
ABSTRACT

Image compression plays an important role in multimedia applications. It reduces memory requirements for storage of images. The most distinctive feature of Haar Transform lies in the fact that it lends itself easily to simple manual calculations. Modified Fast Haar Wavelet Transform (MFHWT), is one of the algorithms which can reduce the calculation work in Haar Transform (HT) and Fast Haar Transform (FHT). This project attempts to describe the algorithm for image compression using MFHWT. It includes a number of examples of different images to validate the utility and significance of algorithm's performance. Comparison of HT and MFHWT is done for different images and compared by PSNR, MSE and CR. It is seen that MFHWT is more efficient compression method than HT.

KEYWORDS: Image compression, Haar Transform (HT), Modified fast haar wavelet transform (MFHWT).

INTRODUCTION

As computers have become more and more powerful, the temptation to use digital images has become irresistible. Image compression plays a vital role in several important and diverse applications, including tele-video conferencing, remote sensing, medical imaging and magnetic resonance imaging and many more. The basic idea behind the image compression is that in most of the images we find that their neighboring pixels are highly correlated and have redundant information. The wavelet transform is often used for signal and /or image smoothing keeping in view of its "energy compaction" properties, i.e. large values tend to become larger and small values smaller, when the wavelet transform is applied. Since the Haar Transform (HT) is memory efficient, exactly reversible without the edge effects, it is fast and simple. As such the Haar Transform technique is widely used these days in wavelet analysis. Modified Fast Haar Transform (MFHWT) is one of the algorithms which can reduce the tedious work of calculations.

MATERIALS AND METHODS**Haar Transform**

The Haar Transform (HT) is one of the simplest and basic transformations from the space domain to a local frequency domain. A HT decomposes each signal into two components, one is called average (approximation) or trend and the other is known as difference (detail) or fluctuation.

The Haar transform $HT^n(f)$ of an N -input function $X^n(f)$ is the 2^n element vector

$$HT^n(f) = H^n X^n(f)$$

The Haar transform cross multiplies a function with Haar matrix that contains Haar functions with different width at different location. The Haar transform is performed in levels. At each level, the Haar transform decomposes a discrete signal into two components with half of its length: an approximation (or trend) and a detail (or fluctuation) component. The first level of approximation $a^1 = (a_1, a_2, \dots, a_{N/2})$ is defined as,

$$a_m = \frac{X_{2m-1} + X_{2m}}{\sqrt{2}}$$

Modified Fast Haar Wavelet Transform

In modified fast haar wavelet transform, first average subsignal, $a^l = (a_1, a_2, \dots, a_{N/2})$, at one level for a signal of length N i.e. $f = (f_1, f_2, \dots, f_N)$ is,

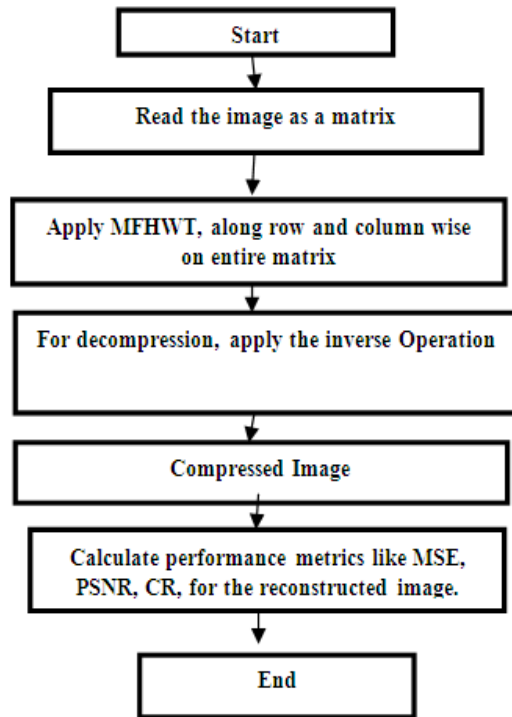
$$a_m = \frac{f_{4m-3} + f_{4m-2} + f_{4m-1} + f_{4m}}{4}, \quad m = 1, 2, 3, \dots, N/4,$$

and first detail subsignal, $d^l = (d_1, d_2, \dots, d_{N/2})$ at the same level is given as,

$$d_m = \begin{cases} \frac{(f_{4m-3} + f_{4m-2}) - (f_{4m-1} + f_{4m})}{4}, & m = 1, 2, 3, \dots, N/4, \\ 0, & m = N/2, \dots, N. \end{cases}$$

Here four nodes are considered at a time instead of two nodes as in HT.

Flow chart of Modified Fast Haar Wavelet Transform:



Flow chart of Modified Fast Haar Wavelet Transform

Performance parameters

The performance parameters such as MSE (Mean Square Error), PSNR (Peak Signal to Noise Ratio) and Compression Ratio (CR) were used to compare the compression methods on different types of images including medical images.










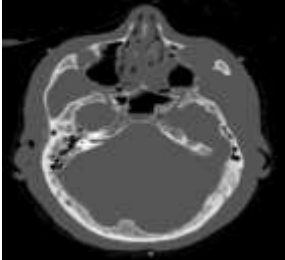
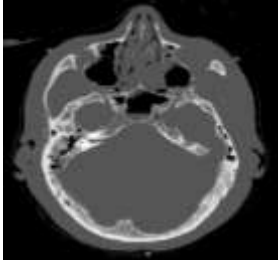
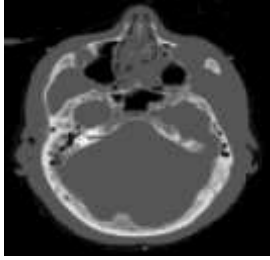



The images X-Ray, Ligament, Knee, MRI, Brain, Parrot, Lena, M.Gandhi, N. Modi and Animal are used for the research purpose.







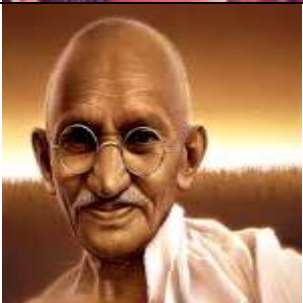
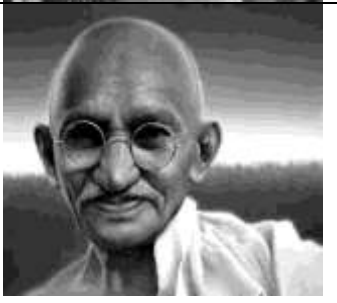
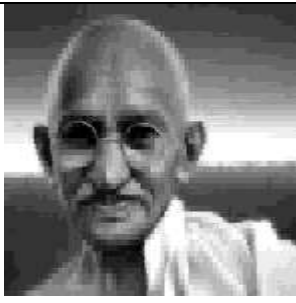




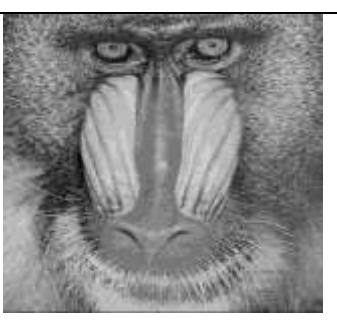
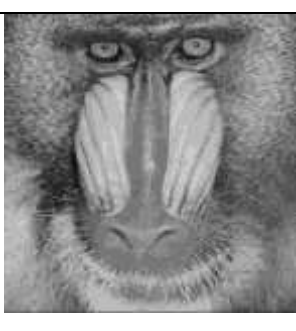
RESULTS AND DISCUSSION

The HAAR and MFHWT Algorithm was successfully implemented on color images as well as on medical images which resulted in the compression of greater than 95% which is the highest compression as other approaches are seen. The reconstructed image has greater than 85% similarity factors with respect to original image .The experiment was computed on number of images, results were tested for medical images . From used techniques it is seen that the MFHWT method of compression gives good results in terms of qualitative, quantitative and visual quality measures.

Fig:

The original image, image compressed with HT and image compressed with MFHWT of X-Ray, Ligament, Knee, MRI, Brain, Parrot, Lena, M.Gandhi, N. Modi and Animal are shown in figures below

| Image Name | Original Image | Reconstructed Image (HT) | Reconstructed Image (MFHWT) |
|------------|---|---|---|
| X-Ray |  |  |  |
| Ligament |  |  |  |
| Knee |  |  |  |
| MRI |  |  |  |
| Brain |  |  |  |

| | | | |
|---|---|--|---|
| Parrot |  |  |  |
| Lena |  |  |  |
| M Gandhi |  |  |  |
| N Modi |  |  |  |
| Animal |  |  |  |
| Result of HAAR and MFHWT for Image Compression | | | |

Tables:

Table . Comparison Of Haar and Modified Fast Haar Wavelet Transform

The performance parameters as Compression Ratio (CR), Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) obtained and used for comparison of haar and modified fast haar wavelet transform are as below.

| Sr. No. | Parameters | | | | |
|---|------------|--------|--------|-------|--------|
| | Images | Method | CR in% | PSNR | MSE |
| 1 | X-Ray | HT | 35.32 | 60.74 | 0.054 |
| | | MFHWT | 99.80 | 82.12 | 0.0003 |
| 2 | Ligament | HT | 43.58 | 57.85 | 0.106 |
| | | MFHWT | 96.52 | 71.06 | 0.0050 |
| 3 | Knee | HT | 42.53 | 58.45 | 0.092 |
| | | MFHWT | 98.72 | 75.65 | 0.0017 |
| 4 | MRI | HT | 51.68 | 57.72 | 0.109 |
| | | MFHWT | 98.84 | 78.99 | 0.0008 |
| 5 | Brain | HT | 94.163 | 48.86 | 0.84 |
| | | MFHWT | 95.49 | 72.24 | 0.0038 |
| 6 | Parrot | HT | 36.40 | 54.16 | 0.249 |
| | | MFHWT | 98.69 | 71.23 | 0.004 |
| 7 | Lena | HT | 35.02 | 61.34 | 0.047 |
| | | MFHWT | 98.94 | 75.04 | 0.002 |
| 8 | M Gandhi | HT | 35.36 | 60.41 | 0.059 |
| | | MFHWT | 99.07 | 75.17 | 0.001 |
| 9 | N Modi | HT | 35.03 | 62.41 | 0.037 |
| | | MFHWT | 99.75 | 77.68 | 0.001 |
| 10 | Animal | HT | 35.02 | 49.66 | 0.702 |
| | | MFHWT | 97.17 | 69.57 | 0.007 |
| Table: Experimental Results for Haar and Modified Fast Haar Wavelet Transform | | | | | |

CONCLUSION

We studied, the performance in terms of PSNR, CR and MSE that obtained with MFHWT (Modified Fast Haar Wavelet Transform) compression technique and compared with HT (Haar Transform). It is seen that,

- 1) The MFHWT is faster in comparison to HT and reduces the calculation work.
- 2) In MFHWT, we get the values of approximation and detail coefficients one level ahead than the HT.
- 3) The MFHWT is faster and memory efficient.

MSE and PSNR values of reconstructed images are as good as in HT.

It may be concluded that with compare to HT we get better results in MFHWT as,

- a) 61% increase in CR
- b) 20% increase in PSNR
- c) 5% decrease in MSE

This approach has the potentiality of application in medical images. In short, the main benefit of MFHWT is sparse representation and fast transformation and possibility of implementation of fast algorithms.

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