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Bocko et al.

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(54) **DATA HIDING VIA PHASE MANIPULATION OF AUDIO SIGNALS**

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(51) **Int. Cl.**
G10L 21/00 (2006.01)

(52) **U.S. Cl.** **704/273; 704/270; 704/253**

(58) **Field of Classification Search** **704/273, 704/270, 253**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,937,000 A *	8/1999	Lee et al.	375/141
6,175,627 B1	1/2001	Petrovic et al.	
6,266,430 B1	7/2001	Rhoads	
6,363,159 B1	3/2002	Rhoads	
6,404,898 B1	6/2002	Rhoads	
6,427,012 B1	7/2002	Petrovic et al.	

6,430,301 B1	8/2002	Petrovic et al.	
6,442,283 B1	8/2002	Tewfik et al.	
6,526,385 B1 *	2/2003	Kobayashi et al.	704/504
6,539,475 B1	3/2003	Cox et al.	
6,560,349 B1	5/2003	Rhoads	
6,560,350 B2	5/2003	Rhoads	
6,567,780 B2	5/2003	Rhoads	
6,633,654 B2	10/2003	Hannigan et al.	
6,647,128 B1	11/2003	Rhoads	
6,647,129 B2	11/2003	Rhoads	
6,650,762 B2 *	11/2003	Gibson et al.	382/100
6,654,480 B2	11/2003	Rhoads	
6,674,876 B1	1/2004	Hannigan et al.	
6,675,146 B2	1/2004	Rhoads	
6,684,199 B1	1/2004	Stebbins	

(Continued)

OTHER PUBLICATIONS

Gang et al. ("MP3 resistant oblivious steganography", Acoustics, Speech, and Signal Processing, 2001, Proceedings. (ICASSP '01). IEEE, international conference, May 7-11, 2001, p. 1365-1368 vol. 3).*

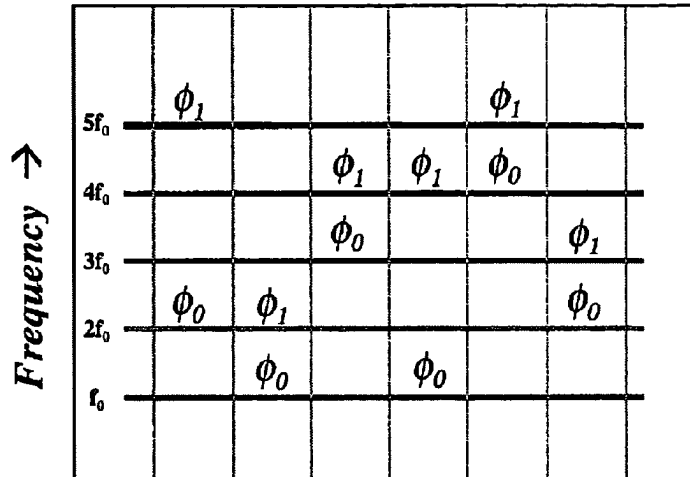
(Continued)

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(57) **ABSTRACT**

Data are embedded in an audio signal for watermarking, steganography, or other purposes. The audio signal is divided into time frames. In each time frame, the relative phases of one or more frequency bands are shifted to represent the data to be embedded. In one embodiment, two frequency bands are selected according to a pseudo-random sequence, and their relative phase is shifted. In another embodiment, the phases of one or more overtones relative to the fundamental tone are quantized.

10 Claims, 8 Drawing Sheets



Source: Es-Lib 1001

U.S. PATENT DOCUMENTS

6,707,409 B1	3/2004	Ignjatovic et al.	
6,737,957 B1	5/2004	Petrovic et al.	
6,792,542 B1	9/2004	Lee et al.	
6,996,521 B2 *	2/2006	Iliev et al.	704/200
2002/0034224 A1 *	3/2002	Srinivasan	375/240
2002/0107691 A1 *	8/2002	Kirovski et al.	704/270
2003/0095685 A1 *	5/2003	Tewfik et al.	382/100

OTHER PUBLICATIONS

H. J. Kim, et al. "Audio watermarking techniques", in *Intelligent Watermarking Techniques*, H. C. Huang, H. M. Hang, and J. S. Pan, (Editor), World Scientific Publishing Co., May 2004.
"Audio Signal Watermaking Based on Replica Modulation", Rade Petrovic, Telsiks 2001, Yugoslavia, Sep. 19-21, 2001, pp. 227-234.
"Data Hiding Within Audio Signals", Rade Petrovic, et al., Telsiks 1999, Oct. 13-15, 1999, pp. 88-95.

* cited by examiner

Figure 1

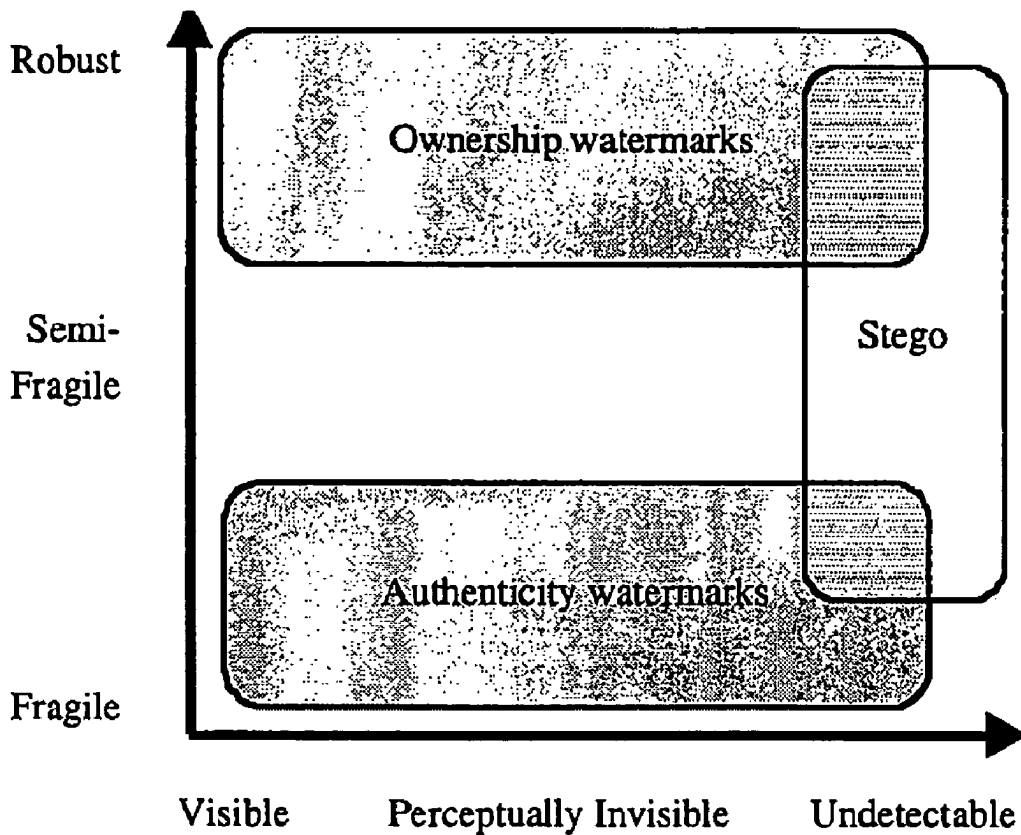


Figure 2

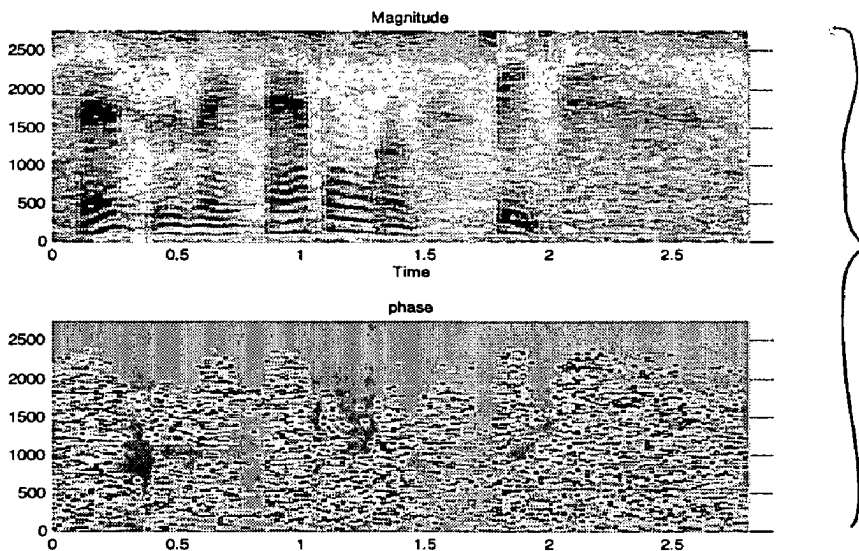


Figure 3

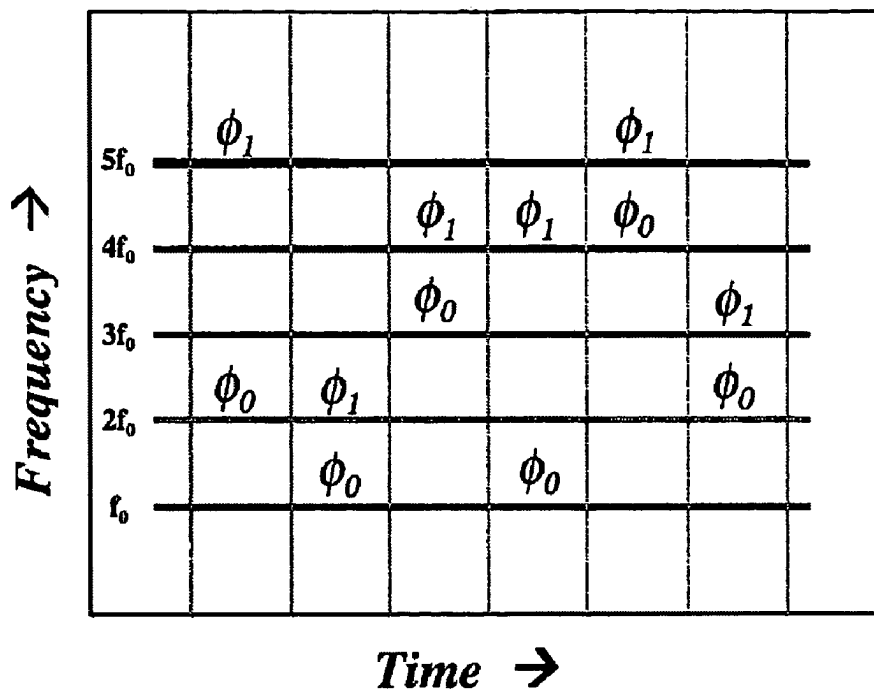


Figure 4

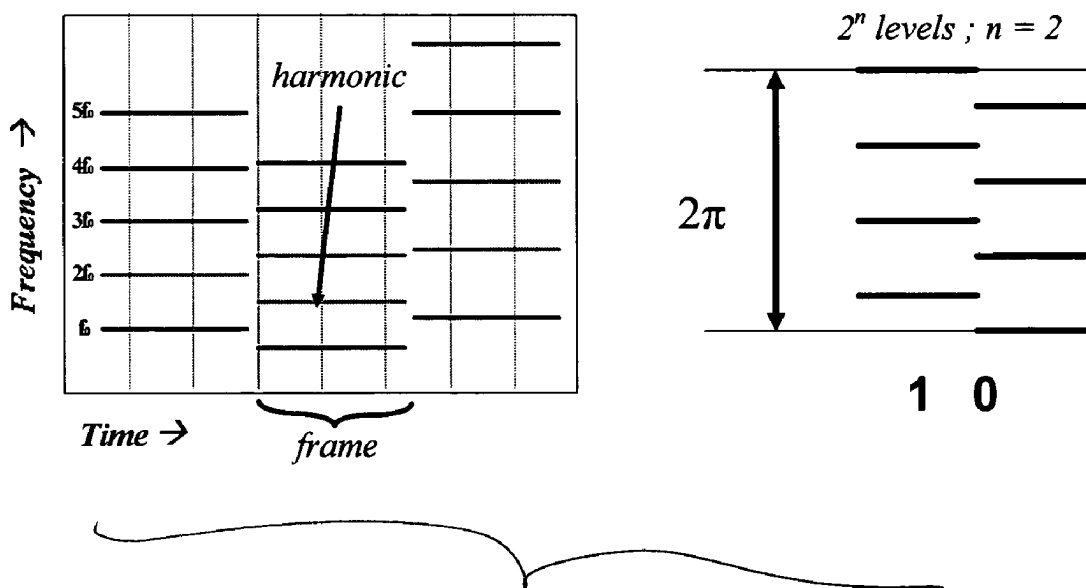


Figure 5

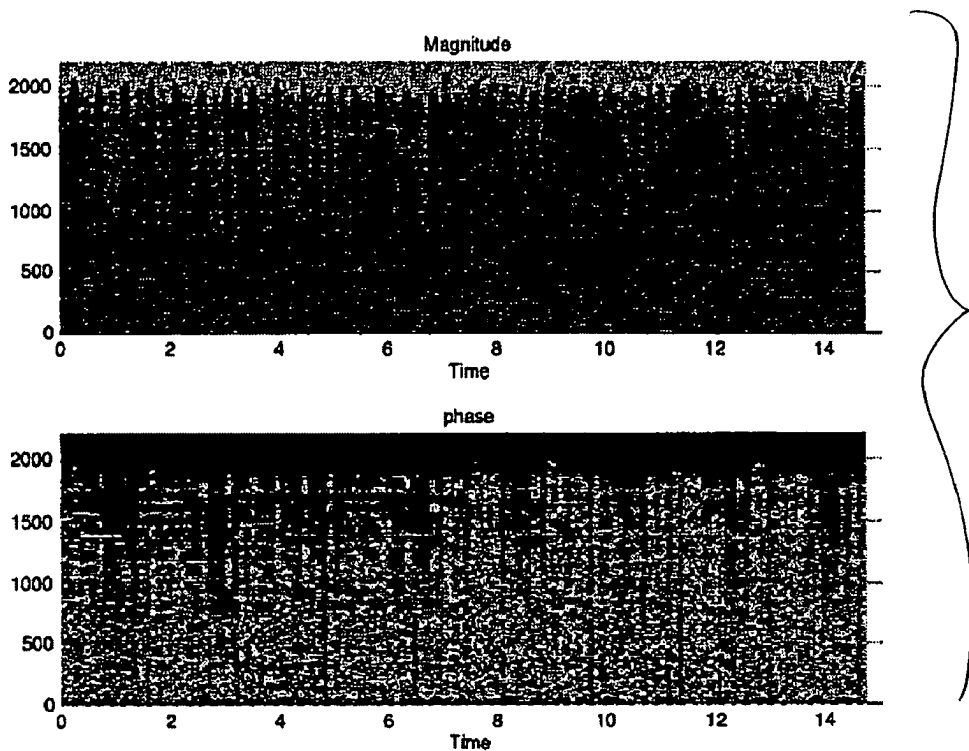
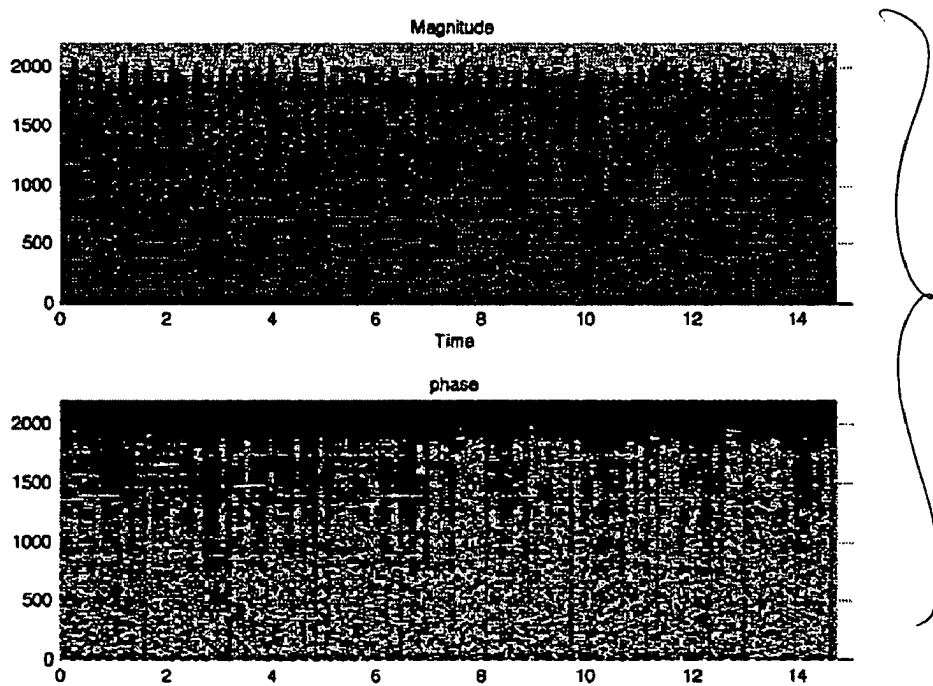


Figure 6



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