REPro.JPEG : A new image compression approach based on Reduction/Expansion image and JPEG compression for dermatological medical images

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ABSTRACT

Medical image are known for their huge volume which becomes a real problem for their archiving or transmission notably for telemedicine applications. In this context, we present a new method for medical image compression which combines image definition resizing and JPEG compression. We baptize this new protocol REPro.JPEG (Reduction/Expansion Protocol combined with JPEG compression). At first, the image is reduced then compressed before its archiving or transmission. At last, the user or the receiver decompress the image then enlarge it before its display. The obtain results prove that, at same number of bits per pixel lower than 0.42, that REPRo.Jpeg guarantees a better preservation of image quality compared to the JPEG compression for dermatological medical images. Besides, applying the REPRo.Jpeg on these color medical images is more efficient while using the HSV color space compared to the use of RGB or YCbCr color spaces.

Keywords: Telemedicine, Archiving, Transmission, Medical Images, Image Compression, JPEG, Image Reduction, Image Expansion, Color Spaces.

1. Introduction

Information is now of paramount importance in our daily life and work. Information can take many forms ie, text, signal, image and video [1]. In this work, we will focus on image type of the data. These images are very rich in information which explains their large file volume [2]. Thus, the image storage requires a large space and can generate a transmission delay of the network [3]. Despite this, the use of images is very common in our daily lives mainly in social networks and platforms for collaborative work [4]. In this context, image is a key component in medical diagnosis and notably in telemedicine applications [5]. Moreover, the doctor requires good visual quality of the image being examined to minimize the chances of misinterpretations. Consequently, image compression is seen as the ideal solution to minimize the storage space of these images and to reduce their transmission time between different hospital involved in a collaborative platform for telemedicine while taking into account the preservation of visual image content [6].

In literature, several encoding image compression techniques are cited such fractal coding methods [7], region of interest coding techniques [8, 9], lossless dynamic and adaptive compression [10], low-complexity compression [11] and genetic algorithms [12]. However, JPEG [13], JPEG 2000 [14, 15], TIFF and JPEG-LS (JLS) [16] have remained among the widespread methods used as standards since they provided better performances in image compression. So to compress an image, it will, at first, be represented on a specific color space (RGB, YCbCr, HSV, ...). Then, the image will be transformed to the compression appropriate domain such the frequency domain for the JPEG compression and the multiresolution field for the JPEG 2000 compression. Next, the a quantization process will be applied to the new image representation. The obtained result shows the presence of grate rate of symbol redundancy which facilitate image encoding by several algorithms such RLE, Shannon, Huffman,.... As result we obtained a compressed image file [17]. We note that the quantization step has an great impact on the loss or lossless behavior of the compression scheme.

However we presented, on earlier work, a new compression method (REPro: Reduction/Expansion Protocol) which based on reducing the pixels number of the image to transmit or to archive [18]. In fact, the image will be reduced before its archiving or transmission. To display it, the image should be enlarged before to get its initial size [19].

In this work, we present a new protocol of image compression for transmitting and archiving images based on image reduction then JPEG compression of images during storage or transmission and decompression flowed expansion at the reception and the display. As this technique combines the resizing image aspect of the REPro and the encoding aspect of the JPEG compression, we named it REPro.Jpeg (Reduction/Expansion Protocol combined with JPEG compression). A particular attention will be paid to the impact of the choice of the color space on the performances of this new compression scheme.

In the next section of this paper we will focus on earlier works namely JPEG and REPro which we will fuse to obtain the REPro.Jpeg. The second section will be dedicated to detail the used image processing tools needed to achieve and to assess our proposed approaches. The principal of REPro.Jpeg will been explained in third section. The last section will present the results of REPro and REpro.Jpeg evaluation and a comparison between the compressed REPro and JPEG compression applied on our dermatological medical image database. Finally, we ended our paper by our conclusion.

2. Earlier works

The high price of medical equipments, the small number of specialized and experienced medical staff and the great dispersion of the population in rural areas present a great obstacle to the proper conduct of a medical examination 6. Given this situation, telemedicine is seen as an ideal solution to overcome these shortcomings 20. Indeed, thanks to technological advances in the fields of electronics, telecommunications and information technology, it is now possible to perform medical consultations, analysis, medical treatments and staff meetings remotely. Thus, these platforms must ensure a real time and huge information exchanges in signal, text, voice, image and video forms.

Figure 1. Telemedicine

However, the large volume of information exchanged between stakeholders and the limitation of bandwidth in certain covered areas can hinder the exploitation of collaborative platforms. Given the large volume of medical images and their frequent use, we propose a new image compression technique that aims to lighten bandwidth when transmitting these images and reduce their volumes of storage in medical images servers [21]. This approach is based on the combination of the REPro and JPEG compression. These two methods are the subject of this section.

2.1. JPEG image compression

The JPEG image compression standard is one of the most used image compression and supported by the majority of informatics platforms to benefit from its high compression ratio and its image quality preservation. JPEG exists in loss and lossless modes. In medicine, the JPEG compression standard is integrated in the DICOM file format [22]. To apply the JPEG algorithm on a color image, the image is firstly converted to YCbCr color space. Then, each 8 by 8 bloc will be transformed to the frequency domain using the Discret Cosinus Transform (DCT). Next, we quantify the obtained image representation. At last we apply the RLE (Run Length Encoding) and Huffman encoding to obtain the compressed image code [23].

However we note that medical image should ensures a good quality image preservation to guaranty a correct diagnosis. This impose the adoption of a low compression ratio (Equation 1) which mean a high Number of Bits per Pixel (NBpP : Equation 2)

$$compression\ ration = \frac{original\ image\ file\ volume(bits)}{compressed\ image\ file\ volume(bits)} \qquad (1)$$

$$NBpP = \frac{compressed\ image\ file\ volume(bits)}{image\ pixel\ number} \qquad (2)$$

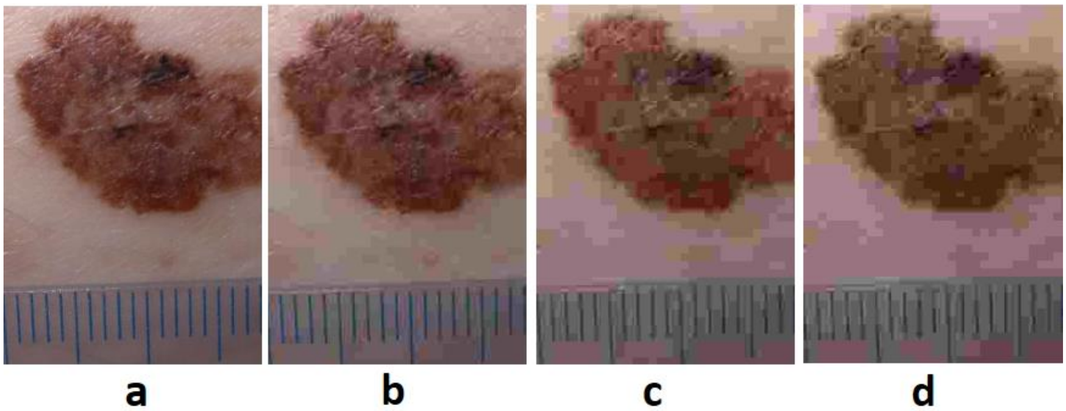

Figure 2. Image compression using JPEG,
a. Original Sample,
b. JPEG compression at nbpp = 0.35,
c. JPEG compression at nbpp = 0.25,
d. JPEG compression at bpp = 0.15.

According to Fig 2, its clear that the choice of the NBpP has a great impact on the display of the compressed image. In fact, the increase of NBpP ensures a better restitution of the image but it yields also a raise of the image file volume to storage or to transmit.

2.2. REPro : Reduction/Expansion Protocol

Reduction/Expansion Protocol called REPro is a new approach for image compression which consists on reducing the image size by sub-sampling it before its transmission or archiving. Using the mesh square-square decimation, mesh square-square decimation or the filtered mesh square-staggered-square decimation, in this phase, reduces the image volume to the quarter. However, displaying this image does not guaranty a visual comfort due to reduced size of the image. Therefore, we suggest to enlarge the image size before its display. Several techniques for over sampling this image could be used such zero padding, polynomial interpolation and B-spline transform. In this context, REPro aims to find the best reduction/expansion combination (R/E in Fig 3) to guarantee a maximum preservation of the image quality.

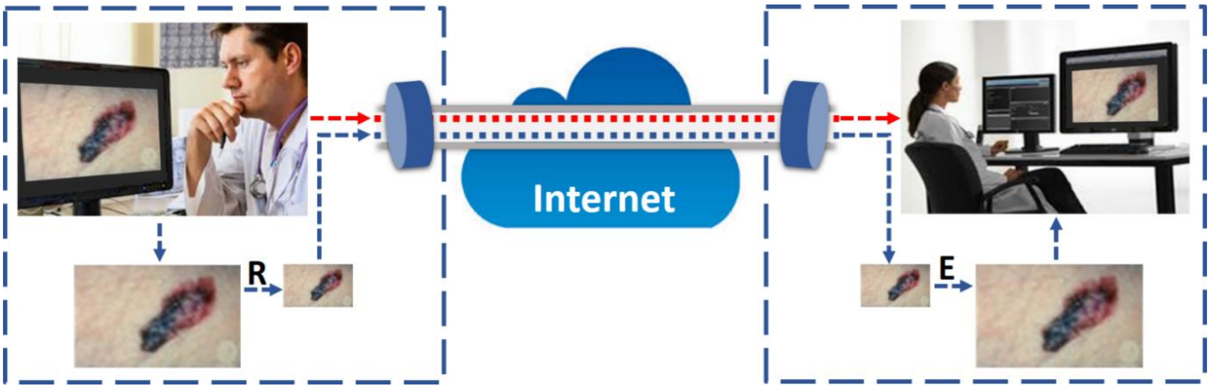

Figure 2. REPro Image compression in telemedicine application

We note that a space color conversion could be applied to the image to reduce by (R) before its decimation. A such process imposes a conversion to the RGB model before the expansion (E) phase.

3. Used image processing tools

In the following, we will detail the different tools necessary for the development and the evaluation of our new approach REPro.Jpeg. As the JPEG compression algorithm is very familiar, we will focus on the reduction and expansion techniques as well as color spaces needed to complete the compression chain REPro.Jpeg. The evaluation will be based on metrics PSNR (Peak Signal to Noise Ratio) and MSSIM (Means Structural SIMilarity index) and their derivatives selection rates.

3.1. Used reduction and expansion techniques

A. *Square-square mesh decimation*

To reduce the image volume file we can simply reduce the image definition which decreases the image pixels number. In literature, several techniques of image sub-sampling are cited such as square-square mesh decimation staggered-square mesh decimation and square-staggered-square decimation. Previous works [17] proof that square-square mesh decimation insures the best visual image quality. This image reduction method consists on preserving one pixel and removing 3 pixels from a 2 by 2 pixels bloc. This decimation yields to image reduction by a factor equal to 2.

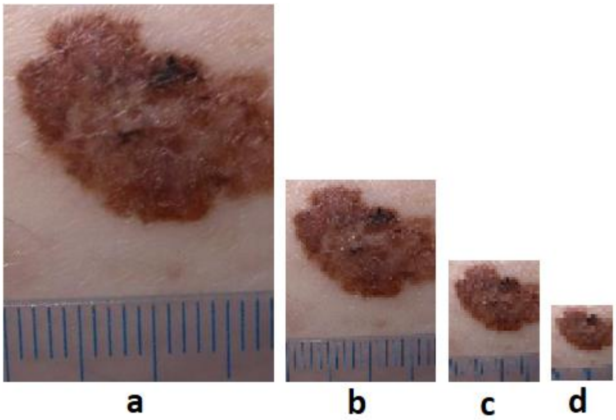

Figure 4. Image reduced by square-square mesh decimation,
a. Original Image,
b. Image reduced by a factor equal to 2,
c. Image reduced by a factor equal to 4,
d. Image reduced by a factor equal to 8

Generally, an image reduction by a factor equal to 2^n remains on applying the square-square mesh decimation on the reduced image by a factor 2^{n-1}. We note, also, that a reduction by factor of (a) decreases the image pixel number to (a^{th}) pixels number of the original image.

B. *Expansion methods*

The major purpose of image expansion is to increase the visual comfort of the viewer and by raising the image definition (the number of pixels in the processed image). This resizing application is frequently used to access the image details in several fields such as photocopying, computer graphics, medicine, military, the analysis of satellite images, etc. The expansion is based on preserving the visual content of the image and is done through several techniques which such as the zeros padding, the nearest neighbor interpolation, polynomial interpolation and the B-Spline transformation.

The technique of zero-padding [24] is based on preserving the spectral content of the image. Indeed, the image is transformed to the frequency domain using the Discrete Fourier Transform (DFT). Next, we add zeros in the image high frequencies. At last, the resulting image representation is converted to spatial domain by applying the inverse Discrete Fourier Transform (DFT^{-1}) [25].

The polynomial and B-Spline transform interpolations for image expansion are based on the preservation of the frequency and spatial contents of the image to enlarge. Thus, the pixels and the frequency spectrum of the original image are preserved. This image interpolation can be achieved easily in the spatial domain. Indeed, to enlarge an image by a factor of (a) using polynomial interpolation, we began by interlacing (a-1) pixels between each pair of adjacent pixels. Then, we compute values of the new pixels initially set to zeros using the adopted interpolation function and the near preserved pixels.

For a polynomial of degree 0, this method is called a interpolation to the nearest neighbor. In this case, we assign to each new pixel the value of its nearest original pixel [26]. Equation 3 describes this polynomial.

$$\begin{cases} h(x)=1 & if\ |x| \langle \frac{1}{2} \\ h(x)=\frac{1}{2} & if\ |x|=\frac{1}{2} \\ h(x)=0 & otherwise \end{cases} \tag{3}$$

By raising the polynomial degree to 3, we obtain the cubic interpolation. The use of this function to compute the value of a new added pixel takes in consideration the 4 closest preserved pixels. The following equation [27] describes the polynomial to be used in this expansion:

$$\begin{cases} h(x)=\frac{3}{2}|x3|-(A+3)x^2+1 & if\ |x| \leq 1 \\ h(x)=\frac{1}{2}(|x3|-5x^2+8|x|-4) & if\ 1\leq|x|\leq 2 \\ h(x)=0 & otherwise \end{cases} \tag{4}$$

The latest expansion technique we used is the B-Spline transformation interpolation. It consists in an analog to digital conversion which provides a smooth curve including all elements of the discrete function. In our case we use a B-spline transform applied to a Dirac impulsion. The given function involves all the original pixels to calculate values of new pixels [28]. The process of the B-spline transformation is detailed in [17].

In Fig.5, we present the results of a test sample (Fig 5.a) magnified by a factor equal 16 magnification using the different adopted approaches.

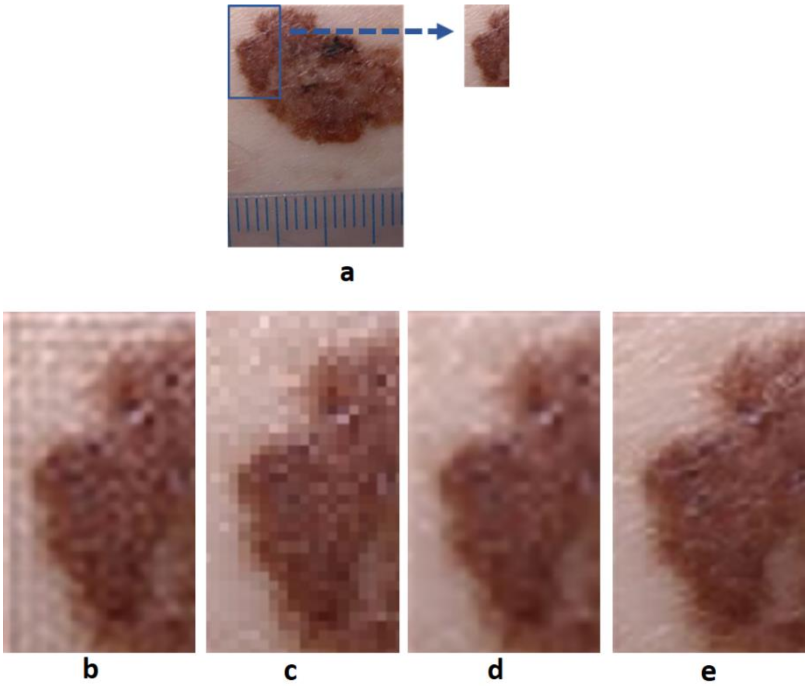

Figure 5. Visual effects of image enlargement by a factor equal to 16, **a.** Sample of the original image, **b.** Expansion by Zeropadding, **c.** Expansion by thenearest neighbor technique, **d.** Expansion by cubic interpolation, **e.** Expansion by B-Spline function.

This figure shows ripples at the edge of the image enlarged by the zero padding technique (Fig 5.b) which reflects the frequency discontinuity introduced by inserting components zero at high frequencies. On the other hand, the pixelation is clearly present in Fig 5.c. Indeed, the expansion by interpolation to the nearest neighbor yields to the apparition of grouping pixels having the same values. This undesirable effect is reduced by the cubic interpolation to cause the appearance of blur (Fig 5.d) due to the dependence of new pixels values to those of its preserved neighboring pixels. Finally, the B-Spline transformation seems the most efficient expansion technique by removing the pixilation flaw and by reducing the blur in the enlarged image (Fig 5.e) [17].

3.2. Image color space representations

During this study, we will interest to 3 color image models namely RGB, YCbCr and HSV. The RGB (Red, Green and Bleu) space color image encoding is the image representation which takes into consideration the display standards. As the display devices use the variation of the three components of the RGB additive base to display the image, color image is represented by

3 matrices which quantify for each pixel its red, green and blue chrominances. The superposition of these three chromas gives the color of each pixel.
In another hand, YCbCr is a standard appeared essentially for analog video by separating the luma Y, chroma Cb and chroma Cr. This system developed to adapt televisions whose display is in grayscale at the reception of color video. This format is also the starting color space of the JPEG compression [29]. The equation below describes the RGB to YCbCr transform [30].

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} +0.299 & +0.587 & +0.114 \\ -0.147 & -0.289 & +0.463 \\ +0.615 & -0.515 & -0.100 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{5}$$

The last color space that we will adopt is the HSV space. This type coding codes the image in 3 matrices: H (Hue) codes perceived color, S (saturation) represents the purity of color and V (Value) quantifies the amount of light color [31]. This type of coding is widely used for the segmentation of color images [32]. The following equation describes the RGB to HSV transform.

$$\begin{aligned} V &= \max(R,G,B) \\ S &= \frac{V-\min(R,G,B)}{V} \\ H &= \begin{cases} \dfrac{G-B}{V-\min(R,G,B)} & if\ V=R \\ 2+\dfrac{B-R}{V-\min(R,G,B)} & if\ V=G \\ 4+\dfrac{R-G}{V-\min(R,G,B)} & if\ V=B \end{cases} \end{aligned} \tag{6}$$

Where R,G and B represent the red, Green and blue chromas in the RGB space color.
By displaying in RGB color space the RGB, YCbCr and HSV matrices of the same image (Fig 6), we note that these views show the same image structure but with different colors.

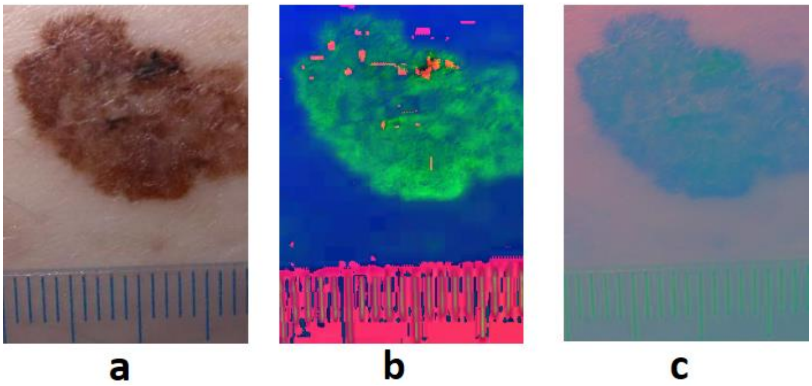

Figure 3. A sample of dermatological image displayed. **a.** RGB color spaces, **b.** HSV color spaces, **c.** YCbCr color spaces

3.3. Evaluation metrics

To ensure a correct diagnosis, the proposed compression techniques should guaranty a good preservation of the image visual content. To quantify the distortion involved by the use of the compression methods, we will use the PSNR and MSSIM metrics.

A. *PSNR (Peak Signal to Noise Ratio) and MSSIM (Means Structural SIMilarity index)*

The PSNR quantifies the dissemblance (in decibel dB) between 2 images X and Y having the same dimensions (nxm) [33]. The PSNR is computed from the MSE (Mean Squared Error) function as described in the following equations

$$MSE(X,Y) = \frac{1}{n \times m} \sum_{i=1}^{n} \sum_{j=m}^{m} (X(i,j) - Y(i,j))^2 \quad (7)$$

$$PSNR(X,Y) = 10\log_{10}(\frac{L^2}{MSE(X,Y)}) = 10\log_{10}(\frac{255^2}{MSE(X,Y)}) \quad (8)$$

where L is the dynamic range of the pixel-values

In another hand, the MSSIM quantifies the structural similarity between the 2 images X and Y. The MSSIM function is described by the equation 9.

$$MSSIM = \frac{1}{M} \sum_{i} \sum_{j} SSIM(i,j) \quad (9)$$

where M is the total number of local SSIM indices and SSIM(i,j) is the local structural similarity of the bloc (i,j).
In fact, in each one of the X and Y images is subdivided into M blocs x and y having the same dimension (generally 8x8 blocs). The equation 10 illustrates the equation of SSIM index of (x,y) blocs [34].

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)} \quad (10)$$
$$C_1 = (K_1L)^2,\ C_2 = (K_2L)^2$$

where μ_x, μ_y, σ_{xy}, σ_x, σ_y denote respectively the average of the window x (from X), the average of the window y (from Y), the covariance of x and y, the standard deviation of x and the standard deviation of y. C_1 and C_2 are 2 small positive constants with K_1=0.01 and k_2=0.03 by default.

B. *Reduction-enlargement selection rate based on PSNR or SSIM metrics*
During our evaluation, we will look for each image the best combination of image reduction/enlargement adopted for REPro and REPro.JPEG. For an image a combination is said "selected" if it provides the best fidelity between the original image and its reduced then enlarged counterpart image in terms of PSNR or SSIM. Subsequently, we can calculate, for each test image basis, the selection percentage of each reduction/enlargement combination.

4. Proposed approach: compressed REPro (REPro.Jpeg)

JPEG and REPro represent two different schemes for image compression. In fact, REPro compress image by reducing its size. However, the JPEG apply an encoding algorithm on the transformed image to frequency domain. The REPro.JPEG combine these two approaches and consists on reducing the image to its quarter number of pixels then compressing it by applying the JPEG algorithm on the reduced image before its archiving or transmission. Subsequently, before its display, the received or archived image should be decompressed then magnified. Such color images could have many representation depending to the chosen color space. The adoption of a image color space representation could yield to the modification of the best

Reduction/Expansion combination. For this reason, we suggest introducing a space color conversion to improve the performances of our compression approach as shown on the below figure where (Red. Comp. Image) is the reduced then compressed image to archive or to transmit.

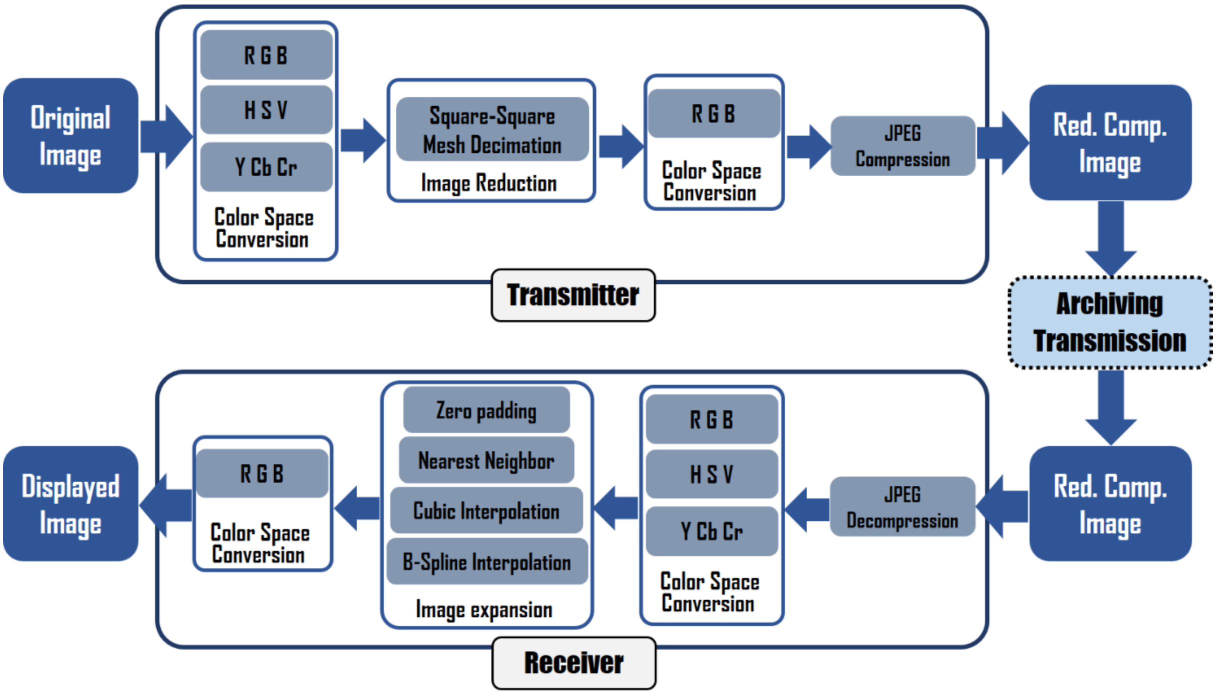

Figure 4. *Principal of the REPro.Jpeg*

So the REPro.Jpeg parameters are the chosen color space, the image reduction technique (square-square mesh decimation in our case), the image expansion technique and the NBpP of the JPEG compression.

5. Results and discussion

To highlight the contribution of our compression approach REPro.JPEG, we will compare its performances with those of the JPEG in terms of NBpP and in terms of preserving the image content quantified by PSNR and SSIM. At first, it is necessary to define the REPro parameters. These parameters are the reduction and expansion techniques and the starting color space adopted in the proposed compression scheme. During this assessment, we will use image color image database compounded by 30 medical dermatological images.

We began by the determination of the best reduction/expansion image combination for each color space. Tables 1-3 summarize the evaluation results of this study in terms of PSNR averages, SSIM averages and selection rates for the image database. In these illustration, we named R the square-square mesh decimation used for image reduction, A1, A2, A3 and A4 respectively the zero padding, nearest neighbor, cubic interpolation and B-Spline interpolation techniques used for image enlargement.

The application of REPro on these images reduces the image pixel number to the quarter which involves a decrease of the storage image file volume in bitmap format to almost the quarter of the original image volume. Thus, the preservation of the image content becomes the determining factor in the selection of the reduction/enlargement combination.

Table 1. *Assessment of the REPRo combinations applied on RVB dermatological image database*

		RoA$_1$	**RoA$_2$**	**RoA$_3$**	**RoA$_4$**
PSNR	Average (dB)	31,00	**34,58**	32,25	31,59
	Selection Rate	0%	**100%**	0%	0%
SSIM	Average	0,9237	0,9648	**0,9651**	0,9295
	Selection Rate	0%	0%	**100%**	0%

Table 2. *Assessment of the REPRo combinations applied on HSV dermatological image database*

		RoA$_1$	**RoA$_2$**	**RoA$_3$**	**RoA$_4$**
PSNR	Average (dB)	32,19	**35,64**	33,42	32,69
	Selection Rate	0%	**100%**	0%	0%
SSIM	Average	0,9076	**0,9654**	0,9585	0,9002
	Selection Rate	0%	**100%**	0%	0%

Table 3. *Assessment of the REPRo combinations applied on YCbCr dermatological image database*

		RoA$_1$	**RoA$_2$**	**RoA$_3$**	**RoA$_4$**
PSNR	Average (dB)	29,05	**32,76**	30,29	29,54
	Selection Rate	0%	**100%**	0%	0%
SSIM	Average	0,9142	**0,9628**	0,9599	0,9196
	Selection Rate	0%	**100%**	0%	0%

Based on the established results in tables 1-3, we note that the enlargement by nearest neighbor technique of the reduced image guarantees the best fidelity to the original image in terms of PSNR for all images of the image database (PSNR selection rate 100%) and RGB, HSV and

YCbCr color spaces. This same decimation/expansion combination seems the most adequate for the REPro applied in the HSV and YCbCr color spaces according to the SSIM. However, the RGB space color promotes the use of the cubic interpolation to enlarge image according to the SSIM metric (table 1) for all images (SSIM selection rate = 100%).

Given this disagreement at the $REPro_{RGB}$ (REPro applied on RGB images) assessment where PSNR promotes the RoA_2 combination while SSIM promotes the RoA_3 combination, we merged these two metrics to choose between these two combinations. This metric fusion is based on the product operator that gives us a score equal to 33.36 for RoA_2 (PSNR 34.58 x SSIM 0.9648) and a score equal to 31.12 for RoA_3 (PSNR 32.25 x SSIM 0.9651). Consequently, we can consider the combination of the reduction by square-square mesh decimation and the expansion by the nearest neighbor (RoA_2) as the best REPro configuration in the RGB color space.

Moreover, we note that the HSV color space seems the best image color model for the REPro compression approach for all reduction-enlargement.

The REPro compressed protocol (REPro.Jpeg) combines a reduction of the image pixel number followed by the JPEG compression. In what follows, we will apply this new compression approach on our dermatologica image database transformed on the RGB, HSV and YCbCr color spaces. The best combination of each color space will be used for the REPro.Jpeg and will be compared to the standard JPEG compression. Thus, the REPro protocol will be represented by the couple RoA_2 (square-square mesh decimation and interpolation to the nearest neighbor) in RGB, HSV and YCbCr spaces. This assessment will highlight the compression performances in terms of NBpP versus the image alteration quantified by PSNR and SSIM.

The figure below illustrates the results of this comparison that evaluates the standard JPEG (———purple color), $REPro.Jpeg_{RGB}$ (— — green color), the $REPro.Jpeg_{HSV}$ (········ red color) and the $REPro.Jpeg_{YCbCr}$ (—·— blue color).

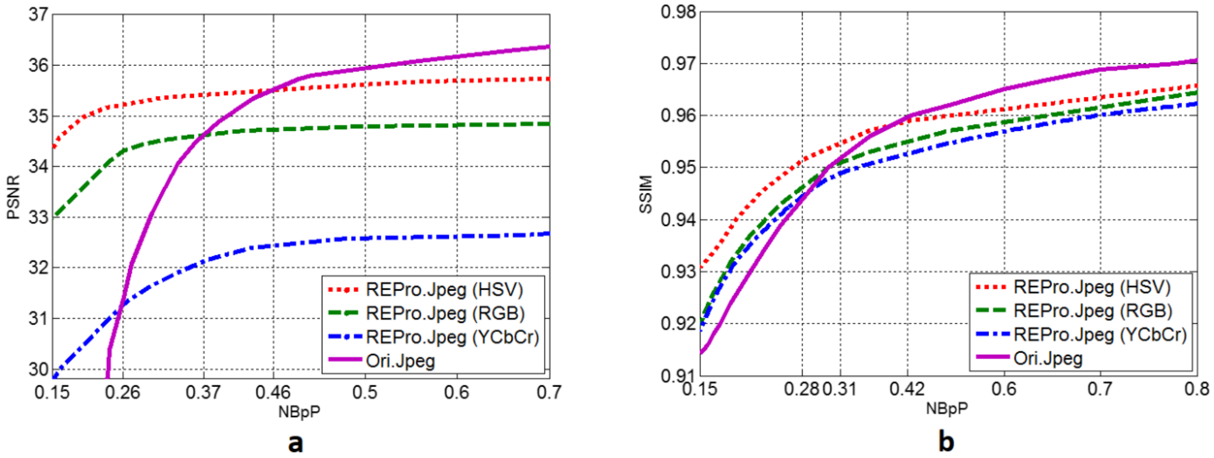

Figure 5. Comparison of REPro.Jpeg and JPEG, **a.** Evaluation in terms of NBpP Vs PSNR, **b.** Evaluation in terms of NBpP Vs MSSIM

The comparison of the different variants of REPro.Jpeg revealed a clear advantage of REPro.Jpeg in HSV space view it provides the best preservation of visual image content in terms of PSNR (Fig 8.a) and SSIM (Fig 8.b) compared to the REPro.JpegRGB and the REPro.JpegYCbCr. On the other hand, the choice between the compressed REPro and the standard JPEG compression for dermatological images transmission or archiving depends on the referred quality of the image compression. Indeed, the standard JPEG compression ensures less image distortion in terms of PSNR for dermatological image compression with NBpP higher than 0.46. This threshold is shifted to 0.42 when we adopt an assessment based on the SSIM metric. Below this threshold, the compressed REPro and especially REPro.JpegHSV guarantee a better preservation of the image visual content. This advantage of REPro.Jpeg becomes relevant for low NBpP. In fact, below the NBpP equal to 0.24, the standard JPEG compression causes heavy damage on the dermatological images that are expressed throughout PSNR lower than 30 dB. This fault is very inconvenient to the observer and can lead to misinterpretations as shown in Fig 9.

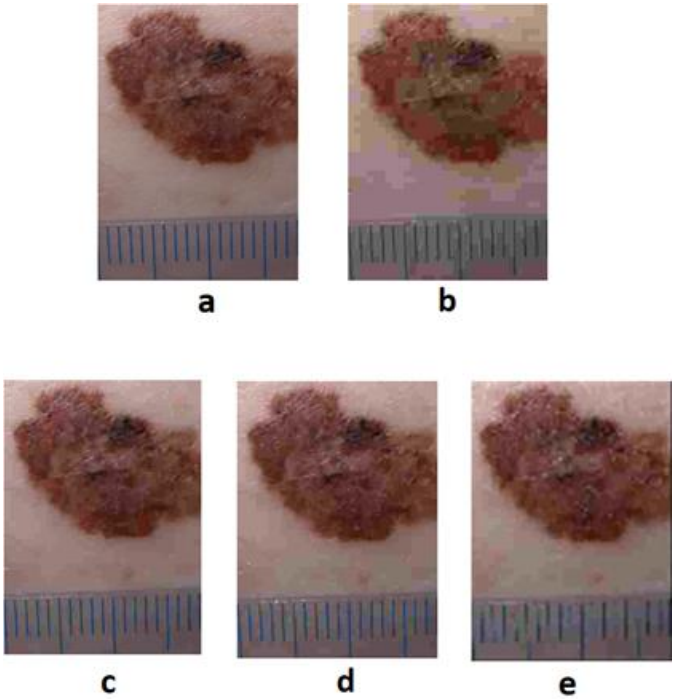

Figure 6. Visual Evaluation of REPro.Jpeg and JPEG at bpp = 0.25,
a. Originale image,
b. Image compressed by JPEG (PSNR : 28.33 dB , SSIM : 0.9126),
c. Image compressed by REPro.JPEGRGB (PSNR : 30.93dB , SSIM : 0.9293),
d. Image compressed by REPro.JpegHSV (PSNR : 35.80 dB , SSIM : 0.9438),
e. Image compressed by REPro.JpegYCbCr (PSNR : 33.30 dB , SSIM : 0.9329)

The visual inspection (Fig. 9) of the compression of the sample shown in (Fig. 9.a) at NBpP equal to 0.25 by the JPEG standard shows a sharp deterioration in the image as pixilation and loss of color shades. This distortion will be reduced by the adoption of different variants of REPro.Jpeg especially by REPro.Jpeg$_{HSV}$ which allows a good restitution of the original image. This visual inspection is aligned with the quantitative assessment in terms of PSNR and SSIM. Indeed, the PSNR of REPro.Jpeg are greater than 30 dB to exceed 35 dB through the REPro.Jpeg$_{HSV}$ marking a distinct advantage over conventional JPEG that provides us a PSNR of 28.33 dB. This last PSNR value unveils a flagrant dissimilarity between the original image and the image compressed by JPEG.

6. Conclusion

Image compression is still one of the busiest areas of research especially in the telemedicine domain. Indeed, medical images are known for their large data volume which can slow their transmissions and hinder their storages. Thus, compression is a necessity for the exploitation of these images. However, a high compression can result a loss of information and leads to a false diagnosis. In this context, the JPEG is seen as the most common compression standard. In this paper, we propose a new approach that combines the encoding aspect of the JPEG compression to the image resizing aspect of the REPro (Reduction/Expansion Protocol). Thus, our new approach which we named REPro.Jpeg consists on reducing the number of image pixel before its storage or its transmission and then its compression through JPEG. At the reception or when it is displayed, the image is decompressed and expanded. The reduction is provided by the square-square mesh decimation. To enlarge the image, we proposed 4 techniques namely zero Padding, interpolation to the nearest neighbor, cubic interpolation and interpolation by the transformed B-Spline. In addition, we studied the impact of the choice of the starting color space in the proposed compression scheme. Indeed, the REPro and REPro.Jpeg were tested on a database including 30 dermatological images which could be coded in the RGB, HSV and YCbCr color spaces.

The preliminary study on REPro demonstrated an advantage of the combination square-square mesh decimation followed by an expansion based on the nearest neighbor interpolation. Moreover, we noted that the HSV space is the most adequate image representation to the REPro. Combining the REPro and the standard JPEG compression, we note again that the adoption of the HSV color space ensures a better preservation of visual content of the compressed image by REPro.Jpeg. In this paper, we also compared the JPEG compression to the compressed REPro (REPro.Jpeg). This assessment reveals a advantage for JPEG during compression at NBpP higher than 0.46 in terms of PSNR. This threshold will be reduced to 0.42 for the assessment in terms of SSIM. Below these thresholds, the REPro.Jpeg_{HSV} guarantee a better restitution of the original image. In addition, below the 0.24 threshold we note a sharp distortion of the images compressed by JPEG and which gives PSNR lower than 30 dB while REPro.JPeg_{HSV} provides PSNR superior than 34 dB which allows us to exploit image compressed by our approach.

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