

EXHIBIT 4



US008321213B2

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Petit et al.

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(45) **Date of Patent:** ***Nov. 27, 2012**

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 540 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/606,146**

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

(65) **Prior Publication Data**
US 2010/0128894 A1 May 27, 2010

Related U.S. Application Data
(63) Continuation-in-part of application No. 12/139,333, filed on Jun. 13, 2008, and a continuation-in-part of application No. 11/805,987, filed on May 25, 2007, now abandoned.
(60) Provisional application No. 61/108,426, filed on Oct. 24, 2008.

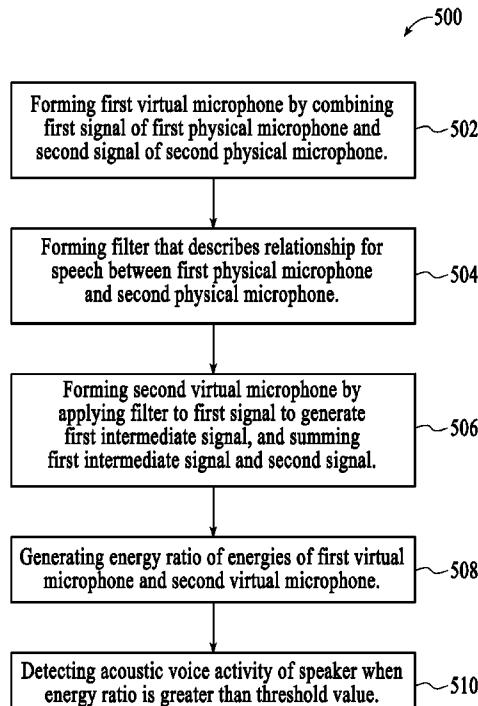
(51) **Int. Cl.**
G10L 11/06 (2006.01)
(52) **U.S. Cl.** **704/208; 704/214**
(58) **Field of Classification Search** 704/208, 704/210, 214, 215; 381/99, 100, 46
See application file for complete search history.

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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.

42 Claims, 35 Drawing Sheets



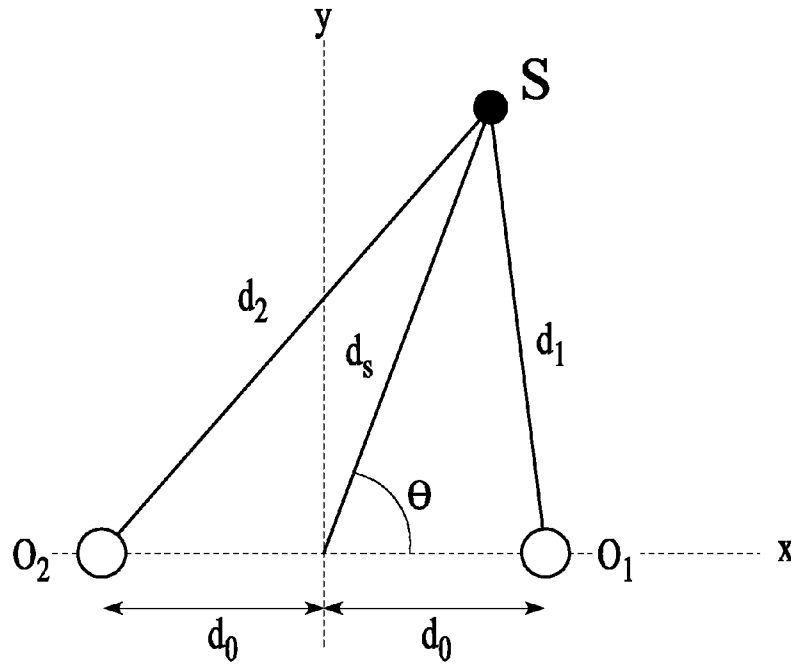


FIG.1

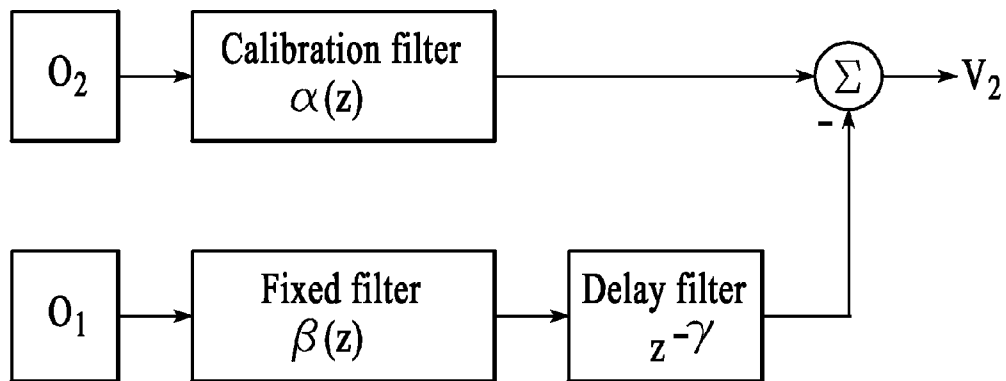


FIG.2

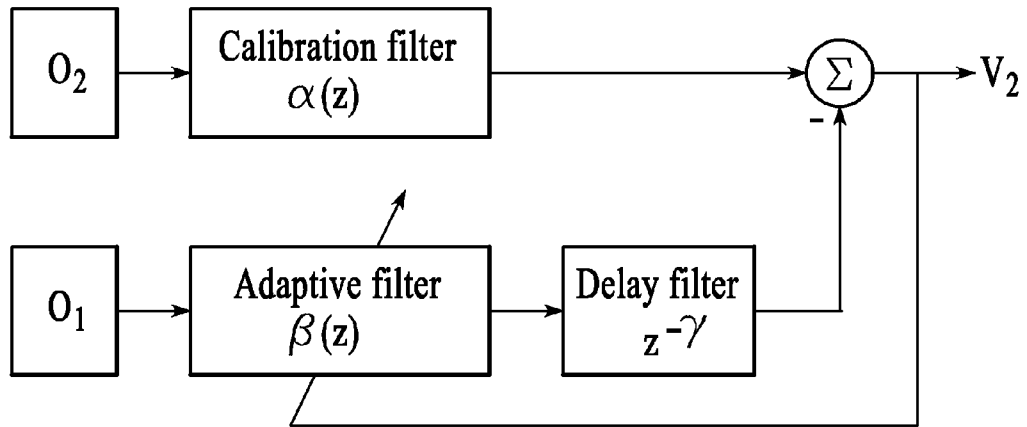


FIG.3

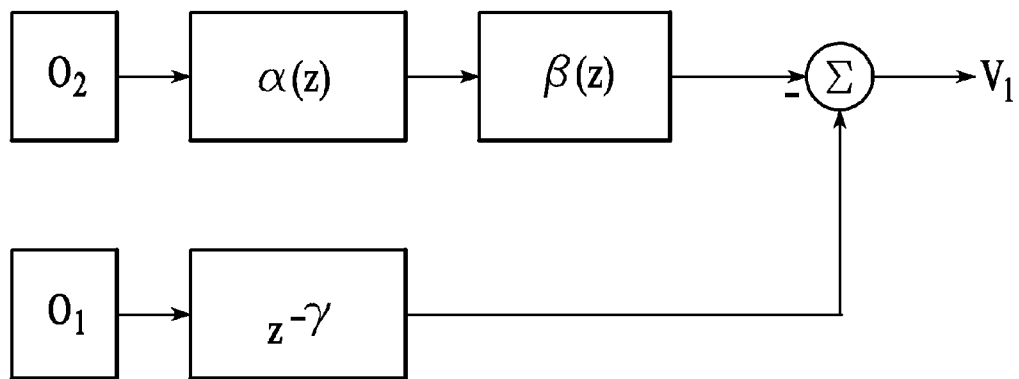


FIG.4

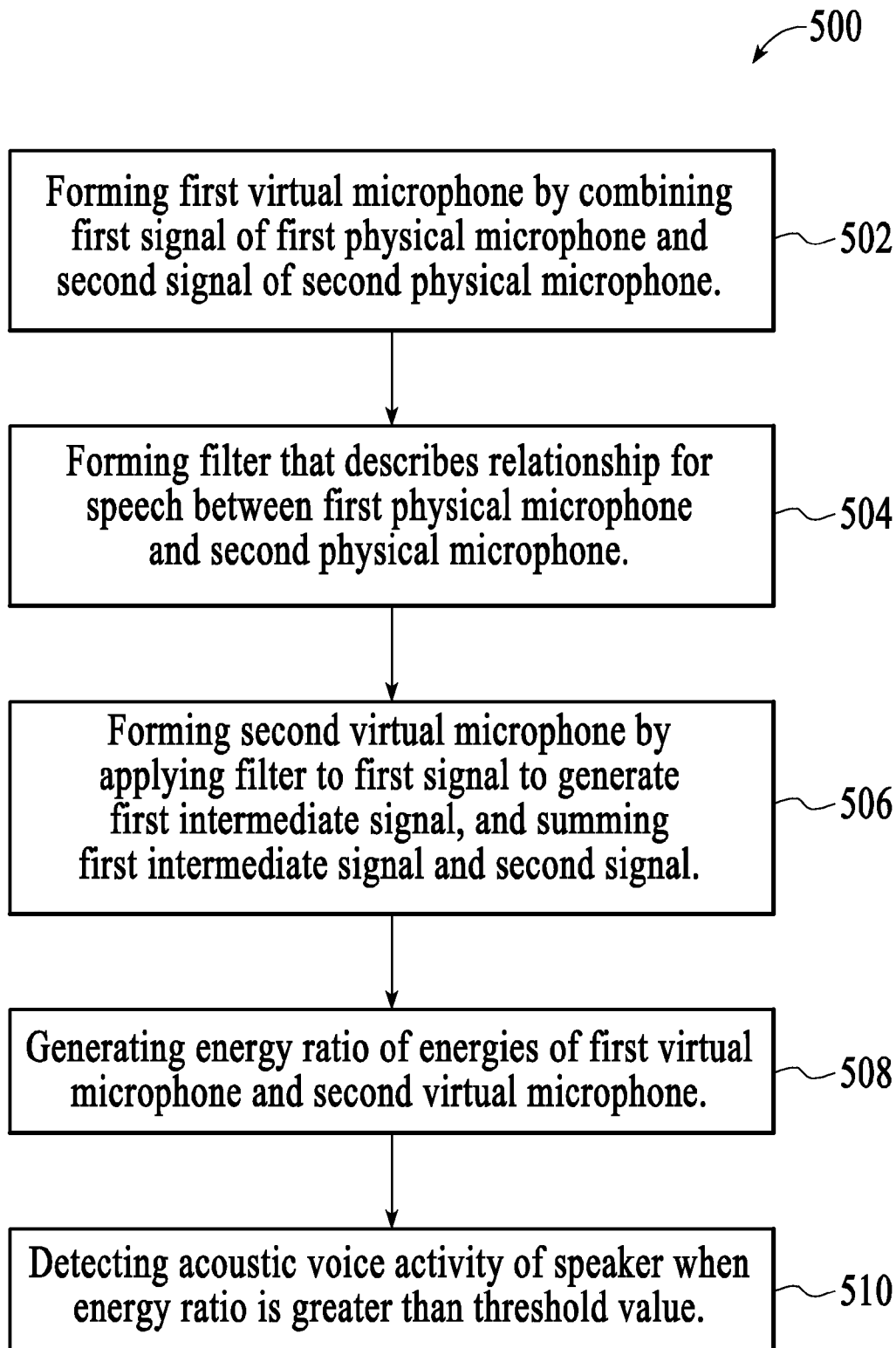


FIG.5

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