

Front pages of 4 granted US patents



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

(10) **Patent No.:** **US 10,952,622 B2**
(45) **Date of Patent:** **Mar. 23, 2021**

(54) **METHOD AND APPARATUS FOR HEMODYNAMICALLY CHARACTERIZING A NEUROLOGICAL OR FITNESS STATE BY DYNAMIC LIGHT SCATTERING (DLS)**

(58) **Field of Classification Search**
CPC A61B 5/0205; A61B 5/02108; A61B 5/02116; A61B 5/0261; A61B 5/0285; A61B 5/165; A61B 5/7253
(Continued)

(71) Applicant: **ELFI-TECH LTD.**, Rehovot (IL)

(56) **References Cited**

(72) Inventors: **Ilya Fine**, Rehovot (IL); **Alexander Kaminsky, II** (IL)

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(73) Assignee: **ELFI-TECH LTD.**, Rehovot (IL)

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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 40 days.

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(21) Appl. No.: **15/770,590**

WO 2015022583 A2 2/2015

(22) PCT Filed: **Aug. 15, 2016**

(86) PCT No.: **PCT/IB2016/001240**

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§ 371 (c)(1),

(2) Date: **Apr. 24, 2018**

Geyer M. J. et al. "Using wavelet analysis to characterize the thermoregulatory mechanisms of sacral skin blood flow" (2004) Journal of rehabilitation research and development, vol. 41, No. 6A, pp. 797-805, Dec. 2014 (Dec. 31, 2004). Dec. 31, 2004 (Dec. 31, 2004).

(87) PCT Pub. No.: **WO2017/072568**

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(Continued)

(65) **Prior Publication Data**

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Primary Examiner — Christopher A Flory

(74) *Attorney, Agent, or Firm* — Marc Van Dyke; Momentum IP Group

Related U.S. Application Data

(60) Provisional application No. 62/295,138, filed on Feb. 14, 2016, provisional application No. 62/249,303, filed on Nov. 1, 2015.

(57) **ABSTRACT**

A method and apparatus for hemodynamically characterizing a neurological or fitness state by dynamic scattering light (DLS) is disclosed herein. In particular, a non-pulsatile blood-shear-rate-descriptive (BSRD) signal(s) is optically generated and analyzed. In some embodiments, the BSRD signal is generated dynamically so as to adaptively maximize (i.e. according to a bandpass or frequency-selection profile) a prominence of a predetermined non-pulsatile physiological signal within the BSRD. In some embodiments, the BSRD is subjected to a stochastic or stationary-

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(51) **Int. Cl.**

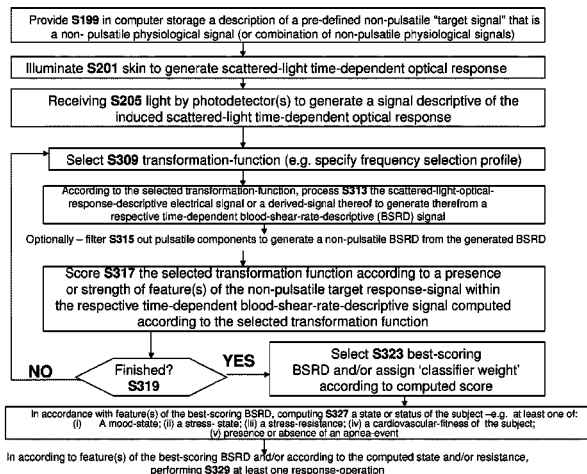
A61B 5/0205 (2006.01)

A61B 5/026 (2006.01)

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(52) **U.S. Cl.**

CPC **A61B 5/0205** (2013.01); **A61B 5/0261** (2013.01); **A61B 5/0285** (2013.01); **A61B 5/165** (2013.01); **A61B 5/7253** (2013.01)



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

(10) **Patent No.:** **US 10,720,755 B2**
(45) **Date of Patent:** **Jul. 21, 2020**

(54) **ENSEMBLE-AVERAGED MEASUREMENT OF STOCHASTIC MOTION BY CURRENT-MODULATING OF VCSEL WAVELENGTH**

(71) Applicants: **Ilya Fine, Rehovot (IL); Alexander Kaminsky, Tbilisi (GE)**

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(73) Assignee: **ELFI-TECH LTD., Rehovot (IL)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/890,388**

(22) Filed: **Feb. 7, 2018**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
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G01N 15/14 (2006.01)
G01N 33/86 (2006.01)

(52) **U.S. Cl.**
CPC **H01S 5/183** (2013.01); **G01N 15/1434** (2013.01); **G01N 33/86** (2013.01); **G01N 2015/1445** (2013.01)

(58) **Field of Classification Search**
CPC H01S 5/183; G01N 33/86; G01N 15/1434; G01N 2015/1445
See application file for complete search history.

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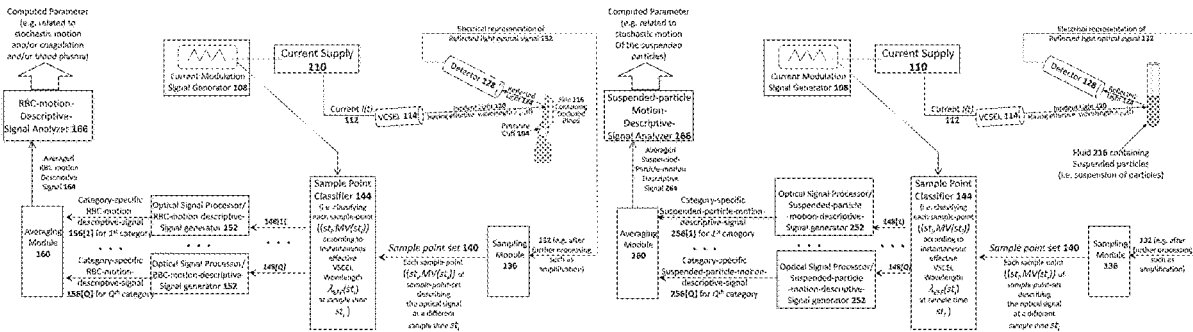
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Primary Examiner — Mohamed K Amara
(74) Attorney, Agent, or Firm — Marc Van Dyke; Momentum IP Group

(57) **ABSTRACT**

Embodiments of the invention relate to a method and apparatus for measuring at least one parameter that is (i) descriptive of stochastic motion of suspended particles within a fluid; and/or (ii) is a rheological property of the fluid or of the suspension; (iii) describes a concentration of suspended particles within the fluid; and/or (iv) is a diffusion coefficient of the suspended particles and/or (v) is a viscosity of the fluid or of the suspension; and/or (vi) is a food aging or spoilage parameter and/or (vii) is an in-vivo or in-vitro blood coagulation parameter.

5 Claims, 24 Drawing Sheets





US008708907B2

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

(10) **Patent No.:** **US 8,708,907 B2**
(45) **Date of Patent:** **Apr. 29, 2014**

(54) **METHOD AND APPARATUS FOR DETERMINING ONE OR MORE BLOOD PARAMETERS FROM ANALOG ELECTRICAL SIGNALS**

(75) Inventors: **Ilya Fine**, Rehovot (IL); **Alexander Kaminsky**, Rehovot (IL)

(73) Assignee: **Elfi-Tech**, Rehovot (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 416 days.

(21) Appl. No.: **12/774,056**

(22) Filed: **May 5, 2010**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/175,981, filed on May 6, 2009.

(51) **Int. Cl.**

- A61B 5/02** (2006.01)
- A61B 5/14551** (2006.01)
- A61B 5/145** (2006.01)
- A61B 8/06** (2006.01)
- A61B 8/12** (2006.01)
- A61B 5/026** (2006.01)

(52) **U.S. Cl.**

USPC **600/369**; 600/301; 600/323; 600/324; 600/336; 600/364; 600/368; 600/465; 600/467; 600/468; 600/504

(58) **Field of Classification Search**

CPC **A61B 5/026**; **A61B 5/0261**; **A61B 5/1455**
USPC **600/368**, **369**, **301**, **323**, **324**, **336**, **364**, **600/465**, **467**, **468**, **504**

See application file for complete search history.

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Primary Examiner — Jacqueline Cheng

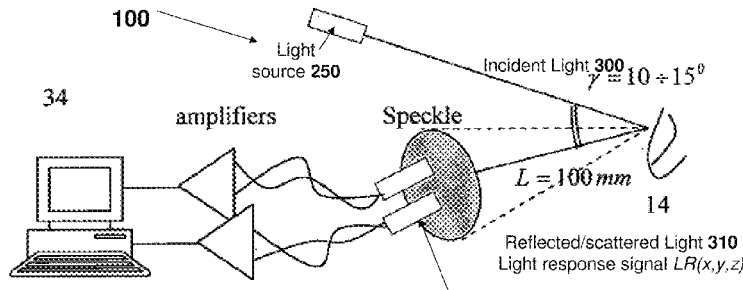
Assistant Examiner — Puya Agahi

(74) *Attorney, Agent, or Firm* — Marc Van Dyke

(57) **ABSTRACT**

Embodiments of the present invention relate to a system and method for in vivo measurement of blood parameters by processing analog electrical signals from a plurality of photodetectors. In some embodiments, it is possible to determine one or more blood parameters according to (i) a first electrical signal from a first detector and (ii) a second electrical signal from a second photodetector. A difference analog electrical signal is generated, indicative of a difference between the light response signal at the first location and light response signal at the second location, is generated. One or more blood parameters may be detected according to the difference analog electrical signal.

12 Claims, 14 Drawing Sheets



Photodetector(s) 260 for detecting light field $LF(x_0, y_0, z_0, t)$ at a location (x_0, y_0, z_0) including light response signal

$$LF(x_0, y_0, z_0, t) = LF_{\text{SLOWLY_FLUCTUATING}}(x_0, y_0, z_0, t) + LF_{\text{RAPIDLY_FLUCTUATING}}(x_0, y_0, z_0, t) + LF_{\text{SLOWLY_FLUCTUATING}}(x_0, y_0, z_0, t) + [LF_{\text{REGULAR}}((x_0, y_0, z_0, t) + LF_{\text{STOCHASTIC}}(x_0, y_0, z_0, t))]$$



US008277384B2

(12) **United States Patent**
Fine

(10) **Patent No.:** **US 8,277,384 B2**

(45) **Date of Patent:** **Oct. 2, 2012**

(54) **SYSTEM AND METHOD FOR IN VIVO MEASUREMENT OF BIOLOGICAL PARAMETERS**

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(75) Inventor: **Ilya Fine**, Rehovot (IL)

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(73) Assignee: **Ilya Fine**, Rehovot (IL)

International Search Report and Written Opinion, mailed Jun. 4, 2008, from International Application No. PCT/IL20071001317, filed Oct. 30, 2007.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 626 days.

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(21) Appl. No.: **12/431,469**

(22) Filed: **Apr. 28, 2009**

Primary Examiner — Eric Winakur

(65) **Prior Publication Data**

US 2009/0209834 A1 Aug. 20, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/IL2007/001317, filed on Oct. 30, 2007.

(60) Provisional application No. 60/855,143, filed on Oct. 30, 2006.

(51) **Int. Cl.**
A61B 5/02 (2006.01)

(52) **U.S. Cl.** **600/485; 600/502; 600/504; 600/481**

(58) **Field of Classification Search** **600/310, 600/322, 323, 324, 502, 481, 485, 504**
See application file for complete search history.

(57) **ABSTRACT**

A system, method and medical tool are presented for use in non-invasive in vivo determination of at least one desired parameter or condition of a subject having a scattering medium in a target region. The measurement system comprises an illuminating system, a detection system, and a control system. The illumination system comprises at least one light source configured for generating partially or entirely coherent light to be applied to the target region to cause a light response signal from the illuminated region. The detection system comprises at least one light detection unit configured for detecting time-dependent fluctuations of the intensity of the light response and generating data indicative of a dynamic light scattering (DLS) measurement. The control system is configured and operable to receive and analyze the data indicative of the DLS measurement to determine the at least one desired parameter or condition, and generate output data indicative thereof.

(56) **References Cited**

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23 Claims, 11 Drawing Sheets

