US007215802B2

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

(10) **Patent No.: US 7,215,802 B2**
(45) **Date of Patent: May 8, 2007**

(54) **SYSTEM AND METHOD FOR VASCULAR BORDER DETECTION**

(75) Inventors: **Jon D. Klingensmith**, Shaker Heights, OH (US); **Anuja Nair**, Cleveland Heights, OH (US); **Barry D. Kuban**, Avon Lake, OH (US); **D. Geoffrey Vince**, Avon Lake, OH (US)

(73) Assignee: **The Cleveland Clinic Foundation**, Cleveland, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 404 days.

(21) Appl. No.: **10/837,352**

(22) Filed: **Apr. 29, 2004**

(65) **Prior Publication Data**

US 2005/0196026 A1 Sep. 8, 2005

Related U.S. Application Data

(60) Provisional application No. 60/550,620, filed on Mar. 4, 2004.

(51) **Int. Cl.**
G06K 9/00 (2006.01)

(52) **U.S. Cl.** **382/128**; 600/483; 600/485

(58) **Field of Classification Search** 382/128–134, 382/173, 197, 199, 203, 219, 256, 298; 600/407, 600/424, 425, 437, 440, 443, 463, 466, 467–469, 600/542, 570, 324, 431, 481–484, 500, 513; 128/916; 604/532; 606/194
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,228,804 A 10/1980 Holasek

(Continued)

OTHER PUBLICATIONS

Chen, C., Lu, H., Hsiao. A., "A Dual-Snake Model of High Penetrability for Ultrasound Image Boundary Extraction", Ultrasound in Medicine and Biology, 2001, pp. 1651-1665, vol. 27, No. 12, Elsevier, New York, U.S.A.

(Continued)

Primary Examiner—Jingge Wu
Assistant Examiner—Abolfazl Tabatabai
(74) *Attorney, Agent, or Firm*—O'Melveny & Myers LLP

(57) **ABSTRACT**

A system and method is provided for using the frequency spectrum of a radio frequency (RF) signal backscattered from vascular tissue to identify at least one border (e.g., tissue interface, etc.) on a vascular image. Embodiments of the present invention operate in accordance with a data gathering device (e.g., an intra-vascular ultrasound (IVUS) device, etc.) electrically connected to a computing device and a transducer via a catheter. The transducer is used to gather radio frequency (RF) data backscattered from vascular tissue. The RF data is then provided to (or acquired by) the computing device via the data-gathering device. In one embodiment of the present invention, the computing device includes (i) at least one data storage device (e.g., database, memory, etc.) for storing a plurality of tissue types and parameters related thereto and (ii) at least one application (e.g., a characterization application, a gradient-border application, a frequency-border application and/or an active-contour application). The characterization application is used to convert (or transform) the RF data into the frequency domain and to identify a plurality of parameters associated therewith. The identified parameters are then compared to the parameters stored in the data storage device to identify the corresponding tissue type. This information (e.g., tissue type, corresponding RF data, etc.) is then used, either alone or together with other border-related information (e.g., gradient information, other-border information, etc.), to determine at least one border on a vascular image.

18 Claims, 4 Drawing Sheets