

CLAIMS

1. A system (100, 400, 600) for actively cancelling an acoustic noise signal (112) entering a room (410) through an aperture (420) of the room (410), the system (100, 400, 600) comprising:

- a sensor (110) configured to detect the acoustic noise signal (112) and to convert the acoustic noise signal (112) into an electronic noise signal (114);

- a plurality of transducers (120) configured to generate an acoustic anti-noise signal (122) from an electronic anti-noise signal (124) to cancel, at least part of, the acoustic noise signal (112), when the acoustic anti-noise signal (122) is added to the acoustic noise signal (112); and

- a controlling circuit (130) operably coupleable to the sensor (110) and the plurality of transducers (120), such that when operably coupled, the controlling circuit (130):

- receives (140) the electronic noise signal (114) from the sensor (110),

- classifies (150) the electronic noise signal (114) by matching a sample of the electronic noise signal (114) to one or more pre-determined cancellation filter candidates (160),

- selects (160) a first pre-determined cancellation filter (162) from the one or more pre-determined cancellation filter candidates (160), by basing a selection on the classified sample of the electronic noise signal (114),

- generates (170) the electronic anti-noise signal (124) by applying the first pre-determined cancellation filter (162) on the electronic noise signal (114), and

- transmits (180) the electronic anti-noise signal (124) to the plurality of transducers (120).

2. The system (100, 400, 600) of claim 1, wherein matching the sample of the electronic noise signal (114) to the one or more pre-determined cancellation filter candidates (160) comprises:

- determining, at least one characteristic from the sample of the electronic noise signal (114),

- determining, if the at least one characteristic from the sample of the electronic noise signal (114) has a same characteristic to at least one corresponding characteristic of an

exemplary electronic signal stored within each one of the one or more pre-determined cancellation filter candidates (160).

3. The system (100, 400, 600) of claim 2, wherein the at least one characteristic from the sample of the electronic noise signal (114) comprises an amplitude, a phase, and/or a frequency.

4. The system (100, 400, 600) of any one of claims 2 to 3, wherein the controlling circuit (130) is further configured to deactivate the system (100, 400, 600) when the at least one characteristic from the sample of the electronic noise signal (114) is different from the at least one corresponding characteristic of the exemplary electronic signal stored within each one of the one or more pre-determined cancellation filter candidates (160).

5. The system (100, 400, 600) of any one of claims 2 to 4, wherein the controlling circuit (130) is further configured to:

- determine a deviation of the at least one characteristic from the sample of the electronic noise signal (114) to a corresponding pre-determined threshold value, and
- activate the system when the deviation of the at least one characteristic from the sample of the electronic noise signal (114) is greater than the corresponding pre-determined threshold value.

6. The system (100, 400, 600) of any one of claims 1 to 5, wherein each of the one or more pre-determined cancellation filter candidates (160) comprises a pre-determined coefficient ($\mathbf{w}_{k, fixed}^T(n)$) for generating the electronic anti-noise signal (124).

7. The system (100, 400, 600) of any one of claims 1 to 5, wherein generating the electronic anti-noise signal (124) comprises convolving a reference signal $\mathbf{x}(n)$ with a pre-determined coefficient ($\mathbf{w}_{1, fixed}^T(n)$) of the first pre-determined cancellation filter (162) implemented using a finite impulse response filter.

8. The system (100, 400, 600) of any one of claims 1 to 7, wherein the one or more pre-determined cancellation filter candidates (160) are stored within a library of pre-determined cancellation filters (190), and

wherein the library of pre-determined cancellation filters (190) is stored in one or more of: a server; a memory of the controlling circuit (130).

9. The system (100, 400, 600) of any one of claims 1 to 8, wherein the acoustic anti-noise signal (122) cancels, at least part of, the acoustic noise signal (112) entering the aperture (420) of the room (410) by minimizing a sum-of-the-squared acoustic pressure level at a reference position (430) in the room, wherein the reference position (430) is spaced apart from the aperture (420) of the room (410).

10. The system (100, 400, 600) of any one of claims 1 to 9, wherein the controlling circuit (130) is configured to generate the electronic anti-noise signal (124), when the electronic noise signal (114) is in a range of 20 Hz to 850 Hz, preferably between 100 Hz to 700 Hz.

11. The system (100, 400, 600) of any one of claims 1 to 10, further comprising a user interface (610) operably coupled to the controlling circuit (130), wherein the controlling circuit (130) is further configured to:

- receive an input from the user interface (610), wherein the input comprises a user's selection of a second pre-determined cancellation filter (164) from the one or more pre-determined cancellation filter candidates (160), and wherein the second pre-determined cancellation filter (164) differs from the first pre-determined cancellation filter (162), and
- deactivate the first pre-determined cancellation filter (162) and activate the second pre-determined cancellation filter (164) in response to the received input.

12. The system (100, 400, 600) of any one of claims 1 to 11, further comprising a stationary frame (510) attached to the aperture (420) of the room (410), and

wherein the plurality of transducers (120) configured to generate the acoustic anti-noise signal (122) are mounted on a support (520) which is removably disposable in relation to the stationary frame (510).

13. The system (100, 400, 600) of claim 12, wherein the plurality of transducers (120) configured to generate the acoustic anti-noise signal (122) are mounted on at least one edge of the support (520).

14. The system (100, 400, 600) of any one of claims 12 to 13, wherein the sensor (110) is affixed to an outer moveable frame (530) coupled to the stationary frame (510).

15. The system (100, 400, 600) of any one of claim 14, further comprising a motion sensor (560) configured to detect a movement of the outer moveable frame (530) in relation to the stationary frame (510), and to determine information about an arrangement of the stationary frame (510) and the outer moveable frame (530), wherein the arrangement comprises a closed arrangement or an open arrangement,

wherein in the closed arrangement, the outer moveable frame (530) is in contact with the stationary frame (510),

wherein in the open arrangement, the outer moveable frame (530) is partially separated from the stationary frame (510), and

wherein the controlling circuit (130) is further configured to:

- receive the information about the arrangement from the motion sensor (560),
- activate the system (100, 400, 600) when the motion sensor (560) determines that the arrangement is the open arrangement, and
- deactivate the system (100, 400, 600) when the motion sensor (560) determines that the arrangement is the closed arrangement.

16. A method (700, 800A, 800B, 800C) for actively cancelling an acoustic noise signal (112) entering a room (410) through an aperture (420) of the room (410), comprising:

- providing (710) a sensor (110) to detect the acoustic noise signal (112) and to convert the acoustic noise signal (112) into an electronic noise signal (114);
- transmitting (720) the electronic noise signal (114) from the sensor (110) to a controlling circuit (130) operably coupled to the sensor (110) and to a plurality of transducers (120);
- classifying (730) using the controlling circuit (130), the electronic noise signal (124) by matching a sample of the electronic noise signal (114) to one or more pre-determined cancellation filter candidates (160);

- selecting (740) using the controlling circuit (130), a first pre-determined cancellation filter (162) from the one or more pre-determined cancellation filter candidates (160), by basing a selection on the classified sample of the electronic noise signal (114),

- generating (750) using the controlling circuit (130), an electronic anti-noise signal (124) by applying the first pre-determined cancellation filter (162) on the electronic noise signal (114),

- transmitting (760) using the controlling circuit (130), the electronic anti-noise signal (124) to the plurality of transducers (120),

wherein the plurality of transducers (120) generates the acoustic anti-noise signal (122) from the electronic anti-noise signal (124) to cancel, at least part of, the acoustic noise signal (112), when the acoustic anti-noise signal (122) is added to the acoustic noise signal (112).

17. The method (700, 800A, 800B, 800C) of claim 16, wherein matching the sample of the electronic noise signal (114) to the one or more pre-determined cancellation filter candidates (160) comprises:

- determining at least one characteristic from the sample of the electronic noise signal (114),

- determining if the at least one characteristic from the sample of the electronic noise signal (114) has a same characteristic to at least one corresponding characteristic of an exemplary electronic signal stored within each one of the one or more pre-determined cancellation filter candidates (160).

18. The method (700, 800A, 800B, 800C) of claim 17, wherein the at least one characteristic from the sample of the electronic noise signal (114) comprises an amplitude, a phase, and/or a frequency.

19. The method (700, 800A, 800B, 800C) of any one of claims 17 to 18, further comprising:

- terminating (780, 842), using the controlling circuit (130), the method (700, 800A, 800B, 800C) when the at least one characteristic from the sample of the electronic noise signal (114) is different from the at least one corresponding characteristic of the exemplary electronic signal stored within each one of the one or more pre-determined cancellation filter candidates (160).

20. The method (700, 800A, 800B, 800C) of any one of claims 17 to 19, further comprising:
- determining (790), using the controlling circuit (130), a deviation of the at least one characteristic from the sample of the electronic noise signal (114) to a corresponding pre-determined threshold value, and
 - initializing an operation of the method (700, 800A, 800B, 800C), using the controlling circuit (130), when the deviation of the at least one characteristic from the sample of the electronic noise signal (114) is greater than the corresponding pre-determined threshold value.
21. The method (700, 800A, 800B, 800C) of any one of claims 16 to 20, wherein each of the one or more pre-determined cancellation filter candidates (160) comprises a pre-determined coefficient ($\mathbf{w}_{k, fixed}^T(n)$) for generating the electronic anti-noise signal (124).
22. The method (700, 800A, 800B, 800C) of any one of claims 16 to 20, wherein generating the electronic anti-noise signal (124) using the controlling circuit (130) comprises convolving a reference signal ($x(n)$) with a pre-determined coefficient ($\mathbf{w}_{1, fixed}^T(n)$) of the first pre-determined cancellation filter (162), implemented using a finite impulse response filter.
23. The method (700, 800A, 800B, 800C) of any one of claim 16 to 22, wherein the one or more pre-determined cancellation filter candidates (160) are stored within a library of pre-determined cancellation filters (190), and
- wherein the library of pre-determined cancellation filters (190) is stored in one or more of: a server, within a memory of the controlling circuit (130).
24. The method (700, 800A, 800B, 800C) of any one of claims 16 to 23, wherein the acoustic anti-noise signal (122) cancels, at least part of, the acoustic noise signal (112) entering the aperture (420) of the room (410) by minimizing a sum-of-the-squared acoustic pressure level at a reference position (430) in the room (410), wherein the reference position (430) is spaced apart from the aperture (420) of the room (410).

25. The method (700, 800A, 800B, 800C) of any one of claims 16 to 24, wherein the controlling circuit (130) generates the electronic anti-noise signal (124), when the electronic noise signal (114) is in a range of 20 Hz to 850 Hz, preferably between 100 Hz to 700 Hz.
26. The method (700, 800A, 800B, 800C) of any one of claims 16 to 25, further comprising:
- receiving (812) an input from a user interface (610) operably coupled to the controlling circuit (130), wherein the input comprises a user's selection of a second pre-determined cancellation filter (164) from the one or more pre-determined cancellation filter candidates (160), and wherein the second pre-determined cancellation filter (164) differs from the first pre-determined cancellation filter (162), and
 - the controlling circuit (130) in response to the received input, terminating (814) the application of the first pre-determined cancellation filter (162) on the electronic noise signal (114), and applying the second pre-determined cancellation filter (164) on the electronic noise signal (114).
27. The method (700, 800A, 800B, 800C) of any one of claims 16 to 26, further comprising a stationary frame (510) attached to the aperture (420) of the room (410), and
- wherein the plurality of transducers (120) are mounted on a support (520) which is removably disposable in relation to the stationary frame (510).
28. The method (700, 800A, 800B, 800C) of claim 27, wherein the plurality of transducers (120) are mounted on at least one edge of the support (520).
29. The method (700, 800A, 800B, 800C) of any one of claims 27 to 28, wherein the sensor (110) is affixed to an outer moveable frame (530) coupled to the stationary frame (510).
30. The method (700, 800A, 800B, 800C) of any one of claims 27 to 29, further comprising:
- providing (820) a motion sensor (560) to detect a movement of the outer moveable frame (530) in relation to the stationary frame (510),
 - determining (822), using the motion sensor (560), information about an arrangement of the stationary frame (510) and the outer moveable frame (530), wherein the arrangement comprises a closed arrangement or an open arrangement,

wherein in the closed arrangement, the outer moveable frame (530) is in contact with the stationary frame (510), and in the open arrangement, the outer moveable frame (530) is partially separated from the stationary frame (510),

- receiving using the controlling circuit (130), the information about the arrangement from the motion sensor (560),

- initializing (826) the method (700, 800A, 800B, 800C), using the controlling circuit (130), when it is determined that the arrangement is the open arrangement, and

- terminating (828) the method (700, 800A, 800B, 800C), using the controlling circuit (130), when it is determined that the arrangement is the closed arrangement.

31. A method (900) for actively cancelling an acoustic noise signal (112) entering a room (410) through an aperture (420) of the room (410), the method (900) comprising:

- providing (910) a sensor (110) to detect the acoustic noise signal (112) and to convert the acoustic noise signal (112) into an electronic noise signal (114);

- providing (920) a plurality of transducers (120) to generate an acoustic anti-noise signal (122) to cancel at least part of the acoustic noise signal (112), when the acoustic anti-noise signal (122) is added to the acoustic noise signal (112), and to convert an electronic anti-noise signal (124) into the acoustic anti-noise signal (122);

- transmitting (930) the electronic noise signal (114) to a controlling circuit (130) operably coupled to the sensor (110) and the plurality of transducers (120);

- classifying (940) using the controlling circuit (130), the electronic noise signal (114) by matching a sample of the electronic noise signal (114) to one or more pre-determined cancellation filter candidates (160);

- selecting (950) using the controlling circuit (130), a first pre-determined cancellation filter (162) from the one or more pre-determined cancellation filter candidates (160), by basing a selection on the classified sample of the electronic noise signal (114),

- generating (960) using the controlling circuit (130), the electronic anti-noise signal (124) by applying the first pre-determined cancellation filter (162) on the electronic noise signal (114),

- transmitting (970) using the controlling circuit (130), the electronic anti-noise signal (124) to the plurality of transducers (120).

32. The method (900) of claim 31, wherein the controlling circuit (130) comprises a microprocessor or is included in a microprocessor.

33. A computer program comprising instructions to cause a computing system to execute the steps of the method (700, 800A, 800B, 800C, 900) of any one of claims 16 to 32.

34. A computer program comprising instructions to cause the system (100, 400, 600) of any one of claims 1 to 15 to execute the steps of the method (700, 800A, 800B, 800C, 900) of any one of claims 16 to 32.