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Performance Analysis of LSB Based Watermarking for Optimization of PSNR and MSE

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Abstract

This paper shows the synopsis of digital watermarking, an important solution used for ensuring and assisting data authentication, security of digital media and protection of copyright. The Least Significant Bit (LSB) algorithm is used for Image Watermarking. LSB embeds the image into the original image. In this paper, the original image is compared with the watermarked image using two parameters that areMean Square Error (MSE) & Peak Signal to Noise Ratio (PSNR) . Further the image after watermarking is distorted with the Gaussian noise and then watermark is detected. Its analysis is done using MATLAB.

Keywords:*Watermarking, Least Significant Bit (LSB), Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR)*

1. Introduction

In present time, presenting originality is becoming very important. Internet is being used widely, so we are able to access digital data such as images. Internet has progressed over the times so the transfer of image is faster and accurate. Moreover internet has become faster.It has its disadvantages too, which is that it needs to be modified and hackers are being generated everywhere.The valuable information to reach its destination can be modified & altered by many approaches like Watermarking, Cryptography and Steganography can be used to handle with this problem. By using the digital watermarking, any information can be hided. This information can be of any form like image, audio, text or some video. Digital watermarking has numerous applications like protection, anti-counterfeit of the digital media, distribution and labeling of user information. That's the reason that watermarking is most important in information hiding. The enforcement and protection of intellectual property rights for digital media became important issues The watermark can be hided visibly or invisibly in digital data. For stronger watermark good watermarking technique is applied. Algorithm plays a vital role in watermarking.Varioustypes of digital watermarking techniques has been proposed for data protection so that it can be saved from misuse. Basically these techniques are categorized in two different domains, spatialdomain and Frequency domain.

Spatial domainTechnique: In these algorithms, the raw data is directly inserted into the original image. The image of an object is manipulated in the space to hide the data for given application. Hence the direct pixels manipulation is done in an image. The simplest technique in this method is that the image is watermarked by inserting the watermark into the LSB of the host image pixels. Through this Data hiding is good but hardly robust.

Frequency domain Technique: These are more widely applied as compared to spatial domain method. In this technique, watermark is embedded using the spectral coefficient of the host image. For evaluating the spectral coefficients, generally used transforms are DFT (Discrete Fourier Transform), DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform).

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2. Review of LSB

In previous years the techniques which were known embeds the watermark in the LSB of pixels. This method is easy to work upon and understand and does not pixilated the image very much; however, it is not very robust against attacks. The watermark is inserted by selecting a particular set of pixels of the watermark image and then inserting them into the LSB of each pixel of the host image. The principle of embedding is fairly effective and simple. In this paper, images taken are gray scale images with 256*256 Pixels having 8 bit per pixel. An image isused as a base imageor host image in which watermark is going to be inserted. Then the information to be hided is also an imagewhich is called watermark.The principle of inserting the watermark into the host image uses the Least Significant Bit of each of the bytes of the host image i.e the bit on the far right side. For example, in the host image, let pixel value at a particular position is 132 which is 10000100 in binary and here watermark bit to be inserted is 1, then after inserting it in the host image, the pixel value will become 133 which is 10000101 in binary.

3. Performance Evaluation Metric

In this paper, the performance of watermarked image is measured using two parameters i.e. Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE).These ratiosare used as a quality measurement parameterfor the watermarked image and the original image. The MSE is evaluated by cumulating the square of error between the watermarked image and the original image, whereas PSNR is evaluated by finding the peak error between the original image and recovered image. MSE is evaluated in the cases where it is to be evaluated that how much a watermarked image is different from the original image. The lesser value of MSE indicates that the watermarked image does not vary significantly form the original image.
The peak to peak signal to noise ratio i.e. PSNR is calculated from MSE itself by the following formula:-

$$PSNR = 10\log_{10}\frac{L^2}{MSE}$$

where L is the range of pixel intensities in the image. e.g. if the image is having 8 bits/pixel, then L=28-1-255.
Thus PSNR is significant if the images having different dynamic ranges are used otherwise it does not contain any other information. If MSE is minimum, then PSNR will be maximum.

4. Experimental Results

1.Different bit substitution result

The experiment is done using MATLAB image processing toolbox. In the following section, different watermarked images with different bit substitutions are shown.It uses the *logo of AIS for the* watermark and *'baby.tif'* image as original image.Following figures shows original image, watermark image & various watermarked images produced after bit substitution algorithm from Least Significant Bit (LSB) to Most Significant Bit (MSB). Results from LSB substitution closely match with the expected one.

Figure 1. Original Image

Figure 2. Image to Hide

Figure 3. 5th bit Substitution

Figure 4. 6th bit Substitution

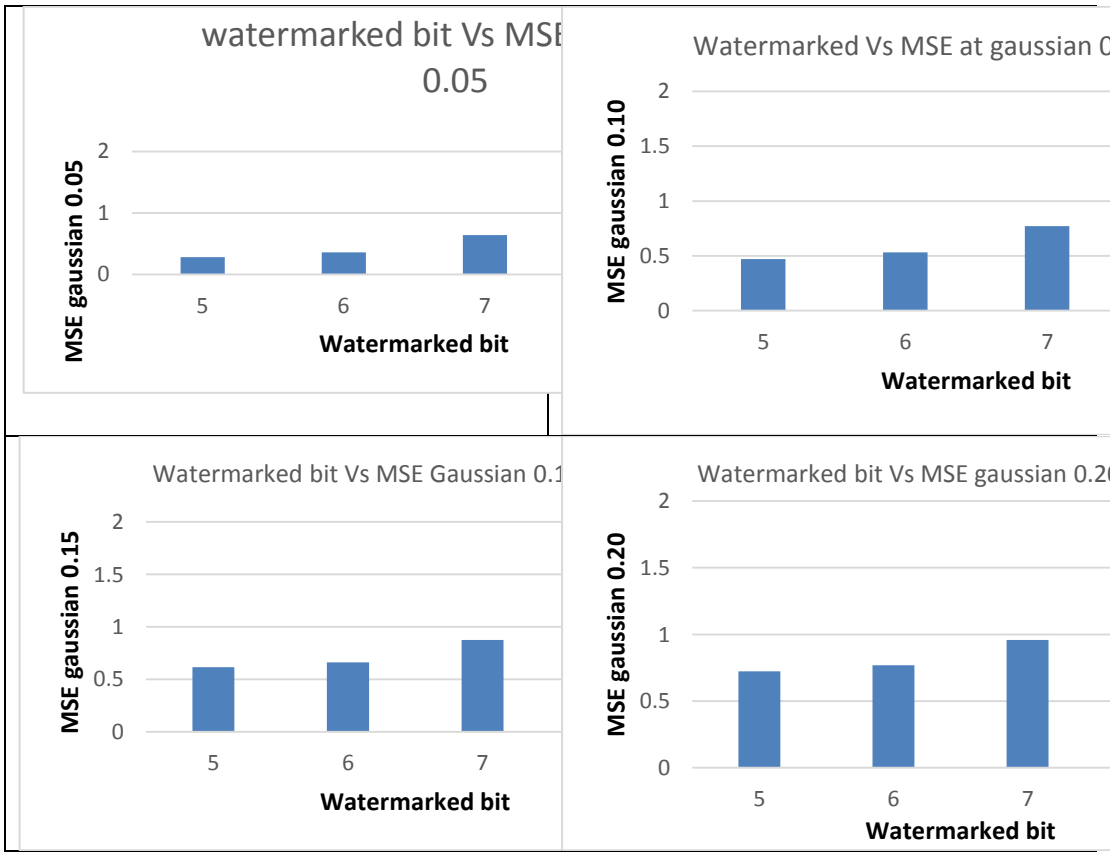
Figure 5. 7th bit Substitution

Figure 6. 8th bit Substitution

Table 1. MSE vs. Watermarked bit Gaussian Noise

Watermarked bit	0.05	0.10	0.15	0.20	0.25
5	0.2840	0.4700	0.6126	0.7222	0.8144
6	0.3618	0.5309	0.6626	0.7697	0.8588
7	0.6414	0.7713	0.8752	0.9594	1.0266
8	1.8088	1.7216	1.6872	1.6751	1.6749

2. MSE & PSNR of watermarked images with distortions Here we have used Gaussian noise pixilation to the watermarked image and the MSE & PSNR of watermarked images is calculated.



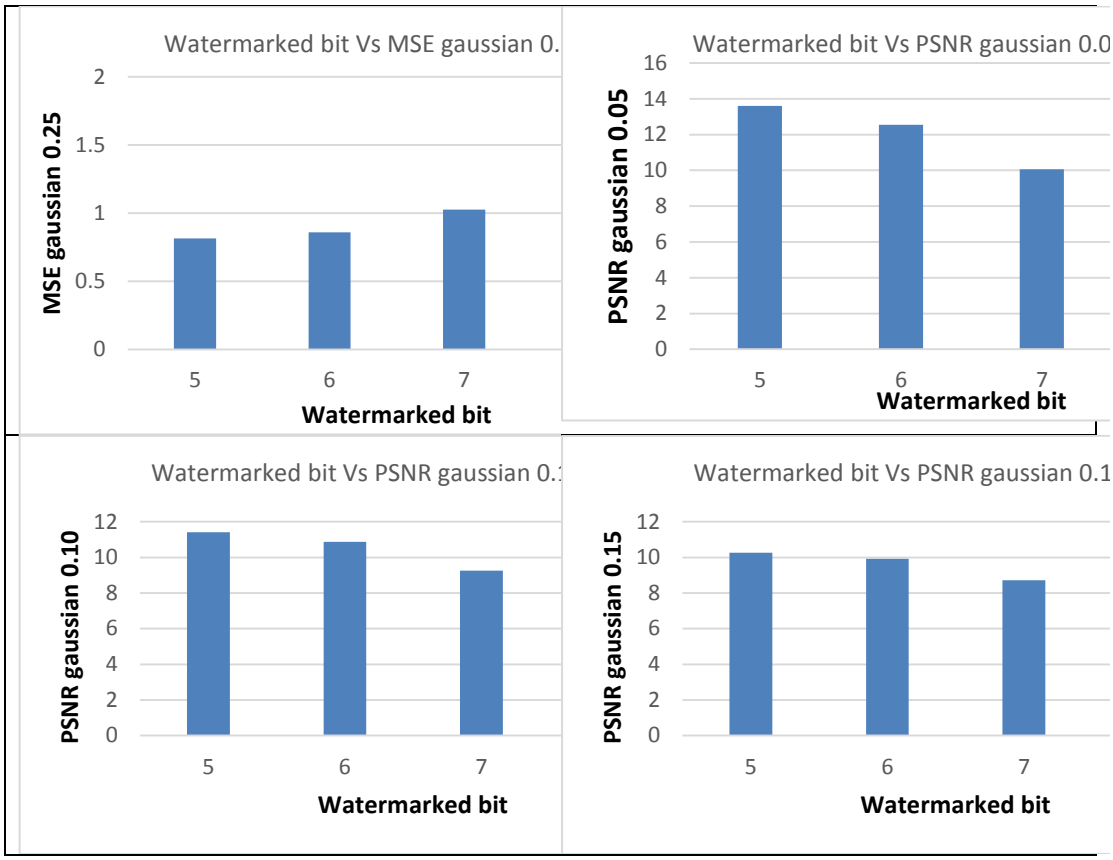
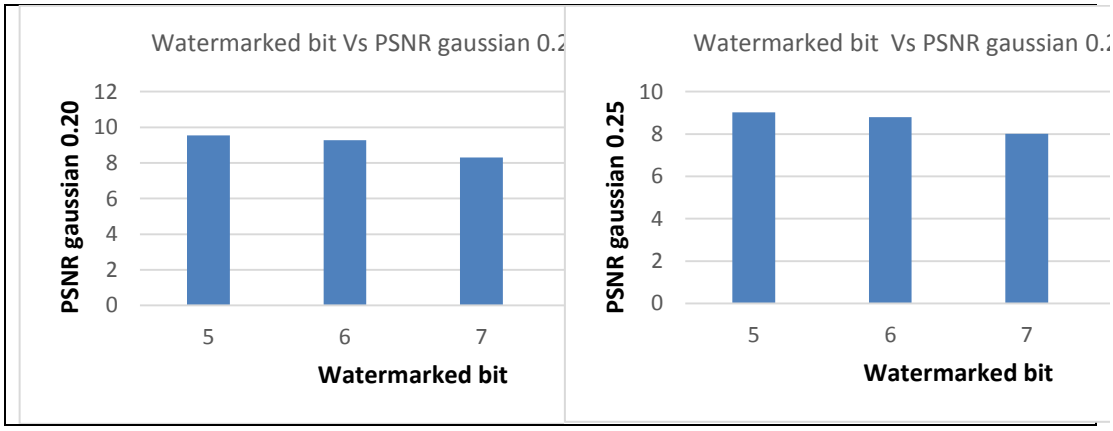


Table 6. PSNR Vs. Watermarked bit at Gaussian Noise 0.05

Watermarked bit	0.05	0.10	0.15	0.20	0.25
5	13.5975	11.4101	10.2589	9.5444	9.0220
6	12.5465	10.8805	9.9182	9.2678	8.7917
7	10.0593	9.2585	8.7099	8.3107	8.0166
8	5.5569	5.7715	5.8592	5.8904	5.8909



5. Conclusion

In this paper, LSB based digital watermarking technique is analyzed by inserting the watermark data in different bits i.e. from LSB to MB of the host image. When the watermark is inserted in the LSB of the host image, then generated watermarked image is without any noticeable distortion. But as the data is embedded in more significant bits, then the distortion becomes noticeable. As substitution changes from LSB to MSB, MSE of watermarked images with the original image increases & PSNR decreases. Also if image get pixilated with various kinds of distortions, MSE of distorted watermarked image with original image further increases and PSNR further decrease in presence of noise.

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