

Proving Rural and Urban Telemedicine with Improved Diacom Image Compression Using EXI Mechanism

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Abstract

Digital Imaging and Communication (Diacom) is a medical image format used in telemedicine. Telemedicine is the core of the modern age. A physician in one area uses a telecommunications device to provide a patient with treatment at a distant site. It's a substitute horizon that the globe publicly pays attention to. Throughout telemedicine sessions, access to personal patient health records and health trackers is on the market, helping you diagnose and efficiently manage patients. It is the main task to reduce each measure of storage and transmission data required for communication. Diacom Image Compression (DIC) is primarily based on the new Efficient Extensible Interchange (EXI) mechanism to realize this goal. Efficient Extensible Interchange is a very lightweight, high-performance XML representation that was designed to function well in a wide variety of applications. It boosts performance while slashing bandwidth requirements, all while preserving other resources including battery life, code size, computing power, and memory. The proposed work focuses on advance compression methodology for patient's historical data, electronic medical records of clinical information, and diagnostic test record. The results of the simulation recommends that the outcome of the proposed mechanism is better than the current approach. The present work compares the proposed methods with existing methodology and experimental analysis depicts that EXI based compression methodology is far better than traditional SVD compression methodology.

Key-words: Telemedicine, Diacom Image Compression, Healthcare, EXI, Singular Value Decomposition.

1. Introduction

The most effective instrument for epidemic conditions is telemedicine. Telemedicine is a growing healthcare sector, evolving from the synergistic convergence of bioscience with information technology, which has immense potential to solve the challenges of providing rural and remote healthcare[1].It can be as easy as two health professionals discussing the medical issues of a patient and seeking guidance over a direct telephone as complicated as transmitting electronic medical records of clinical information, diagnostic tests such as E.C.G., imaging images, etc. and ending immersive real-time medical video conferencing with the assistance of IT-based hardware and software, satellite video conferencing. Patient safety data such as prior examinations, laboratory test results, recorded medical images, etc. in digitized form can be easily transmitted over the network in these systems. The goal of telemedicine is to improve the delivery of healthcare to a wider population [2]. Because of its enormous size and transmission, it needs enormous bandwidth and transitional space in its raw state. Therefore, before transmission or storage, there is a need to compress medical data. The cost-effective DIC is crucial for ensuring service efficiency in order to satisfy the demand for high-speed image transmission in efficient image storage and remote treatment. Technically, as lossless and lossy, all image data is compressed into two groups. Data is lost within the lossy compression [3]. But many applications do not tolerate any loss in their data, such as satellite image processing and biomedical imaging, and are typically compressed using lossless compression methods in which only a few important coefficients need to be encoded, while the remainder of insignificant coefficients can be omitted while the reconstructed image standard does not change significantly. The aim of the research proposal is to find an innovative quality model for successful lossless compression methodology to be optimized for high-speed medical image transmission while maintaining diagnostic integrity without reducing radiological image quality. The research proposed a novel technique using Efficient Extensible Interchange (EXI) to compress diacom image in a lossless image.

The remainder of the paper is developed as follows. Section I includes the introduction of the DIC. In Section II, the context of compression strategies is given. In Section III, EXI features and properties are discussed. Section IV addresses the proposed DIC prototype. The experimental work, outcomes and discussions are presented in Section V. Conclusions are eventually discussed in Section VI.

2. Background

In literature lots of compression methods have been given. Among those methods wavelet transform for DIC is reviewed. In 1991, Majid Rabbani [4] studied the lossless and lossless image compression techniques where Discrete Cosine Transformation (DCT) is used together with Differential Pulse Code Modulation (DPCM) but DCT requires broad computational resources. Logeswaran Rajasvaran et.al.[5] introduced model-based medical image compression, but Dicom format cannot be stored directly via Hierarchy plot model result. Kamrul Hasan Talukder et al.[6] addressed the compression method and its quality evaluation based on Haar Wavelet but Haar Wavelet is discontinuous. Moorthi et al.[7] developed an integration model Using region separation where region of interest is compressed using Curvelet transform, DPCM and non-VOI is compressed using IWT, SPIHT and adaptive arithmetic encoding. Performance is degraded in IWT when edges are smooth curve after fusion results obtained. According to Sujitha Juliet Devaraj, [8] the reconstructed medical image slices with VOI were proposed 3D IWT and 3D EBCOT process in 2012. Result shows 3D object improvement obtained from reconstructed 3D images but smooth curve edge produces IWT hindrances. V.K. Bairagi et al.[9] listed transform compression based image compression and comparative analysis between KLT, DCT, WHT, DCT, DWT and IWT transformation is explored. J Erickson Bradley M.D. et. al.[10] stressed the importance of lossy compression of medical images. Response indicates that wavelet compression is better for radiographs than JPEG but its downside is that it does not manage curve discontinuities well. Lihong Zhao [11] highlighted combination of IWT and DPCM simple approach. In smooth curve areas IWT still is poor. Gram Badshah et al.[12] discussed watermarking ultrasonic medical images with lossless compression of LZW. It produces better results but in dictionary, LZW generates entries that might never be used. Brady Mathews [13] discussed in his paper regarding image compression using svd method. Image is represented on a matrix being visually displayed through pixels of red, green and blue on your computer. SVD method utilizes mathematical concept of Eigen vectors This data can be manipulated through the use of the SVD theorem to calculate a level of precision close to the original without storing as much data. Singular value decomposition is to reduce a dataset containing a large number of values to a dataset containing significantly fewer values, but which still contains a large fraction of the variability present in the original data. Let A be an $m \times n$ matrix. Performing SVD to A factorizes it into a product of orthogonal matrix, diagonal matrix and another orthogonal matrix. $A = USV^T$ Where, A is image matrix U is $m \times m$ matrix S is $m \times n$ matrix V is $n \times n$ matrix Singular Value Decomposition technique splits given matrix into a product of orthonormal matrices and a

diagonal matrix. This approach is purely mathematical and Complex. It require considerable amount of computations which is time consuming. The complexity of SVD itself is of the order of $O(n^3)$ In 2010 layer outlined by Maheshwari et al.[14]. Methodology of layer based compound image compression using XML for the foreground layer and JPEG for background layer compression is discussed. The most important downside is the long-winded XML scripts. Aforesaid survey concluded that transforming based techniques such as DCT; wavelet (DWT, IWT, hair, WHT) reduces performance when transferring images into unreliable networks with curve discontinuities. Literature says that transformation based methodologies are better for DIC. XML based compression method consist of redundancy and verbosity [15]. Therefore it is required a novel DIC methodology for high speed transmission of medical images used in telemedicine. After analyzing various technique EXI methodology is suggested for lossless image compression.

3. Efficient Extensible Interchange (EXI)

To overcome aforesaid deficiencies of xml, Binary xml technologies came into existence. Binary xml refers to any specifications that define the compact representation of xml data transmission over the network. It decline verbosity of xml document, reduce cost of parsing and provide indexing and random access of xml documents. There are various techniques of binary xml such as i) Fast Infoset (ISO/IEC and ITU-T) ii) EXI W3C recommendation based on work by Efficientxml from AgileDeltaInc. iii) Extensible Binary Meta Language (EBML) from Matroska iv) Wireless Binary Xml (WBXML). EXI is ready to directly integrate into the present XML stack and network architectures. EXI doesn't need the reengineering of information or physical spec; it merely “extends” what exist already and supply backwards likewise as future compatibility. EXI delivers future best approach through XML compression that permits information measure increase through file size reductions, and is backed by the belief of the increasing usage of XML within the IT world. EXI is a very compact representation for the Extensible Markup Language (XML) Information Set that is intended to simultaneously optimize performance and the utilization of computational resources [16]. The EXI format uses a hybrid approach drawn from the information and formal language theories, plus practical techniques verified by measurements, for entropy encoding XML information. Using a relatively simple algorithm, which is amenable to fast and compact implementation, and a small set of data type representations, it reliably produces efficient encodings of XML event streams Ultimately, if EXI is wide enforced, the attention organization are ready to deploy XML primarily based network traffic additional, specifically to the Cloud internet Service

or different tiny mobile and wireless network edge devices. Through the employment of Cloud internet Service in Hospital organization it'll be useful for all patients and additionally for Doctors World Health Organization will access patient data like patient report, previous check pictures and alternative data for immediate medical treatment. EXI format eliminates redundant tags and values from XML documents and encodes numeric contents in binary format. Experiments were conducted for evaluating the effectiveness of EXI. Schema-informed EXI method is way faster and finally ends up in smaller EXI documents compared to schema-less [17]. It is used as a total compression utility or is directly integrated into host applications. To prevent the expense of translating to and from XML, host applications may read and write EXI streams. EXI uses the fastest EXI processors in the world, and is able to evaluate and get winds of EXI heaps faster than recent XML processors. EXI is designed for devices which have very limited resources, in addition as mass market mobile handsets. It's deployed on a decent vary of varied platforms with restricted memory, storage, method power, battery life. EXI creates opportunities for adding heaps of compelling content and applications on existing devices whereas not extra resources. EXI is bit aligned so it can pack more information but drawback of bit alignment is that it requires more center processing unit instructions per byte. It need same encoding decoding algorithm in both schema and schemaless mode. Efficiency is provided by several components like EXI uses info from schema to boost compactness and process potency. Since EXI is compact, it takes less space for memory, storage and information measure. You can reverse the process to restore the content (e.g. element tags, values, and attributes) of the XML file. By default, non-essential information such as comments, processing instructions, and non-significant whitespaces are not encoded[18]. OpenEXI can optimize and restore any XML-compliant document. If there is no schema available, OpenEXI can build the grammar model by learning and inferring one as it processes a document. Using the default transformation options, you can encode an XML file by providing only an input stream and an output stream.

4. Proposed Diacom Image Compression Prototype

The suggested diacom image compression technique using EXI is depicted in Fig.1, CT scan images for patients are taken as input, and these input images are preprocessed for noise or some form of distortion removal in the next step. As an output of this phase we will obtain enhanced diacom images. The Python programming language is used for implementation of Dicom-to-Xml transformation. XML _To_ EXI encoding is carried out using the openEXI tool to achieve improved

compression and security. OpenEXI is a free, open source, java-language implementation of the XML document representation format EXI. The desired compressed diacom image is obtained after this phase. EXI to xml inverse transformation is required at the receiving end for decompression. The output of this stage is xml file, which is further transformed to diacom file inversely to find the original diacom image. Architectural view of proposed DIC prototype is outlined in Fig 2.

Fig.1 - EXI based novel Diacom Image Compression (DIC) Prototype

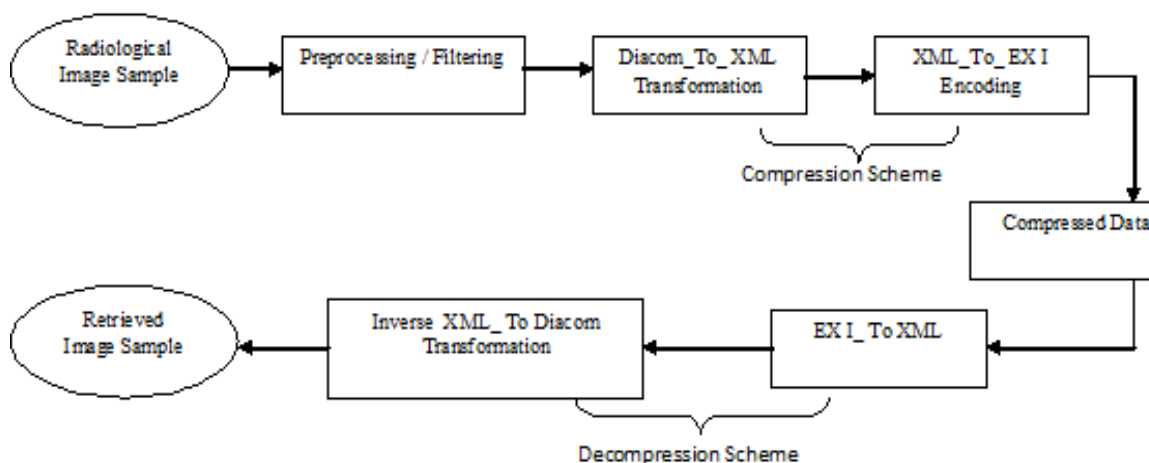
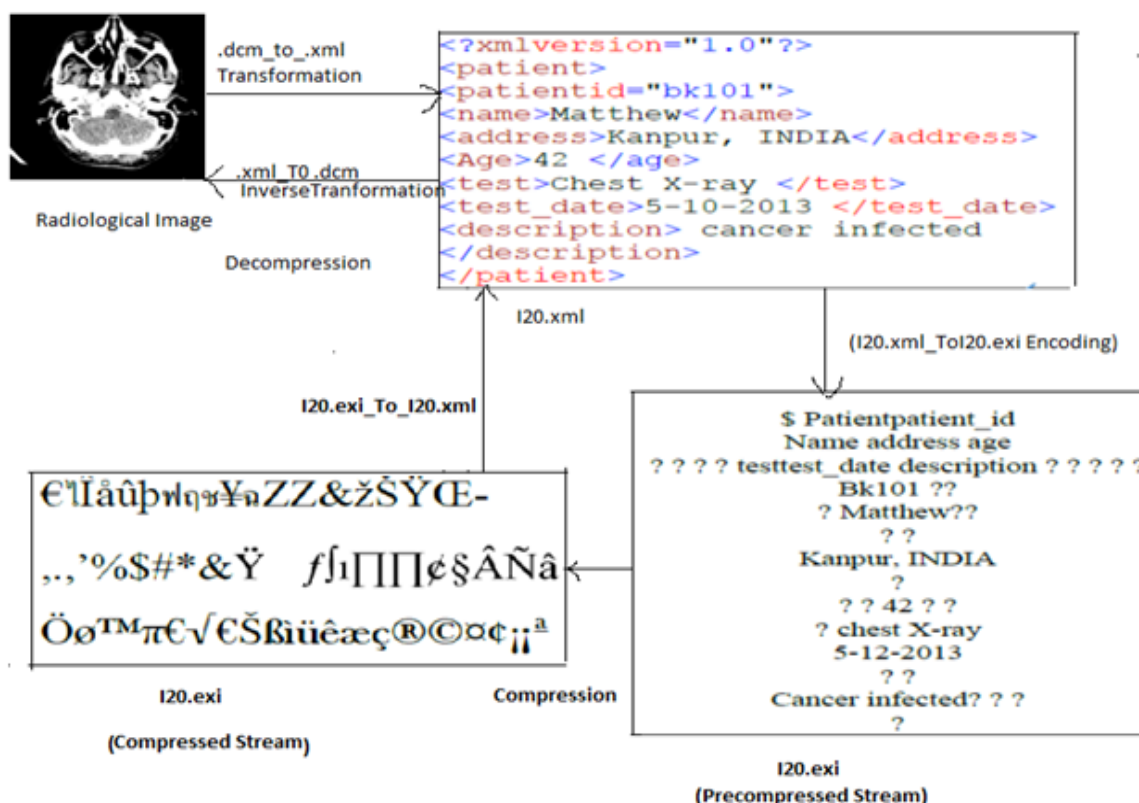
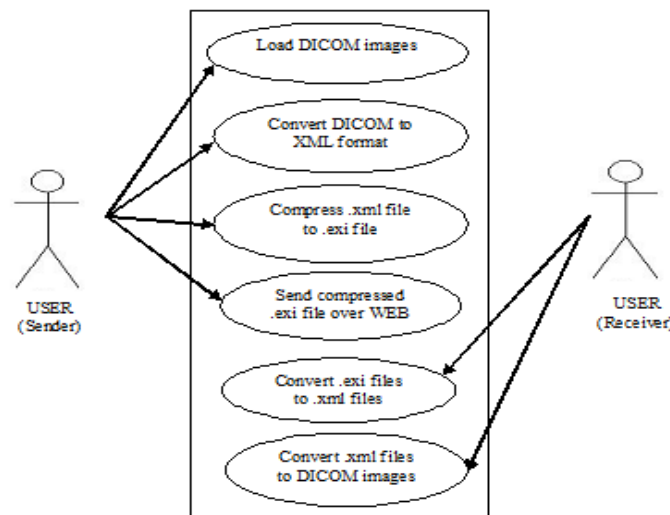


Fig. 2 - Architectural view of DIC Prototype



The aforesaid methodology provided optimum results as compare to the existing one. EXI is meant to at the same time optimize performance and also the utilization of process resources. Performance Parameters like Compression Ratio, Signal to Noise Ratio (SNR), Peak Signal to Noise Ratio (PSNR), Entropy, Mean Squared Error (MSE), Histogram, Compression Time, Decompression Time etc are evaluated for measuring the efficiency of the proposed system. Using use case diagram we can understand the user interaction with the architecture. The Usecase diagram of proposed approach is depicted in fig 3. The IBM Rational Software Architect tool is required for design of usecase diagram. It is a modeling and development environment that uses the unified modeling language for designing usecase diagram of proposed architecture

Fig. 3 - Usecase diagram for proposed architecture



Proposed Algorithm for DIC:

Step1: Insert the diacom image $f(x, y)$ of size $512 * 512$ of 8 bits/pixel.

Step2: Apply Gaussian noise removing technique in order to eliminate noise of the input images

Step 3: Apply Diacom_To_Xml Transformation using Python.

Step4: Encode the resulting image through Xml_To_EXI encoding through openEXI/EXIP tool and get the compressed encoded data.

Step5: For decompression, Decode the compressed image using EXI_To_Xml decoding.

Step6: Apply inverse Xml_To_Diacom transform to obtain original uncompressed image.

Step7: Compute performance measures like Compression size, Compression ratio, Space Saving, Signal to noise ratio (SNR), Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE), Entropy, Bits Per Pixel (bpp), Compression time, Decompression Time etc.

5. Experimental Findings and Discussions

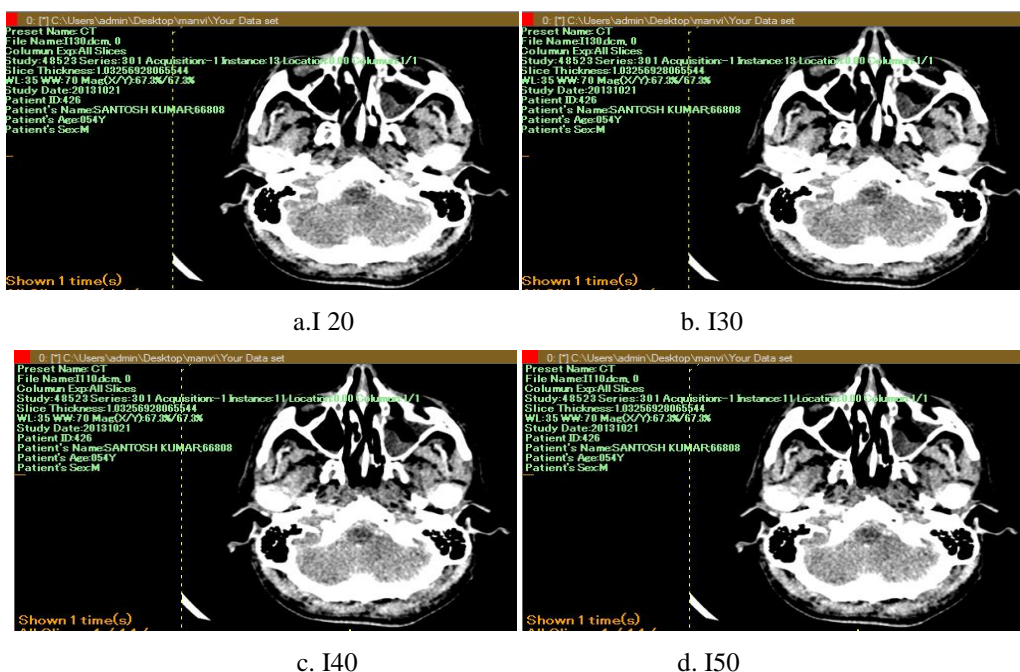
The performance of proposed technique is evaluated on a collection of medical images of size 512*512, eight bits/pixel and therefore the quality of compressed image has been assessed in terms of compression ratio, peak signal to noise ratio, signal to noise ratio, entropy, bits per pixel (bpp), mean squared (mse) error, compression time, decompression time etc To implement and analyze the methodology Yakami diacom viewer, openEXI and Python software are used. Test Setup environment is given in table 1.

Table 1 - Testbed specifications of powerful resource environment

Operating System	Windows 8
CPU	Intel Core (TM) i7-9750H CPU@ 2.60 GHz
System Type	64-bit OS, x64-based processor
RAM	8 GB

Fourteen computerized tomography images were studied using our new algorithm. Image I20, I30, I40 etc ...datasets have been taken from hospital for experimental work. As shown in fig 4. To analyze the result we compared our proposed method with existing svd technique and find out performance matrix like CR, SNR, PSNR, Bpp etc.as outlined in table 2 and 3. The results of proposed method is shown in table 4 and 5.

Fig. 4 - Input Diacom Images for Experimental Work



The result of performance matrices are shown in table I and II. The Outcome reveals overall 47.23% space saving is achieved. Evaluated parameters are given below:

- **Space Saving** is reduction in size relative to the uncompressed size or original size. Thus, a representation that compresses the storage size of a file from 10MB to 2MB yields a space saving of $1 - 2/10 = 0.8$, often notated as a percentage, 80%.

$$\text{Space Saving} = 1 - (\text{Size Compressed image}) / (\text{Size of Uncompressed image})$$

- **Compression Ratio** is defined as the ratio between the uncompressed size and compressed size. Formula of CR is given below.

$$\text{Compression Ratio} = (\text{Size of Original image}) / (\text{Size of Compressed image})$$

- **Bits per Pixel bpp** is an absolute measure and represents the average number of bits needed to encode each image pixel information (e.g. color). For uncompressed image bpp is typically related to the used color model and the quantization of color information.
- **Signal-to-noise ratio (SNR or S/N)** is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. SNR is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise.
- **Peak Signal to noise ratio (PSNR):** The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image.

$$\text{PSNR} = 20 \text{ Log } 10 \left(\frac{\text{Max Pixel}}{\text{MSE } 1/2} \right)$$

- The **Mean-Square Error (MSE)** and the peak signal-to-noise ratio (PSNR) are used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error. To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$\text{MSE} = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$$

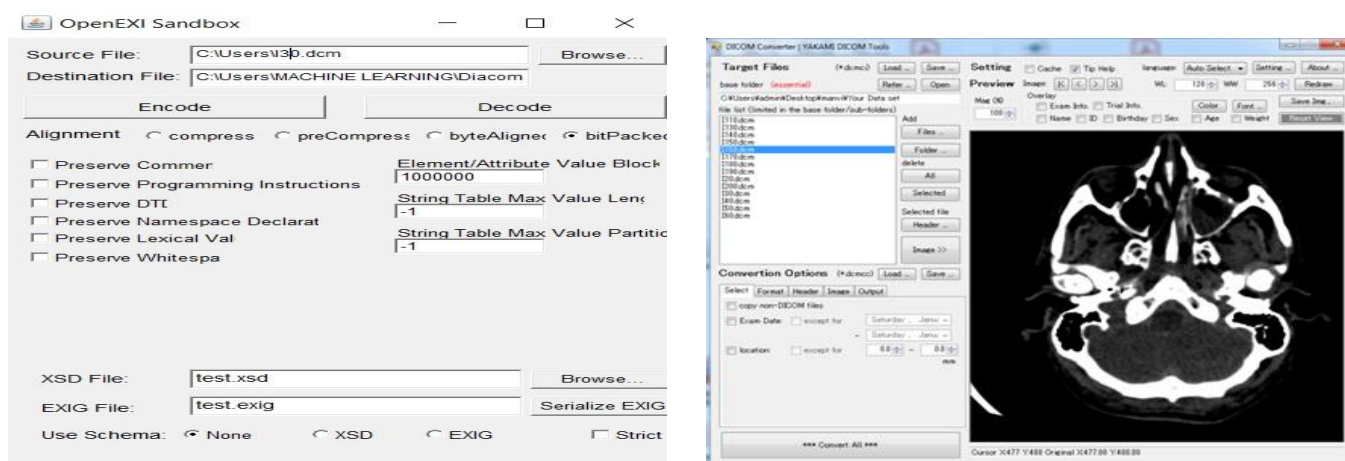
Where n is number of data point, Y_i is observed value and \hat{Y}_i is the predicted values.

- **Entropy** is a measure of image information content, which is interpreted as the average uncertainty of information source. It is described as corresponding intensity states to be adjusted by the individual

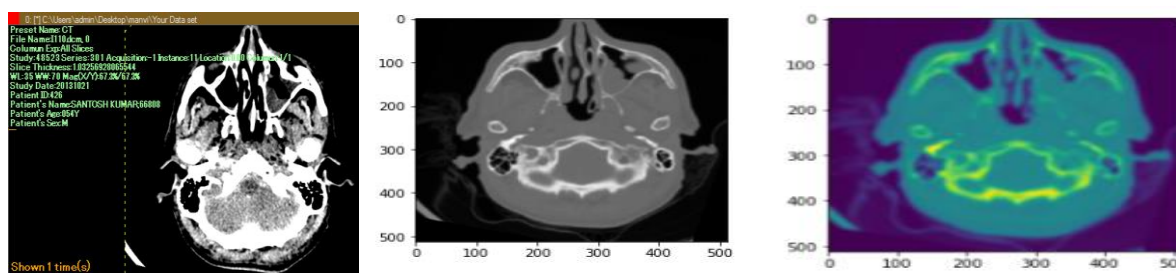
pixels. **Entropy** is a measure of randomness. Much like the concept of infinity, **entropy** is used to help model and represent the degree of uncertainty of a random variable.

- **Complexity Analysis** The proposed method doesn't create any computational overhead at compression side Methodology is quite apt and simple.
- **Compression Time:** represents the elapsed time during the compression process, i.e. the period of time between the start of program execution on a document until all the data are written to disk.
- **Decompression Time:** represents the elapsed time during the decompression process i.e. the period of time between the start of program execution on reading the decompressed format of the XML document until delivering the original document

Fig. 5 - Experimental Work



a. OpenExi Software Interface b. Diacom Image viewer



c. Original Image d. After Noise Removing e. Reconstructed Image

The fig 5 depicts observed work images where fig a, fig b shows software interface images. The fig c represent original image and fig d depicts image after noise reduction. Eventually reconstructed diacom image is gained as shown in fig e. The Diacom to xml transformation is represented in fig 6.

Fig. 6 - Dicom to xml transformation

```
(0010, 0010) Patient's Age AS: 054Y
(0018, 0022) Scan Options CS: 'HELIX'
(0018, 0050) Slice Thickness DS: "1.03256928065544"
(0018, 0060) KVP DS: "120.0"
(0018, 0090) Data Collection Diameter DS: "500.0"
(0018, 1020) Software Versions LO: "2.3.0"
(0018, 1030) Protocol Name LO: 'Brain HELICAL SMOOTH/RHLHEAD'
(0018, 1100) Reconstruction Diameter DS: "200.0"
(0018, 1120) Gantry/Detector Tilt DS: "0.0"
(0018, 1130) Table Height DS: "112.0"
(0018, 1140) Rotation Direction CS: 'CW'
(0018, 1151) X-Ray Tube Current IS: "270"
(0018, 1152) Exposure IS: "300"
(0018, 1160) Filter Type SH: 'UA'
(0018, 1210) Convolution Kernel SH: 'UA'
(0018, 5100) Patient Position CS: 'HFS'
(0018, a001) Contributing Equipment Sequence 1 item(s) ----
(0008, 0070) Manufacturer LO: 'PHILIPS'
(0008, 0080) Institution Name LO: 'EBW3'
(0008, 0081) Institution Address ST: 'EBW3'
(0008, 1010) Station Name SH: 'PHILIPS-EAB35FC'
(0008, 1040) Institutional Department Name LO: 'EBW3'
(0008, 1090) Manufacturer's Model Name LO: 'EBW3'
(0018, 1000) Device Serial Number LO: 'EBW3'
(0018, 1020) Software Versions LO: '3.5.0.2250'
(0040, a170) Purpose of Reference Code Sequence 1 item(s) ----
(0008, 0100) Code Value SH: '109102'
(0008, 0102) Coding Scheme Designator SH: 'DCM'
(0008, 0104) Code Meaning LO: 'Processing Equipment'

(0008, 0008) Image Type CS: ['DERIVED', 'SECONDARY', 'MPR']
(0008, 0012) Instance Creation Date DA: '20131024'
(0008, 0013) Instance Creation Time TM: '081533.968'
(0008, 0016) SOP Class UID UI: CT Image Storage
(0008, 0018) SOP Instance UID UI: 1.3.46.670589.33.1.41474112031634
3664.31508296062747830911
(0008, 0020) Study Date DA: '20131021'
(0008, 0022) Acquisition Date DA: '20131021'
(0008, 0023) Content Date DA: '20131021'
(0008, 0030) Study Time TM: '150610'
(0008, 0032) Acquisition Time TM: '150726'
(0008, 0033) Content Time TM: '150727.379'
(0008, 0050) Accession Number SH: ''
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(0008, 0081) Institution Address ST: 'KANPUR'
(0008, 0090) Referring Physician's Name PN: 'DR.S.K.B'
(0008, 1010) Station Name SH: 'philips-bf680f9'
(0008, 1030) Study Description LO: 'BRAIN PLAIN'
(0008, 103e) Series Description LO: 'Batch 1'
(0008, 1040) Institutional Department Name LO: 'Radiology'
(0008, 1070) Operator's Name PN: ''
(0008, 1090) Manufacturer's Model Name LO: 'Brilliance 40'
(0008, 1140) Referenced Image Sequence 1 item(s) ----
(0008, 1150) Referenced SOP Class UID UI: CT Image Storage
(0008, 1155) Referenced SOP Instance UID UI: 1.2.840.113704.1.111.3548.1382
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(0010, 0010) Patient's Name PN: 'SANTOSH KUMAR;66808'
(0010, 0020) Patient ID LO: '426'
(0010, 0030) Patient's Birth Date DA: ''
(0010, 0040) Patient's Sex CS: 'M'

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```

Table 2 - Results of computed parameters like, compression ratio, compression size and space saving, SNR & PSNR

S.No	DCM image	Original Size (KB)	SVD Method				
			Compression Size (KB)	Compression Ratio	Space Saving (%)	SNR	PSNR
1	I20	547	291	1.8797	46.80	0.2541845	30.94
2	I30	547	291	1.8797	46.80	0.2560081	30.85
3	I40	547	291	1.8797	46.80	0.2551101	30.80
4	I50	547	291	1.8797	46.80	0.2558695	30.76
5	I60	547	291	1.8797	46.80	0.2553151	30.70
6	I110	547	291	1.8797	46.80	0.2565467	30.65
7	I130	547	291	1.8797	46.80	0.2582791	30.73
8	I140	547	291	1.8797	46.80	0.2554457	30.07
9	I150	547	291	1.8797	46.80	0.2570228	30.67
10	I160	547	291	1.8797	46.80	0.2594592	30.62
11	I170	547	291	1.8797	46.80	0.2585969	30.57
12	I180	547	291	1.8797	46.80	0.2582663	30.55
13	I190	547	291	1.8797	46.80	0.2586969	30.50
14	I200	547	291	1.8797	46.80	0.2576574	30.48
Average:		547	291	1.8797	46.80	0.256889	30.63

Table 3 - Results of computed parameters like BPP, Entropy, MSE, Compression and Decompression Time

S.No	DCM image	Original Size (KB)	SVD Method				
			Bits Per Pixel (BPP)	Entropy	Mean Squared Error (MSE)	Compression Time (Sec)	Decompression Time(Sec)
1	I20	547	0.562675	6.33	5829.60	2	2
2	I30	547	0.562675	6.28	5953.86	2	2
3	I40	547	0.562675	6.24	6015.18	2	2
4	I50	547	0.562675	6.24	6071.45	2	2
5	I60	547	0.562675	6.24	5816.122	2	2
6	I110	547	0.562675	6.25	5214.334	2	2
7	I130	547	0.562675	6.26	5672.12	2	2
8	I140	547	0.562675	6.29	5345.81	2	2
9	I150	547	0.562675	6.33	5190.84	2	2
10	I160	547	0.562675	6.35	5750.94	2	2
11	I170	547	0.562675	6.39	6016.18	2	2
12	I180	547	0.562675	6.38	6001.45	2	2
13	I190	547	0.562675	6.37	5826.12	2	2
14	I200	547	0.562675	6.37	5667.67	2	2
Average:		547	0.562675	6.30	5740.83	2	2

Table 4 - Results of computed parameters like compression ratio, compression size and space saving, SNR and PSNR

S.No	DCM image	Original Size(KB)	Proposed Method				
			Compression Size(KB)	Compression Ratio	Space Saving (%)	SNR	PSNR
1	I20	547	284	1.9260	48.08	0.256752	31.01
2	I30	547	284	1.9260	48.08	0.258594	30.92
3	I40	547	285	1.9192	51.10	0.257687	30.87
4	I50	547	284	1.9260	48.08	0.258454	30.83
5	I60	547	284	1.9260	48.08	0.257894	30.77
6	I110	547	285	1.9192	51.10	0.259139	30.72
7	I130	547	285	1.9192	51.10	0.260888	30.80
8	I140	547	286	1.9125	51.28	0.258026	30.77
9	I150	547	288	1.8993	51.65	0.259619	30.74
10	I160	547	290	1.8862	52.01	0.26208	30.69
11	I170	547	291	1.8797	52.19	0.261209	30.64
12	I180	547	291	1.8797	52.19	0.260875	30.62
13	I190	547	291	1.8797	52.19	0.26131	30.57
14	I200	547	291	1.8797	52.19	0.26026	30.55
Average :		547	305	1.9056	47.23	0.25948	30.75

Table 5 - Results of computed parameters like BPP, Entropy, MSE, Compression and Decompression Time

S.No	DCM image	Original Size(KB)	Proposed Method				
			Bits Per Pixel (BPP)	Entropy	Mean Squared Error (MSE)	Compression Time (Sec)	Decompression Time(Sec)
1	I20	547	0.554688	6.39	5251.91	7	7
2	I30	547	0.554688	6.34	5363.84	7	7
3	I40	547	0.556641	6.31	5419.09	7	7
4	I50	547	0.554688	6.30	5469.78	7	7
5	I60	547	0.554688	6.30	5547.13	7	7
6	I110	547	0.556641	6.31	5617.90	8	8
7	I130	547	0.556641	6.33	5516.78	8	8
8	I140	547	0.558594	6.36	5545.81	9	9
9	I150	547	0.562500	6.39	5590.84	9	9
10	I160	547	0.566406	6.42	5650.94	10	10
11	I170	547	0.568359	6.45	5718.59	10	10
12	I180	547	0.568359	6.45	5747.93	10	10
13	I190	547	0.568359	6.43	5811.51	10	10
14	I200	547	0.568359	6.43	5841.58	10	10
Average:		547	0.5606	6.37	5578.11	8.5	8.5

The Fig 7 shows the plot of compressed file size for each image. It could be observed from the plot that the compression size for different medical images using the proposed method is high as compared to the existing SVD methods. The fig 8 depicts comparison between compression ratio of svd method and proposed method. It reveals that proposed methods provide high CR as compare to existing method. The Space Saving for medical images using proposed method is shown in fig 9. It could be seen that space saving for the proposed algorithm in high while the existing algorithm give low space saving. Hereby it is concluded that an proposed work is significantly better than the existing one. Fig 10, 11, 12 depicts psnr, entropy and bpp for svd and proposed method. The graph shows that proposed method is better than the existing one. At last Fig 13 shows comparison between compression time / decompression time of proposed method and svd method. The graph outlined that svd method is fast to execute while proposed method is slow for compression and decompression since proposed methods utilizes double phase transformation to achieve compression so it takes time to execute and gives better compressed result as compare to svd method.

Fig. 7 - Comparison between Compressed file size based on SVD Method and Proposed Method

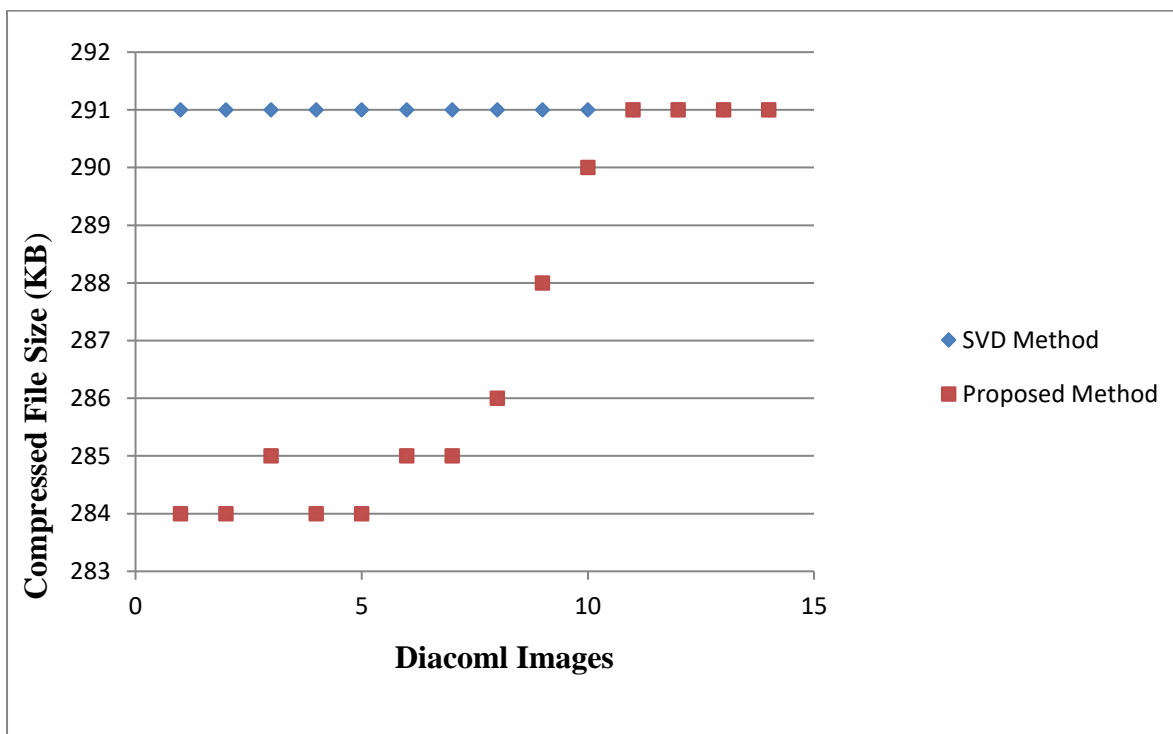


Fig. 8 - Comparison between Compression Ratio based on SVD Method and Proposed Method



Fig. 9 - Comparison between Space Saving based on SVD Method and Proposed Method

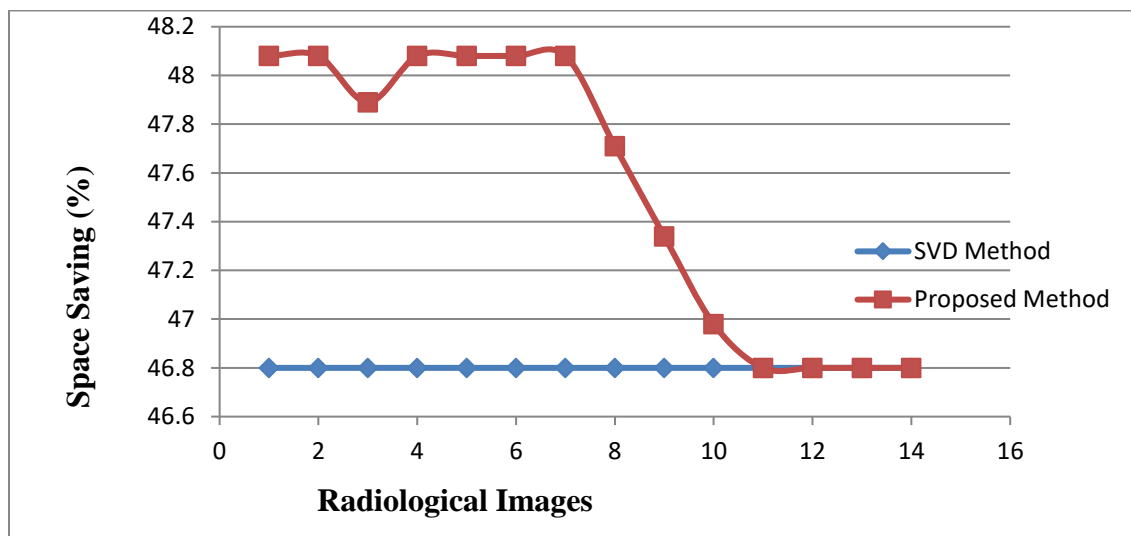


Fig. 10 - Comparison between PSNR based on SVD Method and Proposed Method

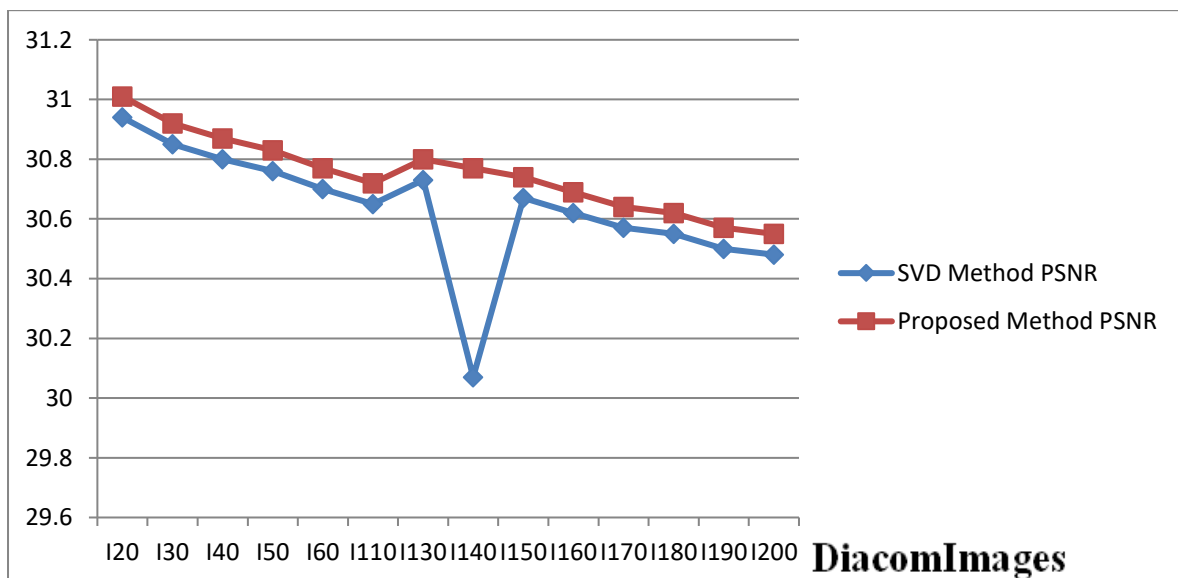


Fig. 11 - Comparison between Entropy based on SVD Method and Proposed Method

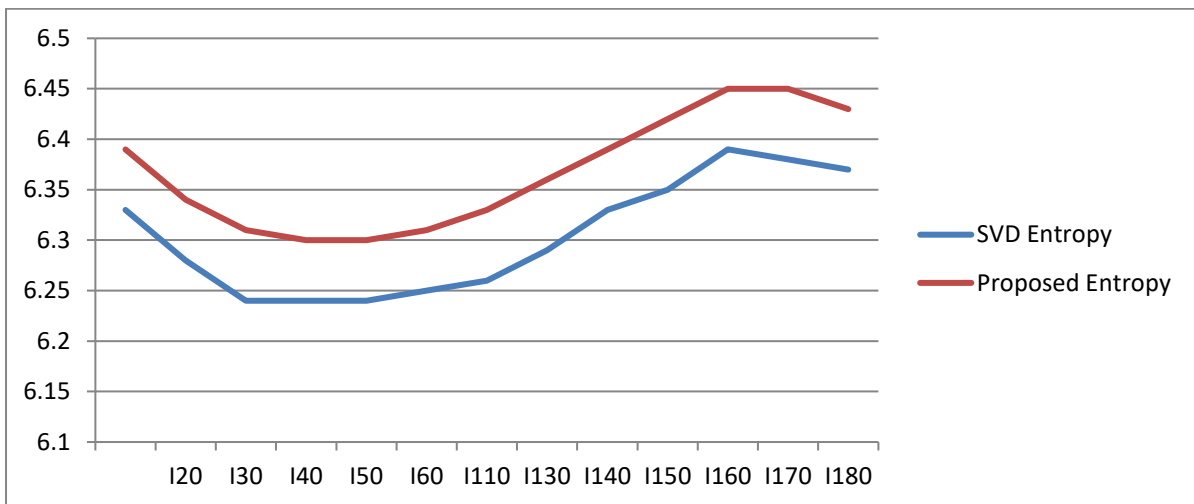


Fig. 12 - Comparison between BPP based on SVD Method and Proposed Method

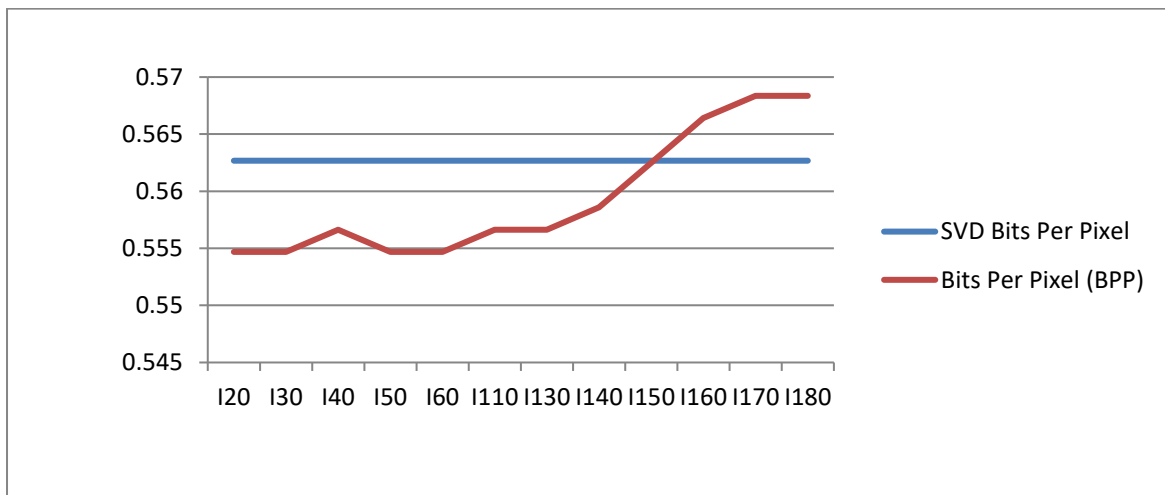
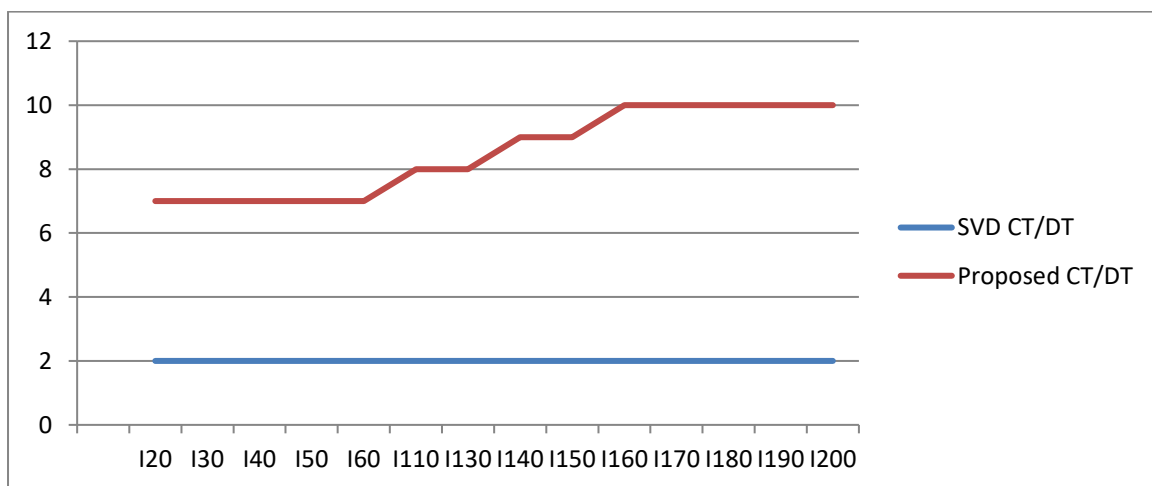


Fig. 13 - Comparison between CT and DT based on SVD Method and Proposed Method



6. Conclusions and Future Work

Telemedicine can prove to be the most reliable, cost-effective, and time-efficient method of bridging the rural-urban health divides. From a technical standpoint, an improved infrastructure is needed to support current-generation telemedicine services. Every image contains some redundant information, which needs to be identified by the user to obtain compression. Lots of compression techniques are available as discussed in background. In this paper a novel approach using EXI has been suggested for diacom image compression. Experiment Results shown to be better than that of the previous technique. In the present work SVD method for image compression is compared with the proposed EXI based image compression. EXI-based compression is providing better results as compared to svd technique, along with preservation of diagnostically important information in terms quality matrices but the proposed method takes more time to compress and decompress the diacom images since compression is two step process over here but in case of SVD it take less amount of time. Such method is recommended for telemedicine system especially rural area, where network resources have limitations. Proposed DIC can generate compressed DICOM file with the value of the space savings of fifty two percent.

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