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(71) Applicant: **CERAGOS Electronics & Nature**
06800 Cagnes-sur-Mer (FR)

(72) Inventor: **Cerasani, Luca**
06800 CAGNES-SUR-MER (FR)

Remarks:
Amended claims in accordance with Rule 137(2) EPC.

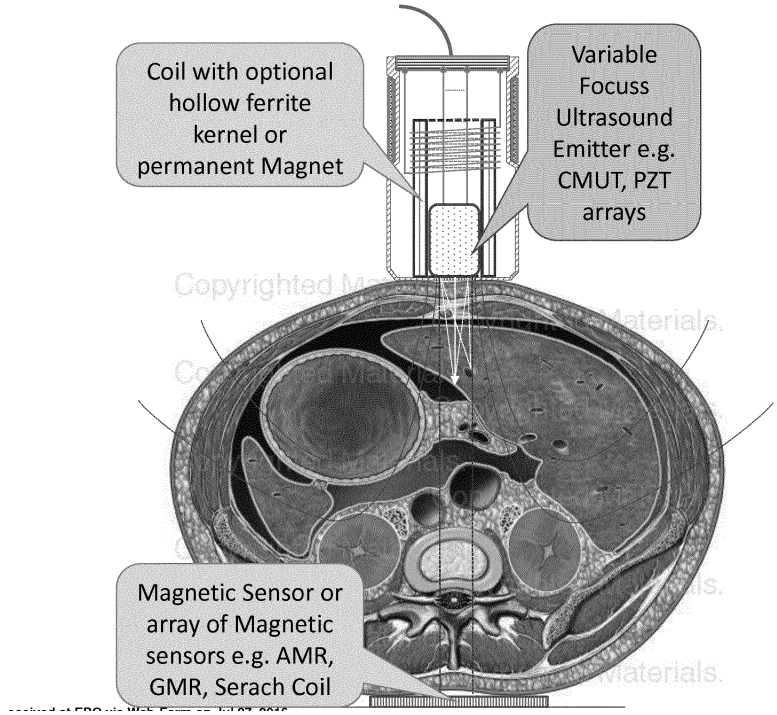
(54) REFRACTIVE ULTRASOUND SCANNER

(57) Today, Ultrasounds Medical imaging is based on analysis of reflected Ultrasound waves across tissues. This methodology in spite of being largely implemented and offering several advantages such as non-invasiveness and safety presents a few drawbacks such as limited useful depth of analysis and image quality is deteriorated by artifacts linked to multiple reflections.

The new methodology will use refracted (penetrating) ultrasound waves. The volume to be analyzed is subjected to a strong but harmless Magnetic Field and then it is scanned by Focused Ultrasound waves. Magnetic Field generated by vibrating micro-volumes of tissues are detected by magnetic sensors like search coils or Anisotropic Magneto-Resistor (AMR).

The useful depth of analysis is significantly increased and refracted Ultrasound waves will "follow" paths with lower reflection coefficient e.g. blood vessels providing a complementary analysis to present systems. Image quality will not suffer of most reflection waves artifacts.

Figure 1: Refracted (Transmited/Penetrating) Ultrasound Scanner



EP 3 275 366 A1

Description

Introduction :

[0001] Today, Ultrasounds Medical imaging is based on analysis of reflected Ultrasound waves across tissues. This methodology in spite of being largely implemented and offering several advantages such as non-invasiveness and safety presents the following drawbacks:

- Duplicated path to/from target tissue (incident and reflected Ultrasound waves)
- Inherent artifacts due to multiple waves reflections
- Use of Transducer with high Intensity dynamic range is required because the Transducer is also used for reception of Ultrasound waves

[0002] Four D systems (3D plus Time) have been developed as well as color imaging.

Description :

[0003] The system can be split into 4 main parts (Also see here joined Figure 1):

- A permanent Magnet or a Coil to slightly magnetize the tissues to be analyzed. Magnetic field generated can be either constant or variable according to time or according to position
- An Ultrasound Emitter generating Ultrasounds with variable intensity and frequency (typically less or equal to 1 MHz). The Ultrasound Emitter should be able to either focus the beam at any micro volume of the tissue to be analyzed or is made of an array of independent micro emitting devices such as CMUT (Capacitive Micro-machined Ultrasound Transducers)
- A magnetic sensor such as a search Coil or a Anisotropic Magneto-Resistor (AMR) is used to detect the variation of the magnetic field in the tissue micro volume when the Ultrasound beam is focused on it. The sensor can be replaced by an array of micro magnetic sensors to allow the detection of the position of the Ultrasound beam (on the plane perpendicular to the beam direction) especially when beam is not focused and Ultrasound waves are guided by tissues or liquids with lowest absorption coefficient such as Ultrasounds waves in blood inside vessels
- An Electronic circuit used to control all elements and provide a visual output

Notes:

[0004]

- As attenuation of Ultrasound waves is proportional to the logarithm of the frequency it is possible to evaluate the attenuation of the refracted waves at any time by slightly modifying the Emitter frequency considering that the amplitude of detected signal is proportional to the frequency and to the exponential of the attenuation coefficient which is also dependent of the frequency (starting from first tissue micro layer and one micro layer by one micro layer)
- If the speed of Ultrasound waves when crossing various tissues cannot be considered as constant the temporal position of the wave (in the wave direction) cannot be evaluated by registration of the phase variation of sensed magnetic field variations due to vibration of contiguous micro-tissue volumes because it is independent of the speed of Ultrasounds. The focus point distance (also independent of speed of Ultrasounds) can be used as an evaluation of the depth of the analyzed micro-volume of tissue or a sensors array aligned with the Ultrasound wave direction could alternatively be implemented.

Claims

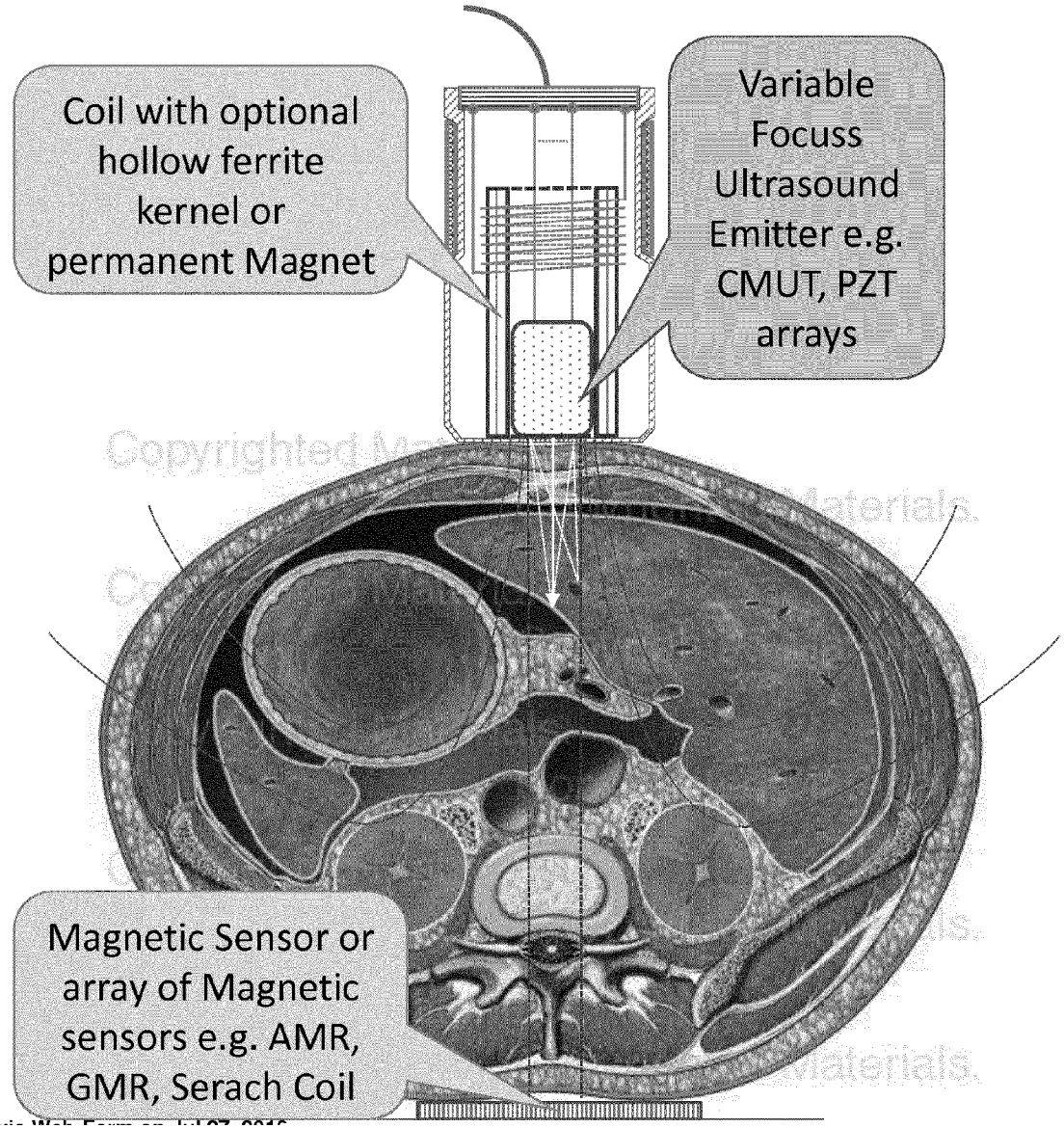
1. A new method to analyze and visualize internal tissues by using refracted waves instead of echoed/reflected waves.
Refracted Ultrasound waves can be monitored using Magnetic sensors provided tissues to be analyzed are slightly magnetized using a permanent magnet or a coil with a ferrite kernel.
Compared to current technology it offers the following advantages:

- One way Ultrasound waves providing an increased depth of tissue analysis
- Significant decrease of artifacts linked to Reflected waves is expected because only transmitted waves are monitored and direction of Ultrasound waves are better set as perpendicular to the tissues surface
- Ultrasound waves will "follow" tissues with lower reflection coefficient like Blood in vessels providing a complementary analysis to present systems
- Less complex Ultrasound transducer circuitry can be envisaged

Amended claims in accordance with Rule 137(2) EPC.

1. A new method to analyze and visualize internal tissues by using refracted Ultrasound waves instead of echoed/reflected waves.
Electromagnetic detection is typically used but not exclusively and Microwave detection is not needed.
This methodology is non-invasive and does not require the analyzed tissues to be charged.

Figure 1: Refracted (Transmited/Penetrating) Ultrasound Scanner



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EUROPEAN SEARCH REPORT

Application Number
EP 16 02 0280

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 952 763 A1 (JAPAN SCIENCE & TECH AGENCY [JP]) 6 August 2008 (2008-08-06) * abstract * * paragraphs [0042], [0048] * * figure 5 *	1	INV. A61B5/05 G01R33/02 ADD. A61B8/15
X	WO 2006/122203 A1 (UNIV HOUSTON SYSTEM [US]; BRAZDEIKIS AUDRIUS [US]; WOSIK JAROSLAW LECH) 16 November 2006 (2006-11-16) * paragraphs [0062], [0063] * * figure 9 *	1	
X	US 2009/281422 A1 (SALAMA KHALED N [US] ET AL) 12 November 2009 (2009-11-12) * claim 9 * * figures 1,4 *	1	
X	US 2011/054345 A1 (NAGATANI YUKINORI [JP]) 3 March 2011 (2011-03-03) * abstract *	1	

TECHNICAL FIELDS SEARCHED (IPC)

A61B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 December 2016	Willig, Hendrik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 02 0280

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15-12-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1952763 A1	06-08-2008	EP 1952763 A1	06-08-2008
		EP 2630912 A2	28-08-2013
		EP 2668899 A2	04-12-2013
		EP 2724669 A1	30-04-2014
		JP 4919967 B2	18-04-2012
		JP 5460668 B2	02-04-2014
		JP 5460669 B2	02-04-2014
		JP 2012047750 A	08-03-2012
		JP 2012047751 A	08-03-2012
		US 2009221900 A1	03-09-2009
		US 2012220853 A1	30-08-2012
		WO 2007055057 A1	18-05-2007
WO 2006122203 A1	16-11-2006	US 2009322323 A1	31-12-2009
		WO 2006122203 A1	16-11-2006
US 2009281422 A1	12-11-2009	NONE	
US 2011054345 A1	03-03-2011	US 2011054345 A1	03-03-2011
		US 2015182417 A1	02-07-2015
		WO 2009122485 A1	08-10-2009

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

专利名称(译)	屈光超声扫描仪		
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发明人	CERASANI, LUCA		
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外部链接	Espacenet		

摘要(译)

今天，Ultrasounds Medical成像基于对组织中反射的超声波的分析。该方法虽然在很大程度上被实施并且提供诸如非侵入性和安全性之类的若干优点，但是存在一些缺点，例如有限的分析有用深度，并且图像质量因与多次反射相关联的伪像而恶化。新方法将使用折射（穿透）超声波。待分析的体积经受强而无害的磁场，然后通过聚焦超声波扫描。通过诸如搜索线圈或各向异性磁电阻器（AMR）的磁传感器检测由振动的微量组织产生的磁场。有用的分析深度显着增加和折射超声波将"跟随"具有较低反射系数的路径，例如，血管为现有系统提供补充分析。图像质量不会受到大多数反射波伪影的影响。

Figure 1: Refracted (Transmited/Penetrating) Ultrasound Scanner