A NOVEL LSB8 METHOD FOR MESSAGE STEGANOGRAPHY USINGDIGITAL SPEECH SIGNAL

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ABSTRACT

Providing a simple and secure way to preserve confidential messages is crucial, given the widespread exchange of messages across various communication channels. This research paper presents a straightforward and effective method for protecting secret messages. The approach utilizes a speech file as the cover medium, enhancing the hiding capacity by enabling the concealment of a message that matches the size of the cover media. The method hides one character from the secret message using every sample of the speech file. The sample values of the speech file will be converted into 64-bit binary numbers, with the 8 least significant bits of each sample reserved for embedding the 8-bit character. Replacing the eight least significant bits of each sample with the binary value of the character will minimally impact the sample's value. As a result, the stego sample value will closely resemble the original cover sample value, ensuring excellent quality in the stego file. The mean square error will be close to zero. The suggested method will be tested using several messages and cover speech files. The resulting experimental data will be analyzed to demonstrate the method's enhancements in increasing hiding capacity, speeding up the message embedding process, and minimizing the error between the cover and stego speech, effectively making the stego speech indistinguishable from the original.
Keywords: *Steganography, Covering speech, Stego Speech, LSB, LSB2, LSB8, MBM, CBBM, Quality.*

1. INTRODUCTION

A digital speech file (DSF) has a good feature, making this file a simple covering media to hold secret information [1-25]. DSF is efficiently represented by a matrix, making matrix operations straightforward and allowing for easy storage, retrieval, and manipulation. Its large size provides a high hiding capacity, and sample values can be easily converted between decimal and binary. Each sample can be represented as a 64-bit binary number, where modifying the eight least significant bits minimally affects the sample value, keeping source DSF nearly identical to the stego DSF [26- 40]. DSF can easily represent the negative and positive values using the same 64-bits binary format. Message steganography using DSF as a covering media requires the hiding and extracting functions. The hiding function processes the covering DSF and the secret message to produce a stego DSF. The extracting function processes the stego DSF to produce the secret message as shown in Fig. 1. The extracted secret message should match the source secret message. The stego DSF must be of a high quality and almost identical to the covering DSF [55-60]. The quality parameters assessed between the source and stego digital speech file (DSF) should fulfill these requirements: a minimum mean square error (MSE), a high peak signal-to-noise ratio (PSNR), a close to one correlation coefficient (CC), and a low number of samples change rate (NSCR) [40-54]. Numerous message steganography methods [1-10] have been developed, primarily relying on the least significant bit (LSB) method and its alternative, LSB-2 [64]. LSB method uses the LSB of the covering byte to hold a bit from the message character, while LSB-2 method uses the two LSBs of the covering byte to hold two bits from the message character as shown in Fig. 2 [61-65]. The capacity of LSB1 and LSB2 methods is limited to the covering image size. LSB based method requires a complex logical operation to employ message

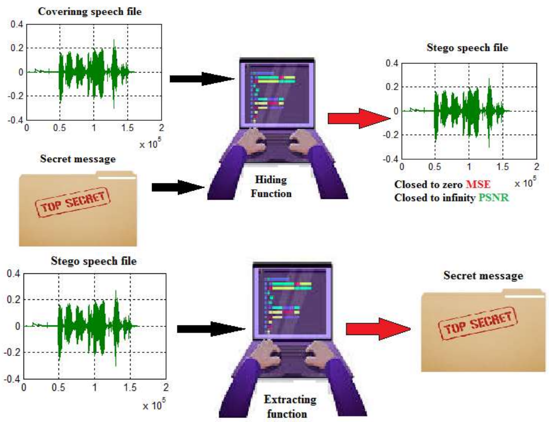

Figure 1: Hiding and Extracting function process

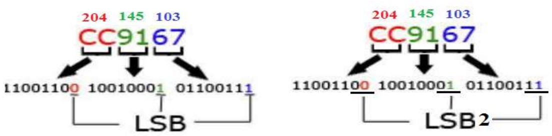

Figure 2: Used LSBs of the covering bytes

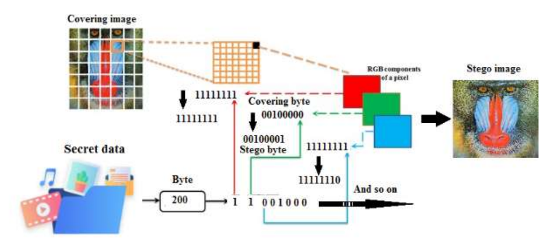

Figure 3: LSB method data hiding

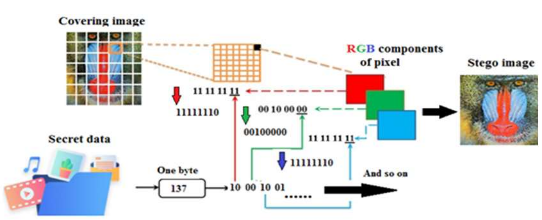

Figure 3: LSB2 method data hiding

hiding and extracting. The message bytes are to be hidden-extracted byte by byte and a consecutive set from the covering image colors are to be used as shown in Fig. 3 and Fig. 4.

2. THE SUGGESTED METHOD

LSB-8 bits from the binary version of the speech sample are used to hold the binary version of one character from the secret message. Fig. 5 and 6 illustrate how to use the LSB-8 bits from the speech sample to apply character hiding and extracting:

Covering sample:
0.22567
Binary:
0011111111001100111000101100000100101010110110000001101011011111
Character:
A
Decimal:
65
Binary:
01000001
Insert in covering sample:
0011111111001100111000101100000100101010110110000001101001000001
Stego sample:
0.2257

MSE=1.9232e-029
PSNR= 631.4364

Step 1. Message preparation: Obtain the message, convert to decimals, Get the message length. Then Covert the message to binary.
Step 2. Prepare the covering Reshape the speech file. Define the quantizer with double option (64-bits representation).
Step 3. Message hiding: Use the quantizer to convert the covering samples to binary. Let the LSB-8 bits of the covering samples equal the binary version of the message. Use the quantizer to convert the stego sample to decimals. Return the stego samples back to the speech row matrix. Reshape the speech file back to the original sizes to get the stego speech file.

Figure 5: Using LSB-8 bits hiding function implementation

Stego sample:
0.2257
Binary:
0011111111001100111000101100000100101010110110000001101001000001
Extract 8 LSBs:
01000001
Decimal:
65
Character:
A

Step 1. Stego file preparation: Obtain the stego speech file, reshape to one row matrix, Get the message length.
Step 2. Message extracting: Define the quantizer with double option. Get the stego samples. Use the quantizer to convert the samples to binary. Let the message equal all the LSB8s of the stego samples. Convert the binary message to decimal. Convert the decimal message to characters to get the secret message

Figure 6: Using LSB-8 bits for character extracting.

An illustration of the message hiding and extracting, Samples from 1000:1009 of a speech file was selected, and the ten were covered the ten characters message 'ABCDEFGHIJ' is shown in Fig.7.

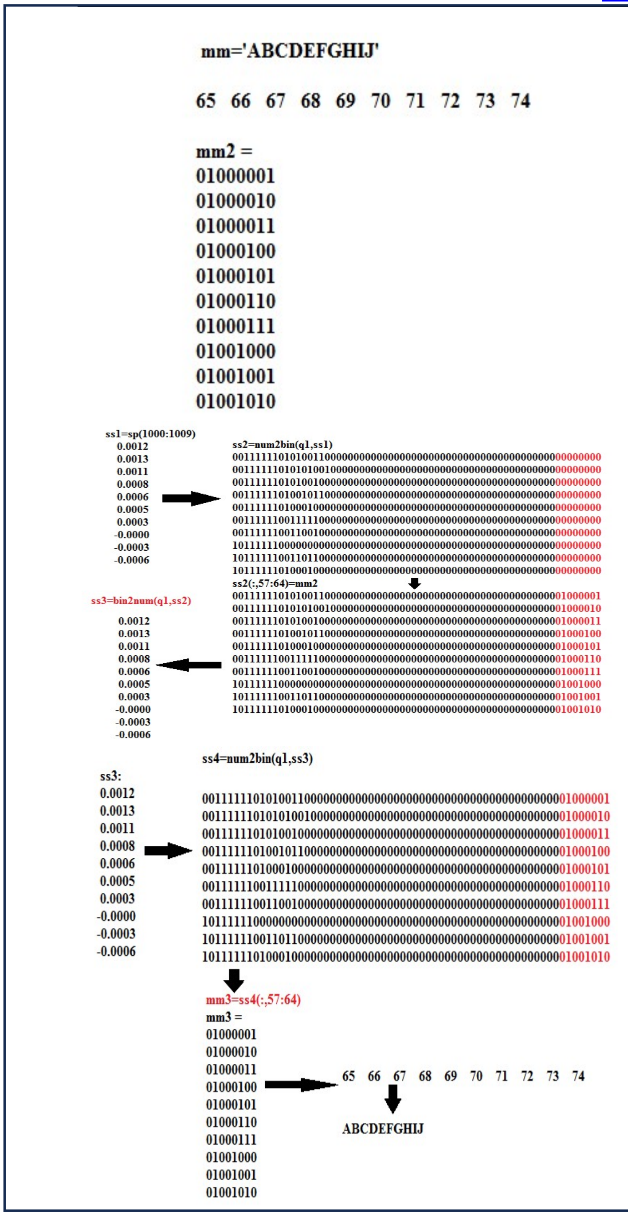

Figure 7: Illustration of the message hiding and extracting, Samples from 1000:1009 of a speech file was selected, and the ten were covered the ten characters message 'ABCDEFGHIJ'

3. IMPLEMENTATION AND RESULTS DISCUSSION

3.1 Speed analysis

A DSF of 321536 samples was chosen as a covering media, numerous messages were hidden and extracted using the suggested method. Hiding time, extracting time, hiding throughput, and extracting throughput are denoted as: HT, ET, HTP and ETP respectively. All parameters were calculated in table 1.

Table 1: Speed results

Message length (Byte)	HT (s)	ET(s)	HTP (K bytes /second)	ETP (K bytes /second)
100	0.0620	0.0100	1.5751	9.7656
500	0.0730	0.0180	6.6888	27.1267
750	0.0780	0.0220	9.3900	33.2919
1000	0.0910	0.0280	10.7315	34.8772
1500	0.1080	0.0370	13.5634	39.5904
2500	0.1460	0.0560	16.7220	43.5965
5000	0.2430	0.0950	20.0939	51.3980
10000	0.4320	0.1910	22.6056	51.1289
50000	2.0450	0.8020	23.8768	60.8829
100000	4.3890	1.5570	22.2502	62.7208
321536	14.7140	5.0020	21.3402	62.7749
Average	2.0346	0.7107	15.3489	43.3776

From table 1 it is shown that the proposed method provided good speed results, the required times are linearly grown up when increasing the message length, while the throughputs remain stable when the messages reach a certain length as shown in Fig. 8.

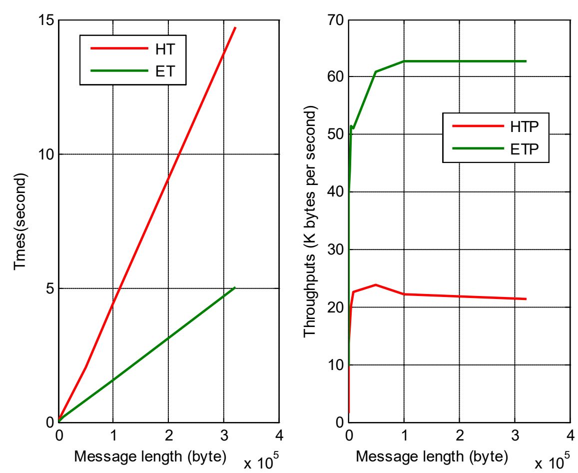

Figure 8: Speed parameters as a function of message length

Comparing with other methods speeds, a message of 1500 characters was selected, speed up of our method equal our method throughput divided by other method throughput, the speed parameters were calculated, and Table 2 displays the obtained results. From Table 2 it is shown that the proposed method provided a good speed up, it decreased the total processing time (PT=HT+ET) and increased the total throughput of message steganography.

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Table 2: Speed parameters comparisons

Method	HT	ET	PT	TPT	Speed up of the proposed method
Proposed	0.1080	0.0370	0.1450	10.1024	1.0000
CLSB[65]	0.093	0.109	0.2020	7.2517	1.3931
SLSB[65]	9.376	0.109	9.4850	0.1544	65.4301
DSLSB[65]	1.029	0.109	1.1380	1.2872	7.8484

3.2 Quality Analysis

A 1000-character message was processed using our method, several DSFs were selected, the quality parameters between the covering DSFs and the stego DSFs were calculated, table 3 shows the obtained quality results.

Table 3: Quality of the selected stego DSFs

DSF	Size	MSE	PSNR	CC	NSCR
1	321536	0	Infinity	1	0.3107
2	200704	0	Infinity	1	0.4982
3	227328	0	Infinity	1	0.4395
4	430080	0	Infinity	1	0.2320
5	82880	9.3703e-	763.0191	1	1.1957
6	64448	8.8793e-	739.5271	1	1.5501
7	122816	1.0814e-	755.8036	1	0.8118
8	138176	1.3695e-	775.9066	1	0.7230

The low values of MSEs, high values of PSNRs, low values of NSCR and the one values for CC prove that our method satisfies the quality requirements, the stego file always has good quality and it is very close to the covering DSF. Fig. 9 displays the quality of our method.

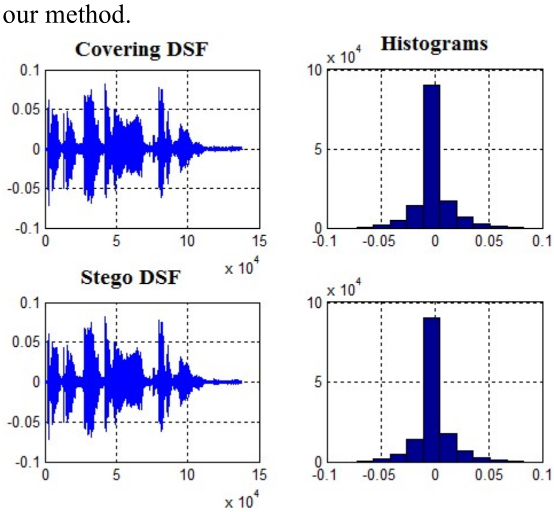

Figure 9: DSF holding 1000 characters message.

The excellent quality of the stego DSF will persist even when the message length equals the DSF size. to show this DSF 1 was selected, and several messages were hidden and extracted using this speech file, table 4 shows the obtained quality parameters, Fig. 9 visually proves the quality of the proposed method:

Table 4: Quality parameters when varying the message

Message	MSE	PSNR	CC	NSCR
100	0	Infinity	1	0.0311
500	0	Infinity	1	0.1549
750	0	Infinity	1	0.2326
1000	0	Infinity	1	0.3107
1500	0	Infinity	1	0.4662
2500	0	Infinity	1	0.7763
5000	1.6933e-	843.3945	1	1.5507
10000	1.7078e-	843.3088	1	3.1042
50000	4.7685e-	717.9115	1	15.5217
100000	1.1357e-	686.2077	1	31.0401
321536	6.0173e-	669.5336	1	99.8072

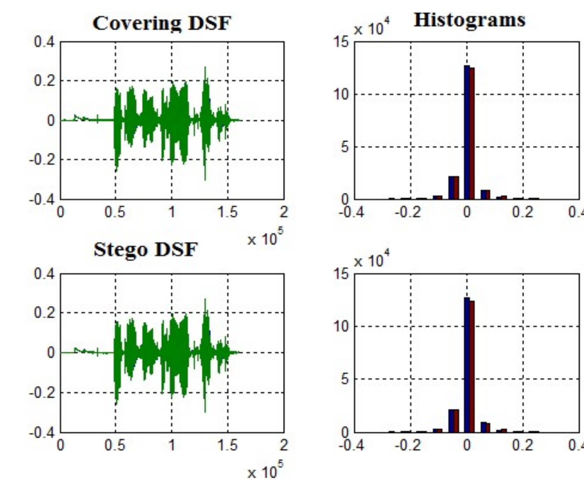

Figure 10: 321536 samples DSF holding 321536 characters message

4. CONCLUSION

A high-capacity method of message steganography was suggested through simplified hiding and extracting functions. The hidden message size was equal to the covering speech file size, Increasing the message length did not impact the quality of the stego file. speech file, the stego speech file was very close to the covering one even if the message size was equal the covering file size. The covering speech file samples were represented by 64-bits binary numbers and the LSB-8 bits from the covering samples were used to hold-extract the message characters.

Our method was tested using numerous speech files. Visual demonstrations showed that our method produced excellent quality stego files. Quality parameters between the cover files and the stego files were calculated and tabulated. The resulting values confirmed the effectiveness of the suggested method. The speed of our method was validated, showing favorable performance results. Compared to other existing methods, our approach significantly improved speed by reducing the time required for message steganography.

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