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# Quality Analysis of Using DSF and DCI as a Stego Medias

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### **Abstract:**

High quality of the stego media is an important issue to evaluate the stego system, the stego media must be closed to the covering one and the MSE measured between them must be low as possible, while the PSNR measured between them must be high as possible. In this paper research a detailed analysis of stego media will be produced, the quality of digital color image will be compared with the quality of digital speech file. Digital color image will be used to hold various messages, the same messages will be hidden in a digital speech file, and the quality parameters will be calculated. The results of using the image will be compared with the results of using digital speech file to raise some recommendation. 2 and 4 bits for message hiding will be tested using short, medium and long messages.

**Keywords:** Steganography, SM, DCI, DSF, MSE, PSNR, MBM, SBM, IBM.


### **Introduction**

Secret message (SM) [60-64] is a set of characters, each character can be represented by an ASCII value, this value is an integer unsigned decimal value within the range 0 to 255. The SM can be easily converted to binary to produce a message binary matrix, the 8\_bits binary representation is to be used and MBM will contain 8 columns and number of rows equal the number of characters in the SM. MBM can be easily reshaped to 1 or more columns and vice versa, figure 1 show various methods of SM representation [55-59].

```

message='ABCDE'
m1=uint8(message)
;Decimal
65 66 67 68 69
m2=dec2bin(m1,8)
;Binary
01000001
01000010
01000011
01000100
01000101
MBM

```



```

0000
0001
0001
0000
0000
m3=reshape(m2,10,4) : 1001
1000
1001
1010
1011

```

Figure 1: SM presentations

In this research paper SMs will be classified to short messages (with length up to 100 characters), medium messages (with length less or equal 1000 characters) and long messages (with length greater than 1000 characters) [49-54]. Digital color image (DCI) is a set of colors values organized in a 3D matrix, the color value requires one byte, the value of this byte is an integer unsigned decimal and it is within the range 0 to 255 [45-49]. The 3D image matrix can be easily reshaped to one row matrix, and this matrix can be easily converted to binary using 8\_bits binary representation to form the image binary matrix, and DCI can be presented by the 3D matrix, the colors histograms, and the image binary matrix (IBM), and figures 2 and 3 show how DCI can be presented [40-44].

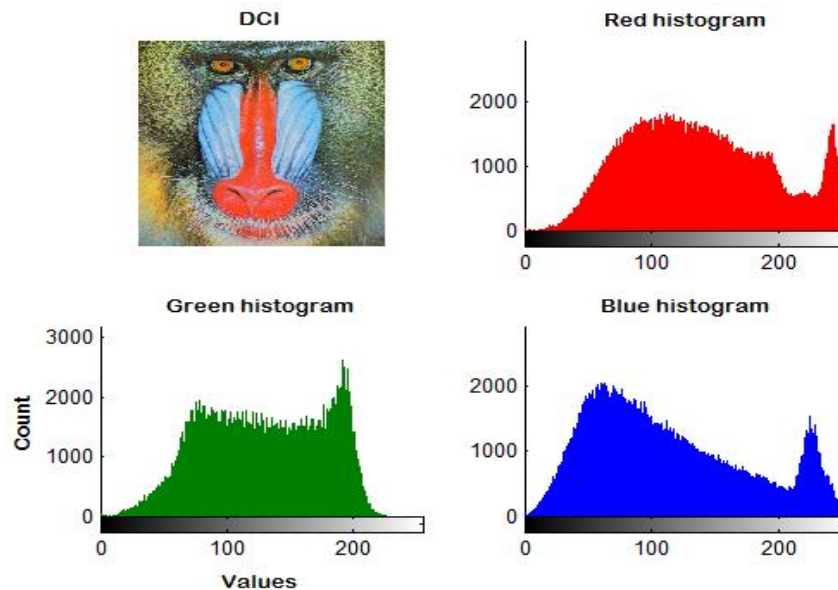


Figure 2: DCI and histograms



DSF and DCI are a good media to be used in a stego system to hold SMs [1-10]. Message steganography as shown in figures 5 and 6 means hiding SM in DSF or in DCI, without affecting much the covering media, the produced stego media must be closed to the covering media, the calculated mean square error (MSE) between the covering media and the stego media must be very low as possible, while the peak signal to noise ratio (PSNR) calculated between them must be high as possible [26-30]. The hiding and extracting functions will be the same when using DSF or when using DCI [11-15]. The hiding function will process the covering media and the SM to produce a stego media, while the extracting function will process the stego media to produce an extracted message identical to the source SM [21-25].

The quality of the stego media must be high, and it must be closed to the covering media [29-34]. The quality is an important issue to evaluate any method of message steganography, the stego media must have a good quality when dealing with any message: sort, medium or long message [16-20],

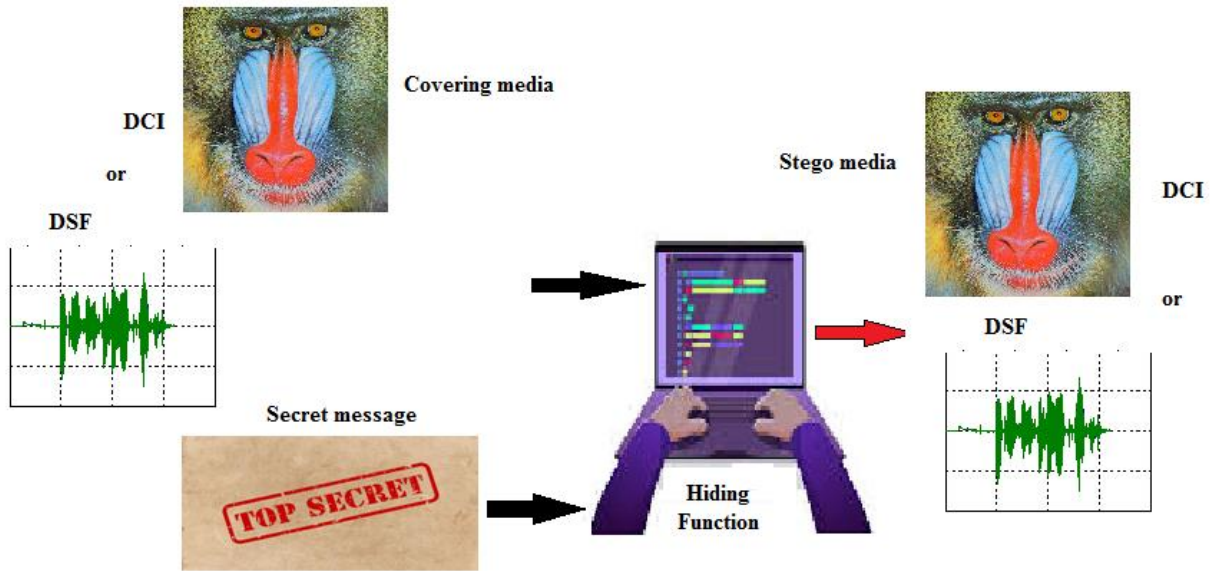


Figure 5: Hiding process

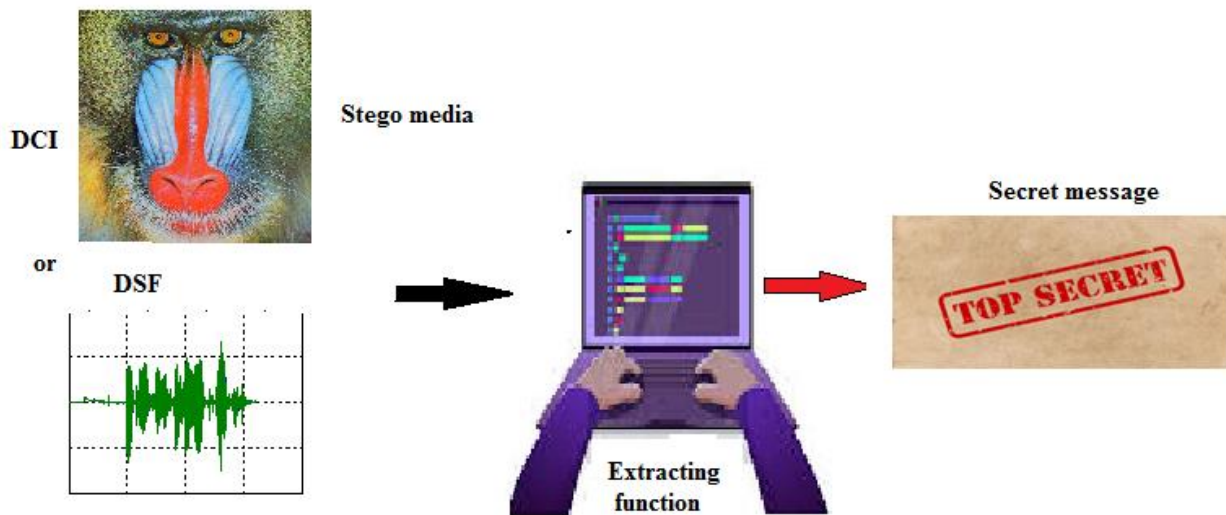


Figure 6: Extracting process

### Stego Media Quality Analysis

The process of hiding SM in DCI or in DSF can be implemented applying the following steps:

- 1) Get the covering media.
- 2) Retrieve the media size.
- 3) Reshape the media matrix to one row matrix
- 4) Get the SM.
- 5) Retrieve the message length.
- 6) Convert the message to decimal.
- 7) Get the covering bytes/samples.
- 8) Convert the covering bytes/samples to binary.
- 9) Convert the message to binary to get MBM.
- 10) Reshape MBM to the required number of columns.
- 11) Let the required columns of the covering binary equal the reshaped MBM.
- 12) Convert the covering byte/samples to decimal to get the stego bytes/samples.
- 13) Return back the results to the media row matrix.
- 14) Reshape back the row matrix to the original sizes to get the stego media.

Figure 7 illustrate an example of using DCI to hide a message, while figure 8 illustrates an example of using DSF to hide a message.

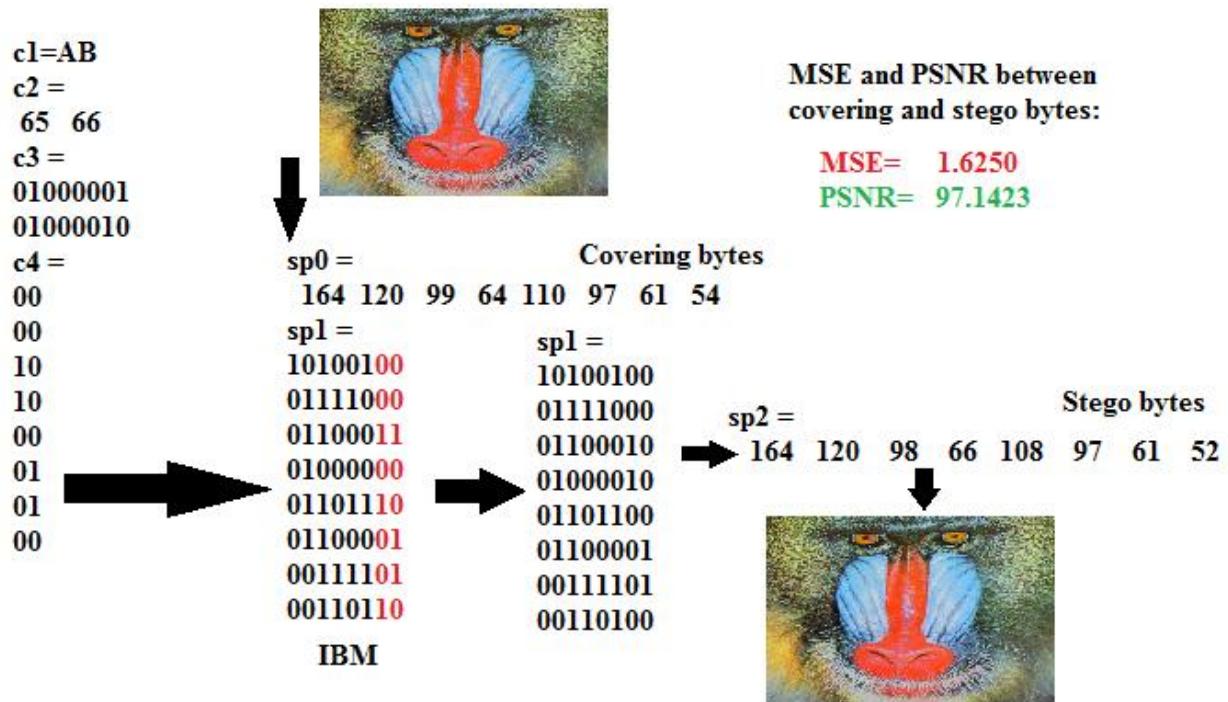


Figure 7: Using DCI to hide a message

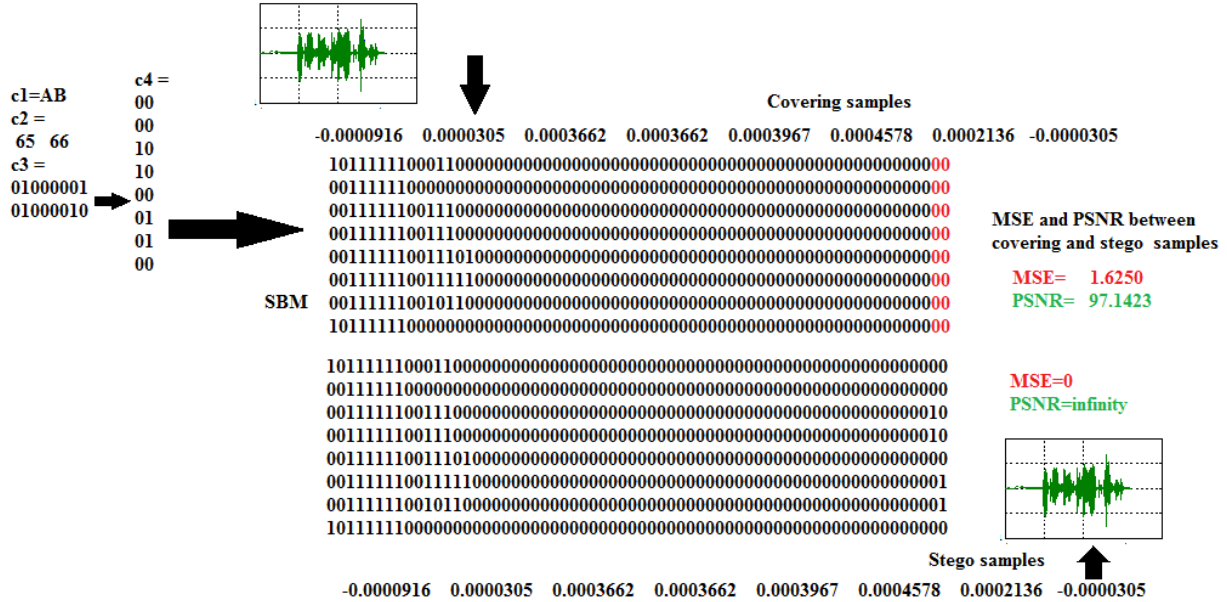


Figure 8: Using DSF to hide a message

The process of extracting the message will be implemented applying the following steps:

- 1) Get the stego media.
- 2) Reshape the stego media matrix to one row matrix.
- 3) Get the stego bytes/samples/
- 4) Convert the stego bytes/samples to binary.
- 5) From the binary matrix extract the required columns.
- 6) Reshape the matrix to 8 columns to get MBM.
- 7) Convert MBM to decimal.
- 8) Convert the decimal results to characters to get the SM.

Below are the two matlab programs which were used to apply the quality analysis:

K1: is a multiplying factor to get the required number of bytes/samples.

K2: reshaping factor (number of columns).

P1, P2, P3, and P4 are numbers of LSBs

**Using DCI:**

**:SM hiding**

```

K1=4;K2=2;P1=7;P2=8;
cc1=imread('C:\Users\win 7\Desktop\st_images\4.2.03.tiff');
[sn1 sn2 sn3]=size(cc1);
LS=sn1*sn2*sn3;
spp=reshape(cc1,1,LS);
c1='AB';
c2=uint8(c1);
L1=length(c2);
c3=dec2bin(c2,8);
c4=reshape(c3,L1*K1,K2);
sp0=spp(1,1:L1*K1);
sp1=dec2bin(sp0,8);
sp1(1:L1*4,P1:P2)=c4;
sp2=bin2dec(sp1)';
spp(1,1:L1*K1)=sp2;
sp3=reshape(spp,sn1,sn2,sn3);
    
```

**Extracting**

```
sp4=reshape(sp3,1,LS);
sp5=sp4(1,1:L1*K1);
sp6=dec2bin(sp5,8);
c5=sp6(:,P1:P2);
c6=reshape(c5,L1,8);
c7=bin2dec(c6)';
c8=char(c7)
```

**Using DSF: SM Hiding:**

```
K1=4;K2=2;P1=63;P2=64;P3=7;P4=8;
q1 = quantizer('double');
[sp fs]=wavread('C:\Users\win 7\Desktop\voices\al1.wav');
sp=[sp];
[sn1 sn2]=size(sp);
LS=sn1*sn2;
spp=reshape(sp,1,LS);
c1='AB';
c2=uint8(c1);
L1=length(c2);
c3=dec2bin(c2,8);
c4=reshape(c3,L1*K1,K2);
sp0=spp(1,1:L1*K1);
sp1=num2bin(q1,sp0);
sp1(:,P1:P2)=c4;
sp2=bin2num(q1,sp1);
spp(1,1:L1*K1)=sp2;
sp3=reshape(spp,sn1,sn2);
```

**; SM extracting:**

```
K1=4;K2=2;P1=63;P2=64;P3=7;P4=8;
sp4=reshape(sp3,1,LS);
sp5=sp4(1,1:L1*K1);
sp6=num2bin(q1,sp5);
c5=sp6(:,P1:P2);
c6=reshape(c5,L1,8);
c7=bin2dec(c6)';
c8=char(c7)
```

A set of SMs were selected, table 1 shows the basic information of these messages:

Table 1: Selected SMs information

SM number	Type	Length (character)
1	Short	10
2		50
3		100
4	Medium	200
5		500
6		1000

7	Long	5000
8		10000
9		25000
10		50000

The selected messages were implemented using DCI as a covering media, LSB1, LSB1 and LSB2, and LSB1 to LSB4 bits were used for SM hiding, MSE and PSNR between the covering and stego images were calculated and table 2 shows the obtained quality results:

Table 2: Stego DCI quality results

SM#	LSB1		LSB1 and LSB2		LSB1+LSB2+LSB3+LSB4	
	MSE	PSNR	MSE	PSNR	MSE	PSNR
1	3.5604e-005	213.2558	1.1317e-004	201.6915	0.0012	178.2691
2	2.6830e-004	193.0593	6.8283e-004	183.7179	0.0058	162.2615
3	5.2007e-004	186.4407	0.0013	176.9934	0.0113	155.6409
4	0.0010	179.5706	0.0026	170.4842	0.0220	149.0147
5	0.0026	170.3856	0.0066	161.0504	0.0524	140.3174
6	0.0051	163.6374	0.0129	154.3098	0.1110	132.8068
7	0.0254	147.5595	0.0635	138.3941	0.5374	117.0348
8	0.0508	140.6210	0.1259	131.5502	1.0866	109.9945
9	0.1269	131.4703	0.3155	122.3599	2.7014	100.8875
10	0.2547	124.5035	0.6375	115.3280	5.4145	93.9344

It is shown from table 2 the following:

- MSE increased when the SM length increased, while PSNR decreased when increasing the SM length.
- Using more than 1 bit for SM hiding increased MSE and decreased PSNR.
- For long SM MSE will rapidly increase and PSNR will rapidly decreased, this is shown in figures 9 and 10, here we can see the changes in the stego image histogram.
- The quality of the stego images when holding short and medium messages are acceptable

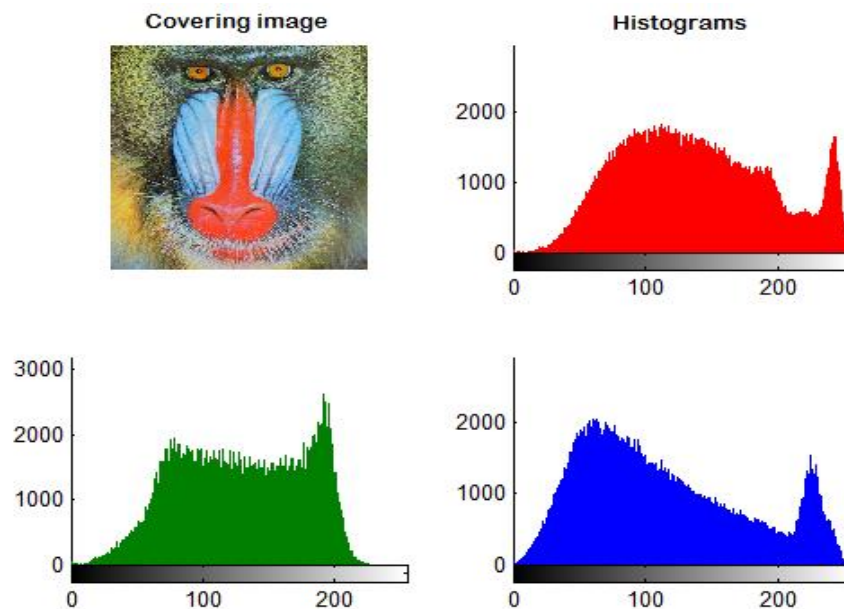


Figure 9: Covering DCI and histograms

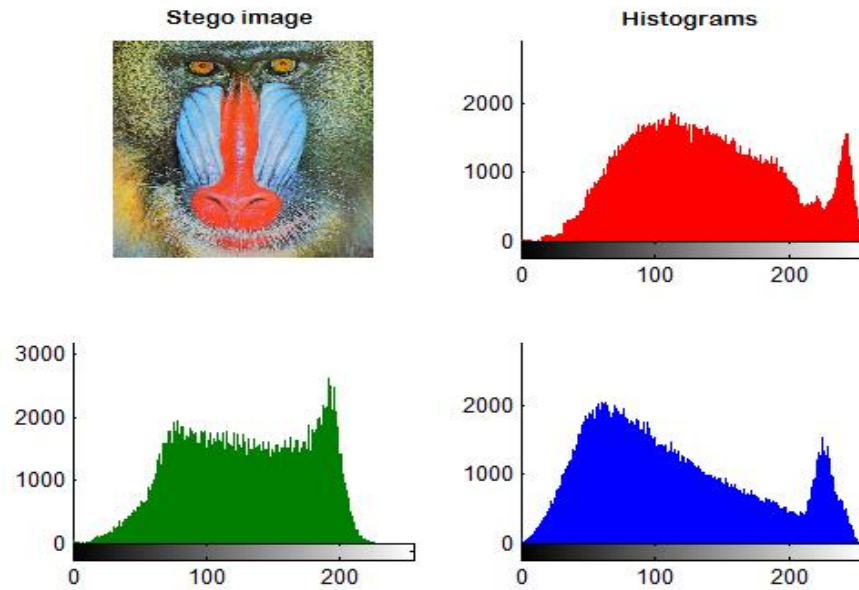


Figure 10: Stego image holding SM with 50000 characters

Figure 11 shows how PSNR value will rapidly drop down when using 4 bits for message bits hiding

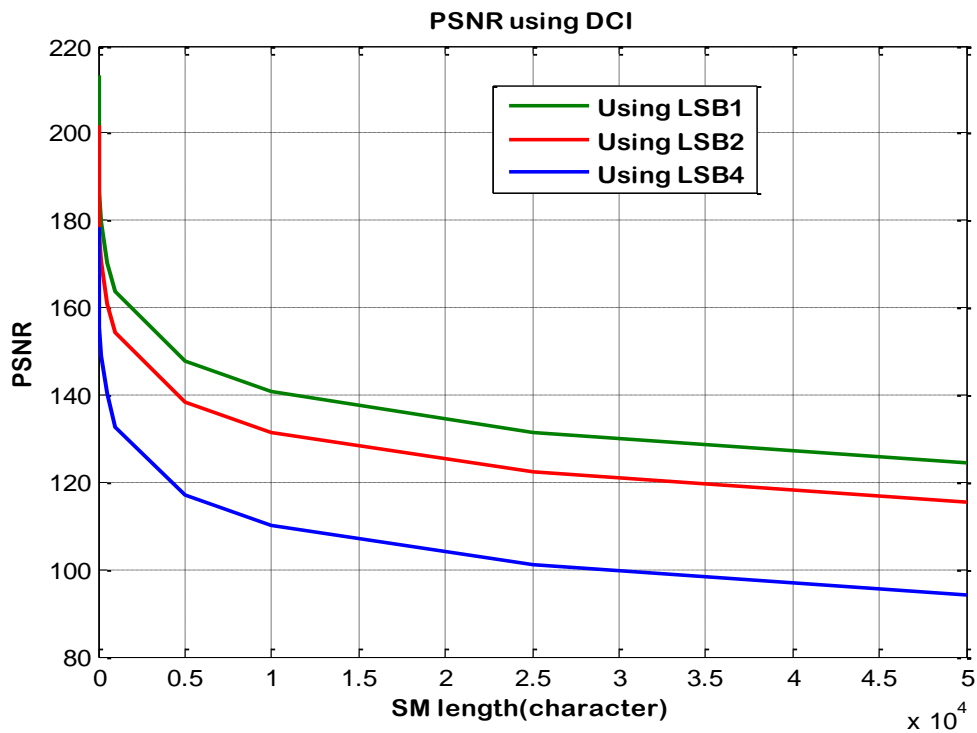


Figure 11: PSNR vs SM length using various numbers of bits

The previous experiment was repeated for the selected messages, but the covering media was a selected DSF, these messages were implemented, and table 3 shows the obtained quality parameters:

Table 3: Quality of stego DSFs

SM#	LSB1		LSB1 and LSB2		LSB1+LSB2+LSB3+LSB4	
	MSE	PSNR	MSE	PSNR	MSE	PSNR
1	0	Infinity	0	Infinity	0	Infinity
2	0	Infinity	0	Infinity	0	Infinity
3	0	Infinity	0	Infinity	0	Infinity
4	0	Infinity	0	Infinity	0	Infinity
5	8.3257e-044	965.6227	0	Infinity	0	Infinity
6	1.9286e-043	957.2223	5.2589e-043	947.1911	0	Infinity
7	3.5608e-038	835.9611	1.9351e-037	819.0338	3.1855e-041	906.1526
8	8.5570e-037	804.1677	2.5293e-037	816.3558	4.4068e-036	787.7778
9	2.7032e-036	792.6651	9.3082e-036	780.3004	8.5825e-036	781.1121
10	6.6077e-036	783.7269	1.8675e-035	773.3373	2.0767e-034	749.2498

From table 3 it is shown that for short and long messages the stego files were identical to the covering files, MSE was equal zero and PSNR was equal infinity. For long messages the MSE was very low, while PSNR was very high. From the previous results we can recommend using DSF if we quality of the stego file is the main target, and the high order bits of the speech samples can be used for message hiding keeping the quality of the stego DSF excellent, figure 12 shows a stego DSF holding a SM with 50000 characters length.

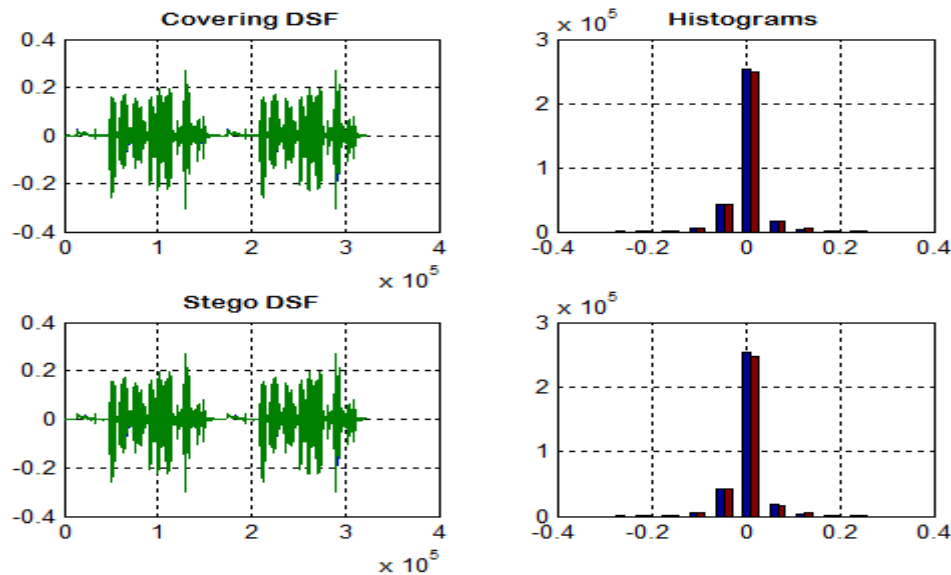


Figure 12: Stego DSF holding 50000 characters

### Conclusion

A detailed analysis of the quality of the stego media used in a stego system was applied. A set of short, medium and long messages were implemented using digital color image and digital speech file as a covering media, 1, 2, and 4 bits were selected to hold the secret message bits. The obtained results showed that an excellent quality can be achieved by using DSF regardless the number of bits used for message hiding, and thus using this media was recommended especially when the message is too long. The message length did not much affect the quality of the stego DSF. Increasing the message length will negatively affect the quality of the stego DCI, increasing the message length will rapidly increase the MSE value and at the same time will decrease the PSNR value.

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