Pyramidal Algorithm for Image Sharpening & Edge Detection Using DWT-UM

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Abstract:

Digital Image Processing(DIP) which is a field under Image Processing may be subdivided into the following categories: restoration, enhancement, coding, and understanding. The objective is to obtain a symbolic description of the scene, leading to autonomous machine reasoning and perception and to enhance the image for purpose of human interpretation and improving visual appearance. It is built on a base of 1D and 2D signal processing theory. Sharpening is one of the most impressive transformations one can apply to an image since it seems to bring out image details that were not there before. A large number of algorithms have been designed for this purpose such as Unsharp Masking (UM),. we have also measured the amount of sharpness by using the percentage of rise in values parameter. Finally the results for the image enhancement by using UM and DWT-UM techniques have been compared and have shown that there is enormous enhancement in image reproduction by using the proposed algorithm.

Keywords: ***Digital Image Processing, Grayscale Images, Unsharp masking (UM), Discrete Wavelet Transform (DWT),Edge Detection.***

1. Introduction

We depend heavily on our vision to make sense of the world around us. We not only look at things to recognize them, but we can scan for differences, and obtain an overall rough feeling for a scene with a quick look. Humans have very exact visual skills: we can recognize a face in an instant; we can differentiate colors; we can process a large amount of visual information very quickly. For our purposes, an image is a single picture which represents something. It may be a picture of a person, of people or nature [1], [2], or of an outdoor scene, or the result of medical imaging, or a microphotograph of an electronic component, An image is represented as a Two Dimensional (2D) array of coefficients also called pixels, each coefficient representing the brightness level in that point.

It is not possible to differentiate between coefficients, which are more important ones, and lesser important ones. Most natural images have smooth color variations, with the fine details being represented as sharp edges in between the smooth variations. In this paper we will describe a brief knowledge of all techniques and algorithms for sharpening the images and also about the DWT. The fundamental idea of image sharpening is to add to the input signal a high-pass filtered version of the signal itself. Wavelet coefficients provide multi-resolution high frequency components of an image. Making use of this property, a sharpening algorithm is proposed in this paper.

2. Proposed Algorithum

Here we propose an algorithm [3] that used the both UM and 2-D DWT transform. After taking the 2-D DWT transform of image, we got the approximation (CA) and detail coefficients (CH, CV, CD). Then these coefficients are modified by processing with UM. The complete process is shown in the following figure 2.1.

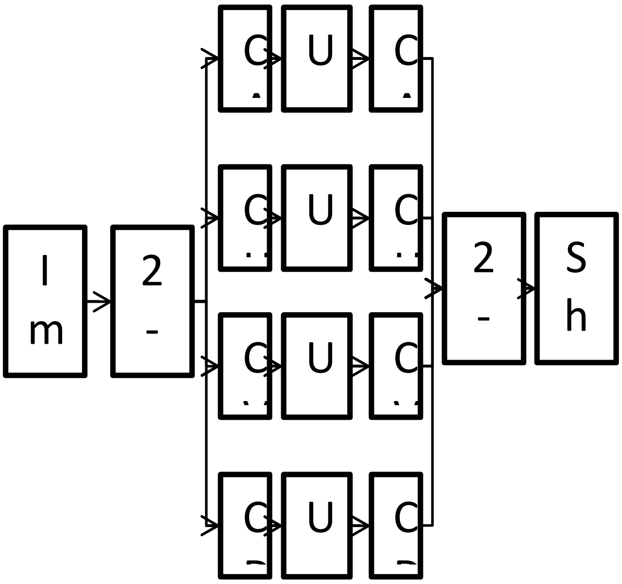

Figure 2.1: Proposed algorithm to compute the sharper image using 2D DWT and UM

In this we modified the coefficients by passing them through the UM, and got new coefficients (CA’, CH’, CV’, CD’). One can see the difference between 1 level 2-D DWT transform shown in fig.2.2 and modified 2 level 2-D DWT transform of the Taj Mahal image shown in fig.2.3 [4] The main purpose of using UM on the transform is to obtain the high-frequency spatial detail.

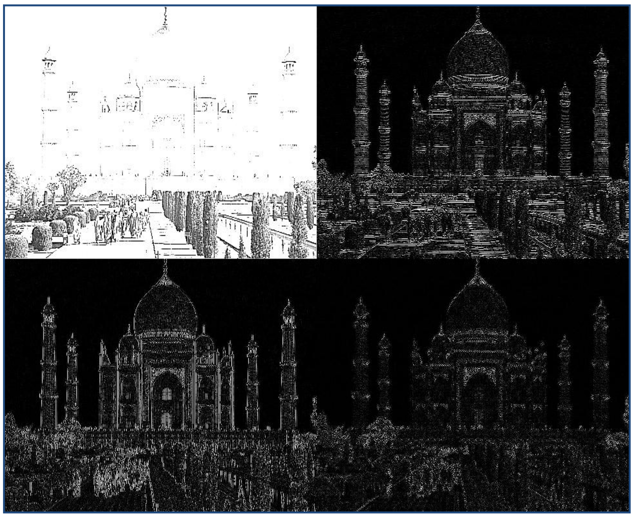

Figure 2.2: Modified 1 level 2D DWT of Taj Mahal

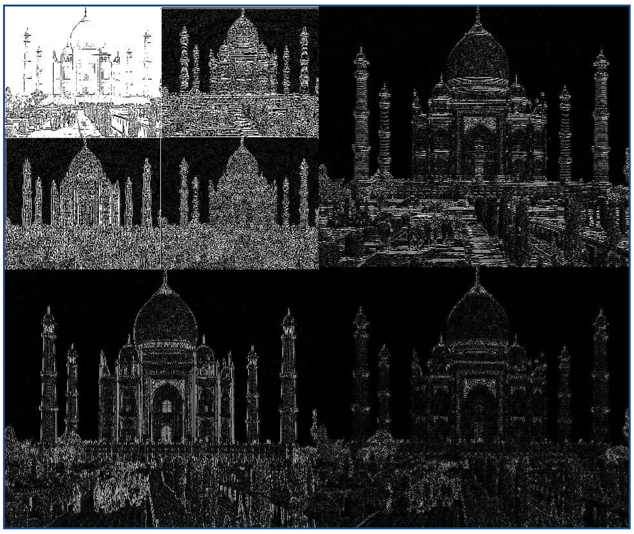

Figure 2.3: Modified 2 level 2D DWT of the Taj Mahal

3. DWT and UM Based Technique

In this paper introduction and importance of DWT in digital image processing is described [5]. Combining DWT and UM we proposed a new technique to sharp the edges in gray scale images. UM and our proposed algorithm(DWT-UM) are applied to the test image in fig.3.1 and fig.3.2 & 3.3 compares the operation of proposed algorithm to the UM. In this process, only 1 level resolution is taken, since a higher level tends to give a very excessive overshoot on the edges.

Figure 3.1: A sample picture of Taj Mahal

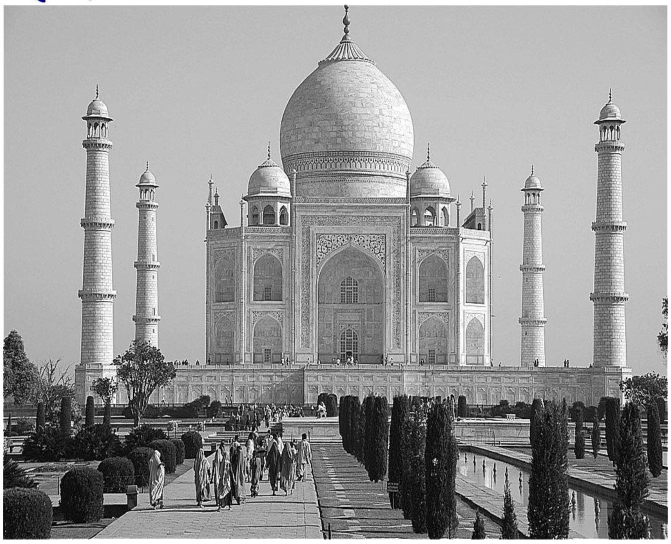

Figure 3.2: Processed with Unsharp Masking(UM)

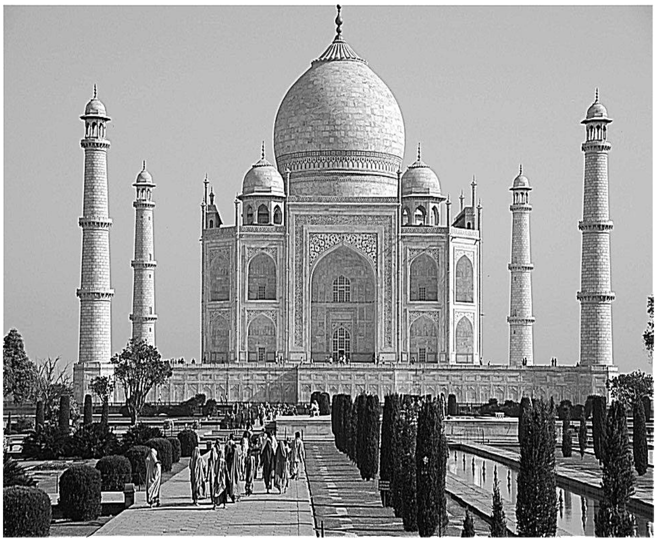

Figure 3.3: Processed with our proposed scheme (DWT-UM)

Comparison between UM and DWT-UM

We can see that image shown in figure 3.3 obtained from our proposed algorithm is much more sharp and better than that obtained from UM shown in figure 3.2.

4. Results

To observe the modification in coefficient values, before and after processing with DWT-UM, we have taken a part of sample picture shown in figures 4.1, 4.2, and 4.3 [6]. Small part for observation inside the red rectangle has an edge. The values of the pixels inside this box are shown in tables. Red values in the table presents low frequency elements left to the edge of building, and green values represents the edge. From the tables we observe that there is increase in values at once just after the red values. This shows the occurrence of high frequency elements or pixels or we can say the presence of edge.

Figure 4.1: Original image

Table 4.1: Values of pixels in a small part of original image

0.768627	0.760784	0.772549	0.764706	0.772549	0.843137	0.909804
0.768627	0.772549	0.776471	0.764706	0.768627	0.85098	0.901961
0.768627	0.768627	0.768627	0.764706	0.772549	0.862745	0.905882
0.768627	0.764706	0.764706	0.764706	0.780392	0.870588	0.909804
0.768627	0.764706	0.764706	0.768627	0.784314	0.87451	0.909804
0.768627	0.768627	0.772549	0.772549	0.784314	0.870588	0.909804
0.768627	0.768627	0.772549	0.772549	0.784314	0.866667	0.905882
0.768627	0.768627	0.772549	0.772549	0.780392	0.866667	0.905882
0.768627	0.764706	0.768627	0.768627	0.784314	0.870588	0.905882
0.772549	0.776471	0.764706	0.768627	0.780392	0.87451	0.921569

Amount of Sharpness:

Average value of red values in 5th column (Av_{red}) =0.7792,

Average value of green values in 6th column (Av_{green}) =0.8651,

Percentage of rise in values (P_{rise}) = $\frac{(Av_{green}-Av_{red})\times 100}{Av_{red}}$

= $\frac{(0.8651-.7792)\times 100}{.7792}$ = 11.02%.

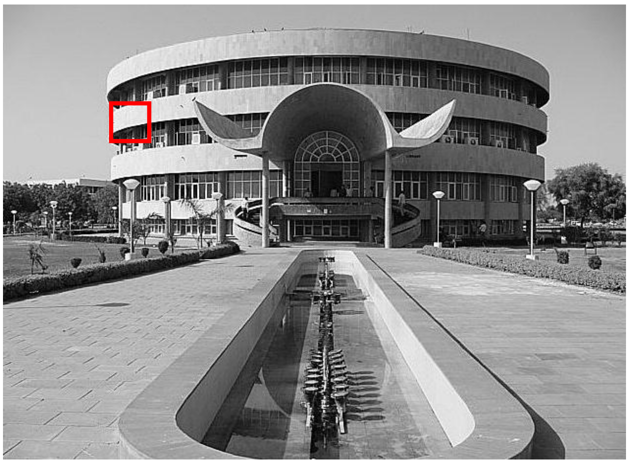

Figure 4.2: Sharpen image with Unsharp Masking (UM)

Table 4.2: Values of pixels in a small part of image processed with UM

0.781699	0.743791	0.793464	0.754248	0.718954	0.853595	0.976471
0.773856	0.781699	0.801307	0.750327	0.686275	0.87451	0.933333
0.772549	0.76732	0.771242	0.750327	0.690196	0.909804	0.939869
0.775163	0.75817	0.760784	0.747712	0.70719	0.92549	0.946405
0.773856	0.756863	0.756863	0.755556	0.713725	0.933333	0.943791
0.771242	0.768627	0.781699	0.764706	0.711111	0.918954	0.946405
0.768627	0.764706	0.776471	0.762092	0.713725	0.908497	0.935948
0.769935	0.76732	0.780392	0.764706	0.699346	0.909804	0.938562
0.766013	0.750327	0.766013	0.754248	0.715033	0.918954	0.934641
0.784314	0.797386	0.752941	0.747712	0.691503	0.926797	0.994771

Amount of Sharpness:

Average value of red values in 5th column (Av_{red}) =0.7047,

Average value of green values in 6th column (Av_{green}) =0.9080, Percentage of rise in values (P_{rise}) = $\frac{(Av_{green} - Av_{red}) \times 100}{Av_{red}}$

= $\frac{(0.9080 - .7047) \times 100}{0.7047}$ = 28.85%.

So by using UM technique, the amount of sharpening increased from 11.02% to 28.85%.

Figure 4.3: Sharpen image after processed with DWT-UM

Table 4.3: Values of pixels in a small part of image processed with DWT- UM

0.773856	0.750327	0.783007	0.698039	0.640523	0.861438	1.048366
0.775163	0.798693	0.798693	0.684967	0.622222	0.879739	1.003922
0.772549	0.779085	0.760784	0.667974	0.636601	0.909804	1.024837
0.768627	0.756863	0.741176	0.658824	0.665359	0.935948	1.037908
0.771242	0.756863	0.741176	0.670588	0.681046	0.946405	1.037908
0.768627	0.769935	0.769935	0.68366	0.677124	0.930719	1.033987
0.769935	0.771242	0.768627	0.68366	0.677124	0.913725	1.016993
0.766013	0.763399	0.768627	0.677124	0.657516	0.91634	1.014379
0.763399	0.756863	0.742484	0.669281	0.670588	0.929412	1.020915
0.780392	0.792157	0.734641	0.654902	0.653595	0.950327	1.067974

Amount of Sharpness:

Average value of red values in 5th column (Av_{red}) =0.6582,

Average value of green values in 6th column (Av_{green}) =0.9194,

Percentage of rise in values (P_{rise}) = $\frac{(Av_{green} - Av_{red}) \times 100}{Av_{red}}$ = $\frac{(0.9194 - .6582) \times 100}{0.6582}$ = 39.38%.

Using rise value parameter, it is observed that there is 11.02%, 28.85% and 39.38% [8]rise in values near the edge of original sample image, image after processed with UM method and image after processed with DWT-UM method respectively. So there is a large enhancement in sharpness by using DWT-UM [7].

5. Applications of DIP

Image processing has an enormous range of applications; almost every area of science and technology can make use of image processing methods. Here is a short list just to give some indication of the range of image processing applications.

5.1Medicine

- Inspection and interpretation of images obtained from X-rays, MRI or CAT scans,
- Analysis of cell images, of chromosome types.

5.2 Agriculture

- Satellite/aerial views of land, for example to determine how much land is being used for different purposes, or to investigate the suitability of different regions for different crops,
- Inspection of fruit and vegetables distinguishing good and fresh produce from old.

5.3 Industry

- Automatic inspection of items on a production line,
- Inspection of thesis samples.

5.4 Law enforcement

- Fingerprint analysis,
- Sharpening or de-blurring of speed-camera images.

6. Conclusion

The objective of the paper we have proposed a new algorithm that makes use of both DWT and UM techniques to update the coefficients values. The algorithm makes use of the correlation between different wavelet planes to select a set of high frequency coefficients describing the edges of the original image. The updated coefficients are used to calculate the inverse DWT, generating a new image with enhanced visual quality.

7. Future Work

The knowledge is ever expanding and so are the problems which the mankind strive to solve. This work focused on gray-scale images. The future scope of this work can be extended to improve the sharpening of color images.

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