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Watermarking Using Energy-LSB Embedded Method

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ABSTRACT: Digital watermarking technology is increasingly used to protect copyright and demonstrate ownership of digital multimedia (such as text, music, photos, and videos). In order to safeguard intellectual property rights and rules of ownership for multimedia, this project suggests a text watermark algorithm. The process of hiding little text or grayscale images is the main focus, though. The masking of a watermark text in a high-color or high-density area of the block picture has been proposed using an embedding technique based on an energy function and the Least Significant Bits (LSB) method. Even with various format types and picture sizes chosen to conceal and cover a changing message size, the quality results demonstrate that the watermark image suffers from less distortion than the cover image, and the suggested algorithm is powerful to conceal a random watermark text even with smaller block sizes. An additional optional choice to encrypt the text watermark before embedding is also recommended because doing so would make it harder for hackers to read the text. This text can be encrypted using the Caesar cipher method before embedding is implemented in images. The experimental results of using the suggested algorithm for embedding and extracting watermark text for various sizes in a large number of images were satisfactory, giving a level of peak signal-to-noise ratio (PSNR) and Signal to Noise Ratio (SNR) with low mean square error (MSE) values. However, PSNR degrades more quickly than LBS as the watermark text size increases, so it was determined that it is more suitable for applying a watermark rather than a stego It is employed in order to share information securely.

Keywords: watermark, Energy, (Least Significant Bits) LSB, MSE, SNR, PSNR

1. INTRODUCTION

Encryption and decryption are methods for transmitting data safely in open networks. To shield private image data from unauthorized access should be prevented using various approaches because each type of data has its own characteristics. The main objective of any design is to: The purpose of the encryption and decryption technique is to send the recipient an unreadable text message while concealing the actual message. Over the internet, secret message communication is possible. The effectiveness of an algorithm depends on how challenging it is to break the original message. Although most of the existing encryption algorithms are used for text data, data encryption is commonly employed to assure security. By utilizing a key that is not publicly known, encryption transforms the original image data into another anonymous structure. identified any person. Decryption is the process of restoring the original data from an encrypted object [1].

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2. WATERMARK

The most popular way in the modern digital world for encoding hidden messages is the use of digital images. This is due to the fact that it can benefit from the human visual system's limited capacity (HVS). A digital image can conceal any plain text, encrypted text, image, or other data that can be encoded into a bit stream. This topic will expand extremely quickly given the development of powerful graphics capabilities in computers and the research being done on image-based watermarks. Different carriers (cover medium in digital format) are used by watermark techniques to conceal the data; these carriers can be network packets, hard drives, amateur radio waves, or generally any type of computer file, such as text, graphics, audio, or video.picture, sound, and video Due to the threat from law enforcement and rights enforcement groups and the requirement for organizations to secure their information, restrictions and rules are considered while utilizing watermarks [2]. On one side of a connection, there are numerous simple watermark techniques accessible to hide secret communications, while on the other side, hidden information can be detected. Watermark employs a cover to embed hidden data; this cover is chosen at random, and for the same secret data, anyone can choose a different cover without knowing which one is preferable because no standards or guidelines are used to select an appropriate cover [3].

By replacing pixels with bits from the secret message, the least significant bit (LSB) approach is utilized to embed information in a cover image.The human sight system is unable to detect these alterations. Each character (byte) of the secret message is represented by a group of 8 bits (1 byte). Then, in the watermark-image, hide/replace the character-related bits in the least important bit of the pixels. If the secret message has n characters, then the LSB approach requires at least (n*8) pixels in the watermark-image to hide the bits of the n characters. By using an energy function, a watermark technique can choose which set of pixels to embed based on the content of the image. This contrasts with conventional techniques that employ some a priori defined plan, such as dispersing the message randomly over the image. What the energy tells us about the colors' properties dispersed. Assuming that P(g) represents the distribution of colors in an image with g=0..L-1, the energy function can be defined as follows [4]:

$$f = \sum_{g=0}^{L-1} \{P(g)\}^2 \tag{1}$$

3. EVALUATION PARAMETERS

Commonly the Signal to Noise Ratio(SNR), Peak Signal-to-Noise Ratio (PSNR)and Mean-Squared Error (MSE),measurements can be used to evaluate the quality of the output results [5].

3.1 SIGNAL TO NOISE RATIO (SNR)

SNR is defined as the ratio of the average signal value to the standard deviation of the signal value .Higher SNR value showed a better quality image and low SNR indicates the certain region of image weakness relative to background noise . The represent an input image and is the standard deviation of the image [5].SNR is measured in decibels (dB),the equation as follows:

$$SNR = 10log_{10}\frac{Ps}{Pn} \tag{2}$$

Where: Ps=single power , Pn= noice power

3.2 PEAK SIGNAL TO NOISE RATIO (PSNR)

The term peak signal-to-noise ratio (PSNR) is an expression for the ratio between the maximum intensity of an image and the distorting noise that affects the quality of its representation. PSNR is usually expressed in terms of the logarithmic decibel scale. The bigger the PSNR, the better the visual quality of the restored image [5]. PSNR is measured in decibels (dB).

$$PSNR = 10log_{10}\frac{(2^{\,n} - 1)^2}{\sqrt{MSE}} \tag{3}$$

3.3 MEAN-SQUARED ERROR (MSE)

Mean Square Error (MSE), MSE is computed by averaging the squared intensity of the original (input) image and the resultant (output) image pixel as justify [5].

$$MSE = \frac{1}{MN}\sum_{I=1}^{M}\sum_{J=1}^{N}(fij - gij)^2 \tag{4}$$

Where : M and N are the number of rows and columns in the input images, respectively.
fij : It is the pixel of the original image
gij : It is the pixel of the image after hiding

4. THE PROPOSED SYSTEM OPERATIONS

In this paper an algorithm based on blocking a cover image, and finds the maximum energy blocks to embedding an encrypted secret watermark message in the least significant bit method (LSB) .The user enter the watermark text to be hidden and before the embedding process the program encrypting the text in a Caesar method for encryption, then the text is included in the higher-energy blocks, Figure (1) show the block diagram of the proposed method . The idea of blocking is proposed to be used with the energy function as methods to increase the security hide of the watermark text secret message in the cover image and avoiding the traditional sequentially hiding method.

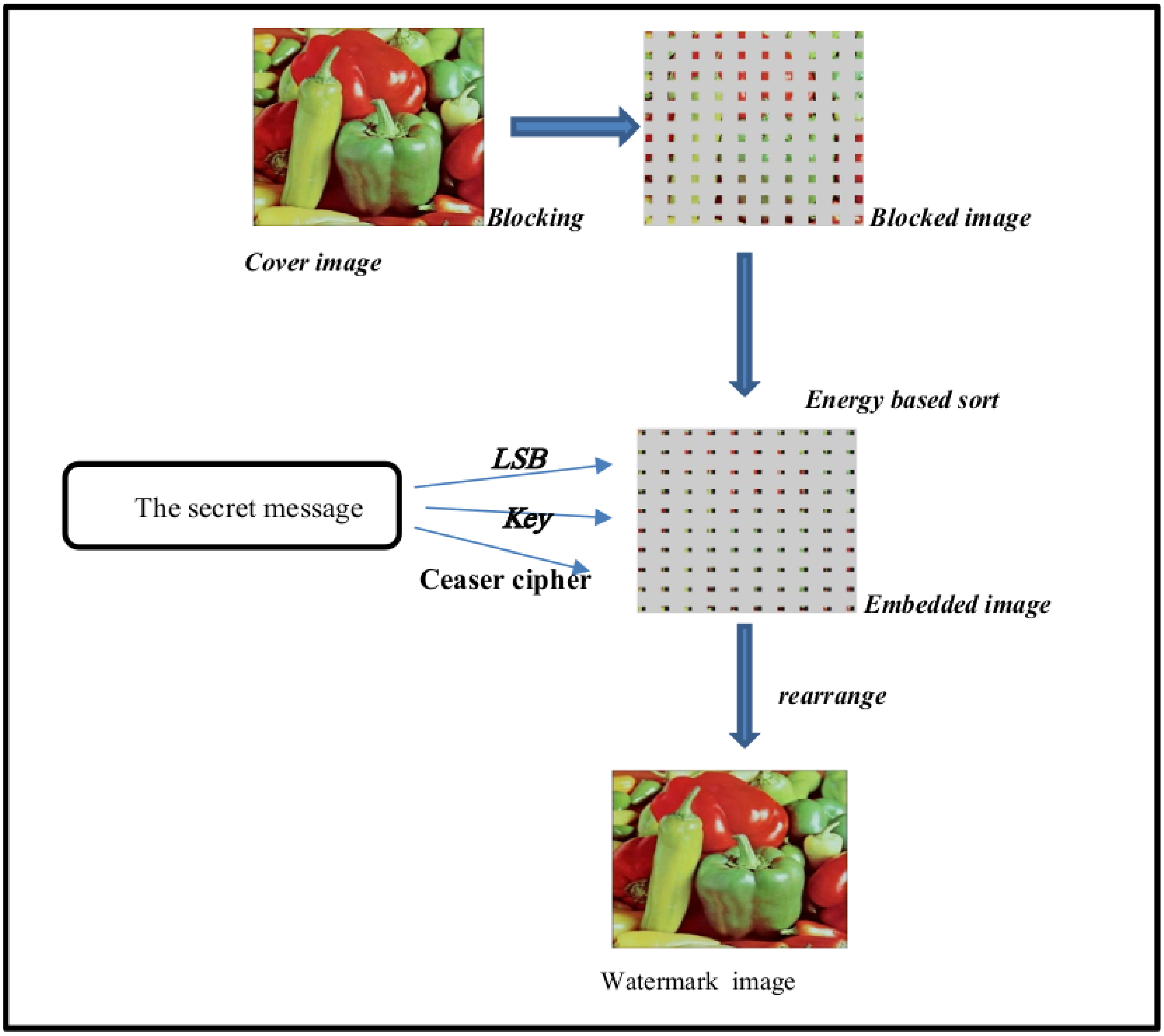
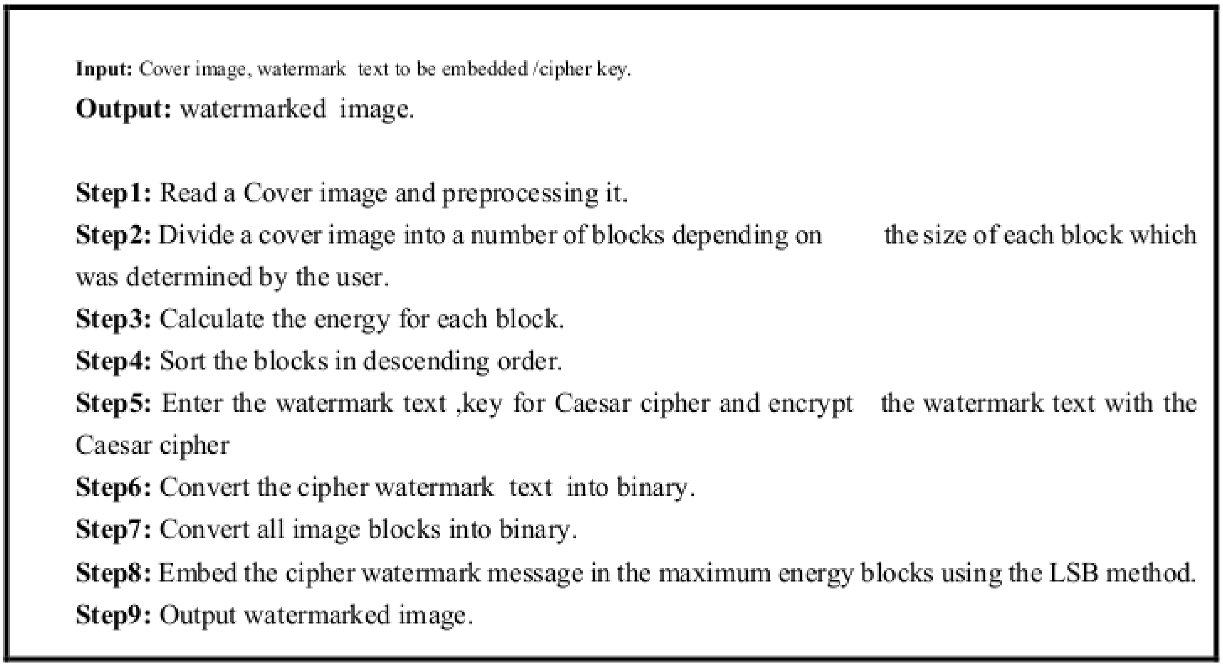


FIGURE 1. **Block diagram of applying the proposed watermarking method**

4.1 ENERGY-LSB EMBEDDED ALGORITHM

A watermark text can be hidden in a cover image using the proposed method illustrated in algorithm (1)

Algorithm 1. Energy-LSB embedding Algorithm



```
Input: Cover image, watermark  text to be embedded /cipher key.
Output: watermarked  image.

Step1: Read a Cover image and preprocessing it.
Step2: Divide a cover image into a number of blocks depending on     the size of each block which was determined by the user.
Step3: Calculate the energy for each block.
Step4: Sort the blocks in descending order.
Step5: Enter the watermark text ,key for Caesar cipher and encrypt   the watermark text with the Caesar cipher
Step6: Convert the cipher watermark  text  into binary.
Step7: Convert all image blocks into binary.
Step8: Embed the cipher watermark message in the maximum energy blocks using the LSB method.
Step9: Output watermarked image.
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5. EXPERIMENTAL RESULTS

Different cover image types and sizes are utilized, including (jpg, bmp, and png). The images utilized in the tests. The experiments that varied depending on the variation of many factors that affect the performance of the proposed algorithm, such as the size of the cover image, number of the blocks of cover image, and the length of the secret message, used the evaluation parameters MSE, SNR, and PSNR to verify the image quality between cover image and watermarked image.

5.1 EXPERIMENT 1

The first experiment focuses on the effect of changing the number of the blocks used to dividing the cover image. The number of blocks is varied depending on the size of the block previously determined by the user. By selecting a size of 768*768 pixels for the 15 coverd images with a block size of 8×8, 16×16,32×32, and 64×64 pixels) and use the key=2 for Caesar cipher and the length of watermark text message is 10 character, the evaluation results for this experiment, can be illustrated in table (1).

Table 1. **evaluation results for the first experiment)block size 8and 16)**

Image	MSE(8)	SNR(8)	PSNR(8)	MSE(16)	SNR(16)	PSNR(16)
P1.jpg	0.000101725	81.6261	88.0565	6.10352e-005	83.8445	90.275
P2.png	0.00012207	81.7361	86.3685	6.4426e-005	84.5114	89.6572
P3.bmp	0.000103421	82.2933	87.5661	6.61214e-005	84.236	89.5087
P4.jpg	8.81619e-005	78.8377	87.196	4.91672e-005	81.3738	89.732
P5.png	0.000113593	80.5111	86.8308	5.42535e-005	83.7207	90.1507
P6.jpg	0.000115289	83.0032	87.5129	5.42535e-005	86.277	90.7865
P7.png	0.000120375	81.3257	86.0825	6.27306e-005	84.1562	88.9131
P8.jpg	0.000111898	81.4517	87.6085	4.91672e-005	85.0229	91.1799
P9.jpg	0.000105116	84.5938	87.9141	5.42535e-005	87.4662	90.7865
P10.bmp	0.000110202	82.4579	87.0731	6.61214e-005	84.6764	89.2915
P11.bmp	0.00010003	81.3382	87.5667	6.95123e-005	82.9195	89.1109
P12.png	0.000103421	82.985	87.9847	5.42535e-005	85.787	90.7865
P13.jpg	0.000101725	83.8545	88.0565	6.95123e-005	85.5083	89.7102
P14.png	0.000108507	81.2226	87.177	6.78168e-005	83.2641	89.1816
P15.jpg	0.000113593	81.4615	87.5773	6.27306e-005	84.039	90.156

Table 1. continue. evaluation results for this first experiment)block size 32 and 64)

Image	MSE(32)	SNR(32)	PSNR(32)	MSE(64)	SNR(64)	PSNR(64)
P1.jpg	5.76443e-005	84.0927	90.5232	6.78168e-005	83.3863	89.8174
P2.png	5.42535e-005	85.2582	90.114	6.95123e-005	84.1819	89.2915
P3.bmp	6.61214e-005	84.236	89.4729	5.25581e-005	85.233	90.5057
P4.jpg	4.74718e-005	81.5261	89.8844	5.76443e-005	80.683	89.0412
P5.png	6.10352e-005	83.2087	89.5656	6.10352e-005	83.3313	89.7248
P6.jpg	6.4426e-005	85.5305	90.0402	6.78168e-005	85.3079	89.8174
P7.png	4.57764e-005	85.5246	90.2814	5.08626e-005	85.067	89.8239
P8.jpg	5.59489e-005	84.4619	90.6188	5.59489e-005	84.4618	90.6188
P9.jpg	5.76443e-005	87.203	90.5232	4.57764e-005	88.2042	91.5244
P10.bmp	7.12077e-005	84.3547	88.9697	4.74718e-005	86.116	90.876
P11.bmp	6.27306e-005	83.3651	89.5567	4.57764e-005	84.7338	91.0339
P12.png	3.2213e-005	88.0502	93.0505	5.76443e-005	85.5237	90.5232
P13.jpg	6.78168e-005	85.6158	89.8174	6.78168e-005	85.6155	89.8174
P14.png	5.42535e-005	84.2328	90.114	5.25581e-005	83.6027	90.3616
P15.jpg	6.10352e-005	84.1582	90.275	6.27306e-005	84.0389	90.156

The results illustrated in table (1) shows that how block size affects the quality of watermarked image. It can be seen that by increasing the block sizes, the SNR and PSNR increase (become higher quality), for the most images but the MSE increases when the block size is larger and vice versa. This is due to the increase in the number of pixels in the cover image, such that the increasing the speeding of data.

5.2 EXPERIMENT 2

The second experiment focuses on the effect of changing the size of cover image. Selecting a different size for the 40 cover image with sample of the maximum energy blocks for a block size (64×64 pixels) and use the key=2 for Caesar cipher and the length of watermark text message is 10 character . Table (2) shows results of evaluation measurement for this experiment .

Table 2. evaluation results for this second experiment(different size image)

Image	Image size	MSE	SNR	PSNR
P1.png	2880*2880	4.34028e-006	96.3501	101.721
P2.jpg	1024*1024	3.52859e-005	83.718	92.3427
P3.png	832*832	7.51202e-005	84.5604	88.8828
P4.png	768*768	5.93397e-005	84.5451	90.2253
P5.bmp	704*704	5.8513e-005	83.661	89.8224
p6.jpg	640*640	7.56836e-005	80.4733	89.3408
P7.jpg	512*512	9.53674e-005	82.1761	88.3368
P8.jpeg	448*448	0.000194316	79.7062	85.2457
P9.jpg	384*384	0.000257704	76.1017	83.7427
P10.jpeg	320*320	0.000390625	77.2985	82.2132
P11.jpg	256*256	0.000595093	74.1582	80.1081

image is affected by increasing in the size of the cover image such that SNR, PSNR is increasing (greater quality) by increasing the size of the cover image while the MSE is decreasing and vice versa. This is due to the increasing of the number of pixels in the cover image, which will change so that the distortion decreases and the quality increases even with the increase in the number of blocks by reducing the block size, because the ratio of pixels in the image to the number of characters increases and therefore distortion decreases.

5.3 EXPERIMENT 3

The three experiment focuses on the effect of cipher watermark text length. Selecting a different size for the 36 cover image with sample of the maximum energy blocks for a block size (64×64 pixels) and use the key=2 for Caesar cipher and the length of watermark text message is 10,50 character . Table(3) shows results of evaluation measurement for experiment .

Table 3. evaluation results for this three experiment(length of watermark text (10,50))

Image	Image size	MSE(10)	SNR(10)	PSNR(10)	MSE(50)	SNR(50)	PSNR(50)
P1.png	2880*2880	5.42535e-006	95.3825	100.787	2.14603e-005	89.4104	94.8145
P2.png	1024*1024	2.95639e-005	86.314	93.4232	0.000150681	79.2411	86.3502
P3.png	832*832	6.78971e-005	85.0048	89.8123	0.000252808	79.2954	84.1029
P4.png	768*768	5.59489e-005	84.8165	90.6188	0.000289917	77.6716	83.4739
P5.png	704*704	7.46546e-005	81.783	89.3318	0.00034099	75.1861	82.735
P6.jpg	640*640	8.05664e-005	80.204	89.0693	0.000393066	73.3209	82.1861
P7.jpg	512*512	0.000148773	79.8872	86.4056	0.000629425	73.623	80.1414
P8.jpeg	448*448	0.000144491	80.2166	85.3677	0.000827089	72.6395	77.7906
P9.jpg	384*384	0.000196669	77.4766	85.1934	0.00110541	69.9787	77.6956

It is clear from table (3) that the watermarked image quality is affected by increasing the watermark text length so that the SNR and PSNR (greater quality) increases by decreasing the watermark text length while the MSE decreases and vice versa. This is due to the increasing of the number of pixels in cover image that will change such that the distortion is increases and the quality is decreases.

6. CONCLUSIONS

A watermarking algorithm based on a combination of LSB and the maximum energy is proposed in this work. From this work it can be conclude:

The quality of the watermark image is measured using SNR, PSNR and MSE. The idea of using the maximum energy blocks to hide the secret message is that the maximum entropy is mean the most interesting intensity pixels such that the changes in these pixels produce less disturbances and less distortion. The size of the blocks of the cover image and cipher algorithm is affects the quality of the watermark image; therefore the increasing of the block size decreases the changes in watermark image such that increase the quality (SNR,PSNR) and decrease the MSE. And not use the cipher algorithm also creases the changes in watermark image such that increase the quality (SNR,PSNR) and decrease the MSE .Even with decrease the sizes of the blocks used to hide the secret images and use the cipher algorithm but the proposed algorithm is robust. The length of the secret message is decrease the quality of watermark image and increase the error ratio when it increases. This is because the increasing of distortion of pixels, but the change is very low because the robust of the proposed algorithm.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

REFERENCES

[1] P. Gaur and N. Manglani, “Image watermarking using LSB technique,” *Int. J. Eng. Res. Gen. Sci*, vol. 3, no. 3, pp. 1424–1433, 2015.

[2] A. Bamatraf, R. Ibrahim, and M. N. B. M. Salleh, “Digital watermarking algorithm using LSB,” *2010 International Conference on Computer Applications and Industrial Electronics*, pp. 155–159, 2010.

[3] Z. M. Hussain, . Al-Mansour, and J, “Steganography using Energy-LSB Embedded Method,” 2015.

[4] I. Davidson, G. Paul, and S. S. Ravi, “Steganography using spatially interesting pixels,” *Lect. Notes Comput. Sci*, vol. 2137, pp. 289–302, 2004.

[5] U. Sara, M. Akter, and M. S. Uddin, “Image quality assessment through FSIM, SSIM, MSE and PSNR-a comparative study,” *J. Comput. Commun*, vol. 7, no. 3, pp. 8–18.