December 2019

Wireless charging dock with low frequency speaker

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ABSTRACT

High quality audio playback requires faithful reproduction of low, middle, and high frequency portions of audio. Low frequency sound playback on small devices such as mobile phones is difficult because of the relatively small size of the transducers used and other constraints. This disclosure describes a charging stand with a built-in speaker that receives and plays low frequency portion of audio from a phone coupled to the stand. The speakers in the phone are utilized for playback of other portions of the audio. Low frequency audio content is obtained using a low pass filter on the phone and is sent via a wireless link, such as Bluetooth or NFC. This provides is a less expensive mechanism for audio playback than speakers or stands that reproduce the entire frequency range of audio.

KEYWORDS

- Wireless charger
- Phone charger
- Charging stand
- Phone stand
- Charging dock
- Speaker dock
- Bass reproduction
- Wireless speaker
- Bass speaker

BACKGROUND

High quality audio playback requires faithful reproduction of low, middle, and high frequency portions of audio. Low frequency sound playback on small devices such as mobile phones is difficult because of the relatively small size of the transducers used. Additionally, speaker protection algorithms implemented in phones limit the low frequency content, especially at high sound levels, to prevent irreversible damage to the micro-speakers, transducers, and flat panel displays in the phone.

Current solutions to this problem involve coupling a mobile phone to a set of external speakers in a dock or standalone speakers (e.g., Bluetooth speakers), and leveraging these external speakers for audio playback. The design of such speakers requires that digital signal processing circuitry, amplifiers, and drivers to reproduce the entire range of audio frequencies be included.

DESCRIPTION

This disclosure describes a charging stand with a built-in speaker that receives and plays low frequency portion of audio from a phone coupled to the stand. The speakers in the phone are utilized for playback of other portions of the audio. Low frequency audio content is obtained using a low pass filter on the phone and is sent via a wireless link, such as Bluetooth or NFC. This provides is a less expensive mechanism for audio playback than speakers or stands that reproduce the entire frequency range of audio. Fig. 1 illustrates an example of a mobile phone wireless paired to a charging stand for charging and for audio playback.

Per techniques described herein, a high-pass configuration is used to separate audio in a mobile phone (100) into a low frequency portion that is sent to a charging dock and other portions that are played using built-in speakers of the mobile phone. This operation can be

performed using a digital signal processor (DSP) core of the phone. The speaker of the dock (102) plays the received low-frequency portion of the audio.

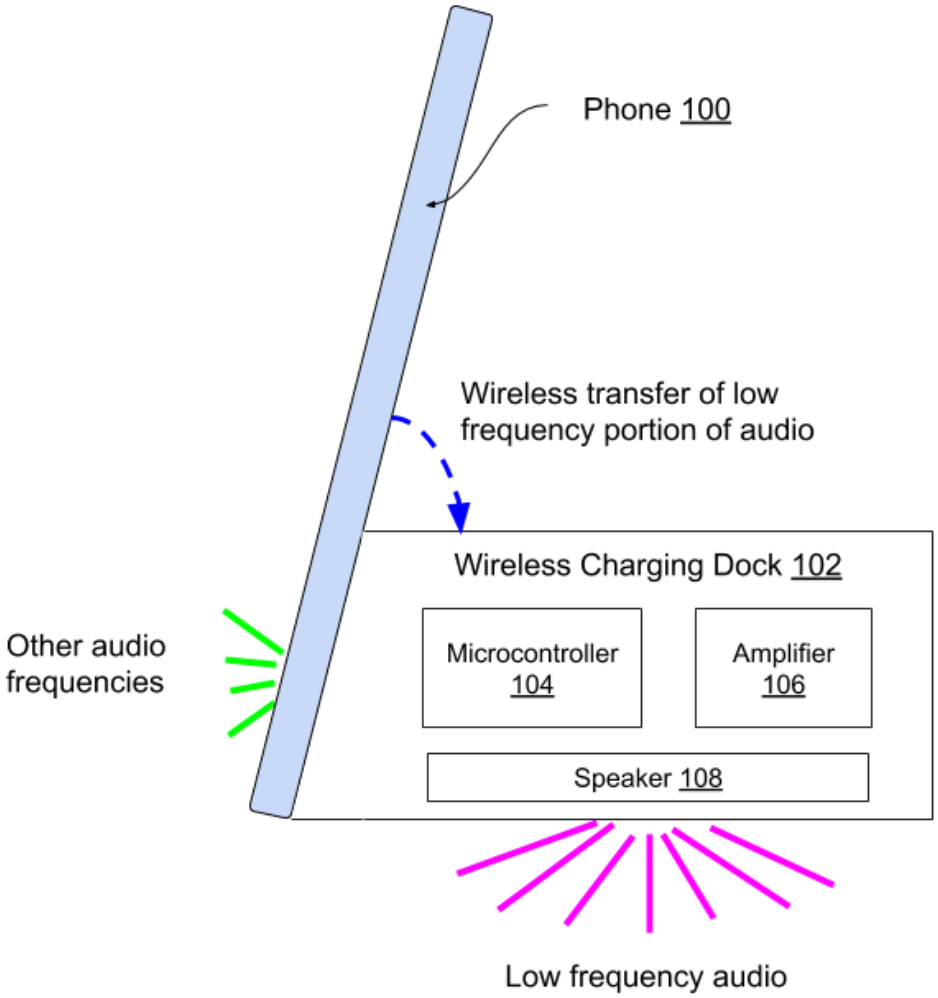

Fig. 1: Audio playback using phone speaker and charging stand

The low-frequency audio content is sent to the wireless charging dock using a wireless link, e.g., Bluetooth or Near Field Communication (NFC), or other suitable mechanism. The low frequency audio stream can be decoded by a pre-existing microcontroller in the wireless charging dock (104) or by a separate dedicated microcontroller. The resultant audio stream is amplified by an amplifier (106). The low frequency audio stream can be enhanced by the digital signal processor (DSP) on the phone prior to sending to the dock or by a DSP in the dock. The

DSP can be a standalone DSP or can be a part of the amplifier. The amplifier can be configured to drive an active speaker, an active speaker and one or multiple passive radiators, or an acoustic exciter.

Other portions of the audio are played back on the mobile phone speakers. High-frequency content is sensitive to direction of sound. Placement of the phone on the wireless charging dock in an upright position and at a tilted angle allows the phone to project sound in an optimal way. Low-frequency content is less sensitive to direction, of sound. Thus, the dock speaker, even if not positioned facing the user, can still output this content without an impact on the overall sound quality. Thus, the combination of phone and dock allows for high-quality playback, as compared to playing the entire content on the phone.

Further, in comparison to other docking station solutions, the dock described herein provides a less expensive mechanism for audio playback. The reduction in cost is achieved by eliminating separate mid and high frequency drivers in the dock by leveraging existing components in the mobile phone, e.g., dedicated transducers on mobile phone used as a tweeter. The solution is seamless as the dock can detect the smartphone and can switch automatically to hybrid playback mode and vice versa. Audio fidelity of the output is high since dedicated transducers in the phone and dock are used for different frequency ranges, and the high quality DSP in the phone is used to process audio content according to the specification of the system. Further, the overall system has a smaller footprint, since smartphone transducers are reused.

Further developments can use the array of microphones in the system to perform reverberation and equalization (EQ) calibration based on the position of the dock in a room to enhance sound quality and ensure consistency across setups. Machine learning engines on the phone can also be used to improve playback quality.

CONCLUSION

This disclosure describes a charging stand with a built-in speaker that receives and plays low frequency portion of audio from a phone coupled to the stand. The speakers in the phone are utilized for playback of other portions of the audio. Low frequency audio content is obtained using a low pass filter on the phone and is sent via a wireless link, such as Bluetooth or NFC. This provides is a less expensive mechanism for audio playback than speakers or stands that reproduce the entire frequency range of audio.