Correlation between PSNR and Bit per Sample Rate in Audio Steganography

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Abstract: - Steganography is a form of security technique through obscurity; the science and art of hiding the existence of a message between sender and intended recipient. Steganography has been used to hide secret messages in various types of files, including digital images, audio and video. The three most important parameters for audio steganography are imperceptibility (indicated as PSNR), payload (bit rate or capacity), and robustness. Any technique which tries to improve the payload or robustness should preserve imperceptibility. The noise which is introduced due to bit modification would limit payload. This paper presents the correlation between PSNR and bit per sample rate that is calculated in an experimental way.

Key-Words: - artificial intelligence; multimedia security; digital data hiding; steganography; watermarking

1 Introduction

Steganography and watermarking techniques embed information in a digital media in a transparent manner. Steganography is a technique for covert information, but digital watermarking may not hide the existence of the message from third persons [1-5].

Watermarking usually requires robustness to withstand against attacks intended to remove or destroy the hidden message from the watermarked media as well as preserving the carrier signal quality. This makes digital watermarking appropriate for those applications where the knowledge of a hidden message leads to a potential danger of manipulation [6-13].

The most well-known examples of steganography go back to ancient times when Histiaus shaved his slave's head, and then he tattooed a message on his scalp. After that his hair had re-grown the tattooed message was disappeared. He was going to call his men to attack to the Persians [14-22].

Steganography is the study of methods for hiding the existence of secondary information in the presence of primary information in a way which neither affects on the size nor results in perceptual distortion. The secondary information is referred to as hidden message, hidden file or hidden information while primary information is referred to as carrier, host or original signal, before embedding and stego signal, file, bit stream or sequence, after embedding [23-30].

Watermarking techniques are principally context-specific, that means, the algorithms must be designed regarding the media type of the data to be watermarked. Therefore, watermarking indicates a specific application of steganographic techniques. Specifically, the additional requirement for robustness of digital watermarks against attacks or manipulations during the data processing entails a lower payload of the watermarking methods compared to steganographic algorithms [31-36].

2 PSNR of Different Bit per Sample Rates

This section presents the result of embedding twelve messages into twelve different music files in different bit per sample rates. The embedded messages were carefully selected to be in the suitable size to cover the hosts completely, to make the PSNR calculation accurate. Also, host files were selected from twelve different genres intentionally to make the result more general.

The focus of this research is the audio steganography, particularly with respect to WAV files. This format of audio file is selected because that is the original format of other formats. In other words, the audio files which have other formats, either are converted from WAV format, or can be easily converted to WAV format.

2.1 Obtained PSNR for one bit per sample rate

Twelve different messages were embedded into twelve different hosts with a payload of one bit per sample. The size of message files, host files and obtained PSNR are tabulated in Table 1.

TABLE 1. OBTAINED PSNR FOR ONE BIT PER SAMPLE RATE

	Music Genre	WAV Size (Byte)	Message Size (Byte)	Host to Message Size Ratio	Sample Size (Bits)	PSNR
1	Blues	12420894	775702	16.01	16.00	72.22
2	Classical	15427614	775702	19.89	16.00	72.42
3	Jazz	16987422	1060253	16.02	16.00	71.67
4	Country	19609374	1224548	16.01	16.00	71.94
5	R&B	20385822	1273075	16.01	16.00	72.01
6	Reggae	21139230	1320969	16.00	16.00	72.20
7	Rap	21143838	1320969	16.01	16.00	71.70
8	Pop	21189918	1323327	16.01	16.00	72.15
9	Rock	24134430	1492201	16.17	16.00	72.27
10	Hip-Hop	28843806	1802456	16.00	16.00	71.80
11	Dance	32884638	2053073	16.02	16.00	72.23
12	Metal	34228254	2083840	16.43	16.00	72.35

As Figure 1 shows, the obtained PSNR for all tested music files is almost between a range of 71.5 db and 72.5 db.

2.2 Obtained PSNR for two bit per sample rate

Twelve different messages were embedded into twelve different hosts with a payload of two bit per sample. The size of message files, host files and obtained PSNR are tabulated in Table 2.

TABLE 2. OBTAINED PSNR FOR 2 BIT PER SAMPLE RATE

	Music Genre	WAV Size (Byte)	Message Size (Byte)	Host to Message Size	Sample Size (Bits)	PSNR
1	Blues	12420894	1552443	8.00	16.00	65.17
2	Classical	15427614	1552443	9.94	16.00	65.41
3	Jazz	16987422	2083840	8.15	16.00	64.63
4	Country	19609374	2449572	8.01	16.00	64.93
5	R&B	20385822	2546121	8.01	16.00	64.99
6	Reggae	21139230	2641442	8.00	16.00	65.09
7	Rap	21143838	2641442	8.00	16.00	64.61
8	Pop	21189918	2645522	8.01	16.00	65.10
9	Rock	24134430	2995890	8.06	16.00	65.24
10	Hip-Hop	28843806	3589932	8.03	16.00	64.78
11	Dance	32884638	4108800	8.00	16.00	65.18
12	Metal	34228254	4108800	8.33	16.00	65.36

As Figure 2 shows, the obtained PSNR for all tested music files is almost between a range of 64.5 db and 65.5 db.

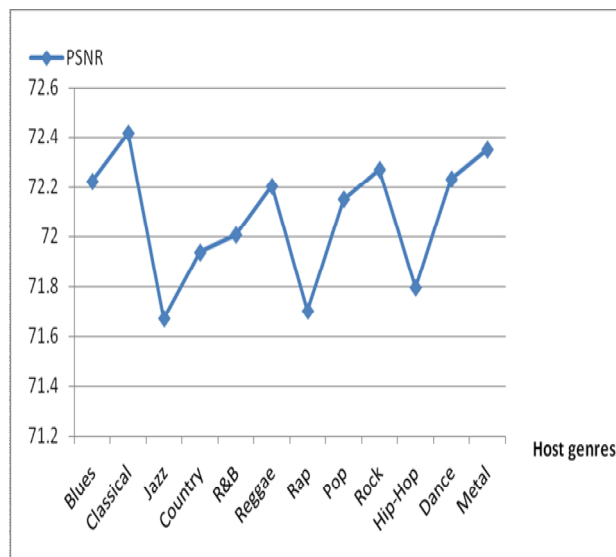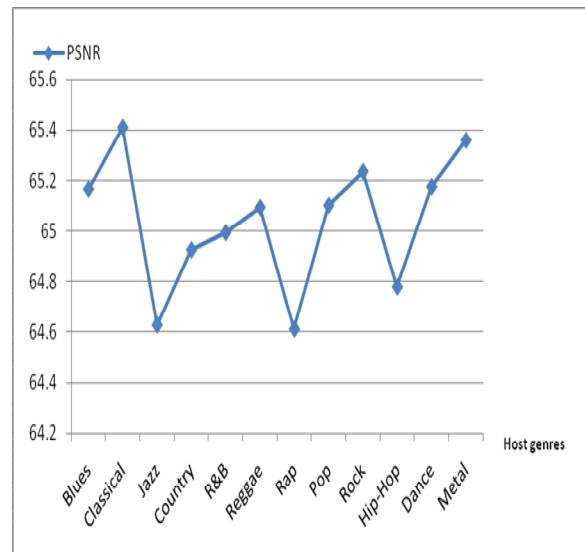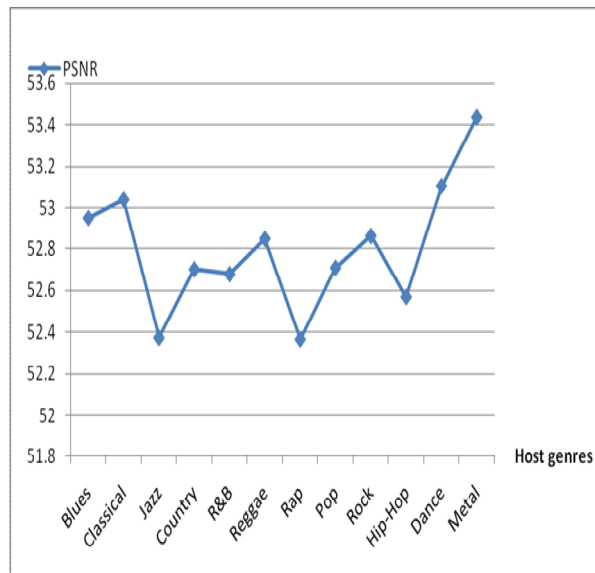Figure 1. Obtained PSNR for 1 bit per sample rate

Figure 2. Obtained PSNR for 2 bit per sample rate

2.3 Obtained PSNR for four bit per sample rate

Twelve different messages were embedded into twelve different hosts with a payload of four bit per sample. The size of message files, host files and obtained PSNR are tabulated in Table 3.

2.4 Obtained PSNR for six bit per sample rate

Twelve different messages were embedded into twelve different hosts with a payload of six bit per sample. The size of message files, host files and obtained PSNR are tabulated in Table 4.

TABLE 3.   OBTAINED PSNR FOR 4 BIT PER SAMPLE RATE

	Music Genre	WAV Size (Byte)	Message Size (Byte)	Host to Message Size	Sample Size (Bits)	PSNR
1	Blues	12420894	3085837	4.03	16.00	52.95
2	Classical	15427614	3085837	5.00	16.00	53.04
3	Jazz	16987422	4219204	4.03	16.00	52.38
4	Country	19609374	4862959	4.03	16.00	52.70
5	R&B	20385822	5082439	4.01	16.00	52.68
6	Reggae	21139230	5263488	4.02	16.00	52.85
7	Rap	21143838	5263488	4.02	16.00	52.37
8	Pop	21189918	5296752	4.00	16.00	52.71
9	Rock	24134430	5990599	4.03	16.00	52.86
10	Hip-Hop	28843806	7063433	4.08	16.00	52.57
11	Dance	32884638	7811072	4.21	16.00	53.11
12	Metal	34228254	7496170	4.57	16.00	53.43

TABLE 4.   OBTAINED PSNR FOR 6 BIT PER SAMPLE RATE

	Music Genre	WAV Size (Byte)	Message Size (Byte)	Host to Message Size	Sample Size (Bits)	PSNR
1	Blues	12420894	4634112	2.68	16.00	40.53
2	Classical	15427614	4634112	3.33	16.00	40.95
3	Jazz	16987422	6319131	2.69	16.00	40.17
4	Country	19609374	7276596	2.69	16.00	40.61
5	R&B	20385822	7532544	2.71	16.00	39.89
6	Reggae	21139230	7754652	2.73	16.00	40.78
7	Rap	21143838	7754652	2.73	16.00	40.28
8	Pop	21189918	7300629	2.90	16.00	40.98
9	Rock	24134430	9035982	2.67	16.00	40.41
10	Hip-Hop	28843806	10030200	2.88	16.00	40.72
11	Dance	32884638	11923854	2.76	16.00	39.84
12	Metal	34228254	11923854	2.87	16.00	40.03

As Figure 3 shows, the obtained PSNR for all tested music files is almost between a range of 52 db and 52.5 db.

As Figure 4 shows, the obtained PSNR for all tested music files is almost between a range of 39.5 db and 41 db.

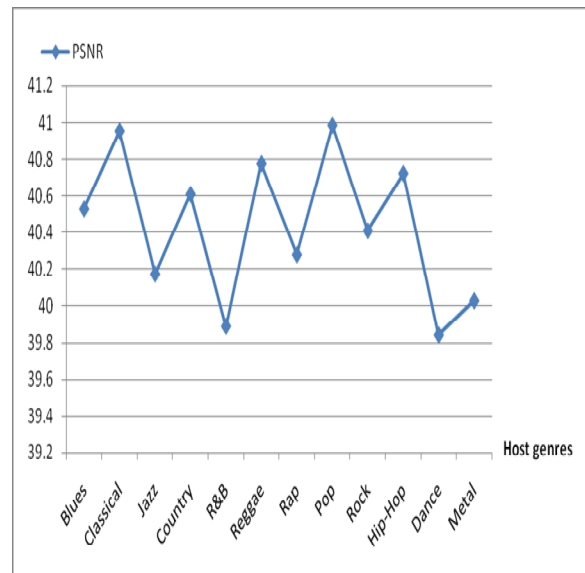Figure 3.   Obtained PSNR for 4 bit per sample rate

Figure 4.   Obtained PSNR for 6 bit per sample rate

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2.4 Obtained PSNR for eight bit per sample rate

Twelve different messages were embedded into twelve different hosts with a payload of eight bit per sample. The size of message files, host files and obtained PSNR are tabulated in Table 5.

TABLE 5.   OBTAINED PSNR FOR 8 BIT PER SAMPLE RATE

	Music Genre	WAV Size (Byte)	Message Size (Byte)	Host to Message Size	Sample Size (Bits)	PSNR
1	Blues	12420894	6078737	2.04	16.00	28.89
2	Classical	15427614	6078737	2.54	16.00	28.86
3	Jazz	16987422	8414449	2.02	16.00	28.33
4	Country	19609374	9717016	2.02	16.00	28.22
5	R&B	20385822	10069125	2.02	16.00	28.51
6	Reggae	21139230	10504574	2.01	16.00	28.59
7	Rap	21143838	10504574	2.01	16.00	28.17
8	Pop	21189918	10504574	2.02	16.00	28.62
9	Rock	24134430	11923854	2.02	16.00	26.41
10	Hip-Hop	28843806	13817831	2.09	16.00	28.01
11	Dance	32884638	16387725	2.01	16.00	28.85
12	Metal	34228254	15525465	2.20	16.00	29.27

As Figure 5 shows, the obtained PSNR for all tested music files is almost between a range of 26 db and 30 db.
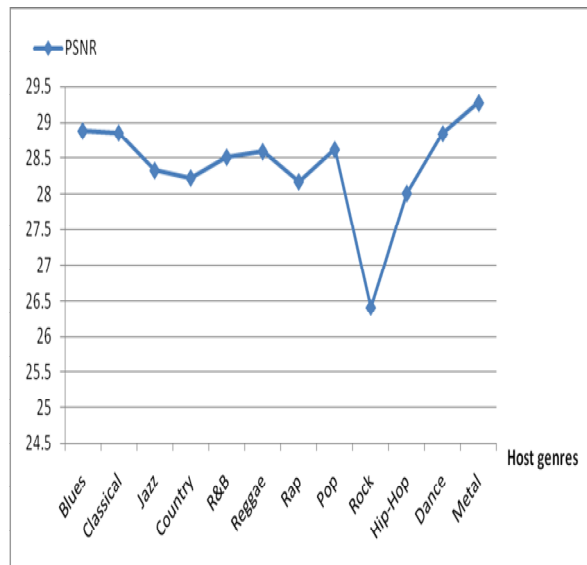

Figure 5.   Obtained PSNR for 8 bit per sample rate

4 Conclusion

As Figure 6 shows, twelve different genres of music files with WAV format were selected.   Then GSBAS was run with five different bit rates. Message bits were different and had different sizes, which was important and was the constant is that selected messages have a size which covers throughout their host. That guarantees the obtained PSNRs are accurate. This study shows that for a specified bit rate almost a specified PSNR yields which is calculated in average in last row. In the other words, if the size of message file is almost the same as host files capacity, the PSNR of embedding depends on the bit per sample rate. Different host and different message file will have a little effect on PSNR.
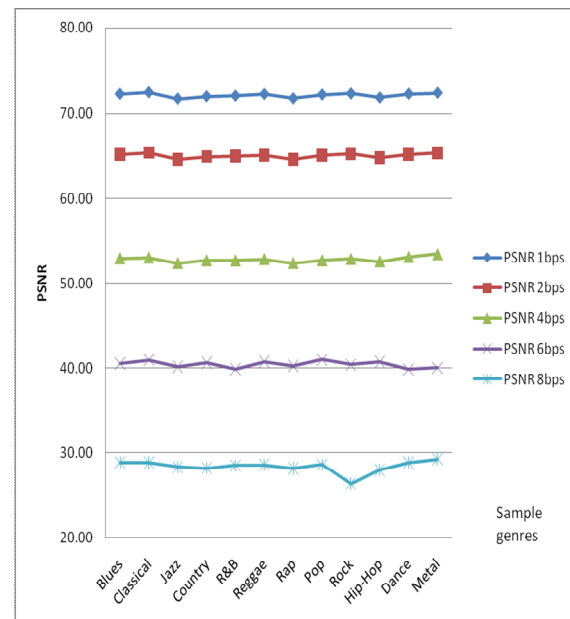

Figure 6.   Obtained PSNR for different bit per sample rates (in dB)

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