A COMPARISON OF WATERMARKING IMAGE QUALITY BASED ON DUAL INTERMEDIATE SIGNIFICANT BIT WITH GENETIC ALGORITHM

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ABSTRACT. The quality of the watermarked images is considered as one of the most important requirements of any watermarking system. In most applications, the watermarking algorithm embeds the watermark without affecting the quality of the host media. In this study, a comparison of watermarking image quality was performed between two existing methods: Dual Intermediate Significant Bit (DISB) and Genetic Algorithm (GA). The first method focuses on the high quality of the watermarked image based on DISB model and this method requires embedding two bits into every pixel of the original image, while the other six bits are modified so as to immediately assimilate the original pixel. In this case, when the two hidden bits are equal to the original bits, there will be no change to the other remaining bits. However, if the original value is not equal to the embedded one, the nearest pixel to the original one will be chosen as the watermarked image. The second method, GA method is used to embed two bits of watermarking data within every pixel of the original image and to find the optimal value based on the existing DISB. On the other hand, if the two embedded bits are equal to the original bits then this means the watermarked image is still the same as the original one without any changes, while in the other case GA is used in determining the minimum fitness value in which the fittest is the absolute value between the pixel and chromosome and the value of chromosome between 0-255. The results indicate that the two methods produce a high quality watermarked image, but there is a big difference in the processing time, so the DISB method is faster than the GA method.

Keywords: Watermarking, GA, Chromosome, Image Quality

INTRODUCTION

Digital watermarking is one of the hiding techniques used in information technologies that embed copyright information into the host media which is utilized in identifying the ownership of various types of multimedia (Peungpanich & Amornraksa, 2010). It achieves the copyright protection purpose of embedding a signal that contains useful certifiable information for the original media owner, such as company logo, producer's name in the host media. Digital watermarking provides a new way to achieve effective copyright protection (Tirkel, Osborne, & Schyndel, 1996). In most applications, the watermarking algorithm embeds the watermark without affecting the quality of the host media (Modaghegh, 2009). Recently, Genetic Algorithm (GA) has become quite popular in the artificial intelligence area due to their evolutionary nature and their special significance for optimization in several areas. In general, improving the quality of the watermarked image should take into consideration the other requirements, such as the resistance against attacks and the distortion for watermarked image should be impenetrable by a third party.

Intermediate Significant Bit (ISB) is a new watermarking technique; it makes a bit-plane of digital images as a set of bits having the same situation in the respective binary numbers. In the gray scale image representation, there are 8 bit-planes: in which the first bit-plane contains the set of the Most Significant Bits (MSB) and the 8th bit-plane contains the LSB. The sets in between, from the 2nd to the 7th bit-planes are ISB (Zeki & Manaf, 2009). Recently, many studies used this ISB technique to improve the watermarking technique. One of these studies developed an algorithm based on changing the ISB of the low frequency approximation sub-band (LL) of the Discrete Wavelet Transform DWT domain to embed the watermark into the host image (Dejun, Rijing, Yuhai, & Huijie, 2009). Another study attempts to find a threshold value, based on Intermediate Bit Values (TIBV) of images by selecting the image pixel for insertion of the watermark (Perumal & Kumar, 2011).

An ISB model based on blocks of pixels are developed to improve its resistance against different types of attacks and at the same time maintain the quality of the image (Zeki & Manaf, 2011). In another ISB model, the data of the watermark are repeated for a certain number of times (3, 5, 7, and 9 times) in order to improve the immunity of the watermarking technique. At the same time, the watermark technique is mainly used in the watermark detecting procedure, which makes the algorithm more resistant, especially to the geometric transformation attacks (Zeki, Manaf, & Mahmod, 2011). An enhanced system based on multiple watermarks in which two different watermarks are embedded concurrently into the ISB of the host image pixels (Emami, Sulong, & Seliman, 2012).

GA has been widely applied through the last years as an optimization technique. GA starts with an initial population which is represented by an encoded binary string called the “chromosome” and the elements in the binary strings or the “genes” are adapted to maximize or minimize the fitness values. The fitness function has to be carefully selected specifically to a particular application and the kind of optimization required (Goyal, Gupta, & Bansal, 2009). Hence, the entire process of GA starts with a set of proposed solutions randomly generated and tries to bring about further possible solutions to achieve the desired optimization i.e. a randomly selected set of chromosomes that encode a set of potential answers. In GA, genes in a chromosome represent the variability of a problem and the chromosomes are evaluated according to a fitness criterion (Anwar, Ishtiaq, Iqbal, & Jaffar, 2010).

Another study used a Genetic Algorithm (GA) method to embed two bits of watermarking data within every pixel of the original image and to find the optimal value based on the existing Dual Intermediate Significant Bit (DISB) (Mohammed, Yasin, & Zeki, 2013). GA is used in determining the minimum fitness value in which the fittest is the absolute value between the pixel and chromosome and the value of chromosome between 0-255. The new method improves the image quality and gets the optimal value for the two embedded bits. The method shows the gradual increase for all bit-planes, in addition, the time calculated for all embedded bits which show the difference between the two methods (Mohammed et al., 2012).

The paper is organized as follows: first introduces the proposed method and the proposed algorithm in detail and discusses the achieved results and compares the proposed method with LSB method. And so concludes the paper. Finally, introduces the references which depending on this paper.

PROPOSED METHOD

A bit- plane of digital images is a set of bits having the same position in the respective pixels of the digital image (Zeki & Manaf, 2009). Hence, the DISB method, can be explained by selecting any two bit-planes from 1 to 8 which are called (k_1, k_2) where ($k_2 > k_1$).

The watermarked object is inserted into the two selected bits and the other 6 bits are changed to directly assimilate the original pixel. In the case when 2 hidden bits are equal to the original bits, there will be no change to the other remaining bits. However, if the original value is not equal to the embedded one, the nearest pixel to the original will be chosen as the watermarked image. On the other hand, the GA method, can be explained by selecting any two bit-planes, the watermarked object is inserted into the two selected bits, in the case of when the 2 embedded bits are equal to the original bits; there will be no change to the other remaining bits. Contrariwise, if the original value is not equal to the embedded one, GA will be used to solve this problem, by creating the population where the size of the population is 256. For each chromosome from 0-255, then by converting each chromosome into binary, the fitness value for each chromosome will be counted. It represents the absolute value of the pixel minus the value of chromosome, this means that the method will check all the probabilities by taking the first two embedded values and consider these values as the optimal values, also for the second, third and so on. According to equation (1) below, Fitness value can be computed.

$$\text{Fitness value} = \left| \text{pixel- chromosome} \right| \tag{1}$$

The method after embedding all of the values will calculate the peak signal to noise ratio (PSNR) and the time value (Mohammed et al., 2012).

According to the previous published papers and the proved results for both methods, a comparison between the quality of the watermarked images to the DISB method (Mohammed et al., 2012), and the GA method based on DISB (Mohammed et al., 2012), is closely identical. The quality of the watermarked images for both techniques increases gradually from (k1=1, k2=2) (MSB) to the (k1=7, k2=8) (LSB). A gradual increase in PSNR value from the first embedding bits (k1=1, k2=2) which is an indication of the lowest PSNR value, while the two embedding bits (k1=7, k2=8) represent the high PSNR value and high quality.

It is clearly that the quality of watermarked images of the two methods has demonstrated improvement. It is observed from the tables (1 & 2) that the time when using the DISB method, is greatly better than the time when using the GA method. This is because the GA method takes all the probabilities for all bit planes which means that it takes a long time to reach the suitable value for the pixel. While the DISB method replaced the new pixels which are the closest to the original ones, and then the time is better. At the same time the quality of both methods is exactly matching and the results demonstrate the improvement in the two methods.

Table 1. Time (seconds) of the DISB for all host images and for all the bit-planes

Bit plane K1	K2	Host 1 Bridge	Host 2 Boats	Host 3 Camera	Host 4 Milk drop	Host 5 Plane	Host 6 Peppers
1	2	24.072956	24.158659	24.326478	24.182818	24.176420	26.359278
1	3	24.028363	24.552305	24.213913	24.784743	24.342618	24.516936

1	4	24.069077	24.117336	24.297099	24.310352	24.314863	24.152103
1	5	24.031508	24.102940	24.332057	24.276632	24.250761	24.206052
1	6	24.122660	24.184117	24.442975	24.172006	24.349632	24.198835
1	7	24.131506	24.229291	24.245418	24.319664	24.328931	24.256518
1	8	24.373659	24.239144	24.334196	24.326571	24.344043	24.347229
2	3	24.017318	24.067735	24.103959	24.131253	24.132135	24.433370
2	4	24.244416	24.105408	24.220477	24.181623	24.207536	24.378236
2	5	24.226584	24.052312	24.246799	24.358380	24.219573	24.183067
2	6	24.293197	24.116909	24.340268	24.296714	24.162078	24.338308
2	7	24.090591	24.205585	24.231257	24.465374	24.240438	24.390419
2	8	24.179250	24.272626	24.304263	24.270194	24.171545	24.328321
3	4	24.023198	24.166605	24.357450	24.197657	24.214774	24.426009
3	5	24.099637	24.403260	24.250509	24.204865	24.140061	24.210264
3	6	24.065720	24.139410	24.301422	24.170181	24.372783	24.380663
3	7	24.155004	24.180062	24.343905	24.210993	24.414472	24.454599
3	8	24.253044	24.218694	24.236660	25.489612	24.244130	24.134379
4	5	24.353096	24.253922	24.425721	24.172493	24.141289	24.129428
4	6	24.254767	24.178023	24.420236	24.220038	24.383904	24.346539
4	7	24.133186	24.220247	24.301184	24.278162	24.251013	24.384200
4	8	24.198867	24.206845	24.220781	24.165735	24.207526	24.236719
5	6	24.319730	24.309608	24.367386	24.297263	24.142034	24.065566
5	7	24.231448	24.285174	24.294283	24.471295	24.258970	24.199370
5	8	24.159791	24.258373	24.154331	24.206877	24.175312	24.169725
6	7	24.146809	24.248790	24.125194	24.388843	24.153367	24.306317
6	8	24.814787	24.290160	24.198313	24.200084	24.221128	24.102909
7	8	24.106557	24.324736	24.265539	24.226687	24.258502	24.172980

Table 2. The Time (seconds) of the GA for all host images and for all the bit-planes

Bit plane		Host 1	Host 2	Host 3	Host 4	Host 5	Host 6
K1	K2	Bridge	Boats	Camera	Milk drop	Plane	Peppers
1	2	1963.792014	1967.653441	1975.420761	1971.201289	1969.989744	1967.778659

1	3	1968.293493	1972.195643	1971.676093	1966.187701	1965.334907	1966.476332
1	4	1969.393744	1968.784532	1967.044716	1965.181299	1959.199055	1965.199054
1	5	1973.908151	1977.345323	1965.038951	1968.160388	1961.793642	1960.789302
1	6	1976.591990	1967.676940	1964.497909	1963.424530	1960.222607	1965.022451
1	7	1967.627825	1964.877564	1969.560327	1974.760113	1971.979563	1972.159032
1	8	1965.834293	1969.78550	1972.766040	1971.011289	1974.334879	1959.098703
2	3	1971.223029	1975.343980	1967.440116	1961.878665	1965.112578	1966.401176
2	4	1968.937338	1971.875641	1976.655324	1966.453970	1963.055986	1974.259840
2	5	1968.199165	1963.166983	1964.211069	1967.634209	1967.447997	1974.905381
2	6	1971.561174	1968.433296	1971.321430	1969.828773	1965.895043	1961.119064
2	7	1976.785172	1973.879552	1969.566458	1972.177546	1969.435548	1968.299043
2	8	1970.304814	1974.437170	1968.061865	1964.405669	1974.483993	1963.201722
3	4	1964.070432	1968.102459	1970.543917	1969.282640	1975.143977	1972.200874
3	5	1959.301702	1965.478990	1961.218265	1963.199564	1968.558165	1976.735027
3	6	1965.624504	1968.770543	1968.221954	1972.340631	1968.116709	1965.157659
3	7	1967.539312	1969.034875	1971.347616	1959.565302	1964.476643	1971.199043
3	8	1964.168715	1972.98520	1968.545721	1969.353286	1969.300453	1970.787402
4	5	1965.456551	1967.540231	1968.446139	1967.647437	1970.878641	1964.558749
4	6	1970.083102	1969.198604	1976.769303	1966.3658506	1962.554925	1966.486750
4	7	1965.148940	1967.210560	1963.904541	1963.953701	1974.460194	1975.155771
4	8	1972.507335	1963.201180	1959.071125	1963.678920	1976.988293	1965.209793
5	6	1965.437950	1968.871062	1966.223678	1968.544739	1973.211984	1966.787601
5	7	1964.720021	1966.491204	1962.298711	1968.0119234	1975.675894	1971.023247
5	8	1968.711608	1964.089671	1969.067683	1969.8559403	1975.937563	1972.657690
6	7	1966.516197	1969.231095	1967.449860	1963.220385	1968.539021	1968.486325
6	8	1966.896139	1967.860771	1964.976552	1970.3994766	1969.200753	1969.036449
7	8	1963.297848	1964.960543	1962.338706	1966.668053	1971.380657	1965.311205

From the above tables, it is clear that the big difference in the processing time between the two methods. Simultaneously, the two methods produce a high quality watermarked image. The time value of the two methods for all the bit-planes are illustrated in Figure 1 below.

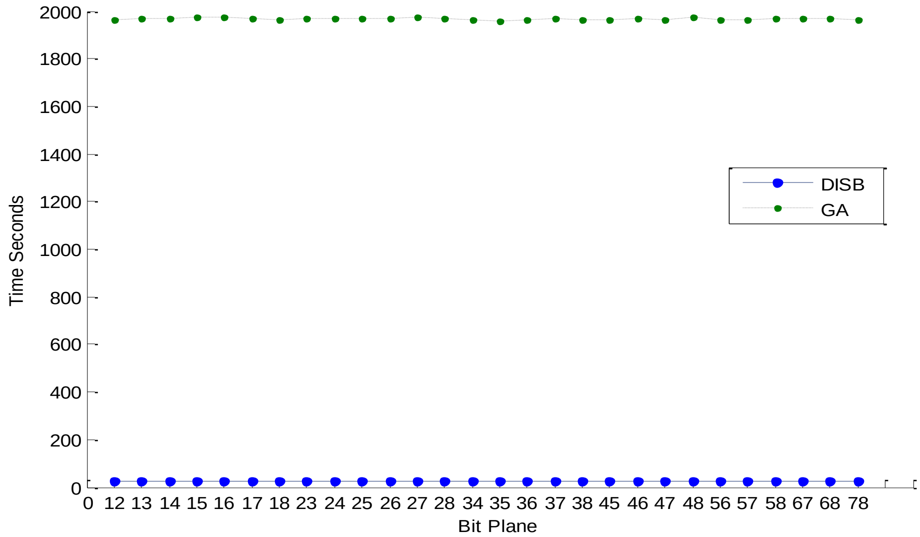

Figure 1. The time values of the DISB and the GA method for the different bit-planes

CONCLUSION

The DISB method requires embedding two bits into every pixel of the original image, while the other six bits are modified are changed so as to directly assimilate the original pixel. While the GA method is used to embed two bits of watermarking data within every pixel of the original image and to ascertain the optimal value based on the existing DISB. However, if the two embedded bits are equal to the original bits then this means the watermarked image is still the same as the original one without any changes, while in the other case GA is used in determining the minimum fitness value where the fittest is the absolute value between the pixel and chromosome and the value of chromosome between 0-255. The GA method takes all the probabilities for all bit planes which means take a long time to reach the suitable value for the pixel. While the DISB method replaced the new pixels which are the closest to the original ones, and then the time is better.

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