Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
Description

[0001] The present invention relates to an obstacle detection system according to claim 1.

[0002] Conventionally, an obstacle detection system that smoothes out dispersion in the oscillation frequency of a microphone used for an ultrasonic sensor is proposed in, for example, US 2003/0034883 A1 (JP 3521892 B2). In this obstacle detection system, first a microphone is assembled in a sensor circuit board, and then an obstacle for a test is disposed against the microphone. Subsequently, the obstacle detection system transmits an ultrasonic wave to this obstacle, finds an oscillation frequency of the ultrasonic wave that has a highest peak voltage of its reflected wave, and stores the oscillation frequency in a nonvolatile memory. Therefore, a stringent specification to the microphone becomes unnecessary.

[0003] In detecting an obstacle actually, an ultrasonic wave of the oscillation frequency stored in this nonvolatile memory is transmitted, whereby the dispersion in the oscillation frequency of the microphone is smoothed out.

[0004] Generally, the ultrasonic sensor is equipped with a filter circuit that filters signals of the reflected wave and eliminates frequency components that deviate from the resonance frequency of the microphone. The center frequency of this filter circuit can be set up in advance based on a resonance frequency that is determined simply by nominal specification without considering the dispersion in the specification of the microphone. For example, when the resonance frequency of the microphone is 40 kHz, the center frequency is set up in advance based on that value.

[0005] In contrast to this, in a case where specifications of the microphones are completely different, for example, there exist a plurality of specifications regarding the resonance frequency of the microphone, such as 40, 50 and 60 kHz, it is necessary to prepare filter circuits corresponding to respective specifications.

[0006] That is, when an ultrasonic sensor is installed on a vehicle and used to detect obstacles existing in the surroundings of the vehicle, it is desired to alter a detection range and a detection span of the ultrasonic sensor according to the type of a vehicle, installation, positions, etc. Therefore, it is necessary to use microphones having different specifications from one another for respective purposes.

[0007] Thus, when microphones having different specifications are used, it is necessary to prepare special filter circuits each corresponding to the specification of each microphone. The hardware including the filter circuit therefore lacks general versatility.

[0008] From WO-A-96/04589 a digital transmit beamformer system with multiple beam transmit capability is known and has a plurality of multi-channel transmitters, each channel with a source of sampled, complex-valued initial waveform information representative of the ultimate desired waveform to be applied to one or more corresponding transducer elements for each beam. Each multi-channel transmitter applies beamformation delays and apodization to each channel's respective initial waveform information digitally, digitally modulates the information by a carrier frequency, and interpolates the information to a DAC sample rate for conversion to an analog signal and application to the associated transducer element or elements. The beamformer transmitters can be programmed per channel and per beam with carrier frequency, delay, apodization and calibration values. For pulsed wave operation, pulse waveform parameters can be specified to the beamformer transmitters on a per firing basis, without degrading the scan frame rate to non-useful diagnostic levels.

[0009] From US-A-2003/052355 a transmitter or receiver is known which comprises several transducers made opposite an aperture in a package. Each transducer comprises a deformable semiconductor membrane intended to be coursed by an electric current and separated from a substrate zone by a cavity allowing the membrane to deform due to the effect of an acoustic pressure or of a Lorenz force.

[0010] From DE-C-32 06 919 a radar equipment is known which includes a receiving and evaluation portion within a video part of the signal processing means and includes also filtering means realized as controllable switch capacitor filter. The pass through range of the switch capacitor filter is determined by the switching frequency with which it is switched to the different capacitors. By controlling the switching frequency the pass through range of the filter is controlled.

[0011] The present invention has an object of providing an obstacle detection system that has high general versatility.

[0012] According to an obstacle detection system of the present invention, a transmission frequency of an ultrasonic signal for each of ultrasonic sensors and a center frequency in filtering processing of a received reflected signal are determined according to frequency setting information transmitted from a control unit. As a result, even when several microphones used in the ultrasonic sensor have completely different specifications, hardware of the ultrasonic sensors except for microphones can be common. This is because it is possible to alter the settings of the transmission frequency of the ultrasonic signal and the center frequency in the filtering processing by changing the setting information transmitted to each sensor.

[0013] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a block diagram showing a vehicular obstacle detection system according to an embodiment of the present invention;
FIG. 2A is a perspective view showing a sensor, and FIG. 2B is a cross sectional view of the sensor in the
frequency of an ultrasonic signal that should be set up in the sensors 10 to 70 and the center frequency that should be set up in the filtering processing in a receiving filter circuit 15 are set up. The sensors 10 to 70 determine the transmission frequencies and the center frequencies by referring to this field.

[0022] The transmission frequency and the center frequency of each sensor are set up based on the correspondence table shown in FIG. 6. That is, the ECU 30 (memory 30a) stores a code type (codes 1 to 6) that shows the correlation between the transmission frequency and the center frequency that should be set up for each of the sensors 10 to 70. This code type corresponds to a specification of a transmission-reception microphone (for example, resonance frequency etc.) used in the sensors 10 to 70.

[0023] The ECU 30 selects the transmission frequency and the center frequency according to the specification of the microphone 10a used for the sensors 10 to 70, based on the correspondence table shown in this FIG. 6. The transmission frequency of each frequency level may be correlated with the center frequency. However, even if the transmission frequency and the center frequency do not coincide exactly with each other, frequency components that deviate from the resonance frequency of the microphone 10a can be eliminated sufficiently.

[0024] Therefore, by correlating each of groups (a 39-41 kHz group and a 42-44 kHz group shown in FIG. 6) of which is composed of a plurality of transmission frequencies having respective different frequency levels to each center frequency having a different frequency level, the need to alter the setting of the center frequency is eliminated, provided that the setting of the transmission frequency is altered within its group.

[0025] As shown in FIG. 3, the circuit unit 10b of the sensor 10 has a LAN control circuit 11, a frequency adjustment circuit 12, a microphone driver circuit 13, a filter circuit 15, a gain adjustment circuit 16, a distance calculation circuit 17, a threshold adjustment circuit 18, a comparator 18a, and a nonvolatile memory 19.

[0026] The LAN control circuit 11, the frequency adjustment circuit 12, the filter circuit 15, the gain adjustment circuit 16, the distance calculation circuit 17, the threshold adjustment circuit 18, the comparator 18a and the memory 19 are constructed integrally with one another in a LSI (Large-Scale Integrated circuit). By this construction, even when a specification of the microphone 10a is completely different from others, the LSI that constitutes hardware except for the microphone driver circuit 13, the microphone 10a, etc. can be used commonly among the sensors 10 to 70.

[0027] The LAN control circuit 11 receives various communication frames transmitted from the ECU 30 through the serial communication lines and also transmits a polling frame for transmitting back measured distance data. In addition, the sensor 10 decodes contents of a communication frame with the control circuit 11.

[0028] The frequency adjustment circuit 12 sets up (adjusts) a transmission frequency that is to be set up in the sensors 10 to 70 and the center frequency that should be set up in the filtering processing in a receiving filter circuit 15 are set up. The sensors 10 to 70 determine the transmission frequencies and the center frequencies by referring to this field.

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When the ECU 30 is started, it performs processing for the sensor 10. The sensor 10 decodes this frequency setting frame and executes setting of the transmission frequency and the center frequency.

[0036] Subsequently, the ECU 30 transmits the frequency setting frame to the sensor 20. Then, the sensor 20 decodes this frequency setting frame, and executes setting of the transmission frequency and the center frequency.

[0037] Next, the ECU 30 transmits the wave transmission instruction frame for indicating transmission of an ultrasonic signal to the sensor 10. The sensor 10 transmits an ultrasonic wave in response to this wave transmission instruction frame. After transmitting the wave transmission instruction frame to this sensor 10, the ECU 30 transmits the wave transmission instruction frame to the sensor 20 after setting an ample time for it to be free from an influence of multi-pass. The sensor 20 transmits an ultrasonic wave in response to this wave transmission instruction frame.

[0038] Then, the ECU 30 transmits the polling frame (P1) for instructing transmission of measured (ranged) distance information to the sensor 10, and the sensor 10 transmits back the polling frame (R1) for transmitting back the measured distance data to the ECU 30.

[0039] Moreover, the ECU 30 transmits a polling frame (P2) for instructing transmission of the measured distance information to the sensor 20, and the sensor 20 transmits back a polling frame (R2) for transmitting the measured distance data to the ECU 30. After this, ECU 30 repeatedly transmits the wave transmission instruction frames and the polling frames, and thereby detects an obstacle.

[0040] In this way, the sensors 10 to 70 in the vehicular obstacle detection system 100 sets up the transmission frequency of the ultrasonic pulse signal and the center frequency in the filter processing in response to the frequency setting frame from the ECU 30.

[0041] Even when specifications of the microphones used in the sensors 10 to 70 are completely different from one another, it is possible to alter the setting of the transmission frequency of the ultrasonic pulse signal and the center frequency in the filter processing according to the specifications. Therefore the hardware of the sensors 10 to 70 except for the microphone driver circuit 13 and the microphone 10a can be used commonly and the general versatility of the hardware is increased. As a result, higher efficiency can be attained in each process of design, manufacture, and management of the hardware of the sensors 10 to 70.

[0042] In the above embodiment, both of the transmission frequency and the center frequency are set up individually. In the ultrasonic signal transmitter part 12, this transmission frequency being set up is set up as the transmission frequency of the ultrasonic pulse signal. In the receiving filter part 15, this center frequency being set up is set up as the center frequency in the filtering processing.

[0043] Alternatively, the frequency setting up may be modified as follows: only one of the transmission frequen-
cy and the center frequency is set up in the frequency setting frame. When the frequency setting frame contains only the center frequency, the ultrasonic signal transmitter part 12 sets up that center frequency as the transmission frequency. When the frequency setting frame contains only the transmission frequency, the receiving filter part 15 sets up that transmission frequency as the center frequency.

[0044] By making the ECU 30 set up only either the transmission frequency or the center frequency in the frequency setting frame and making the sensors 10 to 70 set up the transmission frequency and the center frequency in a coupled manner as described above, data length of a communication frame can be shortened. Moreover, decoding of the communication frame becomes easy also in the sensors 10 and 20.

[0045] In the above embodiment, the ECU 30 starts to operate by being supplied with power from the vehicle-mounted battery when the ignition switch (IG) of the vehicle is turned on, and subsequently transmits a frequency setting frame. This processing is performed each time the IG is turned on.

Claims

1. An obstacle detection system comprising:

an ultrasonic sensor (10) having ultrasonic signal transmitting means (12) for transmitting an ultrasonic signal, wave transmitting and receiving means (10a) for transmitting an ultrasonic wave responsive to the ultrasonic signal and receiving reflected wave, and a control unit (30) connected with the ultrasonic sensor (10) through communication lines, characterized in that the control unit (30) is equipped with processing means for performing processing of transmitting frequency setting information that contains a predetermined transmission frequency of the ultrasonic signal and a predetermined center frequency in the filtering processing to the ultrasonic sensor (10) through the communication line, the ultrasonic signal transmitting means (12) has transmission frequency setting means for setting up a transmission frequency of the ultrasonic signal according to the predetermined transmission frequency contained in the frequency setting information, and said ultrasonic sensor further having receiving filtering means (15) for performing filtering processing on the received signal of the ultrasonic signal; said receiving filtering means (15) being equipped with center frequency setting means for setting up a center frequency in the filtering processing according to the predetermined center frequency contained in the frequency setting information.

2. The obstacle detection system according to claim 1, wherein:

the processing means (30) selects at least either of the transmission frequency and the center frequency that should be contained in the frequency setting information based on a correspondence table showing correlation between the transmission frequency and the center frequency; and the transmission frequency of each frequency level or each group comprised of a plurality of the transmission frequencies having respective different frequency levels is correlated to the center frequency of a different frequency level in the correspondence table.

3. The obstacle detection system according to any of claims 1 to 2, wherein the receiving filtering means (15) includes a switched capacitor filter circuit.

4. The obstacle detection system according to any of claims 1 to 3, wherein:

the ultrasonic sensor (10) has storage means (19) for storing the frequency setting information; and the transmission frequency setting means and the center frequency setting means set up the transmission frequency and the center frequency, respectively, according to frequency setting information stored in the storage means (19).

5. The obstacle detection system according to any of claims 1 to 4, wherein a plurality of ultrasonic sensors (10 to 70) including the ultrasonic sensor (10) are installed on a front bumper part and a rear bumper part of a vehicle; and the control unit (30) includes a memory (30a) storing a combination of the transmission frequency and the center frequency for each of the plurality of ultrasonic sensors (10 to 70).

Patentansprüche

1. Hindernisdetektionssystem, aufweisend:

 einen Ultrasschallsensor (10) mit einer Ultra- schallsignal-Übertragungseinrichtung (12) zum Übertragen eines Ultrassignals, einer Wellenübertragungs- und empfangseinrichtung (10a) zum Übertragen einer Ultrasschallwelle in Reaktion auf das Ultrassignal und Empfan- gen einer reflektierten Welle; und eine Steuerungseinheit (30), die mit dem Ultra- schallsensor (10) durch Datenübertragungslei- tungen verbunden ist,
dadurch gekennzeichnet, dass

2. Hindernisdetektionssystem nach Anspruch 1, wobei:

- die Verarbeitungseinrichtung (30) zumindest entweder die Übertragungsfrequenz oder die Mittenfrequenz, die in den Frequenzeinstellungsinformationen enthalten sein sollen, basierend auf einer Entsprechungstabelle auswählt, die eine Korrelation zwischen der Übertragungsfrequenz und der Mittenfrequenz zeigt; und
- die Übertragungsfrequenz eines jeweiligen Frequenzpegels oder einer jeweiligen Gruppe, die aus einer Mehrzahl von Übertragungsfrequenzen besteht, die jeweils unterschiedliche Frequenzpegel aufweisen, mit der Mittenfrequenz eines unterschiedlichen Frequenzpegels in der Entsprechungstabelle korreliert.

3. Hindernisdetektionssystem nach einem der Ansprüche 1 bis 2, wobei die Empfangsfiltereinrichtung (15) einen Schaltkreis mit einem geschalteten Kondensatorfilter beinhaltet.

4. Hindernisdetektionssystem nach einem der Ansprüche 1 bis 3, wobei:

- der Ultraschallsensor (10) eine Speicherungseinrichtung (19) zum Speichern der Frequenzeinstellungsinformationen aufweist; und
- die Übertragungsfrequenz-Einstellungseinrichtung und die Mittenfrequenz-Einstellungseinrichtung jeweils die Übertragungsfrequenz und die Mittenfrequenz gemäß den Frequenzeinstellungsinformationen einrichten, die in der Speichereinrichtung (19) gespeichert sind.

5. Hindernisdetektionssystem gemäß einem der Ansprüche 1 bis 4, wobei eine Mehrzahl von Ultraschallsensoren (10 bis 70), die den Ultraschallsensor (10) beinhalten, an einem Teil eines vorderen Stoßfängers und einem Teil eines hinteren Stoßfängers eines Fahrzeugs installiert sind; und

- die Steuerungseinheit (30) einen Speicher (30a) beinhaltet, der eine Kombination aus der Übertragungsfrequenz und der Mittenfrequenz für jeden von der Mehrzahl der Ultraschallsensoren (10 bis 70) speichert.

**Revendications**

1. Système de détection d’obstacles, comprenant :

- un capteur ultrasonore (10) ayant un moyen (12) de transmission d’un signal ultrasonore pour transmettre un signal ultrasonore, un moyen (10a) de transmission et de réception d’onde pour transmettre une onde ultrasonore sensible au signal ultrasonore et recevoir une onde réfléchie, et
- une unité de commande (30) connectée au capteur ultrasonore (10) par le biais de lignes de communication,

caractérisé en ce que

l’unité de commande (30) est dotée d’un moyen de traitement pour effectuer un traitement d’informations de réglage de la fréquence de transmission qui contiennent une fréquence de transmission prédéterminée du signal ultrasonore et une fréquence centrale prédéterminée dans le traitement par filtrage au capteur ultrasonore (10) par le biais de la ligne de communication, le moyen (12) de transmission d’un signal ultrasonore dispose d’un moyen de réglage de la fréquence de transmission pour régler une fréquence de transmission du signal ultrasonore selon la fréquence de transmission prédéterminée contenue dans les informations de réglage de la fréquence, et ledit capteur ultrasonore ayant en plus un moyen de filtrage de réception (15) pour effectuer un traitement de filtrage du signal reçu du signal ultrasonore, et ledit moyen de filtrage de réception (15) étant doté d’un moyen de réglage de la fréquence centrale pour régler une fréquence centrale dans le traitement de filtrage selon la fréquence centrale prédéterminée contenue dans les informations de réglage de la fréquence.
2. Système de détection d’obstacles selon la revendication 1, dans lequel
le moyen de traitement (30) sélectionne au moins
l’une de la fréquence de transmission et de la fréquence centrale qui devrait être contenue dans les informations de réglage de la fréquence sur la base d’une table de correspondance montrant une corrélation entre la fréquence de transmission et la fréquence centrale; et
la fréquence de transmission de chaque niveau de fréquence ou chaque groupe composé d’une pluralité de fréquences de transmission ayant différents niveaux de fréquences respectifs est corrélée à la fréquence centrale d’un niveau de fréquence différent dans la table de correspondance.

3. Système de détection d’obstacles selon l’une quelconque des revendications 1 à 2, dans lequel le moyen de filtrage de réception (15) inclut un circuit de filtrage à condensateur commuté.

4. Système de détection d’obstacles selon l’une quelconque des revendications 1 à 3, dans lequel :
le capteur ultrasonore (10) possède un moyen de stockage (19) pour stocker les informations de réglage de la fréquence; et
le moyen de réglage de la fréquence de transmission et le moyen de réglage de la fréquence centrale règlent la fréquence de transmission ainsi que la fréquence centrale, respectivement, selon les informations de réglage de la fréquence stockées dans le moyen de stockage (19).

5. Système de détection d’obstacles selon l’une quelconque des revendications 1 à 4, dans lequel plusieurs capteurs ultrasonores (10 à 70) incluant le capteur ultrasonore (10) sont installés sur une partie de pare-choc avant et une partie de pare-choc arrière d’un véhicule; et
l’unité de commande (30) inclut une mémoire (30a) stockant une combinaison de la fréquence de transmission et de la fréquence centrale pour chacun des plusieurs capteurs ultrasonores (10 à 70).
FIG. 4A

<table>
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<tr>
<th>SENSOR ID</th>
<th>MESSAGE ID</th>
<th>TRANSMISSION FREQUENCY/ FILTER CENTER FREQUENCY</th>
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FIG. 4B

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<th>SENSOR ID</th>
<th>MESSAGE ID</th>
<th>TRANSMISSION FREQUENCY (FILTER CENTER FREQUENCY)</th>
<th>ECC</th>
</tr>
</thead>
</table>

FIG. 5

ECU

SENSOR 10

SENSOR 20

SENSOR 10

SENSOR 20

SENSOR 10 INSTRUCT

SENSOR 20 INSTRUCT

P1

P2

R1

R2

EXECUTE SETTING

EXECUTE SETTING

TRANSMIT WAVE

TRANSMIT WAVE

FIG. 6

<table>
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<tr>
<th>CODE TYPE</th>
<th>TRANSMISSION FREQUENCY (kHz)</th>
<th>CENTER FREQUENCY (kHz)</th>
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REFERENCES CITED IN THE DESCRIPTION

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