Title: SYSTEMS AND METHODS FOR USING A SPEAKER AS A MICROPHONE IN A MOBILE DEVICE

Abstract: In accordance with methods and systems of the present disclosure, a mobile device may include an enclosure adapted such that the enclosure is readily transported by a user of the mobile device, a speaker associated with the enclosure for generating sound, and a controller within the enclosure, communicatively coupled to the speaker. The controller may be configured to receive a signal from the speaker, the signal induced at least in part by sound incident on the speaker other than sound generated by the speaker and process the signal.

FIG. 2

START

200

SPEAKER 110 DISABLED FROM GENERATING SOUND IN A LOW-POWER STATE

202

RESPONSIVE TO SOUND INCIDENT UPON SPEAKER 110, TRANSMIT VOLTAGE SIGNAL INDUCED IN THE SPEAKER 110 BY INCIDENT SOUND TO CONTROLLER 110

204

VOLTAGE SIGNAL CORRESPONDS TO STIMULUS FOR TRANSITIONING MOBILE DEVICE TO HIGHER-POWER STATE?

206

YES

ACTIVATE HIGHER-POWER STATE

208

NO

(Continued on next page)
with amended claims and statement (Art. 19(1))

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AMENDED CLAIMS
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WHAT IS CLAIMED IS:

1. A mobile device comprising:
an enclosure sized and shaped such that the enclosure is readily transported on a
person of a user of the mobile device;
a capacitive microphone;
a speaker within the enclosure for generating sound; and
a controller within the enclosure, communicatively coupled to the speaker, and
configured to:

   receive a signal from the speaker, the signal induced at least in part by
   sound incident on the speaker other than sound generated by the speaker;
   receive the second signal from the capacitive microphone, the second
   signal induced by sound incident on the capacitive microphone;
   process at least one of the signal and the second signal to determine at least
   one characteristic of sound incident upon at least one of the speaker and the
   capacitive microphone; and
   select one of the capacitive microphone and the speaker as a signal source
   for incident sound based on the characteristic.

2. The mobile device of Claim 1, wherein the signal is a voltage signal.

3. The mobile device of Claim 1, wherein the controller is further configured
to:

   operate a first mode wherein the controller communicates an output signal to the
   speaker for generating sound; and
   operate the speaker in a second mode wherein the controller communicates no
   signals to the speaker for generating sound and receives the signal induced by sound
   incident on the speaker other than sound generated by the speaker and processes the
   signal.
4. The mobile device of Claim 1, wherein the controller is further configured to transition the mobile device from a low-power state to a high-power state responsive to a determination that the signal induced by sound incident on the speaker corresponds to stimulus for transitioning the mobile device from a low-power state to a high-power state.

5. The mobile device of Claim 1, further comprising a capacitive microphone configured to generate a second signal induced by sound incident on the capacitive microphone and wherein the controller is further configured to:
   receive the second signal from the capacitive microphone; and
   perform frequency equalization on the signal and the second signal in order to account for differences in the frequency responses to sound incident upon the speaker and the capacitive microphone.

6. The mobile device of Claim 5, wherein performing frequency equalization on the signal and the second signal comprises applying adaptive filtering during periods of time in which both the capacitive microphone is communicating the second signal to the controller and the speaker is communicating the signal to the controller.

7. (Cancelled)

8. The mobile device of Claim 1, wherein the at least one characteristic comprises a sound level.

9. The mobile device of Claim 1, wherein the at least one characteristic comprises a frequency.

10. The mobile device of Claim 1, wherein the controller is configured to:
   determine a magnitude of the signal; and
   subtract a magnitude of a second signal from the magnitude of the signal, the second signal communicated by the controller to the speaker for generating sound at the speaker, such that a difference between the magnitude of the signal and the magnitude of
the second signal is approximately equal to a portion of the signal attributable to sound incident on the speaker other than sound generated by the speaker.

11. The mobile device of Claim 1, the mobile device further comprising a second source for sound incident on the mobile device, the second source comprising one of a capacitive microphone and a second speaker, wherein the controller is further configured to, based on sound incident at the speaker and sound incident on the second source, perform beamforming to determine spatial selectivity of sounds incident on the mobile device.

12. The mobile device of Claim 1, wherein the speaker is a dynamic speaker.

13. A method comprising:
generating, by a speaker within an enclosure of a mobile device sized and shaped such that the enclosure is readily transported on a person of a user of the mobile device, a signal, the signal induced at least in part by sound incident on the speaker other than sound generated by the speaker;

receiving a second signal from a capacitive microphone within the enclosure, the second signal induced by sound incident on the capacitive microphone; and

processing at least one of the signal and the second signal to determine at least one characteristic of sound incident upon at least one of the speaker and the capacitive microphone; and

selecting one of the capacitive microphone and the speaker as a signal source for incident sound based on the characteristic.

14. The method of Claim 13, wherein the signal is a voltage signal.

15. The method of Claim 13, further comprising:
operating the speaker in a first mode wherein a controller within the enclosure communicates an output signal to the speaker for generating sound; and
operating the speaker in a second mode wherein the controller communicates no signals to the speaker for generating sound and receives the signal induced by sound incident on the speaker other than sound generated by the speaker and processes the signal.

16. The method of Claim 13, further comprising transitioning the mobile device from a low-power state to a high-power state responsive to a determination that the signal induced by sound incident on the speaker corresponds to stimulus for transitioning the mobile device from a low-power state to a high-power state.

17. The method of Claim 13, further comprising:
   receiving a second signal from a capacitive microphone within the enclosure, the second signal induced by sound incident on the capacitive microphone; and
   performing frequency equalization on the signal and the second signal in order to account for differences in the frequency responses to sound incident upon the speaker and the capacitive microphone.

18. The method of Claim 17, wherein performing frequency equalization on the signal and the second signal comprises applying adaptive filtering during periods of time in which both the capacitive microphone is communicating the second signal to the controller and the speaker is communicating the signal to the controller.

19. (Cancelled)

20. The method of Claim 13, wherein the at least one characteristic comprises a sound level.

21. The method of Claim 13, wherein the at least one characteristic comprises a frequency.
22. The method of Claim 13, wherein processing the signal comprises:
determining a magnitude of the signal; and
subtracting a magnitude of a second signal from the magnitude of the signal, the
second signal communicated to the speaker for generating sound at the speaker, such that
a difference between the magnitude of the signal and the magnitude of the second signal
is approximately equal to a portion of the signal attributable to sound incident on the
speaker other than sound generated by the speaker.

23. The method of Claim 13, further comprising:
receiving a second signal from a second source within the enclosure, the second
signal induced by sound incident on the second source, the second source comprising one
of a capacitive microphone and a second speaker; and
based on sound incident at the speaker and sound incident on the second source,
performing beamforming to determine spatial selectivity of sounds incident on the mobile
device.

24. The method of Claim 13, wherein the speaker is a dynamic speaker.

25. A mobile device comprising:
an enclosure sized and shaped such that the enclosure is readily transported on a
person of a user of the mobile device;
a first speaker within the enclosure for generating sound;
a second speaker within the enclosure for generating sound; and
a controller within the enclosure, communicatively coupled to the speaker, and
configured to:
receive a first signal from the first speaker, the first signal induced at least
in part by sound incident on the first speaker other than sound generated by the
first speaker;
receive a second signal from the first speaker, the second signal induced at
least in part by sound incident on the second speaker other than sound generated
by the second speaker;
process at least one of the first signal and the second signal to determine at least one characteristic of sound incident on the mobile device;

select one of the first speaker and the second speaker as a signal source for incident sound based on at least one of the volume level and the frequency; and

select the other one of the first speaker and the second speaker to generate sound based on at least one of the volume level and the frequency.

26. The mobile device of Claim 25, wherein the at least one characteristic comprises at least one of a volume level of sound incident on the mobile device and a frequency of sound incident on the mobile device.

27. A method comprising:

generating, by a first speaker within an enclosure of a mobile device sized and shaped such that the enclosure is readily transported on a person of a user of the mobile device, a first signal, the first signal induced at least in part by sound incident on the first speaker other than sound generated by the first speaker;

generating, by a second speaker within the enclosure, a second signal, the second signal induced at least in part by sound incident on the second speaker other than sound generated by the second speaker;

processing at least one of the first signal and the second signal to determine at least one characteristic of sound incident on the mobile device;

selecting one of the first speaker and the second speaker as a signal source for incident sound based on at least one of the volume level and the frequency; and

selecting the other one of the first speaker and the second speaker to generate sound based on at least one of the volume level and the frequency.

28. The method of Claim 27, wherein the at least one characteristic comprises at least one of a volume level of sound incident on the mobile device and a frequency of sound incident on the mobile device.
STATEMENT UNDER ARTICLE 19(1)

In the International Search Report/Written Opinion ("ISR/WO"), at Re Item V 2.10, the Authority asserts that the subject matter of Claims 7 and 19 (which are now recited as the subject matter of Claims 1 and 13, respectively) are not new in light of reference D1, U.S. Pat. No. 7,334,735 to Antebi, et al. (hereafter "D1"). Applicant respectfully traverses this finding, and submits that Claims 1 and 13 are new and novel over D1 at least because D1 does not teach a processor configured to:

- receive a signal from the speaker, the signal induced at least in part by sound incident on the speaker other than sound generated by the speaker;
- receive the second signal from the capacitive microphone, the second signal induced by sound incident on the capacitive microphone;
- process at least one of the signal and the second signal to determine at least one characteristic of sound incident upon at least one of the speaker and the capacitive microphone; and
- select one of the capacitive microphone and the speaker as a signal source for incident sound based on the characteristic

as recited in Claim 1 and as similarly recited in Claim 13. Although the ISR/WO indicates that these limitations are taught by D1 at Column 33, line 8-24 and Column 14, lines 2-8, these sections of D1 are completely silent as to any selection between a capacitive microphone and a speaker as signal source for incident sounds based on a characteristic of sound incident on either. For at least these reasons, Claims 1 and 13 cannot be said to lack novelty over D1.

Also, in the ISR/WO at Re Item V 2.1 and Re Item V 2.3, the Authority asserts that the subject matter of Claims 25 and 27 are not new in light D1. Applicant respectfully traverses this finding, and submits that Claims 25 and 27 are new and novel over D1 at least because D1 does not teach a processor configured to:
receive a first signal from the first speaker, the first signal induced at least in part by sound incident on the first speaker other than sound generated by the first speaker;
receive a second signal from the first speaker, the second signal induced at least in part by sound incident on the second speaker other than sound generated by the second speaker;
process at least one of the first signal and the second signal to determine at least one characteristic of sound incident on the mobile device;
select one of the first speaker and the second speaker as a signal source for incident sound based on at least one of the volume level and the frequency; and
select the other one of the first speaker and the second speaker to generate sound based on at least one of the volume level and the frequency.

as recited in Claim 25 and as similarly recited in Claim 27. Although the ISR/WO indicates that these limitations are taught by D1, D1 is completely silent as to any selection between two speakers as signal source for incident sounds based on a characteristic of sound incident on either. For at least these reasons, Claims 25 and 27 cannot be said to lack novelty over D1.

Accordingly, Applicant submits that Claims 1, 13, 25, and 27, and Claims 2-6, 8-12, 14-18, 20-24, 26, and 28 that depend therefrom are novel and possess inventive step.

Respectfully Submitted,

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