortunately, the generated bit stream does not adhere to the standard. Consequently, it has numerous application limitations.
3.	Michael et al. [15]	Lossy	K-means algorithm and Vector-Quantization (VQ)	Geometric warping into a canonical form followed by efficient coding for each block allows compression performance that is considerably greater than the JPEG-2000 for very low bit rates (in the range of 0.01-0.03 bpp). Since they require about 250 times the amount of memory as the input image, the VQ dictionaries require space in both the encoder and the decoder.
4.	Zhu et al [16]	Lossy and lossless	differential chain and shape adaptive SPIHT (SA-SPIHT) set partitioning in hierarchical trees	The wavelet-based JPEG2000 and SPIHT algorithms have a less severe impact than JPEG, although the human head's interior and edges show observable illegibility. Nevertheless, the recommended image compression technique, which is based on object segmentation, is capable of clearly presenting the reconstructed edge and texture information of human heads in photos, satisfying the standard criterion for official photographs.

5.	Jun et al. [17]	Lossy	Sobel edge detector, thresholding and morphological filter , JPEG2000 with maximum	The system first looks for background. The foreground is then divided into the body and facial regions using the object segmentation technique. The ROI in the following JPEG2000 compression is set to the facial region. Additionally, uniform background can be set to zeros prior to the wavelet transform to decrease the amount of bitrate it consumes in the LL subband. Background information may be omitted or sent as user-reserved data. The generated bit stream complies exactly with the JPEG2000 specification.
6.	Ram et al[18]	Lossy and lossless	Redundant Tree-Based Wavelet Convert (RTBWT), Huffman coding	As can be observed for this system , using both the RTBWT and the RWT during the post-processing stage enhances the performance of the system for all bit rates, the results of this approach when applied to the RTBWT are at least 8 dB better than those obtained when applied to the RWT.
7.	Tariq and Tawheed[19]	Lossy and lossless	Huffman coding and SPIHT or EZW (Embedded Zero Tree)	Both DWT-based compression using Huffman coding for ROI and EZW coding for NROI portions as well as DWT-based compression utilizing SPIHT coding for NROI portions fared well in terms of PNSR, MSE, and compression ratio. When encoding NROI with EZW, the performance was not as good as when encoding it with SPIHT.
8.	Reni et al[20]	Lossy	Master Code Book (FICMCB), VQ	There is a single master code book created through compression. This system makes use of the ferret database, and decompression is carried out using the Master code book. PSNR values that are significant are found for different block sizes. can recognize thirteen different facial characteristics. The only physical markers on the face that can be used to anchor six of them are the eyes, nose, mouth, and chin; the other four are scattered over the face's shape.
9.	Ameer[21]	Lossy and lossless	Predictive coding and scalar quantization	In this system's investigation of frontal face picture compression, effective features-based extraction segmentation is used to distinguish between facial and non-facial regions. Predictive coding and scalar quantization are methods that are combined (or blended) to get near-lossless and lossy results for face and non-facial regions, respectively. The segmentation method used is based on extracting face features, is easy to use, and clearly distinguishes between facial and non-facial portions.
10.	Weqar[22]	Lossy and lossless	(DWT), predictive coding and hard thresholding quantization	This method of investigation into face image compression uses a straightforward procedure of differentiating and thresholding of the global base to distinguish between facial and non-facial parts. The hybrid technique uses the discrete wavelet transform (DWT), predictive coding, and hard thresholding quantization techniques in combination with lossless (for facial component) The hard thresholding techniques used in conjunction with the hierarchical DWT scheme improve compression ratio while maintaining an image and lossy schemes (for background part) of mixing.

11.	Abdullah[23]	Lossy and lossless	Discreet Cosine Transform (DCT) and Spatial Coding (SC) of Pixel Base Technique (PBT) that implicitly mixed between pixel and block nature , Center Mass (CM) and Moment of Inertia (MOI)	this system proposed to address the issues with redundancy inside the background of the image (NON-ROI) and effectively handle ROI, a hybrid method of JPEG and a new pixel-based methodology are combined together. In order to achieve a greater compression ratio and satisfy quality for the reconstructed image, the input uncompressed image is effectively divided into two parts and each one is independently compressed.

6. Conclusion

As can be seen from this paper, the goal of both lossless and lossy images is to reduce image size and storage requirements and speed up image transfer. The compression ratio affects the size of the compressed image. For lossless compression, this ratio is 1: 2 or 1:3 ; As for the lossy compression, it is more than 10:1. In addition, it would not be possible to say that every method is used in every image. As a result, it is necessary to use the correct technique during image compression. Additionally the segmentation technique, which divides the image into ROI and NON-ROI, enables treating each part with a separate technique. Finding a segmentation method that works with all images has proven to be challenging, and there are still lots of real-world issues in applied research. The development of image segmentation techniques may show The integration of various segmentation methods by analyzing the benefits and drawbacks of the different image segmentation algorithms. It is required to mix different segmentation algorithms in order to improve the segmentation result because of the image's diversity and ambiguity.

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