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Dynamic Web-Based 2D Medical Image Visualization and Processing Software

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***Abstract*—**In the course of recent decades, medical imaging has been dominated by the use of costly film media for review and archival of medical investigation, however due to developments in networks technologies and common acceptance of a standard digital imaging and communication in medicine (DICOM) another approach in light of World Wide Web was produced. Web technologies successfully used in telemedicine applications, the combination of web technologies together with DICOM used to design a web-based and open source DICOM viewer. The Web server allowance to inquiry and recovery of images and the images viewed/manipulated inside a Web browser without need for any preinstalling software. The dynamic site page for medical images visualization and processing created by using JavaScript and HTML5 advancements. The XAMPP 'apache server' is used to create a local web server for testing and deployment of the dynamic site. The web-based viewer connected to multiples devices through local area network (LAN) to distribute the images inside healthcare facilities. The system offers a few focal points over ordinary picture archiving and communication systems (PACS): easy to introduce, maintain and independently platforms that allow images to display and manipulated efficiently, the system also user-friendly and easy to integrate with an existing system that have already been making use of web technologies. The wavelet-based image compression technique on which 2-D discrete wavelet transform used to decompose the image then wavelet coefficients are transmitted by entropy encoding after threshold to decrease transmission time, stockpiling cost and capacity. The performance of compression was estimated by using images quality metrics such as mean square error 'MSE', peak signal to noise ratio 'PSNR' and compression ratio 'CR' that achieved (83.86%) when 'coif3' wavelet filter is used.

***Keywords*—**DICOM, discrete wavelet transform, PACS, HIS, LAN.

I. Introduction

WEB advancements rose quickly amid the most recent decade and empowered quick and dependable access to a wide range of data. These days' web applications got all essentials to contend with customary work area applications [1]. The part of stage freedom and availability from relatively every gadget makes web applications considerably all the more encouraging for what's to come. Since programming utilized for restorative applications is regularly exclusive, what is more, for the most part constrained to a particular working framework, the mix of web innovations together with the DICOM standard is a characteristic following stage.

"With the approach of filmless radiology, it ends up essential to have the capacity to appropriate radiologic pictures carefully all through a whole healthcare center" [2].

Another methodology dependent on World Wide Web advances was created to accomplish this goal. This methodology includes a Web server that allows the request and recovery of pictures put away in a DICOM, stored exams pictures could be seen inside a Web browser without require pre-installed programs. A few doctor's facilities around the globe have now understood the significant capacity of using automated picture "advanced pictures" rather than utilizing simple cellulose acetic acid derivation [3], in light of the fact that of the capacity of separating, putting away and transmitting advanced pictures. In addition, online applications as inverse to pre-introduced programming offer multi-stage innovation that permits individuals from various workstations worldwide to have the capacity to access such framework. "In the course of the last few a long time, Picture Archiving and communication Systems (PACS) have invited online advances and opened their skylines to another advanced time of radiology". The picture check can be seen inside a Web program with utilization of a WordPress module in PHP, or, in the other words the program. The framework offers a few points of interest over more conventional picture documenting and correspondence frameworks (PACS): it is anything but difficult to introduce and keep up, is stage autonomous, enables pictures to be controlled and showed proficiently, and is anything but difficult to coordinate with existing frameworks that are as of now making utilization of Web advancements. Dynamic transmission of restorative pictures through Internet has developed as a promising convention for teleradiology applications. The real issue that emerges in teleradiology is the trouble of transmitting expansive volume of medicinal information with generally low data transfer capacity [4]. Teleradiology is a subset of telemedicine managing the transmission and show of pictures, notwithstanding other patient-related data, between a remote site and a specialist focus. The innovation necessity for teleradiology is more stringent than that of general telemedicine in light of the fact that the previous includes pictures. Fundamentally, telemedicine without teleradiology requires just extremely straightforward innovation: a PC accumulates all fundamental understanding data, examination results, and indicative reports, organizes them in legitimate request with or without a standard configuration at the alluding site, and transmits them through media transmission innovation to a second PC at the master focus where the data are shown as delicate on the screen. In the present-day healthcare facilities or centers, the data gathering and the

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game plan of the data in legitimate request can be dealt with by the hospital center data framework “HIS”. At the point when the teleradiology benefit requires a patient's authentic pictures and in addition related data, teleradiology and PACS turn out to be fundamentally the same as. The real distinction between them is in the strategies for picture catch. Some present teleradiology activities still utilize a digitizer as the essential strategy for changing over a film picture to advanced arrangement, in spite of the fact that the pattern is pushing toward DICOM Standard. In PACS, coordinate computerized picture catch utilizing DICOM is generally utilized. In systems administration, teleradiology utilizes slower-speed wide zone systems (WAN) contrasted and the higher-speed neighborhood (LAN) utilized in PACS. In Teleradiology, picture stockpiling is for the most part here and now, while in PACS it is long term. Teleradiology depends intensely on picture compression, though PACS could conceivably [5]. A compression of restorative pictures is a basic territory of biomedical and telemedicine [6]. In restorative picture compression conclusion and investigation are doing great basically when compression methods ensure all the key picture data required for the capacity and transmission. A lot of restorative information is created through therapeutic imaging modalities. The digitization of therapeutic picture data is of massive enthusiasm to the therapeutic network to lessen capacity costs, transmission time, and for execution of the e-human services applications like telemedicine. Basically, there are two sorts of picture compression: "Lossy" or irreversible compression and "Lossless" or reversible compression: In lossless or reversible compression, there is no huge loss of key data in the reproduced picture information. Besides, lossless compression does not include the procedure of quantization but rather makes utilization of picture change and encoding to give a packed picture. This sort of pressure is of constrained application in computerized radiology, for a reason that it influences add up to consequence of diagnostics process because of loss of key data in the recreated picture. "One natural change is the Fourier Transform utilized in recreation attractive reverberation pictures (MRI)". Different technique, for example, the discrete cosine transfer (DCT) and the discrete wavelet transfer (DWT) are ordinarily utilized for picture compression. No loss of data happens in the change step. Quantization is the progression in which the information honesty is lost. "It endeavors to limit data misfortune by specially saving the most essential coefficients where less vital coefficients are generally approximated, frequently as zero. Quantization might be as straightforward as changing over trip guide esteems toward number qualities. At last, these quantized coefficients are minimally spoken to for effective capacity or transmission of the picture [7]. There is no uncertainty in the radiologic writing that the utilization of irreversible compression is accepting increasingly consideration as a method for decreasing the le size of indicative advanced pictures, to diminish capacity and reduction picture transmission times. Irreversible compression technique can give higher compression ratio (CR) contrasted with lossless compression techniques, "however don't impeccably repeat the first picture. In any case, the proliferation might be adequate that there is no detectable picture corruption nor bargained analytic esteem" [8]. A few investigations have been directed to analyze the impact of different compression ratio on the nature of pictures displayed to the radiologist for understanding either for essential analysis or then again for general clinical audit after the essential determination has been accounted for the assessment approach used in the evaluation of eyewitness execution is subjective as opposed to quantitative. This approach was chosen "in light of the fact that radiologists regularly assess pictures subjectively in their day-to-day rehearse and, likewise, in light of the fact that basic measurements utilized for contrasting pictures pre-and post-compression, e.g. mean pixel error, root mean-square error, peak signal to noise ratio, and so forth., may not relate well with visual appraisal of picture quality".

II. Methodology

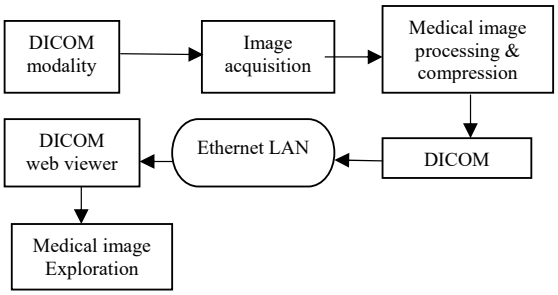

Fig. 1 Web based medical image exploration

A. Web Application

The nature of advanced picture has been considered as a worthy option in contrast to simple pictures for clinical, research, and instructing purposes if an enough data is held in the advanced picture. "Internet training records are a vital wellspring of instructive and referential materials in the radiology network and are generally utilized" [9]. The World Wide Web (WWW) is an awesome stage for disseminating mixed media documents. While DICOM is the standard of medicinal picture organize, to show DICOM records when all is said in done Internet browsers, for example, Internet Explorer, Mozilla or google chrome, it requires an extra DICOM module. Conveying DICOM records in a clinic wide PACS confines the openness since a protected private system can't be gotten to around the world freely. Building a dynamic Web webpage includes hypertext markup dialect (HTML) development and incessant resulting refreshes. Altering the HTML archives can be performed specifically with straightforward word processing programming or utilizing devoted Web distributing programming. The Common Gateway Interface (CGI) and server-side HTML-inserted scripting dialect is two of the most well-known techniques to deliver dynamic HTML reports. Secure, productive, and extensible open-source Web server Apache is currently the most well-known Web server on the planet. The SSL module encryption was presented to give solid cryptography to the

Apache 1.3 Web server through the Secure Sockets Layer (SSL v2/v3) and Transport Layer Security (TLS v1) conventions with the assistance of the Open-Source SSL/TLS toolbox. With solid encryption of the information stream, secret data is secured [10].

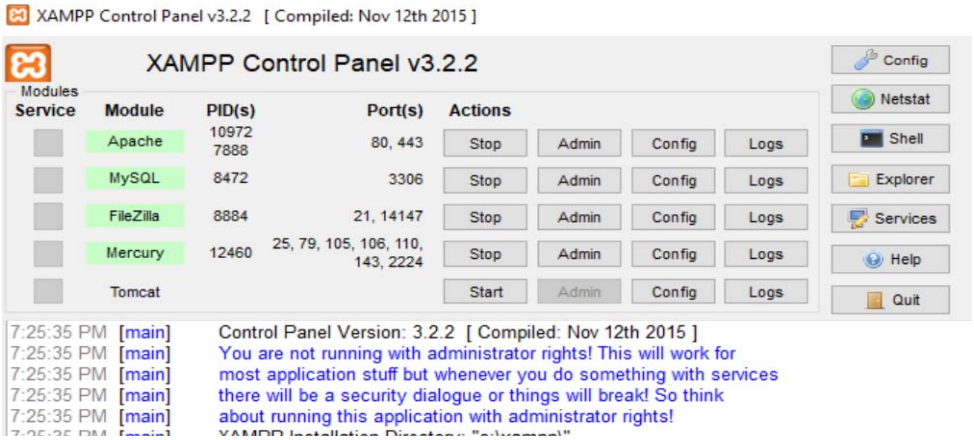

Fig. 2 XAMPP control panel

B. Image Compression

We picked DCT for compression. The DCTs express a limited sequence of information points in terms of a sum of cosine functions oscillating at different frequencies. The DCTs are similar to Fourier series coefficients of a periodically and symmetrically extended sequence, while DFTs are related to Fourier series coefficients of a periodically extended sequence. DCTs are equivalent to DFTs of roughly double the length, operating on real data with even symmetry, though in a few variations the input and/or output data are shifted by half a sample.

In DCT algorithm, we divided the input image into 8 by 8 blocks, computed two-dimensional DCT for each block.

If it represents a 2D image of size x (n1, n2) N × N, the 2D DCT of image is given by:

$$Y[j,k]=\sum_{m=0}^{n-1}\sum_{n=0}^{n-1} C[j]C[k]y[j,k]\cos\left(\frac{(2m+1)j\pi}{2N}\right)\cos\left(\frac{(2n+1)k\pi}{2N}\right) \quad (1)$$

where j, k, m, n=0, 1, 2…., N-1 and

$$C[j] \text{ and } C[k] = \begin{bmatrix} \sqrt{\frac{1}{N}} & if_{j,k=0} \\ \sqrt{\frac{2}{N}} & if_{j,k>0} \end{bmatrix}$$

We quantized DCT coefficients then coded and transmitted. The receiver decoded the quantized DCT coefficients.

Computed the inverse two-dimensional DCT (IDCT) of each block by:

$$X[m,n]= C[j]C[k]\sum_{m=0}^{n-1}\sum_{n=0}^{n-1} x[m,n]\cos\left(\frac{(2m+1)j\pi}{2N}\right)\cos\left(\frac{(2n+1)k\pi}{2N}\right) \quad (2)$$

Finally, put the blocks back together into a single image.

DCT had advantages such as simplicity, satisfactory performance, and availability of special purpose hardware for implementation. However, there was one major disadvantage of the DCT, while the inputs from preprocessed 8x8 blocks were integer-valued, the output values were typically real-valued. Thus, we needed a quantization step to make some decisions about the values in each DCT block and produce output that is integer-valued. The DCT compression code was implemented using MATLAB.

The procedure rehashed recursively on the low-resolution picture to make a progression of decreased goals pictures, likewise alluded to as sub groups. Expanding the quantity of wavelet disintegration levels, the low-low sub band is further stylistic theme related. Nonetheless, the incremental advantages coming about because of progressive wavelet decay are lessened past some pragmatic point of confinement that is fundamentally determined by the quantity of pixels in the first picture.

C. Discreet Wavelet Transforms Phases

1. ***Digitation***: The picture is digitized first. The digitized picture can be described by its power levels, or sizes of dim which extend from 0(black) to 255(white), and its resolution, or what number of pixels per square inch.
2. ***Thresholding***: In specific signs, a large number of the wavelet coefficients are close or equivalent to zero. Through edge these coefficients are adjusted so that the succession of wavelet coefficients contains long series of zeros. In hard edge, an edge is chosen. Any wavelet whose supreme esteem falls beneath the resilience is set to zero with the objective to present a large number without losing a lot of detail.
3. ***Quantization:*** Quantization changes over a grouping of drifting numbers w' to an arrangement of whole numbers q. The least difficult frame is to round to the closest whole number. Another strategy is to increase each number in w'

by a steady k, and after that round to the closest whole number. Quantization is called lossy in light of the fact that it brings mistake into the procedure, since the transformation of w' to q is not coordinated capacity.

4. ***Entropy encoding***: With this strategy, a whole number succession q is changed into a shorter grouping with the numbers in e being 8-bit numbers. The change is made by an entropy encoding table. Series of zeros are coded by numbers 1 through 100, 105, and 106, while the non-zero whole numbers in q are coded by 101 through 104 and 107 through 254. The guideline target of picture improvement strategy is to process a picture so that the resultant picture is more reasonable than the first for application. We utilized a portion of the blunder measurements to analyze the picture pressure methods the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) to accomplish alluring pressure proportions. The MSE is the combined squared error between the compacted and the first picture, while PSNR is a proportion of the pinnacle blunder. Legitimately, a higher estimation of PSNR is great since it implies that the proportion of Signal to Noise is higher. Here, the 'flag' is the first picture, and the 'clamor' is the error in reconstruction.

Compression ratio, otherwise called compression control, is utilized to evaluate the decrease in information portrayal estimate created by information pressure. The information compression ratio is similar to the physical compression ratio. It is utilized to gauge physical compress of substances, and is characterized similarly, as the proportion between the uncompressed size and the packed size.

Mean square error is a model for an estimator: the decision is the one that limits the total of squared error because of predisposition and because of difference. The normal of the square of the distinction between the coveted reaction and the genuine framework yield

$$MSE=\frac{1}{MN}\sum_{y=1}^{M}\sum_{x=1}^{N}[I(x,y)-I'(x,y)]^2 \quad (3)$$

where I (x, y) is the pixel in the input image, I' (x, y) is the pixel in the reconstructed image, M × N is the size of input image.

"PSNR" computes the peak signal-to-noise ratio, in decibels, between two pictures. This proportion is regularly used as a quality estimation between the original and a decompressed picture. The better quality of the compressed, or reconstructed image will be achieved at higher PSNR.

$$PSNR = 20 * log\ 10\left(\frac{255}{\sqrt{MSE}}\right) \quad (4)$$

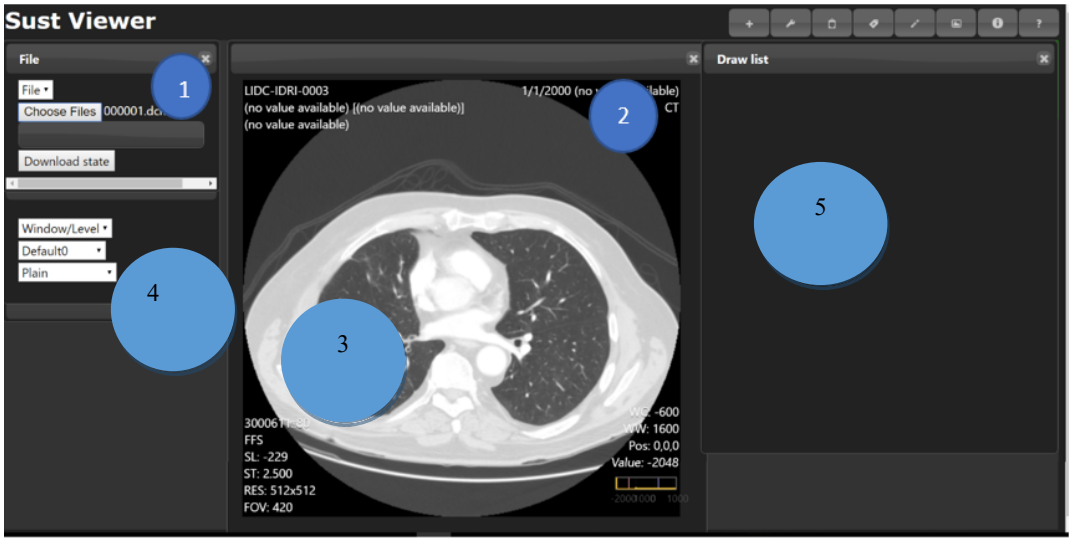

Fig. 3 User interface

III. Result

(1) Input image: options of choose file or download state use to select an image for study, the selected image will be display at the viewer.
(2) Important information displayed in the corners: shown the current window center (WC), the window width (WW), the date and time, the patient name, sex and patient's ID, field of view, resolution, and image modality.
(3) The selected image.
(4) Toolbar: History, DICOM tags, Annotations, Image, Information and Help.
(5) Toolbox.

Toolbox options:

- Window Level: By selecting this functionality, the parameters of the windowing function - window center and window width can be altered. Therefore, the user moves the mouse pointer to the image, presses and holds down the left button of the mouse, moves the pointer

along the x-axis or y-axis and releases the button at the end. “Dragging” along the x-axis changes the value of the window center, along the y-axis the value of the window width. Demonstrate the effect of changes in window-center and window-width values on the same image.

- Zoom: When this functionality is activated, the user can zoom in or out of the image by drag and-drop.
- Draw: When this functionality is activated, the user can put marks (arrow, ruler, protractor, rectangle, ROI, ellipse, free hand) on the image during his diagnosis.
- Livewire: to find the path line between the fixed start point and the variable endpoint.
- Filter: there are three filters (threshold, sharpen and Sobel filters) use for enhancing the image and remove noise.
- Flood fill: this option applied on an image to fill a bounded area with color.
- Default0: provide display options like (min/max, mediastinum, lung, brain, head, and bone).
- Plain: when this functionality activated it provide color calibration display for the image by this method (Invplain, Rainbow, Hot iron, Pet, Hot metal blue and Pet 20 steps to help the specialist in diagnosis.

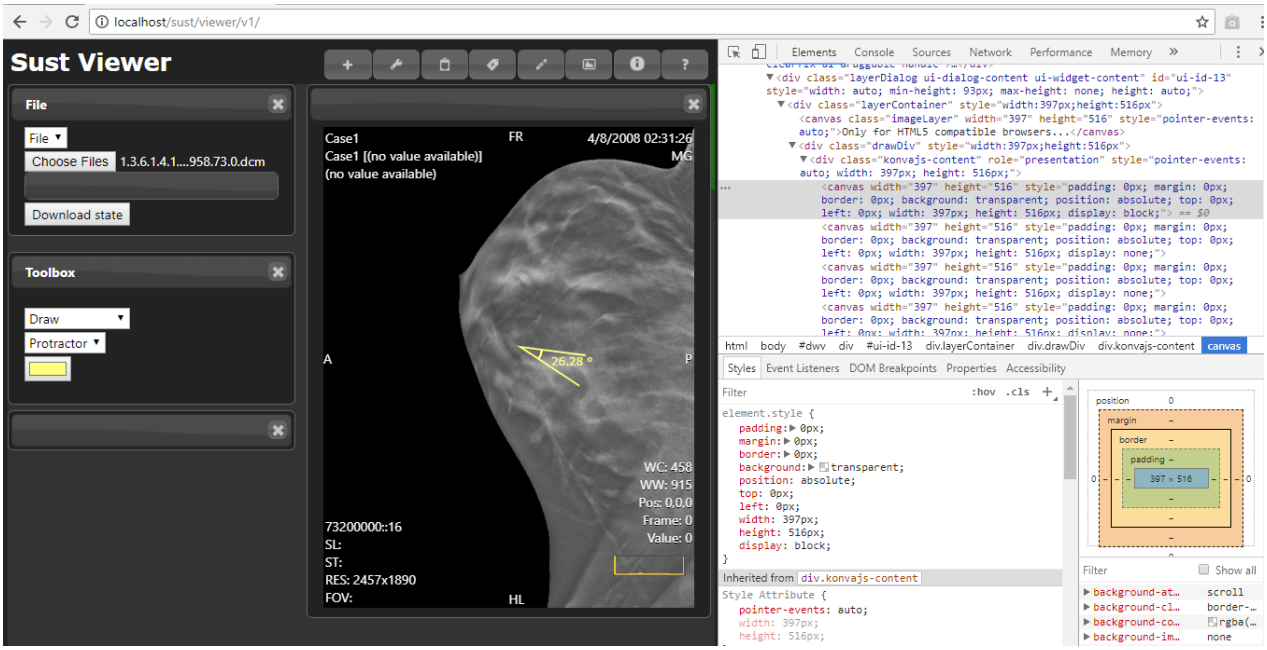

Fig. 4 Front-end & back-end of web-based DICOM viewer using mammogram image

DICOM images of resolution 512x512 pixels are used for experiments and wavelet filter is used for discrete wavelet transform. This section discusses the MATLAB simulation model developed in this project to understand the discrete wavelet transform, the archived experimental result has Percentage” 83.33%” on average of compression ratio of original image:

Fig. 5 Input original image, the compressed image, the reconstruct image

i. The impacts of various wavelet capacities, channel orders, number of decompositions, picture substance, and compression ratio are inspected. The last decision of ideal wavelet in picture compression application relies upon picture quality and computational unpredictability.
ii. Fourier based transform (e.g. DCT) are productive in abusing the low recurrence nature of a picture. The high recurrence coefficients are coarsely quantized, and thus the remade nature of the picture at the edges will have low quality.
iii. High MSE is estimated with lower Compression Ratio.
iv. DCT-based picture coders perform extremely well at moderate piece rates, higher compression ratio, and picture quality debases due to the antiquities coming about because of the blocked-based DCT plot.
v. A reasonable number of decompositions ought to be controlled by methods for picture quality and less computational activity. Decision of ideal wavelet relies upon the strategy, or, in other words picture quality assessment.
vi. Expanding the decomposition level expanding the MSE and Compression Ratio and lower the PSNR.
vii. Higher order filter demonstrates the low compression ratio, low MSE with high PSNR
viii. Wavelet based compression plan can abstain from

blocking curios that is observable in DCT strategy, however it has restrictions in catching geometric curves.so require new procedure for compression ratio.

TABLE I
CR, MSR, AND PSNR OF WAVELET TRANSFORM AT DECOMPOSITION LEVEL 2

Wevelet Filter	Compression Ratio	MSE	PSNR
Db1	83.33	1.51	296.6
Db4	82.88	1.30	2.94
Coif1	83.86	2.22	4.76
Coif5	80.12	2.13	5.16
Dmey	71.96	2.42	4.28
Sym2	83.39	4.54	1.55
Sym8	81.62	2.94	3.43
Sym25	77.00	8.91	8.61
Bior1.1	83.3	1.52	296.26
Bior2.2	83.1	3.05	3.28
Bior4.4	82.98	1.20	403.61
Bior6.8	81.78	2.42	4.26
Rbio1.1	83.5	1.56	296.27

IV. CONCLUSION

In teleradiology web based DICOM viewers are used to view medical images, however current solutions support only uncompressed DICOM files. Research highlighted the advantage of DICOM transmission for telemedicine applications by compressing DICOM images using wavelets transform coding which has much better coding efficiency and less computational complexity, wavelet algorithm implemented by MATLAB. The CR, MSR, and PSNR were calculated. In addition, a description of the source code by flow chart and screenshot show the compressed a reconstructed image.

V. RECOMMENDATIONS

Future aspects related to connect DICOM viewer with wide area network (WAN) for remote access of data and allow transmission between different healthcare facilities.

Due to the sensitivity of medical image content, an encryption method should be investigated for more security and client's privacy.

Web page can be developed and used for educational purpose as medical image archive to be used for E-learning by medicine and radiology students.

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