EXHIBIT 5

(12) **United States Patent**
Petit et al.

(10) Patent No.: **US 8,326,611 B2**
(45) Date of Patent: ***Dec. 4, 2012**

(54) **ACOUSTIC VOICE ACTIVITY DETECTION (AVAD) FOR ELECTRONIC SYSTEMS**

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(73) Assignee: **AliphCom, Inc.**, San Francisco, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 546 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/606,140**

(22) Filed: **Oct. 26, 2009**

(65) **Prior Publication Data**

US 2010/0128881 A1 May 27, 2010

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/805,987, filed on May 25, 2007, now abandoned, and a continuation-in-part of application No. 12/139,333, filed on Jun. 13, 2008.

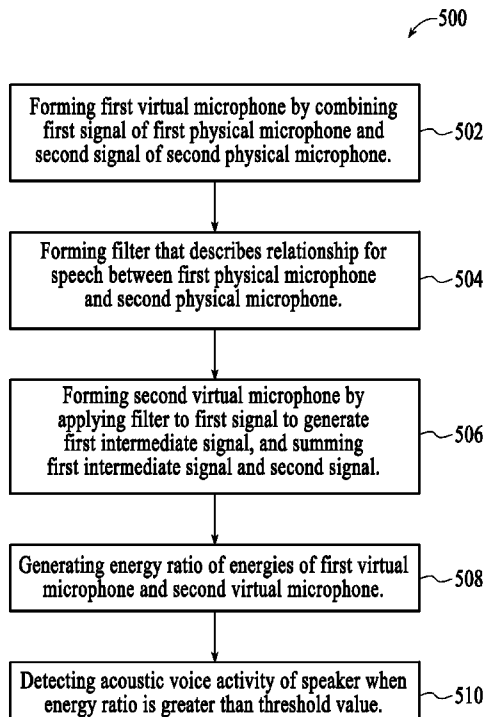(60) Provisional application No. 61/108,426, filed on Oct. 24, 2008.

(51) **Int. Cl.**
G10L 11/06 (2006.01)
(52) **U.S. Cl.** **704/208**; 704/214
(58) **Field of Classification Search** 704/208, 704/210, 214, 215; 381/99, 100, 46
See application file for complete search history.

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(57) **ABSTRACT**

Acoustic Voice Activity Detection (AVAD) methods and systems are described. The AVAD methods and systems, including corresponding algorithms or programs, use microphones to generate virtual directional microphones which have very similar noise responses and very dissimilar speech responses. The ratio of the energies of the virtual microphones is then calculated over a given window size and the ratio can then be used with a variety of methods to generate a VAD signal. The virtual microphones can be constructed using either an adaptive or a fixed filter.
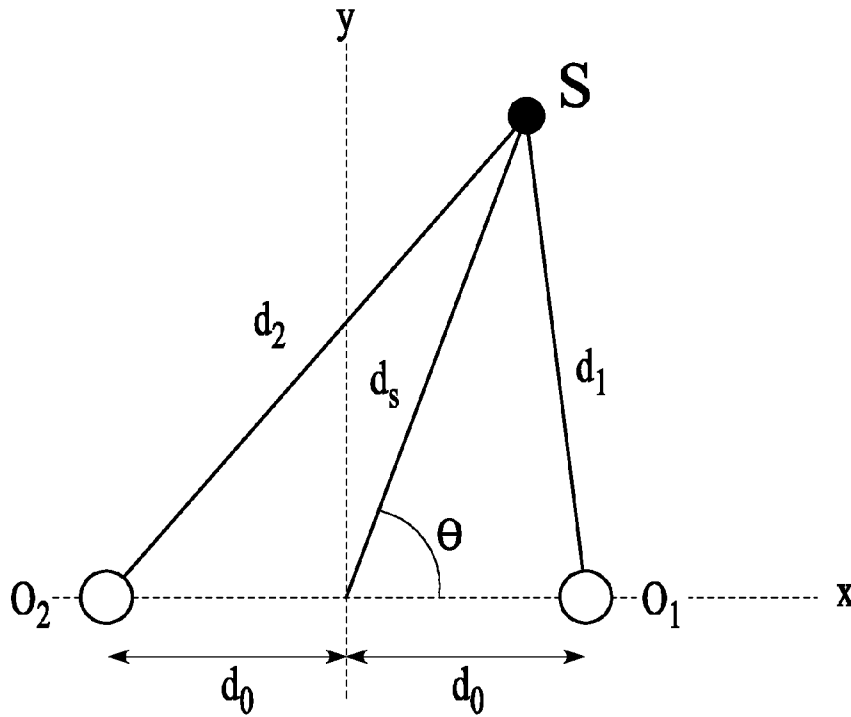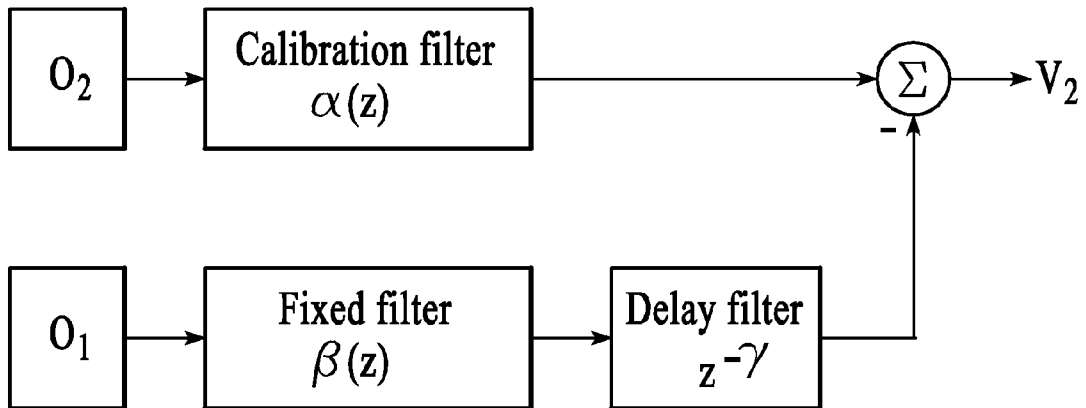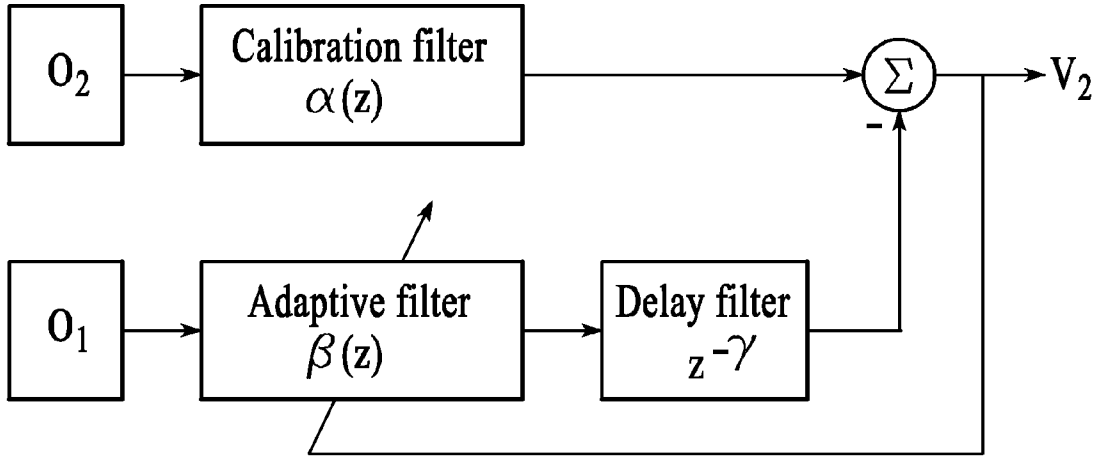
44 Claims, 35 Drawing Sheets

500

Forming first virtual microphone by combining first signal of first physical microphone and second signal of second physical microphone. — 502

Forming filter that describes relationship for speech between first physical microphone and second physical microphone. — 504

Forming second virtual microphone by applying filter to first signal to generate first intermediate signal, and summing first intermediate signal and second signal. — 506

Generating energy ratio of energies of first virtual microphone and second virtual microphone. — 508

Detecting acoustic voice activity of speaker when energy ratio is greater than threshold value. — 510

FIG.1

FIG.2

FIG.3

FIG.4

500

Forming first virtual microphone by combining first signal of first physical microphone and second signal of second physical microphone. ~502

Forming filter that describes relationship for speech between first physical microphone and second physical microphone. ~504

Forming second virtual microphone by applying filter to first signal to generate first intermediate signal, and summing first intermediate signal and second signal. ~506

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Detecting acoustic voice activity of speaker when energy ratio is greater than threshold value. ~510
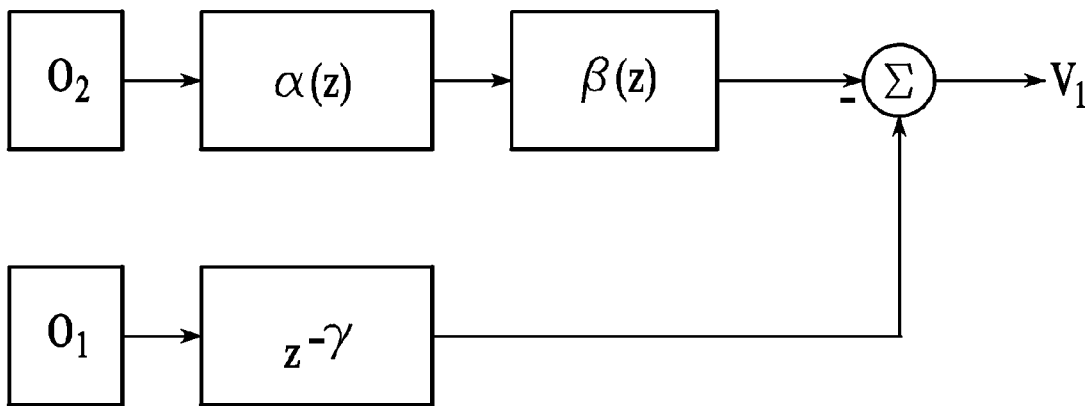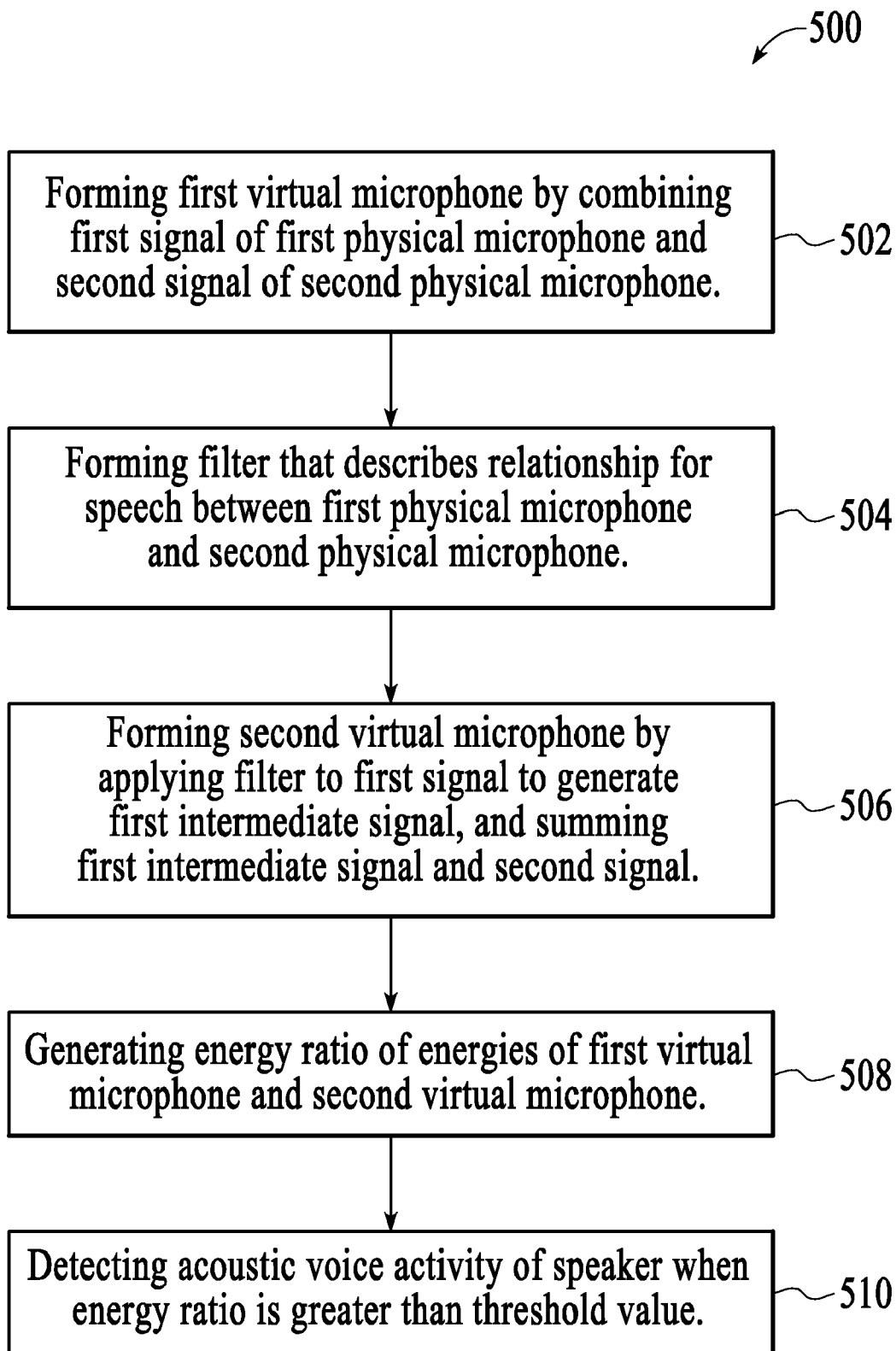
FIG. 5

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