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Bass Response Enhancement For Smart Home Devices

ABSTRACT

This disclosure describes techniques for obtaining improved bass response from a smart home device that has a small factor. An exciter positioned at the base of the smart home device is utilized to improve the bass response by generating additional sound pressure from the surface that the smart display is placed upon. The type of surface is determined based on transmitting a gated (low pass filtered) impulse. Based on received feedback, the exciter(s) are selectively activated. Inputs from a microphone and an accelerometer are utilized to determine the transfer impedance of the contact surface. A smart amplifier is utilized to drive the exciter based on determined transfer impedance and current and voltage sensing (IV sense). Determination of the type of contact surface and its characteristics is made at a time of switching on of the smart home device and then periodically at predetermined intervals and/or when the smart home device is detected as having been moved.

KEYWORDS

- Exciter
- Bass response
- Smart speaker
- IV sense
- Transfer impedance
- Active gain

BACKGROUND

Smart home devices such as smart speakers, smart displays, video conferencing hardware, etc. are utilized for a variety of purposes such as communication, productivity, entertainment, etc. The relatively small form factor (e.g., when compared to conventional audio speakers) of many smart home devices poses a challenge in obtaining high quality bass (low frequency sound) responses during audio playback. In some devices, a bass-reflex system can be
utilized to obtain additional bass response; however, this can introduce problems associated with poor transient response.

**DESCRIPTION**

This disclosure describes techniques for improving the bass response of a smart home device such as a smart display or smart speaker. Per techniques of this disclosure, an exciter at the bottom of the smart home device is utilized to improve the bass response by generation of additional sound pressure from suitable surfaces that the smart display is placed upon.

![Smart Device placed on a surface](image)

**Fig. 1: Smart device placed on a surface**

Fig. 1 depicts an example smart home device that is placed on a surface, e.g. a wooden table. The smart home device includes microphone(s) for receiving audio inputs and speaker(s) for producing audio output, e.g., during a voice call, for playing back music, when responding to a user query, etc. The smart home device includes an exciter, e.g., moving magnet exciter, moving coil exciter, etc. mounted at the bottom of the smart home device. The exciter is utilized
to generate additional sound pressure and improved bass response from the surface (e.g., a table) that it is placed on.

**Fig. 2: Inputs from an accelerometer and microphone are utilized to drive a exciter**

Fig. 2 illustrates an example arrangement of circuit elements for bass enhancement within a smart home device. As depicted in Fig. 2, the smart home device includes an exciter (210) that is driven by an application processor (220). The exciter (transducer) has a soft membrane exterior and is positioned at the base of the smart home device, where it can come into contact with a surface, e.g. table, on which the device is placed.

A gain to be applied to the exciter is determined by the application processor based on surface characteristics and a suitable predicted base response. A gated (low pass filtered) impulse is transmitted from the device. The exciter(s) are selectively activated based on the received feedback. For example, if the smart home device is placed on a granite countertop, a
determination is made that the exciter is to be switched off since the granite countertop does not provide any additional bass response.

Inputs from a microphone (230) and an accelerometer (240) or force gauge are utilized to determine the transfer impedance of the contact surface. A smart amplifier (250) is utilized to drive the exciter based on determined transfer impedance and current and voltage sensing (IV sense).

Determination of a type of contact surface and its characteristics is made at a time of switching on of the smart home device and then periodically at predetermined intervals and/or upon detection that the smart home device has been moved. The large surface area of surfaces commonly used for placement of smart home devices, e.g., TV stands, tables, kitchen table, etc. can provide an excellent bass response for audio that is played back from the device and can mitigate challenges posed by the relatively small form factor.

CONCLUSION

This disclosure describes techniques for improving a bass response of a smart home device. An exciter positioned at a base of the smart home device is utilized to increase the bass response by generation of additional sound pressure from a surface that the smart display is placed upon. A gated (low pass filtered) impulse is transmitted, and based on received feedback, the exciter(s) are selectively activated. Inputs from a microphone and an accelerometer are utilized to determine a transfer impedance of the contact surface. A smart amplifier is utilized to drive the exciter based on determined transfer impedance and current and voltage sensing (IV sense). A determination of a type of contact surface and its characteristics is made at a time of switching on of the smart home device and then periodically at predetermined intervals and/or when the smart home device is moved.