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Datasheet for the decision of 19 October 2011

Case Number: T 1689/08 - 3.2.02

Application Number: 03776327.3

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IPC: A61B 8/00, G01S 7/521

Language of the proceedings: EN

Title of invention:
High frequency high frame-rate ultrasound imaging system

Applicant:
Visualsonics Inc.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56, 123(2)

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step (main request, auxiliary requests 1 and 2: no; auxiliary request 3a: yes)"
"Added subject-matter (auxiliary request 3: yes; auxiliary request 3a: no)"

Decisions cited:
-

Catchword:
-

Case Number: T 1689/08 - 3.2.02

D E C I S I O N
of the Technical Board of Appeal 3.2.02
of 19 October 2011

Appellant: (Applicant)	Visualsonics Inc. 3080 Yonge St. Suite 6020 Box 89 Toronto M4N 3N1 (CA)
Representative:	von Kreisler Selting Werner Deichmannhaus am Dom Bahnhofsvorplatz 1 D-50667 Köln (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted 1 February 2008 refusing European patent application No. 03776327.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman:	M. Noël
Members:	M. Stern
	M. J. Vogel

Summary of Facts and Submissions

I. The applicant lodged an appeal, received on 2 April 2008, against the decision of the Examining Division dispatched on 1 February 2008, to refuse the application No. 03 776 327.3 for lack of inventive step vis à vis the teaching of document D3 (see point VI) having regard to the common general knowledge of a person skilled in the art. The fee for appeal was paid on 2 April 2008.

II. With the statement setting out the grounds of appeal, received on 11 June 2008, the appellant filed a main request and amended sets of claims according to auxiliary requests 1 and 2.

III. The Board forwarded its provisional opinion to the appellant by communication dated 9 June 2011.

IV. In preparation for the oral proceedings, the appellant filed amended sets of claims as auxiliary requests 1a, 2a, 3, and 4 by letter dated 17 October 2011.

V. Oral proceedings took place on 19 October 2011.

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request filed with the letter of 11 June 2008, or of renumbered auxiliary requests 1 or 2 filed as auxiliary requests 1a or 2a, respectively, with the letter of 17 October 2011, or of the auxiliary request 3 filed with the letter of 17 October 2011, or of the auxiliary request 3a filed during the oral proceedings, or of the auxiliary request 4 filed with the letter of 17 October 2011.

VI. The following documents are of importance for the present decision:

D3: M. Berson et al.: "High frequency (20 MHz) ultrasonic devices: advantages and applications"; European Journal of Ultrasound, Vol. 10, pages 53-63; 1999

D8: M. Berson et al: "High-resolution real-time ultrasonic scanner", Ultrasound in Med. & Biol., Vol. 18, No. 5, pages 471-478, 1992.

VII. Claim 1 of the main request reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
means for oscillating the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;

means for determining the spatial position of the transducer (8) along the reciprocating convex arcuate path; and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound image to have a spatial resolution of equal to or less than 100 microns (µm)."

VIII. Claim 1 of the auxiliary request 1 reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
a torque motor configured to oscillate the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;
a position encoder configured to determine the spatial position of the transducer (8) along the reciprocating convex arcuate path; and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the

transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound image to have a spatial resolution of equal to or less than 100 microns (μm)."

IX. Claim 1 of the auxiliary request 2 reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
a limited angle torque motor configured to oscillate the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;
a position encoder configured to determine the spatial position of the transducer (8) along the reciprocating convex arcuate path; and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound

image to have a spatial resolution of equal to or less than 100 microns (μm)."

X. Claim 1 of the auxiliary request 3 reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
a torque motor configured to oscillate the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;
a position encoder (128) configured to determine the spatial position of the transducer (8) along the reciprocating convex arcuate path with an accuracy of at least 1 micron (μm); and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound image to have a spatial resolution of equal to or less than 100 microns (μm)."

XI. Claim 1 of the auxiliary request 3a reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
a torque motor configured to oscillate the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;
a position encoder (128) configured to determine the spatial position of the transducer (8) along the reciprocating convex arcuate path with an accuracy of 1 micron (μm); and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound image to have a spatial resolution of equal to or less than 100 microns (μm)."

Claims 2 to 15 of the auxiliary request 3a are dependent claims.

XII. Claim 1 of the auxiliary request 4 reads as follows:

"A system (100) for developing an ultrasound image, comprising:
a scan head having a transducer (8) capable of generating ultrasound energy at a frequency of at least 20 megahertz (MHz), wherein said transducer (8) is encapsulated within an enclosed volume that is partially defined by an acoustic window (125) positionable between the transducer and a subject (108);
a torque motor configured to oscillate the transducer within the enclosed volume along a reciprocating convex arcuate path at a frequency of at least 7.5 Hz, wherein the transducer is configured to transmit ultrasound energy through the acoustic window into the subject and receive ultrasound echoes from the subject through the acoustic window;
an optical position encoder configured to determine the spatial position of the transducer (8) along the reciprocating convex arcuate path with an accuracy of at least 1 micron (μm) and to position the transducer (8) with an accuracy of 1 micron (μm); and
a processor (134) for processing the ultrasound echoes received through the acoustic window while the transducer is oscillated at a rate of at least 7.5 Hz to generate an ultrasound image at a frame rate of at least 15 frames per second (fps) and wherein the processor is configured to generate the ultrasound image to have a spatial resolution of equal to or less than 100 microns (μm)."

XIII. The appellant's arguments are summarised as follows:

The device disclosed in Figure 1b of D3 did not implicitly require means for determining the spatial position of the transducer in order to generate an ultrasound image from the echo signals. D3 did not disclose either a processor configured to generate an image with a spatial resolution of equal to or less than 100 microns as defined in claim 1, since the spatial resolution of an ultrasound image consisted of axial and lateral resolutions, and in D3 the lateral resolution was of 250 microns. Hence, the subject-matter of claim 1 of the main and auxiliary requests 1 and 2 was not rendered obvious from the disclosure of D3. At the oral proceedings, no comment was presented in relation to document D8 referred to in the Board's communication.

An accuracy of at least 1 micron with which the spatial position of the transducer was to be determined, as defined in claim 1 of the auxiliary request 3, was supported in original claims 21 and 28, on page 22, lines 5 to 8, and on page 16, lines 1 to 9.

A position encoder as defined in claim 1 of the auxiliary request 3a, allowing a determination of the spatial position of the transducer with an accuracy of 1 micron, improved the spatial resolution of the ultrasound image obtained in D3. In particular, the lateral resolution was influenced by the accuracy of the encoder. None of the documents on file disclosed or suggested the presently claimed system, comprising a high frequency ultrasound real-time sector scanner provided with a position encoder having a high degree of accuracy.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Document D3 represents the closest prior art. The ultrasound sector scanning device of Figure 1b relates to an ultrasound system comprising a scan head having a transducer for generating ultrasound energy at a frequency of 20 MHz (cf page 55, first paragraph), means for oscillating the transducer within an enclosed volume along a reciprocating convex arcuate path (see Fig. 1b; page 55, right column, second bullet), and a processor for processing the ultrasound echoes and generating an ultrasound image having an axial resolution of about 80 microns (cf first sentence of the "Conclusions" on page 62; first sentence on page 60). This axial resolution of about 80 microns anticipates the feature in claim 1 of an image having "a spatial resolution of (...) less than 100 microns".

2.2 Contrary to the allegation by the appellant, a sector scanning device as that represented in Figure 1b of D3 implicitly comprises means for determining the spatial position of the transducer along the reciprocating convex arcuate path. The B-mode image of Figure 1b is obtained by oscillating a transducer element around an axis of rotation (see page 55, left column, second paragraph). In order to construct the B-mode image from the individual lines emitted by the transducer element along the arcuate path, the position of the transducer along this path, notably its angular position (and thus its spatial position), necessarily needs to be known and thus needs to be determined. These technical requirements are even acknowledged as prior art in the introductory part of the description of the present application (see page 2, lines 8 to 12 and 27 to 31).

2.3 The appellant's argument that the claimed spatial resolution is new over the teaching of D3 is not convincing. Firstly, claim 1 does not specify which component of the spatial resolution is involved. Moreover, the entire application is silent as to any indication concerning whether the disclosed spatial resolution refers to the "axial" or the "lateral" resolution.

Furthermore, as acknowledged by the appellant in its statement of the grounds of appeal, the axial resolution (which is part of the spatial resolution) is directly connected to the ultrasound frequency. Thus, since an ultrasound frequency of 20 MHz is also used in D3, the same spatial resolution as the one claimed is also obtained in D3. In fact, an axial resolution of approximately 80 microns is disclosed in D3 (cf page 60, first three lines; page 57, last two lines; page 62, lines 4 to 5), which corresponds to an axial resolution falling within the claimed range of less than 100 microns.

2.4 The device of claim 1 differs from the sector scanner described in D3 in that the ultrasound image frame rate is specified to be at least 15 frames per second, and that the transducer is oscillated at a rate of at least 7.5 Hz.

The objective problem to be solved by these differentiating features is finding an optimal image frame rate allowing real-time imaging.

2.5 Document D3 refers (on page 54, left column, lines 23 to 27) to document D8, a previous publication by some of the authors of D3, in which an image frame rate of 15 frames per second has been reported for a sector scanner used for the same purpose as the one in the application in suit, namely allowing real-time imaging (cf page 472, second paragraph and page 474, second paragraph). Document D8 in fact refers to a similar high frequency ultrasound sector scanner having an oscillating transducer (see Figure 2; last full paragraph of page 472 to first paragraph of page 473), providing a frame rate of 15 frames per second.

Hence, it appears obvious for a skilled person to provide the sector scanner described in D3 with a processor producing images at a frame rate of 15 frames per second as reported in the previous publication D8.

2.6 Moreover, it is usual and obvious for the skilled person to use, during each oscillation of the transducer, each of the two consecutive sweeps in opposite directions for the production of a respective image or frame. This technical procedure is well known in the field, as mentioned in the introductory part of the description of the present application, on page 2, lines 12 to 13. Thus, for an image frame rate of

15 frames per second, a transducer oscillation frequency of 7.5 Hz is required.

2.7 Consequently, starting from D3 and having regard to the teaching of D8, the skilled person would readily arrive at the subject-matter of claim 1 of the main request without the exercise of an inventive step in the sense of Article 56 EPC.

3. *Auxiliary requests 1 and 2*

Claim 1 of the auxiliary request 1 limits the subject-matter of claim 1 of the main request by specifying that the means for oscillating the transducer is a torque motor and that the means for determining the spatial position of the transducer is a position encoder. Claim 1 of the auxiliary request 2 further specifies that the torque motor is a limited angle torque motor.

Document D3 is silent as to the specific means which are used to oscillate the transducer illustrated in Figure 1b. However, the provision of a torque motor as a suitable means for limiting the angle of oscillation of the transducer represents no more than a straight-forward technical measure which the skilled engineer would readily contemplate. Torque motors have been known for decades as convenient direct drives which have short axial dimensions and eliminate the need for gears or other mechanical transmission elements, whereby their utilisation for oscillating the transducer of Figure 1b of D3 is immediately regarded as appropriate. Since in D3, the oscillation is performed over a limited angle along a convex arcuate path (as shown in Figure 1b; cf page 55, right column, second bullet), a torque motor having a limited angle appears to the skilled person as an obvious solution on the basis of his common general knowledge.

A position encoder for determining the spatial (notably, the angular) position of the transducer is implicitly disclosed in the device of Figure 1b of D3, as mentioned under point 2.2 above.

The appellant did not present any counterarguments regarding the above findings.

As a consequence, the subject-matter of claim 1 of auxiliary requests 1 and 2 does not involve an inventive step within the meaning of Article 56 EPC.

4. *Auxiliary request 3*

Claim 1 of the auxiliary request 3 further specifies that the position encoder configured to determine the spatial position of the transducer along the reciprocating convex arcuate path has "an accuracy of at least 1 micron", which means that the spatial position of the transducer is determined with an accuracy of 1 micron *or higher*.

Whilst the application as originally filed discloses said accuracy to be (just) 1 micron (see, for example, page 22, lines 5 to 7, or page 16, lines 1 to 2), a higher accuracy has not been disclosed. In particular, the example given on page 16, lines 1 to 2 refers to an embodiment with an optical position encoder capable of (just) 1 micron resolution.

What indeed may be higher than the accuracy with which the spatial position of the transducer is *detected* is the accuracy with which the transducer is *positioned*, as indicated on page 22, lines 7 to 8, or in original claims 21 and 28. The reason for this becomes apparent from the construction depicted in Figure 6 and explained on page 16, lines 1 to 9, in which the position encoder 128 *detects* the proximal end 150 of pivot tube 6 with an accuracy of (just) 1 micron, but depending on the relative lengths of the two opposite arms forming the tube 6 pivoted at point 154, the distal end 152 of the tube carrying the transducer 8 may be *positioned* with an accuracy which could be even higher, i.e. "within 1 micron".

Since an accuracy higher than 1 micron for determining the spatial position of the transducer has not been disclosed as such in the application as originally filed, the added feature of "an accuracy of **at least** 1 micron" leads to the subject-matter of claim 1 of the third auxiliary request extending beyond the content of the application as filed, contrary to the requirement of Article 123(2) EPC.

5. *Auxiliary request 3a*

5.1 Amendments

Claim 1 of the auxiliary request 3a remedies the aforementioned deficiency under Article 123(2) EPC by eliminating the objected expression "at least". Claim 1 is moreover properly based on original independent claim 12, supplemented by features derivable from page 21, lines 6 to 13 and page 32, lines 3 to 4 (concerning the oscillation rate of at least 7.5 Hz corresponding to an image frame rate of at least 15 frames per second, and the spatial resolution of equal to or less than 100 microns); page 22, lines 5 to 7 (concerning the detection of a position encoder with an accuracy of 1 micron); and page 8, lines 26 to 28 (concerning the use of a torque motor).

Hence, claim 1 satisfies the requirement of Article 123(2) EPC.

The dependent claims as well as the description have been adapted to the now limited definition of the invention as claimed in accordance with the requirements of Rules 42 and 43 EPC.

5.2 Inventive step

As indicated above, in particular under points 2.2 and 3, a position encoder for determining the spatial position of the transducer along the reciprocating convex arcuate path is implicitly disclosed for the device of Figure 1b of D3. The subject-matter claim 1 differs from this closest prior art in that the position encoder is configured to determine the spatial position of the transducer along said reciprocating convex arcuate path with an accuracy of 1 micron.

As explained in the application as filed on page 16, lines 1 to 9, the effect of this high positional determination accuracy is that the transducer may be positioned along the arcuate path with a corresponding high degree of accuracy. Thereby, an improved image quality may be obtained, and, in combination with the other features of the claimed system, ultrasound images having spatial resolutions in excess of 30 microns may be attained, as explained on page 21, lines 15 to 18.

In the Board's judgment, therefore, the system defined in claim 1 satisfies the requirement of an inventive step within the meaning of Article 56 EPC. It results therefrom that the dependent claims 2 to 15 are also allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of claims 1 to 15 and description pages 1 to 32 filed during the oral proceedings on 19 October 2011; and drawing sheets 1/21 to 21/21 as originally filed.

The Registrar: The Chairman:

D. Hampe M. Noël