methods of formatting and transmitting inaudible signals to allow for greater flexibility and functionality than has been previously available.

SUMMARY OF THE INVENTION

[0008] In accordance with principles of the present invention, these needs are addressed by a method of encoding, and decoding, a human-inaudible acoustic signal embedded within audio content, suitable for use within the processor of an encoding and broadcasting system or a decoding and receiving system. According to principles of the invention, a binary message is encoded into a human-inaudible acoustic signal for delivery as audio content to a recipient by encoding the binary message into a sequence of symbols selected from a group of two or more symbols, each symbol associated with frequency characteristics, generating audio samples of a digitized version of the sequence of samples using the frequency characteristics associated with the symbols, and providing the audio samples for playback by an audio device.

[0008a] Disclosed herein is a method of decoding a human-inaudible acoustic signal embedded within audio content in the processor of a decoding device, comprising: receiving samples of a digitized version of the audio content including the human-inaudible acoustic signal into the processor of a decoding device; correlating the audio content within said samples with a prefix template for a prefix of the human-inaudible acoustic signal to identify candidate samples potentially associated with the start of said human-inaudible acoustic signal; repeatedly performing a frequency domain transformation of samples of the candidate samples and comparing frequency domain transformations thereof to frequency characteristics associated with two or more candidate symbols to generate a symbol sequence; performing an error correction decoding upon the symbol sequence to determine the validity of the symbol sequence; and upon identifying a valid symbol sequence, transmitting the symbol sequence as the decoded equivalent of the human-inaudible acoustic signal.

[0008b] Disclosed herein is a method of encoding a binary message into a human-inaudible acoustic signal for delivery as audio content to a recipient, comprising: encoding the binary message into a sequence of symbols selected from a group of two or more symbols, each symbol associated with frequency characteristics, the encoding comprising the use of one or more of forward error correction and cyclic redundancy coding; generating audio samples of a digitized version of the sequence of samples using the frequency characteristics associated with the symbols; providing the audio samples for playback by an audio device.

[0008c] According to an aspect of the present invention, there is provided a method of encoding a binary message into a human-inaudible acoustic signal for delivery as audio content to a recipient, comprising: encoding the binary message into a sequence of symbols selected from a group of four or more symbols, each symbol encoding a series of two or more logical bits and associated with frequency characteristics in frequency ranges outside a common range of human hearing; generating audio samples of a digitized version of the sequence of symbols using the frequency characteristics associated with the symbols; providing the audio samples for playback by an audio device.

[0009] In embodiments described herein, the encoding can comprise the use of one or more of forward error correction and cyclic redundancy coding, or both, to increase the robustness of the transmission. Furthermore, the binary bits encoded by the symbols are selected such that a Hamming distance of a single bit transformation exists between symbols associated with adjacent frequencies, so that a frequency error creates only a single bit error.

[0010] Decoding of the signal involves delivering samples of a digitized version of audio content including the human-inaudible acoustic signal into a processor of a decoding device, correlating the audio content within the samples with a prefix template for a prefix of the human-inaudible acoustic signal to identify candidate samples potentially associated with the start of said human-inaudible acoustic signal, and repeatedly performing a frequency domain transformation of samples of the candidate samples and comparing frequency domain transformations thereof to frequency characteristics associated with two or more candidate symbols to generate a symbol sequence.

[0011] To validate the sample sequence, an error correction decoding can be performed upon the symbol sequence to determine its validity, so that upon

CLAIMS

1. A method of encoding a binary message into a human-inaudible acoustic signal for delivery as audio content to a recipient, comprising:

a. encoding the binary message into a sequence of symbols selected from a group of four or more symbols, each symbol encoding a series of two or more logical bits and associated with frequency characteristics in frequency ranges outside a common range of human hearing;

b. generating audio samples of a digitized version of the sequence of symbols using the frequency characteristics associated with the symbols;

c. providing the audio samples for playback by an audio device.

2. The method of claim 1 further comprising receiving a message generated using the decoded human-inaudible acoustic signal and in response thereto delivering content for presentation to a user.

3. The method of claim 2 wherein the message comprises one or more of: time data, date data, accelerometer data, geographic data, demographic data, content delivery device data, and content delivery device user data.

4. The method of claim 2 wherein the content is provided by a content management system and said content is delivered with an indication of a presentation time after the time of receipt.

5. The method of claim 1 wherein the acoustic signal is at a frequency at one or more of below 30 Hz and above 18 kHz.

6. The method of claim 1 wherein the human-inaudible symbols include a count of a number of symbols included in the human-inaudible acoustic signal.

7. The method of claim 1 wherein the binary bits encoded by the symbols are selected to produce a Hamming distance of one bit transformation between symbols associated with adjacent frequencies.

8. The method of claim 1 wherein the encoding comprises the use of one or more of forward error correction and cyclic redundancy coding.