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(54) **SOUND MASKING FOR WHITE GOODS**

(57) The present invention refers to a system for controlling active motor noise (9) for white goods (1) using sound masking technique. In the white good (1), the system is fixed near to the user interface to determine a loading condition and accordingly predicts the active motor noise (9). An original music (6) with appropriate background sound can be selected from the internet or from a system memory. The original music (6) is converted to

plain music (8) by removing a periodic rhythmic background sound (7) from the original music (6). The plain music (8) can be played through a speaker (2). The active motor noise (9) and the plain music (8) can be combined (10) together in air and produce a comfortable music (11). Hence, the rotating motor sound (9) of the white good (1) is masked with the plain music (8).

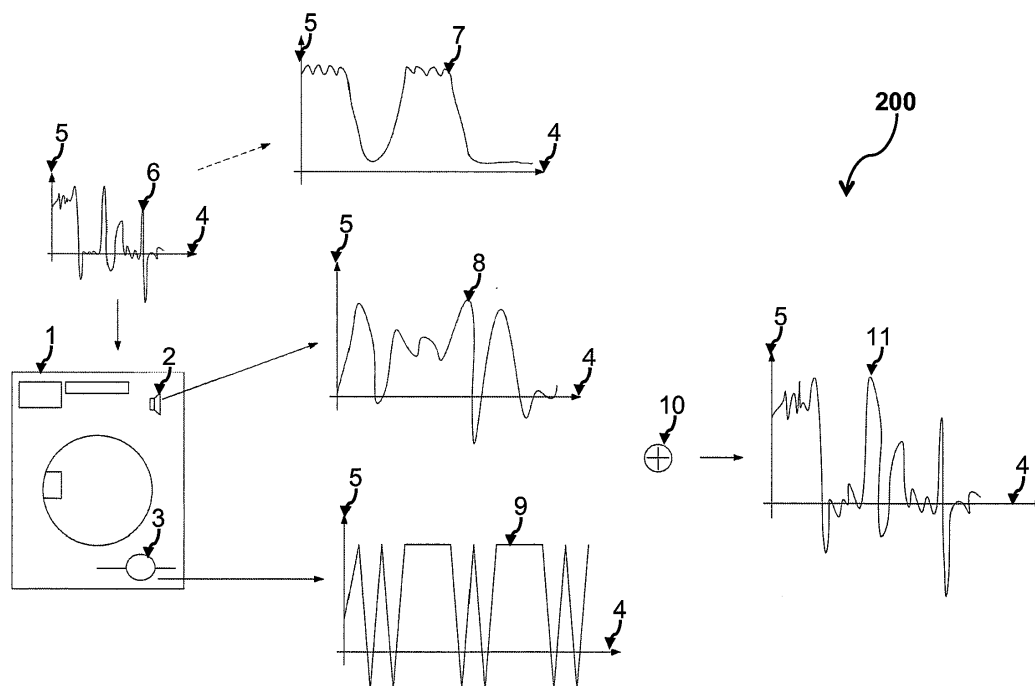


Fig. 2

Description

[0001] This invention refers to a sound masking system to control active noise for white goods according to claim 1 and a method to control active noise for white goods using sound masking technique according to claim 5.

Background of the Invention

[0002] Usually at home, white goods such as washing machine, refrigerators and so on are highly annoying devices with respect to noise. Motors of washing machines and compressors of refrigerators can create very loud unwanted vibrations and sound. Because of the nature of this noise that is created by a rotating motor, special mechanical designs and sound isolations to suppress or shift the frequency of this noise are common. This type of annoying noises is commonly referred as 'active noise'. A general solution for active noise cancellation is to create an anti-noise that can nullify the active noise of the white goods. The anti-noises are destructive interference that can suppress the active noise.

[0003] In the prior art US5781640, the prior art discloses a system for suppressing undesirable noise such as the noise adjacent to freeways arising from vehicular traffic, particularly by transformation of unpleasant noise into sound that is more pleasing to the human ear. More specifically, the prior art provides a system for suppressing the effects of undesirable noise from an annoying noise source contains a plurality of transformation sounds which, when combined with the noise, form a sound that is pleasing to the ear. The incident noise is detected and converted to signals which are dynamically analyzed, filtered and monitored to control the transformation sound selection process. The transformation sounds are modulated by a filtered signal derived from these noise signals that tracks the average energy in the noise. In this case, the active noise is suppressed

[0004] In another prior art US2002150261, the prior art describes a sound masking system for shaping the ambient noise level in a physical environment. The sound masking system comprises a networked and distributed system having a number of master units coupled together and to a control unit. One or more of the master units may include satellite sound masking units which function to reproduce the sound masking signal generated by the master sound masking unit. Each of the master units is addressable over the network by the control unit enabling the control unit to program the contour, spectral band, and gain characteristics of the sound masking output signal. The system may also include a remote control unit which provides the capability to tune and adjust each master sound masking unit in situ without requiring physical access through the ceiling installation. In this case the system requires a feed back control unit to adjust the output.

[0005] In another prior art US6742208, the prior art provides a noise reduction system for a washing machine.

More specifically, a washing machine is provided with a noise reduction and control system which can sense out of balance and pump starvation conditions. A microphone is used in connection with an electronic controller to sense an unbalance or pump starvation condition and alter a washing operation of the machine to counteract the unbalance or pump starvation condition. Additionally, the microphone and controller can respond to voice commands to establish the washing operation for the washing machine. Once an unbalance or excessive vibration condition is sensed, a controller may alter the operation of the machine to counteract system imbalances. For instance, the system can either be stopped for a short amount of time to rebalance the clothing within the washing machine tub or alternatively, stopped altogether. The prior art noise reduction system is configured for washing machine and the noise is reduced by adjusting the operation of the washing machine.

[0006] In the prior art US7854295, the prior art refers an active noise control apparatus and an active noise control system for reducing noise using an active vibrator, such that edges β of the vibrator (i.e. genesis locations of a bending moment of force caused by the vibrator) agree with positions α on a distribution of the bending moment of force caused by noise vibration of a panel, and such that the edges β of the vibrator are aligned with the positions α on the panel where a sign, of the distribution of the bending moment of force over the panel caused by the noise vibration, reverses. As a result, a control vibration approximate to the noise vibration can be excited. Accordingly, when the vibrator is fixed by agreeing the edges β of the vibrator with the positions α determined by noise frequency desired to be reduced, noise due to a target noise frequency can be effectively reduced. In this case, the prior art utilizes a finite element analysis to shift resonance frequency. But the method is complicated and requires expensive devices.

[0007] The subject-matter of US5781640, US2002150261, US6742208 and US7854295 requires a control unit with a feedback and more complex digital processing systems (DSP). Further, the system described in the prior arts are expensive and some systems are limited to specific applications.

Object of the Invention

[0008] It is therefore the object of the present invention to provide a device, in particular a system to control active noise for white goods using sound masking, and a method thereof to control active noise for white goods that has a simple DSP and operates as an open loop system. That is the system does not require feedback unit for active noise control.

Description of the Invention

[0009] The before mentioned object is solved by a system to control active noise for white goods using sound

masking according to claim 1. The system to control active noise / active motor noise for white goods using sound masking according to the present invention preferably comprises a means for determining a loading condition of the white goods, a means for predicting noise that is generated according to the loading condition by the white goods, a means for predicting rhythm from the predicted noise, a means for downloading an original music with similar rhythm of the predicted noise, a means for removing a rhythmic background from the original music to obtain a plain music, and a means for merging the predicted noise with the plain music to create less annoying sound.

[0010] This solution is beneficial since the invention does not require any feedback from the system and provides an improved simple DSP unit.

[0011] Further preferred embodiments are subject-matter of dependent claims and/or of the following specification parts.

[0012] According to a preferred embodiment of the present invention, a pink noise or white noise is added with the plain music at a predetermined level to create better sound masking. The predicted noise can be merged with the plain music to produce more sound than the noise. Comparitively, the generated sound is less annoying and comfortable to a user. Further, the system may utilize an open loop active noise control for sound masking. That is the system does not require any feedback loop from the control for adjusting the output.

[0013] The before mention object is also solved by a method to control active noise for white goods using sound masking, according to claim 5. The method preferably comprising the steps: determining a loading condition of the white goods; predicting noise that is generated according to the loading condition by the white goods; predicting rhythm from the predicted noise; downloading an original music with similar rhythm of the predicted noise; removing a rhythmic background from the original music to obtain a plain music; and merging the predicted noise with the plain music to create less annoying sound, according to any of claims 1 to 4.

[0014] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which components of the invention are exemplarily illustrated. Components of the devices and method according to the inventions, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described in all figures.

[0015] The invention is just exemplarily described with respect to the attached figures in the following.

Brief Description of the Drawings

[0016]

Fig. 1 illustrates an exemplary model of white good

with sound masking, according to an embodiment of the present invention; and

Fig. 2 illustrates the working principle of the system to control active motor noise for white goods using sound masking, according to an embodiment of the present invention.

Detailed Description of the Drawings

[0017] Fig. 1 illustrates an exemplary model 100 of white good with sound masking, according to an embodiment of the present invention. In the white good 1 (for example a front load washing machine), the system is fixed near to the user interface to determine a loading condition and accordingly predicts the active motor noise 9. Further, a speaker 2 of the system is attached near to the user interface and above the rotating motor 3 of the white good 1 or source of the active noise. An original music 6 with appropriate background sound can be selected from the internet or from a system memory. The original music 6 is converted to plain music 8 by removing a periodic rhythmic background sound 7 from the original music 6. The plain music 8 can be played through the speaker 2. The active motor noise 9 and the plain music 8 can be combined 10 together in air and produce a comfortable music 11. Hence, the rotating motor sound 9 of the white good 1 is masked with the plain music 8.

[0018] Fig. 2 illustrates the working principle 200 of the system to control active noise for white goods using sound masking, according to an embodiment of the present invention. The system for controlling active noise using sound masking comprises of a means for determining a loading condition of the white goods 1, a means for predicting active motor noise 9 that is generated according to the loading condition by the white goods 1, a means for predicting rhythm from the predicted active motor noise 9, a means for downloading the original music 6 with similar rhythm of the predicted active motor noise 9, a means for removing the rhythmic background 7 from the original music 6 to obtain a plain music 8, and a means for merging 10 the predicted active motor noise 9 with the plain music 8 to create less annoying sound 11.

[0019] According to the preferred embodiment of the present invention, the system utilizes an open loop (no feedback required) active noise masking (not suppressing) technique. That is the overall sound is higher than the active motor noise 9 but less annoys the user. The system may estimate active motor noise 9 that is generated by either motor of washing machine or compressor of refrigerator (white goods). This active motor noise 9 is partly predictable with certain parameters such as load. Initially, the system can predict the loading condition and based on that the active motor noise 9 is predicted. The active motor noise 9 may include a periodic rhythmic sound. All the sound waves have varying amplitude 4 with respect to time domain 5.

[0020] According to the preferred embodiment of the

present invention, the motor (or compressor) may create periodic rhythmic sound 9. The system can use this periodic rhythmic sound 9 as a background for the original music 6. Whenever rhythm of active motor noise 9 is predicted, the system either downloads or found some original music 6 with similar beat / rhythm. Then the system may delete the rhythmic background 7 from the original music 6 and create a plain music 8. At that stage, the active motor noise 9 and the plain music 8 from the speaker 2 are combined 10 together in air to create less annoying sound 11. The combined sound is not identical with original (that is original music 6) but very similar.

[0021] According to the preferred embodiment of the present invention, a pink noise or white noise is added with the plain music 8 at a predetermined level to create better sound masking. The predicted active motor noise 9 can be merged with the plain music 8 to produce more sound than the active motor noise 9. Comparitively, the generated sound is less annoying and comfortable to a user. Further, the system may utilize an open loop active noise control for sound masking. That is the system does not require any feedback loop from the control for adjusting the output.

[0022] According to the preferred embodiment of the present invention, a method to control active motor noise 9 for white goods 1 using sound masking comprising the steps: determining a loading condition of the white goods 1; predicting active motor noise 9 that is generated according to the loading condition by the white goods 1; predicting rhythm from the predicted active motor noise 9; downloading an original music 6 with similar rhythm of the predicted active motor noise 9; removing a rhythmic background 7 from the original music 6 to obtain a plain music 8; and merging 10 the predicted active motor noise 9 with the plain music 8 to create less annoying sound 11. The method to control active motor noise 9 for white goods 1 using sound masking further comprising the step of adding a pink noise or white noise with the plain music at a predetermined level to create better sound masking.

[0023] The present invention thus refers to a system for controlling active motor noise 9 for white goods 1 using sound masking technique. In the white good 1, the system is fixed near to the user interface to determine a loading condition and accordingly predicts the active motor noise 9. An original music (6) with appropriate background sound can be selected from the internet or from a system memory. The original music 6 is converted to plain music 8 by removing a periodic rhythmic background sound 7 from the original music 6. The plain music 8 can be played through a speaker 2. The active motor noise 9 and the plain music 8 can be combined 10 together in air and produce a comfortable music 11. Hence, the rotating motor sound 9 of the white good 1 is masked with the plain music 8.

List of reference numbers

[0024]

- | | |
|-----|---|
| 1 | White good |
| 2 | Speaker in the machine |
| 3 | rotating motor |
| 4 | time domain |
| 5 | 5 |
| 5 | amplitude |
| 6 | original music or original music either recorded in memory or from internet |
| 7 | periodic rhythmic background removed from original music |
| 10 | 8 |
| 8 | plain music (without background) |
| 9 | periodic motor noise / periodic rhythmic sound |
| 10 | periodic motor noise and plain music are combined on the air |
| 11 | combined sound |
| 15 | 100 |
| 100 | an exemplary model of white good with sound masking |
| 200 | working principle of the system to control active noise for white goods using sound masking |

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Claims

1. A system to control active motor noise (9) for white goods (1) using sound masking comprises of,
 - 25 a means for determining a loading condition of the white goods (1);
 - a means for predicting periodic active motor noise (9) that is generated according to the loading condition by the white goods (1);
 - 30 a means for predicting rhythm from the predicted periodic active motor noise (9);
 - a means for downloading an original music (6) with similar rhythm of the predicted periodic active motor noise (9);
 - 35 a means for removing a rhythmic background (7) from the original music (6) to obtain a plain music (8); and
 - a means for merging (10) the predicted periodic active motor noise (9) with the plain music (8) to create less annoying sound (11).
2. The system of claim 1, wherein a pink noise or white noise is added with the plain music (8) at a predetermined level to create better sound masking.
3. The system of claim 1, wherein the predicted periodic active motor noise (9) that is merged with the plain music (8) to produce more sound than the noise; and wherein the sound is less annoying to a user.
4. The system of claim 1, wherein the system utilizes an open loop active noise control for sound masking.
5. A method to control active noise (9) for white goods (1) using sound masking comprising the step of,
 - 55 determining a loading condition of the white goods (1);
 - predicting periodic active motor noise (9) that is gen-

erated according to the loading condition by the white goods (1);
predicting rhythm from the predicted periodic active motor noise (9);
downloading an original music (6) with similar rhythm of the predicted periodic active motor noise (9);
removing a rhythmic background (7) from the original music (6) to obtain a plain music (8); and
merging (10) the predicted periodic active motor noise (9) with the plain music (8) to create less annoying sound (11).

6. The method of claim 5, wherein the method to control active noise (9) for white goods (1) using sound masking further comprising the step of, adding a pink noise or white noise with the plain music (6) at a predetermined level to create better sound masking.

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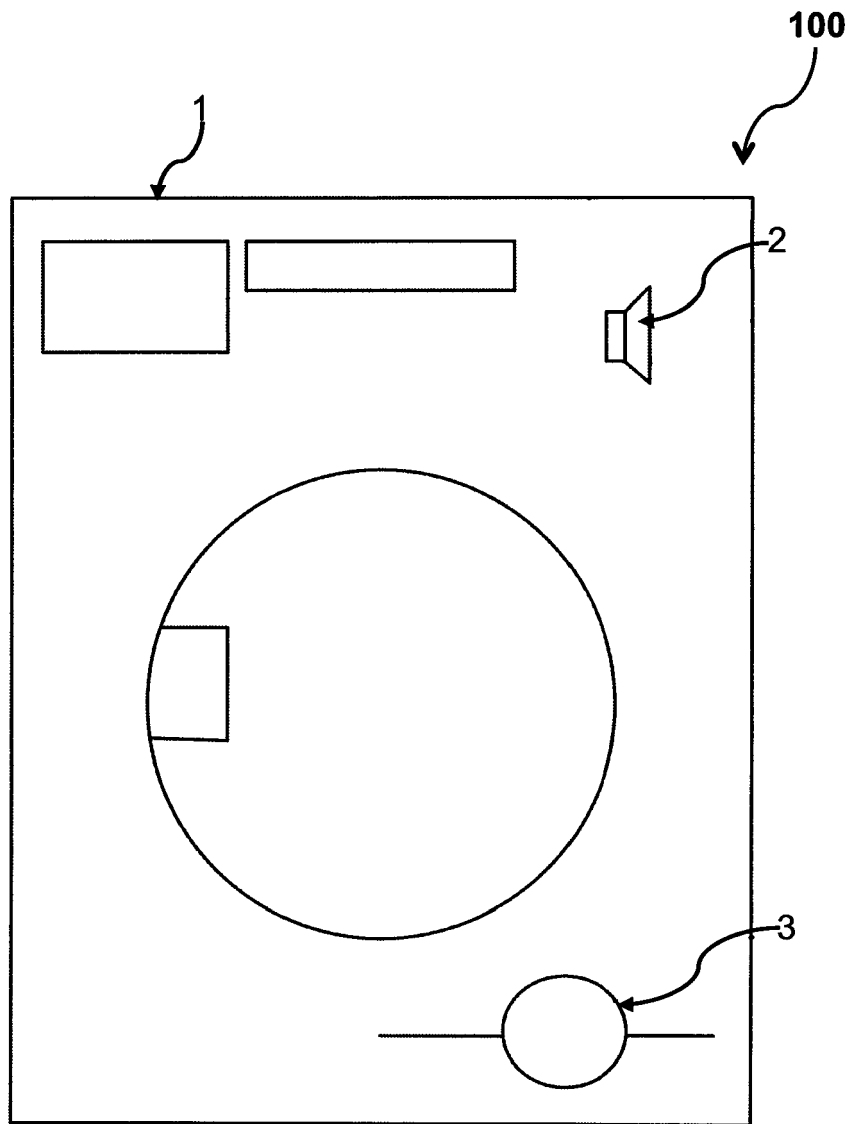


Fig. 1

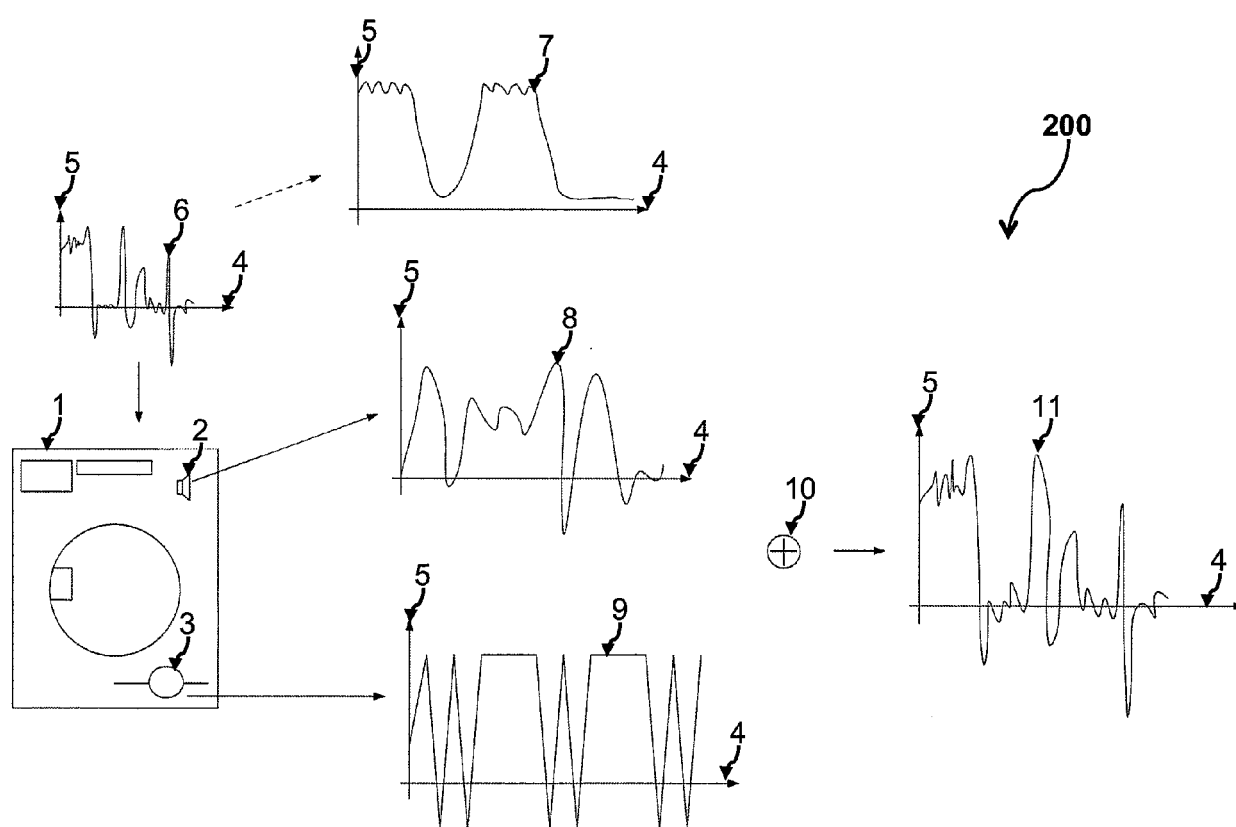


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8006

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Place of search The Hague		Date of completion of the search 20 October 2017	Examiner Brescia, Luca
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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