Claims

1. A transmitter device, comprising a transmission antenna, the transmission antenna comprising at least one transducer and one signal generation unit for generating an acoustic communication signal y(t) to be transmitted to a receiver device including hidden information, wherein the signal generation unit is configured to previously record an original acoustic signal, the signal generation unit being configured to previously divide the total duration of an initial signal x(t) derived from the original acoustic signal into a set of 2M contiguous successive time intervals of a same duration T, the signal generation unit being capable of generating said communication signal y(t) to be transmitted by adding, to the initial signal x(t) an auxiliary signal $\Psi(x)(t)$, previously multiplied by at least one symbol $a_n$ of information to be transmitted corresponding to the nth time interval [nT, (n+1)T], said symbol having a phase and/or an amplitude carrying the hidden information, the auxiliary signal $\Psi(x)(t)$ being calculated from the initial signal x(t) by means of a chosen transformation operator $\Psi$, said transformation operator being defined on each interval among said intervals from a phase parameter exp $j.\beta_k$, the phase parameter depending on a set of phases Pk constituting a steganographic key, k corresponding to the k-th sub-interval, wherein each interval of duration T is divided into 2M sub-intervals U-M, ..., U-1, U1, ..., UM, separated by guard intervals, M being an integer higher or equal to one, the durations of said sub-intervals increasing as a function of the absolute value of k, and wherein the transformation operator is applied to the initial signal over each sub-interval Uk in order to calculate the value of the corresponding auxiliary signal over said interval, wherein the value of the auxiliary signal one each sub-interval Uk is dependent on the phase parameter exp $j. \beta_k$, with k being comprised in the interval [-M, M].

2. The transmitter device as claimed in claim 1, wherein the initial signal x(t) derived from the original acoustic signal is the complex baseband signal obtained after filtering the original acoustic signal in a frequency band of chosen width, centered on a center frequency.

3. The transmitter device as claimed in any one of claims 1 or 2, wherein the generated communication signal at a time t belonging to the $n^{th}$ interval [nT, (n + 1)T] is equal to:

$$y(t) = x(t) + \alpha \, .a_n . \Psi(x)\,(t),$$

where $\alpha$ denotes a gain parameter and $a_n$ denotes the symbol corresponding to the $n^{th}$ interval.

4. The transmitter device as claimed in any one of the preceding claims, wherein the value of the auxiliary signal $\Psi(x)(T/2 + t)$ at a time $T/2 + t$, where t belongs to a sub-interval $U_k$, is dependent on the phase parameter $\exp j.\beta_k$, where $\beta_k$ is in the interval $[0, 2\pi]$ and k is in the interval [-M, M], on the value of an amplitude weighting function p(t) at time t, and on the value of the initial signal at time $(T/2 – t)$.

5. The transmitter device as claimed in claim 4, wherein the value of the auxiliary signal $\Psi(x)(T/2 + t)$ at a time $T/2 + t$, where t belongs to a sub-interval $U_k$, is equal to:
$\Psi(x)\,(T/2 + t) = \exp j.\beta_k \, .p(t) \, . \, x(T/2 – t)$.

6. The transmitter device as claimed in any one of the preceding claims, wherein the duration of the guard intervals between the sub-intervals of successive times $U_k$ and $U_{k+1}$ is chosen such that each of the sub-intervals $U_k$ does not overlap with its neighbors after dilation/compression due to a Doppler phenomenon.

7. A transmitter device, comprising a transmission antenna, the transmission antenna comprising at least one transducer and one signal generation unit for generating an acoustic communication signal to be transmitted to a receiver device including hidden information, wherein the signal generation unit is configured to previously record an original acoustic signal, the signal generation unit being configured to previously divide the total duration of an initial signal x(t) derived from said original signal into a set of contiguous successive time intervals of a same duration T, said signal

generation unit being capable of generating a communication signal y(t) to be transmitted by adding, to the initial signal x(t) an auxiliary signal $\Psi(x)(t)$, previously multiplied by at least one symbol $a_n$ of information to be transmitted corresponding to the nth time interval, said symbol having a phase and/or an amplitude carrying the hidden information, said auxiliary signal $\Psi(x)(t)$ being calculated from the initial signal x(t) by means of a chosen transformation operator $\Psi$, said transformation operator being defined on each interval among said intervals from a phase parameter exp $j.\beta_k$, the phase parameter depending on a set of phases $\beta_k$ constituting a steganographic key, k corresponding to the k-th sub-interval, wherein the signal generation unit is additionally configured to divide each interval of duration T into a set of M sub-intervals of the same duration T/M, M being an integer higher or equal to one, and wherein the value of the auxiliary signal in a given sub-interval of time is obtained from the value of the initial signal in another sub-interval or from the value of the initial signal at time -t in another sub-interval.

8. The transmitter device as claimed in claim 7, wherein the value of the auxiliary signal at a time t belonging to a given sub-interval of time is obtained from the value of the initial signal in another sub-interval weighted by the value of an amplitude weighting function p(t) at time t.

9. The transmitter device as claimed in any claim 7 and 8, wherein the initial signal x(t) derived from the original signal is the complex baseband signal obtained after filtering the original signal in a frequency band of chosen width, centered on a center frequency.

10. The transmitter device as claimed in any claim 7 to 9, wherein the generated communication signal y(t) at a time t belonging to the nth interval [nT, (n + 1)T] is equal to:

$$y(t) = x(t) + \alpha .a_n. \Psi(x) (t),$$

where α denotes a gain parameter and an denotes the symbol corresponding to the nth interval.

11. A receiver device, comprising a receiving antenna, the receiving antenna comprising at least one hydrophone, wherein it comprises a detector for detecting a communication signal transmitted by a transmitter device as claimed in any one of claims 1 to 10 and an extraction unit configured to reconstruct the auxiliary signal by applying said transformation operator to the detected communication signal on the basis of the steganographic key, and to extract the hidden information from the phase and/or the amplitude of the reconstructed auxiliary signal.

12. The receiver device as claimed in claim 11, wherein the extraction unit is additionally configured to apply a filter to the reconstructed signal on the basis of a compensation term $e^{-i\widetilde{\theta u}}$ capable of compensating for the carrier residual corresponding to the difference between the Doppler-shifted carrier frequency and the nominal carrier frequency, the compensation term being estimated by maximizing, at each time t, the modulus of the output z(t) of the filter for a set of possible values of θ, and wherein the extraction function is capable of determining the symbols and the bits of the hidden information on the basis of the phases of the signal z(t) that are calculated at times corresponding to the maxima of the modulus of the signal z(t).

13. A communication system comprising a transmitter device as claimed in one of claims 1 to 10 and a receiver device as claimed in one of claims 11 and 12.

14. A transmission method for generating an acoustic communication signal in a transmitter device, comprising a transmitting antenna, the transmitting antenna comprising at least one transducer, the method comprising the following steps:

- recording an original acoustic signal;
- dividing the total duration of an initial signal x(t) derived from said original signal into a set of 2M contiguous successive time intervals of a same duration T;

- adding, to an initial signal x(t) derived from said original signal, an auxiliary signal $\Psi(x)(t)$ multiplied by at least one symbol of information to be transmitted $a_n$ corresponding to the nth time interval [nT, (n+1)T], said symbol $a_n$ having a phase and/or an amplitude carrying the hidden information and said auxiliary signal $\Psi(x)(t)$ being calculated from the initial signal by means of a chosen transformation operator $\Psi$, said transformation operator being defined on each interval among said intervals from a phase parameter $\exp j.\beta_k$, k corresponding to the k-th sub-interval, the phase parameter depending on a set of phases $\beta_k$ constituting a steganographic key, thereby providing a communication signal y(t);

- transmitting a signal to a receiver device on the basis of the communication signal y(t), wherein the method further comprises dividing each interval of duration T into 2M sub-intervals U-M, ... , U-1, U1, ... , UM, separated by guard intervals, M being an integer higher or equal to one, the durations of said sub-intervals increasing as a function of the absolute value of k, the method comprising applying said transformation operator to the initial signal over each sub interval Uk to calculate the value of the corresponding auxiliary signal over said interval, wherein the value of the auxiliary signal one each sub-interval Uk is dependent on the phase parameter $\exp j.\beta_k$, with k being comprised in the interval [-M, M].

15. A transmission method for generating an acoustic communication signal in a transmitter device, comprising a transmitting antenna, the transmitting antenna comprising at least one transducer, the method comprising the following steps:

- recording an original acoustic signal;

- dividing the total duration of an initial signal x(t) derived from said original signal into a set of contiguous successive time intervals of a same duration T,

- adding, to an initial signal x(t) derived from said original signal, an auxiliary signal $\Psi(x)(t)$ multiplied by at least one symbol of information to be transmitted a, corresponding to the nth time interval [nT, (n+1)T], said symbol $a_n$ having a phase and/or an amplitude carrying the hidden information and said auxiliary signal $\Psi(x)(t)$

being calculated from the initial signal by means of a chosen transformation operator $\Psi$, said transformation operator being defined on each interval among said intervals from a phase parameter exp j. $\beta_k$, k corresponding to the k-th sub-interval, the phase parameter depending on a set of phases $\beta_k$ constituting a steganographic key, thereby providing a communication signal y(t);

- transmitting a signal to a receiver device on the basis of the communication signal y(t), wherein the method comprises dividing each time interval of duration T into a set of M sub intervals of the same duration T/M, M being an integer higher or equal to one, and wherein the value of the auxiliary signal in a given sub-interval of time is obtained from the value of the initial signal in another sub-interval or from the value of the initial signal at time -t in another sub-interval.

16. The method as claimed in claim 15, wherein the value of the auxiliary signal at a time t belonging to a given sub-interval of time is obtained from the value of the initial signal in another sub-interval weighted by the value of an amplitude weighting function p(t) at time t.