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Research Article

IMAGE COMPRESSION FOR DIGITAL IMAGE ARCHIVE USING SUCCESSIVE BLOCKS INTERFRAME CODING

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Abstract

The increasing volume of data generated by new imaging modalities such as HD Digital Camera, scanners and magnetic resonance imaging justifies the use of the proposed Successive Blocks Inter frame Coding (SBIC) compression technique to decrease the cost of storage and improve the efficiency of transmission over networks. The impact on storage and network bandwidth requirements is predicted to increase sharply when departments adopt digital image compression technique SBIC in all modalities, especially digital archiving of the original images. SBIC allows a powerful decrease in digital image file size with no visual quality loss or image degradation. JPEG-2000 is the most widely accepted compression algorithm, but it has been shown that the proposed SBIC algorithm provides higher compression levels than JPEG-2000 at an equivalent or higher image quality. The algorithm has been refined and executed to compress and decompress the given images using SBIC technique in MATLAB R2014b simulation tool. The experimental results shows that SBIC is the most powerful technique and gives a good compression ratio without any data loss and reproduces the original image with the same 100% original file quality.

Keywords: Image Compression, Redundancy, Image Archiving.

Introduction

Generally long term archival of digital data is a challenging task. Media on one hand in which the digital data recorded may be instable or decay with time. Rapid evolution cycle of digital technologies on the other hand which is measured in months or in years tends to the elimination of recording technologies at a fast pace. Oldest data carriers cannot be read anymore because required machinery like tape reader, disk interface etc are commercially no longer available and also the data about the file formats may be lost because new formats have become standard. Hence digital archiving is essentially the task of guaranteeing the purposeful reading and decoding of bits in the far future. The next preference level is the use of compression. There exist two types of compression namely Lossless compression and Lossy compression. Lossless compression saves some space but not changing the image data. Lossy compression does harm to the image because of information loss but can improve the download speed with less quality. Lossy compression can be used if the original data is not as important, the space it occupies, speed of download etc [2][3][4]. The existing compression techniques like JPEG and JPEG 2000 encodes the original RGB image information permanently changing the original numerical data. JPEG 2000 lossy compression produces images with major appearance when compared with the old JPEG. However, no matter the vast superiority of JPEG 2000, support by web browsers for the format is still limited. Only Safari on Mac has full support for JPEG 2000.

The proposed SBIC shows better results when compared with existing techniques JPEG, JPEG2000 and JPEG2000-LS. SBIC doesn't degrade the image quality; also it compresses the image more than the existing techniques like JPEG, JPEG2000 and JPEG2000-LS. Specialty of SBIC is it decodes the image which is same as the original. SBIC hybrid approach is a lossless compression technique that retains the original image quality. The experimental results produce high quality images with high compression ratio and less processing time that proves it is well suited for digital image archiving.

Digital Image Archiving

SBIC shows that there is a tradeoff between the efficiency of lossless compression and error correction ie. redundancy. Many codes such as written language contain a lot of redundancy and thus quite fault tolerant. However, high efficiency is required for digital image archiving systems and hence often compression techniques are used.Usually images do contain lot of redundancy. Example is the probability that a neighboring pixel of a pixel in the blue sky is also blue, which means the redundancy is high [10][5]. Hence compression techniques have been constructed to use these redundancies. The proposed SBIC takes advantage over neighboring blocks pixel redundancy as the compression key to produce a lossless compression at high compression ratio.

Reversible Compression (Lossless)

The image is completely reconstructed and numerically identical to the original image under decompression. Run Length Encoding (RLE), low ratio JPEG and the JPEG-LS algorithms are the examples of lossless compression. Now, the proposed SBIC also joins with this lossless type compression.

Image Analysis

In all the digital images we can see the block with mean ratio of size (0.25:100) that represents the same physical scene of its nearest block. In SBIC, we defined entropy of an information source and the close relationship to its neighboring blocks. This system is also called as mutual compression. This model considers the image as a set of isolated pixels and allows us employing the concepts directly by using its local redundant relation. Most of the applications such as Web, Satellite needs an intelligent compression at high rate which measures the close redundancy on a current block taken into account and compressed/removed from its neighborhood block. We handled different approaches and computed experimental values for a large number of images. We consider images as shown in Fig 1 of N blocks $b \in X = \{b_1, b_2..., b_N\}$ and the relation between the neighborhood blocks are termed in equation 1.

$$Redundancy(block_i, block_{i+1}) = \begin{cases} block_i, & i\sim = (i+1) \\ block_{i+1}, & \sim 30\% - 70\% \end{cases} \qquad (1)$$

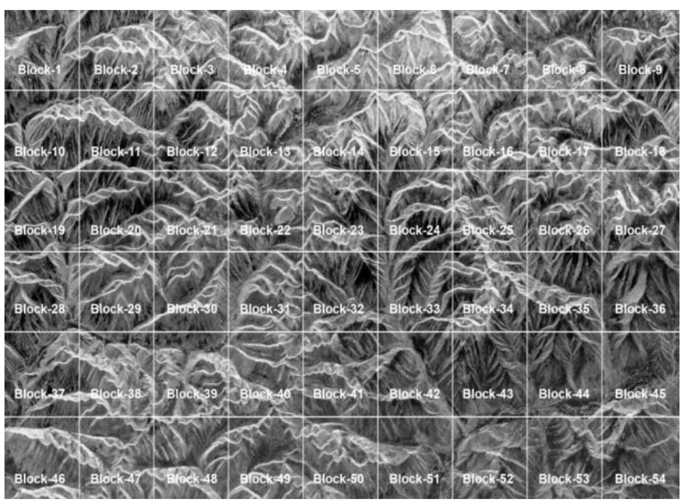

Fig 1: Successive blocks pixel redundancy.

Successive Blocks Inter frame Coding (SBIC)

Unlike other compression techniques SBIC works on the closest relationship of a scene. Any meaningful scene will have successive pixels/blocks relationship: so the proposed model takes advantage of this relationship to compress more than the other formats. MPEG coding is used here. The general flow of the proposed method is shown in Fig 2.

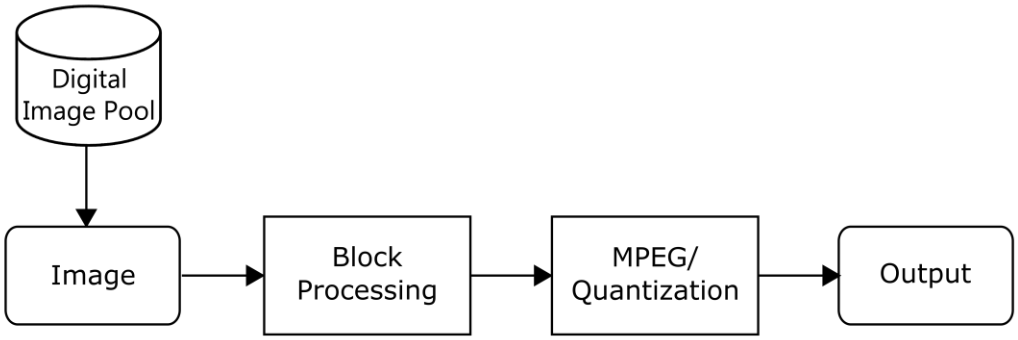

Fig 2: SBIC flow for image archiving.

Tray Preparation: The image is divided into blocks and grouped together in the tray for procedural flow as shown in Fig 3. The tray gets processed in first in first out manner and the total number of trays can be calculated by equation 2. Two types of trays are there; namely odd tray and even tray. The blocks are arranged in ascending order in odd trays and are arranged in descending order in even trays. This process is to link the trays in a sequential manner of nearest neighborhood relationship, after each block is arranged. The aim of preparing trays and arranging the blocks in the tray is to further eliminate redundancies; using motion picture compression technique. Each successive block gets placed in a way similar to the books arranged on a rack; on the tray as shown in Fig 3 [6][7][8][9].

$$\sum(\text{Tray}) = \left\{\frac{\text{image height}}{\text{block size}}\right. \qquad (2)$$

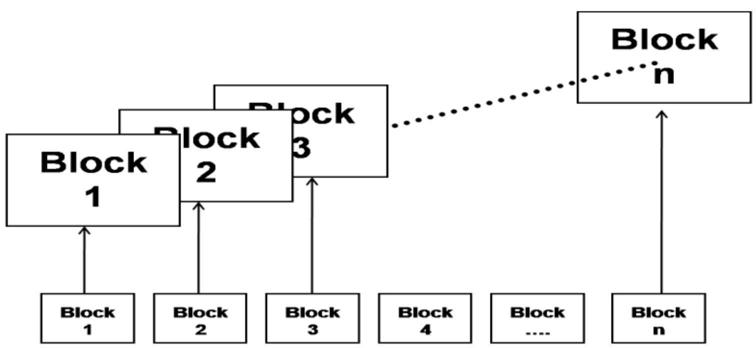

Fig 3: SBIC block's arrangement.

MPEG Encoding and Block Sequencing: Successive blocks in the tray may contain the same objects. Motion Estimation (ME) checks out the move of objects in the sequence of image to find vectors which represents the estimated motion. Motion Compensation (MC) uses the intelligence of object motion so obtained to attain compression. The redundancy between neighboring frames can be abused in which a frame is selected as reference and subsequent frame is predicted from the reference frame for compression using ME. It identifies the blocks that have not been changed from the previous/future frames and the motion vectors are stored in the location of blocks. ME and MC are the efficient algorithms to ignore the temporal redundancy because of high correlation between successive blocks in the process called inter frame coding. The MPEG frame of set {x} is manipulated to MPEG 4 H.264 encoder for compression. The redundant blocks are ignored from the frame when the fixed size blocks are converted into frames and it is shown in Fig 4. ME and MC algorithms are done in the current and reference frames. After ignoring the redundancies, rest of the frames are further compressed using frame difference and the process repeats until all the frames are compressed [1].

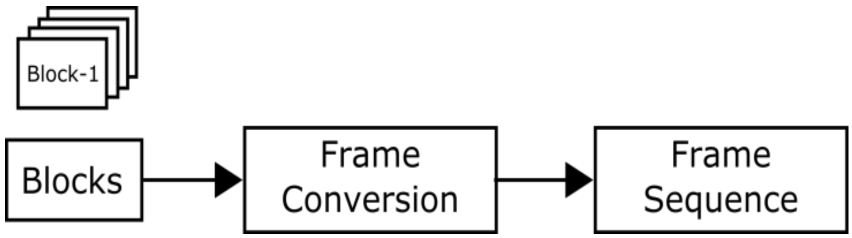

Fig 4: Frame Sequences.

Result & Discussion

A set of test images is analysed and the results are discussed by performing the proposed SBIC and various existing techniques. Performance is measured by the parameters Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE), Mean Absolute Error (MAE) and Root Mean Square Error (RMSE).The proposed SBIC can be carried out on any kind of image and are not limited to these test images. The experimental result shows a feasible quality improvement with high compression ratio when compared with the existing JPEG, JPEG 2000 and JPEG LS.For testing the archive, online source used from DIP3/e—Book Images –Archive.

(http://www.imageprocessingplace.com/downloads_V3/dip3e_downloads/dip3e_book_images/DIP3E_CH01_Original_Images.zip). Test images are shown in Fig 5.

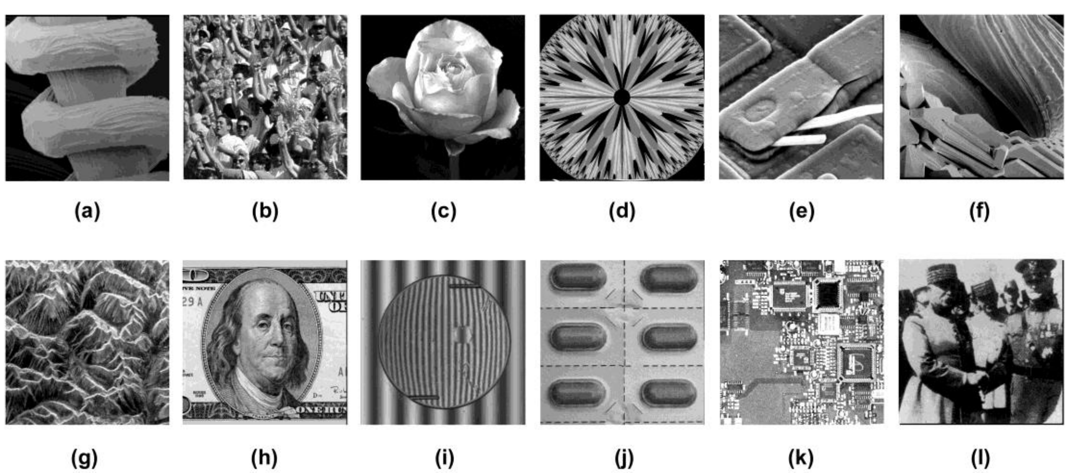

Fig 5: Test images (512x512 pixels).

Performance Parameters

The performance can be measured using the following parameters for the given test images.

PSNR: Image quality of the reconstructed image can be obtained using PSNR and is given in Equation 3.

$$\mathrm{PSNR} = 20\log\left(\frac{\mathrm{N}}{\mathrm{RMSE}}\right)\mathrm{dB} \qquad (3)$$

Where, N is the dynamic range of allowable image pixel intensities.

RMSE: Shows how far the decompressed image is close with the original image on pixel by pixel basis and is given in Equation 4.

$$\mathrm{RMSE} = \sqrt{\frac{1}{\mathrm{N}}\sum_{\mathrm{i}=1}^{\mathrm{N}}(\mathrm{x_i} - \hat{\mathrm{x}}_\mathrm{i})} \qquad (4)$$

Where, $\hat{x}_i$ are the predicted values for times i of a regression's dependent variablex_i.

MAE: It is a quantity used to measure how close forecasts or predictions are to the eventual outcomes and is given in Equation 5.

$$\mathrm{MAE} = \frac{1}{\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{n}}|\mathrm{f_i} - \mathrm{y_i}| = \frac{1}{\mathrm{n}}|\mathrm{e_i}| \qquad (5)$$

Where, f_i is the prediction and $y_i$is the true value.

MSE: MSE is zero when f(i, j) = F(i, j).

$$\mathrm{MSE} = \sum\frac{[\mathrm{f(i,j)} - \mathrm{F(i,j)}]^2}{\mathrm{N}^2} \qquad (6)$$

Where, f(i, j) represents the reference image and F(i, j) represents the distorted image and i, j are the pixel position of the M×N image.

Table 1 shows the comparison of the original image size with various existing compression techniques and proposed SBIC.

Table 1: Comparison Chart.

Input (Test images)	Original Size (bytes)	JPEG	JPEG 2000	JPEG-LS	SBIC	Elapsed Time (Sec)

a	2,909,732	322,293	331,590	330,045	49,228	0.12
b	2,884,664	211,603	223,324	227,402	47,526	0.14
c	2,885,584	258,230	269,899	260,389	48,986	0.11
d	2,735,504	207,793	218,961	225,792	47,265	0.14
e	3,143,176	385,186	395,451	395,090	67,479	0.12
f	2,738,648	152,761	159,610	153,345	37,356	0.14
g	3,537,928	283,399	301,932	303,893	57,113	0.13
h	3,732,676	313,942	354,458	356,011	75,051	0.12
i	3,519,332	316,385	336,324	383,938	61,822	0.13
j	3,413,576	267,745	290,242	333,120	39,832	0.11
k	1,965,920	219,359	240,211	222,440	34,098	0.14
l	2,969,656	309,493	322,811	321,893	48,193	0.11

Table 2: Image Quality Comparison.

Input Image	Original Size	Compressed	MAE	MSE	RMSE	PSNR
a	2,909,732	49,228	0.34	3.29	1.81	98.92
b	2,884,664	47,526	0.24	2.31	1.52	102.45
c	2,885,584	48,986	0.24	2.55	1.6	101.48
d	2,735,504	47,265	0.25	2.39	1.55	102.1
e	3,143,176	67,479	0.41	4.62	2.15	95
f	2,738,648	37,356	0.14	1.65	1.28	105.84
g	3,537,928	57,113	0.25	2.26	1.5	102.66
h	3,732,676	75,051	0.3	2.93	1.71	100.09
i	3,519,332	61,822	0.3	2.63	1.62	101.16
j	3,413,576	39,832	0.25	1.77	1.33	105.14
k	1,965,920	34,098	0.31	2.86	1.69	100.31
l	2,969,656	48,193	0.34	3.23	1.8	99.11

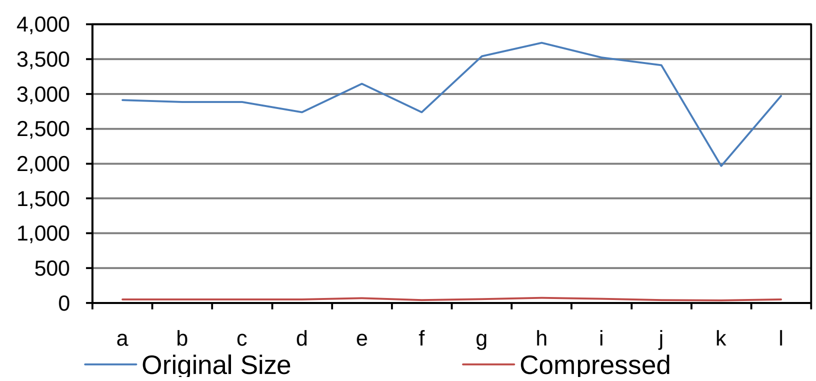

Fig 6: Original vs. Compressed image (Proposed).

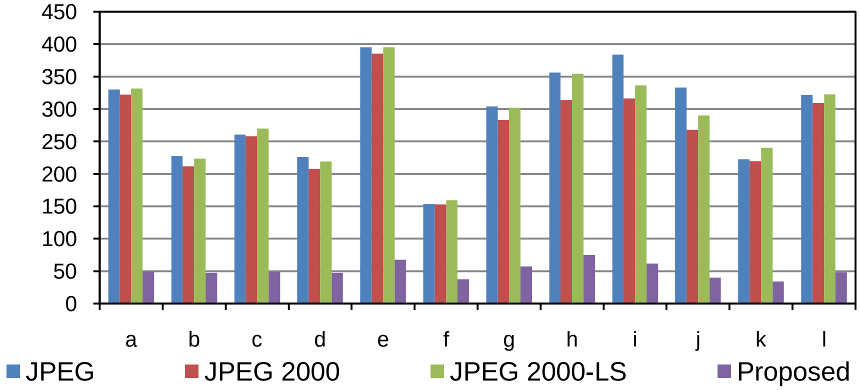

Fig 7: Size of Existing vs. Proposed.

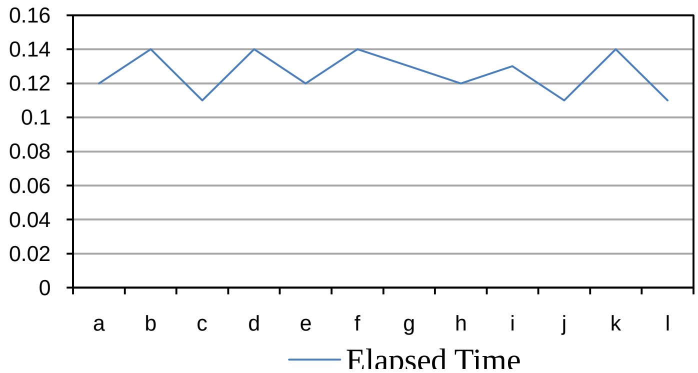

Fig 8: Elapsed time of proposed method.

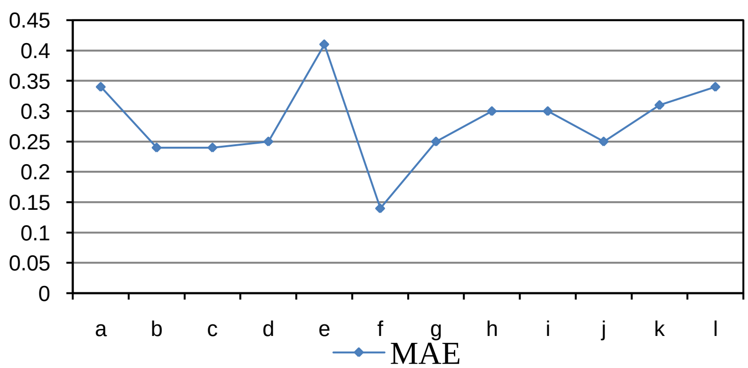

Fig 9: MAE chart.

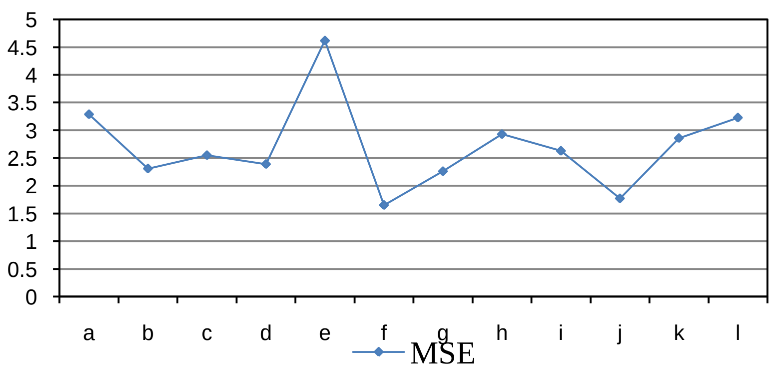

Fig 10: MSE Chart.

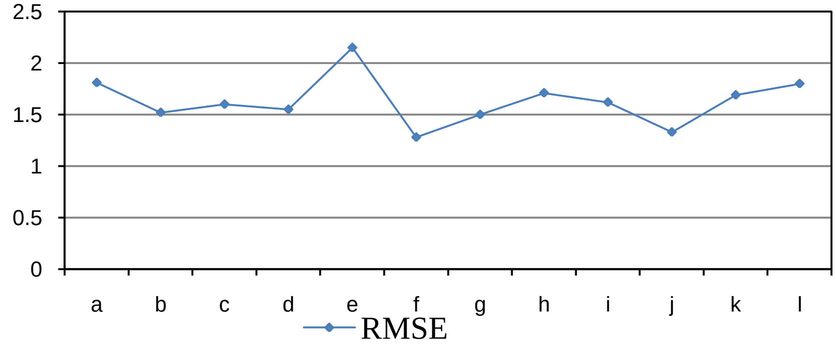

Fig 11: RMSE Chart.

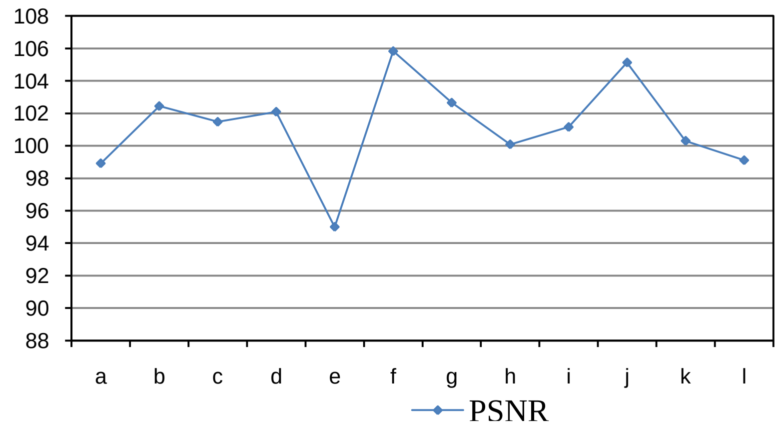

Fig 12: PSNR Chart.

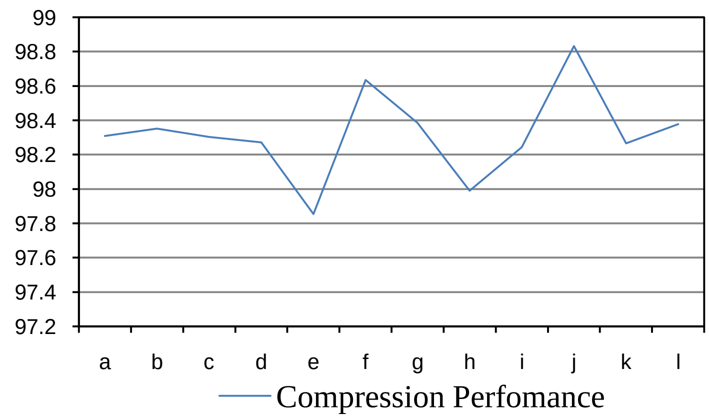

Fig 13: Compression Performance.

Conclusion

Experiments on image archives show that the proposed SBIC compresses a large amount of successive data redundancy. The proposed method achieves high compression and lossless reconstruction of the original images in the digital archives. The experimental result shows that the digital archives obtained high compression ratio and space saving on the disk with low processing time and high compression performance. It shows 81% of PSNR value and also SBIC is suitable for many applications such as remote sensing, military, web based technologies, medical imaging, digital cameras and for storing and transmitting images since no loss of information after decompression. Hence the proposed SBIC is an efficient technique for image compression and decompression than any other methods namely JPEG, JPEG 2000 and JPEG LS.

References

1. J. E. Cabral Jr, Y. Kim, Multimedia systems for Telemedicine and Their Communications Requirements, IEEE Commun Magazine, pp 20-27, July(1996).
2. Stephen Wong, Loren Zaremba, et al, Radiologic Image Compression: A Review,Proc of the IEEE, Vol. 83, No. 2 (1995).
3. N.D.Memon, Khalid Sayood, Lossless compression of video sequences, IEEE Transaction Commun, volume 44, no 10, pp 1340–1345, October(1996).
4. J.R. Jain and A.K. Jain, Displacement measurement and its application in interframe image coding, IEEE Trans Commun, Vol. COM-29, No. 12, pp 1799-1808, Dec. 1981.ff.
5. I.Ueno,W.Pearlman, Region of interest coding in volumetric images with shape-adaptive wavelet transform in Proc SPIE, 2003, vol.5022.
6. J. Curtis, P. Koerbin, P. Raftos, D. Berriman, J. Hunter, AONS-An obsolescence detection and notification service for Web archives and digital repositories, New Review of Hypermedia and Multimedia, Vol. 13, No. 1, January (2007), pp 39-53.
7. Krishnan K. Marcellin, A. Bilgin, M. Nadar, Efficient Transmission of Compressed Data for Remote Volume Visualization, IEEE Trans. on Medical Imaging, vol. 25, no. 9, pp 1189-1199, September(2006).
8. A.F. Ali, J.H. Abir, L Paulo, A Dhiya, An adaptive hybrid image compression method and its application to Medical images, IEEE(2008).
9. Al-Saiegh M.Y, Krishnan S, Fixed block-based lossless compression of digital mammograms, Electrical and Computer Engineering, 2001, Canadian Conference on vol. 2, pp937-942 (2001).
10. M. F. Zhang, J. Hu, L. M. Zhang, Lossless video compression using combination of temporal and spatial prediction, IEEE International Conference Neural Network, Signal Processing, volume. 2, pp1193–1196, December (2003).