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Abstract

Image compression is a key technology for many applications such as multimedia, videoconferencing, medical imaging and many more that involve huge data storage, transmission and retrieval. It plays important role in transmission and storage of digital images because of vast data associated with them. This research proposes a simple and robust image compression scheme with pruning proposal based on discrete wavelet transformation (DWT). The effectiveness of the algorithm has been justified over some real image sequences. The algorithm has been implemented using Visual C++ and tested on a Core i3, 2.9 GHz PC with 2 GB RAM. Experimental results demonstrate that our proposed technique provides superior performance compared to other conventional compression methods.

Motivation and Problem Statement

Fig. 1 shows the basic steps in image compression scheme. The scheme is composed of two distinct structural blocks: an encoder and a decoder. Image $f(x,y)$ is fed into the encoder, and the image $\hat{f}(x,y)$ results from the compression scheme.

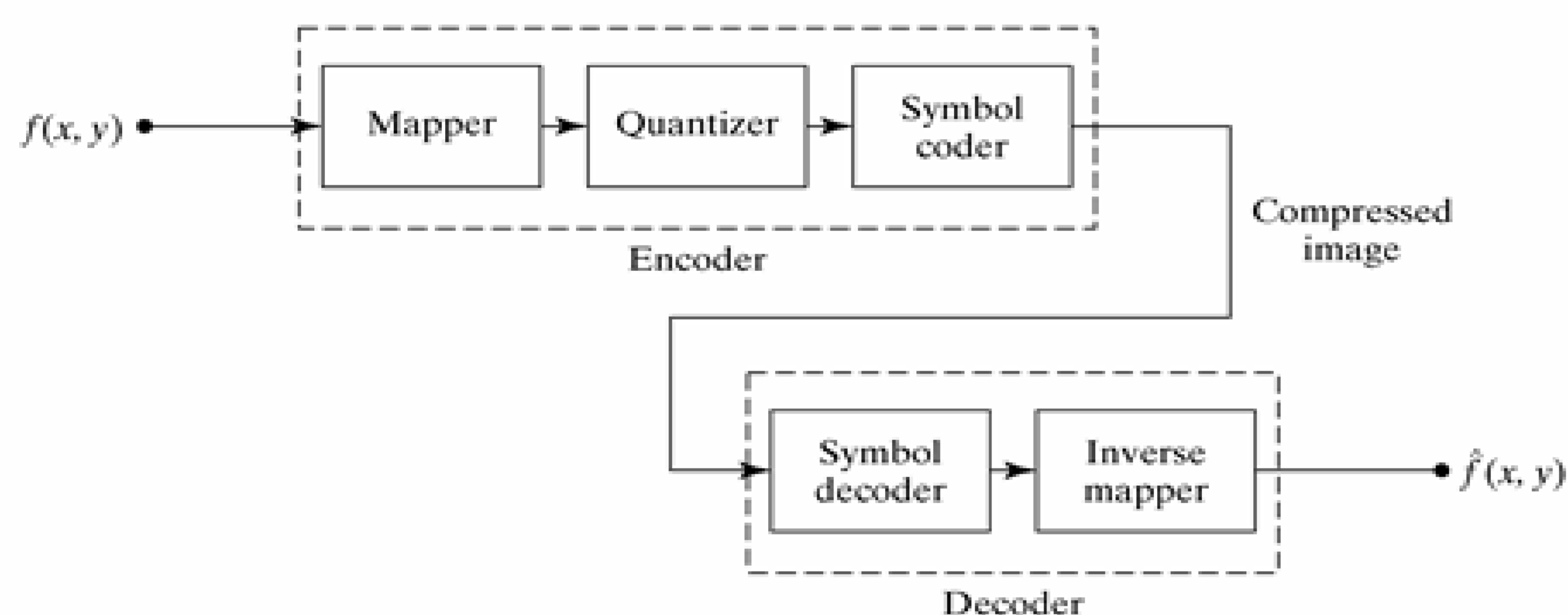


Fig. 1 Basic steps in an image compression system.

With a view to reduce the size of image data for storing or transmitting them in an efficient form, this research aims to develop an efficient compression scheme using discrete wavelet transform. This results in the reduction of file size and allows more images to be stored in a memory space with less degradation of image quality.

Proposed Image Compression

Fig. 2 illustrates the proposed compression technique based on discrete wavelet transform (DWT) with pruning proposal. The proposed technique first decomposes an image into coefficients called sub-bands and then the resulting coefficients are compared with a threshold. Coefficients below the threshold are set to zero. Finally, the coefficients above the threshold value are encoded with a loss less compression technique.

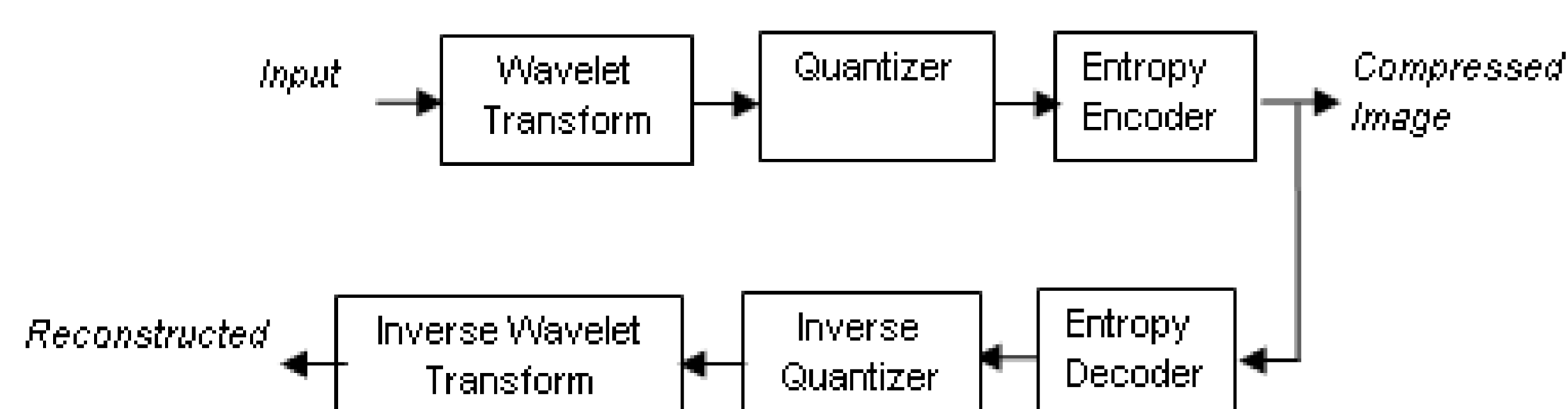


Fig. 2 Proposed image compression scheme using DWT.

The steps of the proposed compression algorithm based on DWT are described below:

I. Decompose

Choose a wavelet and a level N. Compute the wavelet. Decompose the signals at level N.

II. Threshold detail coefficients

For each level from 1 to N, a threshold is selected and hard thresholding is applied to the detail coefficients.

III. Reconstruct

Compute wavelet reconstruction using the original coefficients of level N and the modified detail coefficients of levels from 1 to N.

Experimental Results and Conclusions

The compression that is achieved can be quantified by the compression ratio given by the following formula:

$$C_R = n_1 / n_2 \quad (1)$$

The quality measurement variables, MSE (mean square error) and PSNR (peak signal-to-noise ratio) are estimated to find out how well an image is reproduced with respect to the reference image. PSNR is defined by the following formula:

$$PSNR = 10 \log_{10}(255^2 / MSE) \text{ dB} \quad (2)$$

and, the MSE is given by,

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

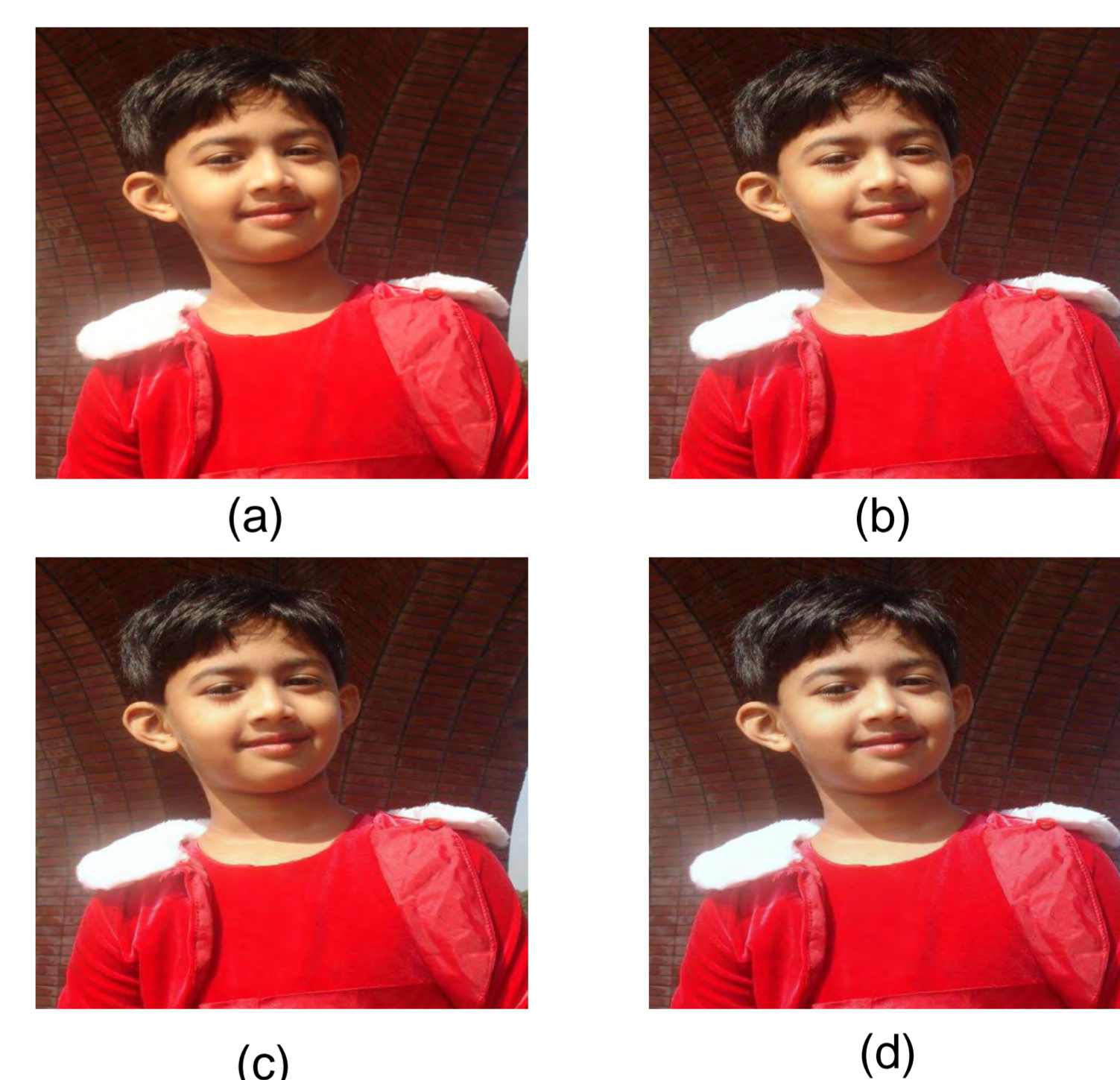


Fig 3: Image compression results. (a) Original (b) GIF compressed image (c) JPEG compressed image (d) Proposed compression.

Table 1. Compression results with proposed method for different thresholds

Threshold values	Size of the original image	Size of the compressed image	Compression Ratio
$\delta=0$	47 KB	2.98 KB	15.77
$\delta=10$	47 KB	2.56 KB	18.35
$\delta=20$	47 KB	2.38 KB	19.74
$\delta=30$	47 KB	2.16 KB	21.75
$\delta=40$	47 KB	2.10 KB	22.38
$\delta=50$	47 KB	1.94 KB	24.22

Table 2. Compression results with proposed method for different thresholds

Compression Techniques	File sizes	Compression Ratio	PSNR (dB)
Original Image (Bmp)	47.00 KB	-	-
GIF	6.40 KB	7.34	27.37
JPEG	3.36 KB	13.98	24.42
DWT (Proposed Method)	2.38KB	19.74	22.86

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