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Datasheet for the decision of 19 April 2018

Case Number: T 2526/12 - 3.5.04

Application Number: 08100389.9

Publication Number: 1947607

IPC: G06T7/00

Language of the proceedings: EN

Title of invention:
A method and system for registering a 3D pre-acquired image coordinates system with a medical positioning system coordinate system and with a 2D image coordinate system

Applicant:
Mediguide Ltd.

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

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Beschwerdekammern

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Case Number: T 2526/12 - 3.5.04

D E C I S I O N
of Technical Board of Appeal 3.5.04
of 19 April 2018

Appellant: (Applicant)	Mediguide Ltd. Advanced Technology Center, P.O. Box 15003 31053 Haifa (IL)
Representative:	Kramer Barske Schmidtchen Patentanwälte PartG mbB European Patent Attorneys Landsberger Straße 300 80687 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 25 July 2012 refusing European patent application No. 08100389.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	C. Kunzelmann
Members:	M. Paci
	B. Müller

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing European patent application No. 08100389.9, published as EP 1 947 607 A1.

II. The documents cited in the decision under appeal included the following:

D1: EP 1 720 039 A2,
D5: US 2006/0064006 A1,
D6: T. Lange et al., "Augmenting Intraoperative 3D Ultrasound with Preoperative Models for Navigation in Liver Surgery", Medical Image Computing and Computer-Assisted Intervention (MICCAI), pages 534-541, Springer-Verlag Berlin Heidelberg, 2004, and
D7: M.A. Audette et al., "An algorithmic overview of surface registration techniques for medical imaging", Medical Image Analysis 4 (2000), pages 201-217, Elsevier Science B.V., 2000.

III. The application was refused on the grounds that the subject-matter of independent claims 1 and 12 of the sole request then on file did not involve an inventive step (Article 56 EPC) in view of prior-art document D1 alone or in combination with either of prior-art documents D6 and D7, and that the subject-matter of the dependent claims did not involve an inventive step because their additional features were known or obvious from at least one of prior-art documents D1 and D5.

IV. In the statement of grounds of appeal, the appellant argued that the claimed subject-matter met the requirements of novelty and inventive step in view of the available prior art.

V. The board issued a summons to oral proceedings, together with a communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA, OJ EPO 2007, 536). It gave its preliminary opinion that it tended to concur with the reasoning of the examining division on inventive step, and explained why the appellant's arguments had not persuaded it. Moreover, it indicated that the subject-matter of claim 1 appeared also to lack inventive step when starting from document D5, for essentially the same reasons as when starting from document D1.

VI. With a letter dated 19 March 2018, the appellant filed amended claims according to a first auxiliary request.

VII. The board held oral proceedings on 19 April 2018, during which the appellant filed amended claims according to second and third auxiliary requests.

The appellant's requests at the end of the oral proceedings were that the decision under appeal be set aside and that a European patent be granted on the basis of the claims of the main request, which is the sole request underlying the decision under appeal, or the claims of the first auxiliary request filed with the letter dated 19 March 2018, or the claims of the second or third auxiliary requests, both filed during the oral proceedings of 19 April 2018.

At the end of the oral proceedings, the chairman announced the board's decision.

VIII. Claim 1 according to the appellant's **main request** reads as follows:

"Method for registering a three dimensional coordinate system with a Medical Positioning System coordinate system, and with a two dimensional coordinate system, the method comprising the procedure of:

acquiring at least one two dimensional image of a volume of interest, said volume of interest including at least one tubular organ within the body of a patient, said two dimensional image being associated with said two dimensional coordinate system;

acquiring a plurality of medical positioning system points, within said at least one tubular organ, said medical positioning system points being associated with said medical positioning system coordinate system, said medical positioning system coordinate system being registered with said two dimensional coordinate system;

estimating a volumetric model of said at least one tubular organ according to said at least one two dimensional image, and said acquired medical positioning system points; and

registering said three dimensional coordinate system with said medical positioning system coordinate system, and with said two dimensional coordinate system,

characterized by extracting a three dimensional image model of said at least one tubular organ from at least one pre-acquired three dimensional image of said volume of interest, said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system; and
in that said three dimensional coordinate system is registered with said medical positioning system coordinate system, and with said two dimensional coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model."

IX. Claim 1 according to the appellant's **first auxiliary request** reads as follows (additions to claim 1 of the **main request** are underlined, deletions are ~~struck-through~~, long identical text portions are replaced by "[...]"):

"Method for registering a three dimensional coordinate system with a ~~M~~medical ~~P~~positioning ~~S~~system coordinate system, and with a two dimensional coordinate system, the method comprising the procedure of:

[...]

characterized by extracting a three dimensional image model of said at least one tubular organ from at least one pre-acquired three dimensional image of said volume of interest, said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system and

in that said three dimensional coordinate system is registered with said medical positioning system coordinate system, and with said two dimensional coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model, wherein said two dimensional coordinate system, said three dimensional coordinate system, and said medical positioning system coordinate system are three different coordinate systems."

X. Claim 1 according to the appellant's **second auxiliary request** reads as follows (additions to claim 1 of the **main request** are underlined, deletions are ~~struck-through~~):

"Method for registering a three dimensional coordinate system with a ~~M~~medical ~~P~~positioning ~~S~~system coordinate

system, and with a two dimensional coordinate system, the method comprising the procedure of:

acquiring ~~at least one~~ a two dimensional image of a volume of interest, said volume of interest including ~~at least one~~ a tubular organ within the body of a patient, said two dimensional image being associated with said two dimensional coordinate system;

acquiring a plurality of medical positioning system points, within said ~~at least one~~ tubular organ, said medical positioning system points being associated with said medical positioning system coordinate system, said medical positioning system coordinate system being registered with said two dimensional coordinate system;

estimating a volumetric model of said ~~at least one~~ tubular organ according to said ~~at least one~~ two dimensional image, and said acquired medical positioning system points; and

registering said three dimensional coordinate system with said medical positioning system coordinate system, and with said two dimensional coordinate system,

characterized by extracting a three dimensional image model of said ~~at least one~~ tubular organ from at least one pre-acquired three dimensional image of said volume of interest, said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system and

in that said three dimensional coordinate system is registered with said medical positioning system coordinate system, and with said two dimensional coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model."

XI. Claim 1 according to the appellant's **third auxiliary request** reads as follows (additions to claim 1 of the

main request are underlined, deletions are ~~struck-through~~):

"Method for registering a three dimensional coordinate system with a ~~M~~medical ~~P~~positioning ~~S~~system coordinate system, and with a two dimensional coordinate system, the method comprising the procedure of:

acquiring ~~at least one~~ a two dimensional image of a volume of interest, said volume of interest including ~~at least one~~ a tubular organ within the body of a patient, said two dimensional image being associated with said two dimensional coordinate system;

acquiring a plurality of medical positioning system points, within said ~~at least one~~ tubular organ, said medical positioning system points being associated with said medical positioning system coordinate system, said medical positioning system coordinate system being registered with said two dimensional coordinate system;

estimating a volumetric model of said ~~at least one~~ tubular organ according to said ~~at least one~~ two dimensional image, and said acquired medical positioning system points; ~~and~~

registering said three dimensional coordinate system with said medical positioning system coordinate system, and with said two dimensional coordinate system, and

~~characterized by~~ extracting a three dimensional image model of said ~~at least one~~ tubular organ from at least one pre-acquired three dimensional image of said volume of interest,

wherein said at least one pre-acquired three dimensional image and said three dimensional image model ~~being~~ are associated with said three dimensional coordinate system, ~~; and~~

~~in that~~ said three dimensional coordinate system is registered with said medical positioning system coordinate system, and with said two dimensional

coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model, said extracted three dimensional image model and said estimated volumetric model are three dimensional triangulated mesh representations of said tubular organ."

XII. The examining division's reasons for the decision under appeal which are relevant to the present decision may be summarised as follows:

The subject-matter of claim 1 lacked inventive step for the following reasons:

Document D1, which was the closest prior art, disclosed all the features of claim 1 except for the following distinguishing features:

- extracting a three dimensional image model of said at least one tubular organ from at least one pre-acquired three dimensional image of said volume of interest, said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system; and
- the three dimensional coordinate system was registered with said medical positioning system coordinate system, and with said two dimensional coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model.

Document D1 disclosed the registering of all three coordinate systems, i.e. the three dimensional coordinate system, the medical positioning system coordinate system and the two dimensional coordinate system (see paragraphs [0087] and [0088]). Document D1

further disclosed that the registration could be based on "contours, discrete points, surfaces or volumes" (see paragraph [0087]). However, D1 was silent on the actual details of the registration process.

Thus, the technical problem to be solved was to specify the details of the necessary registration process used in matching the pre- and intra-operative three dimensional image data.

The claimed solution was obvious. Not only did document D1 disclose the registering of the pre- and intra-operative image data, but it also taught (see paragraph [0092]) registering information imported from other imaging applications, such as pre-acquired computerised tomography (CT) or magnetic resonance imaging (MRI), with the 3D ultrasound-based model.

Hence the subject-matter of claim 1 lacked inventive step in view of document D1 alone.

Moreover, the aforementioned distinguishing features were already known from prior-art document D6: section 2.2 disclosed the registration of both pre- and intra-operative models derived from the pre- and intra-operative image data, respectively, and the extraction of a three dimensional image model of a tubular organ from a pre-acquired three dimensional image. The feature of "said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system" was implicitly disclosed by document D6 because both the three dimensional image and the extracted three dimensional model of document D6 had to be associated with a coordinate system - otherwise,

individual image or model elements could not be addressed.

Hence the subject-matter of claim 1 also lacked inventive step in view of documents D1 and D6.

XIII. The appellant's arguments regarding the issues relevant to the present decision are summarised below.

Main and first auxiliary requests - inventive step

Prior-art documents D1, D5, D6 and D7 did not suggest extracting a three dimensional image **model** of the tubular organ **before** the registering step of the three dimensional coordinate system with the other two coordinate systems, or using this model for carrying out said registering step.

Moreover, document D1, the closest prior art, did not disclose the step of "acquiring at least one two dimensional image of a volume of interest, said volume of interest including at least one tubular organ", because no single 2D image taken by the array of ultrasonic transducers (40 in figure 2) from the inside of a tubular organ could contain the whole tubular organ. There was no obvious way in which the skilled person would have modified the method of D1 to arrive at this step.

Hence the method of claim 1 involved an inventive step.

Second auxiliary request - inventive step

Claim 1 had been amended to make unambiguously clear that a 2D image comprising the whole tubular organ was acquired. This rendered the method of claim 1 inventive

when starting from D1 as closest prior art for the reasons already given with regard to the main request.

Document D5 could not be regarded as the closest prior art because it only related to a method and system for determining a three dimensional representation of a tubular organ (see title of D5) and there was no mention of using a pre-acquired 3D image/model of the tubular organ.

Even if document D5 were regarded as the closest prior art, the skilled person would have had no incentive to combine it with document D6 because of incompatibilities between their methods and because the teachings of D6 would not have improved the method of D5.

Third auxiliary request - inventive step

Claim 1 had been further amended to specify that the extracted 3D image model and the estimated volumetric model were three dimensional triangulated mesh representations of the tubular organ.

A three dimensional triangulated mesh representation could not be used in the method of document D6 because D6 taught using the centre line of the tubular organ. Hence there was no need to model the surface of the tubular organ and thus no need to use a three dimensional triangulated mesh representation.

Reasons for the Decision

1. The appeal is admissible.

Main request - inventive step (Article 56 EPC)

2. Closest prior art

2.1 The examining division held document D1 to be the closest prior art for the subject-matter of claim 1. That has not been disputed by the appellant, and the board concurs too.

2.2 The board agrees with the examining division that D1 discloses the following features of the method of claim 1:

Method for registering a three dimensional coordinate system *(that used for the pre-acquired 3D image mentioned in paragraph [0092] of D1)* with a medical positioning system coordinate system *(that used for the 3D position of the catheter: see paragraph [0080] and figures 1 and 2)*, and with a two dimensional coordinate system *(that used for the 2D ultrasound images taken by the catheter: see paragraph [0066], last sentence, and paragraph [0079])*, the method comprising the procedure of:

acquiring at least one two dimensional image of a volume of interest, said volume of interest including at least one tubular organ within the body of a patient, said two dimensional image being associated with said two dimensional coordinate system *(see paragraph [0066], last sentence, and paragraph [0079])*;

acquiring a plurality of medical positioning system points, within said at least one tubular organ, said

medical positioning system points being associated with said medical positioning system coordinate system, said medical positioning system coordinate system being registered with said two dimensional coordinate system *(see paragraph [0080])*;

estimating a volumetric model of said at least one tubular organ according to said at least one two dimensional image, and said acquired medical positioning system points *(see paragraphs [0085] and [0086])*; and

registering said three dimensional coordinate system with said medical positioning system coordinate system, and with said two dimensional coordinate system *(see paragraphs [0087],[0088],[0092] and [0110])*.

2.3 The appellant disputed that document D1 disclosed the step of "acquiring at least one two dimensional image of a volume of interest, said volume of interest including at least one tubular organ", because no single 2D image taken by the array of ultrasonic transducers (40 in figure 2) from the inside of a tubular organ could contain the whole tubular organ.

The board concurs with the appellant that since the array of ultrasonic transducers 40 shown in figure 2 of D1 is located on only one side of the catheter, it cannot take an image of the whole tubular organ in which it is inserted.

However, the board does not share the appellant's view that claim 1 implies that a single 2D image must contain the whole tubular organ. Indeed, the relevant wording of claim 1 reads as follows:

"acquiring at least one two dimensional image of a volume of interest, said volume of interest including

at least one tubular organ within the body of a patient, said two dimensional image being associated with said two dimensional coordinate system;

[...];

estimating a volumetric model of said at least one tubular organ according to said at least one two dimensional image, and said acquired medical positioning system points".

The board understands from the above wording of claim 1 that the one or more 2D images must allow a volumetric model of the tubular organ to be estimated. It implies that these one or more 2D images, together, cover enough of the surface of the tubular organ to enable a volumetric model to be estimated. However, it does not imply that any single one of these 2D images must comprise the whole surface of the tubular organ.

In D1, a plurality of 2D images of a tubular organ (e.g. a "blood vessel") are taken (at different positions, see paragraph [0079]) by the array of ultrasonic transducers 40 to create a 3D model of the tubular organ (see paragraph [0078]). Hence, these 2D images, together, must comprise essentially the whole surface of the tubular organ. Accordingly, the above disputed features of claim 1 are disclosed in D1.

3. Distinguishing features

The method of claim 1 therefore is distinguished from the method of D1 by the features of the characterising portion, i.e.:

- extracting a three dimensional image model of said at least one tubular organ from at least one pre-acquired three dimensional image of said volume of

interest, said at least one pre-acquired three dimensional image and said three dimensional image model being associated with said three dimensional coordinate system; and

- said three dimensional coordinate system is registered with said medical positioning system coordinate system, and with said two dimensional coordinate system, by matching said extracted three dimensional image model with said estimated volumetric model.

4. Objective technical problem

The examining division held that the objective technical problem was to specify the details of the necessary registration process used in matching the pre- and intra-operative three dimensional image data.

The appellant did not challenge this formulation of the objective technical problem.

The board has no objection to this formulation either.

5. Obviousness

5.1 Document D1 discloses that the pre-acquired 3D image and the volumetric 3D model of the tubular organ estimated from the 2D ultrasound images must be registered so that they can be displayed together (see paragraphs [0087], [0092] and [0110]). However, as to how the registration should be performed, document D1 merely states that it could be performed "using contours, discrete points, surfaces or volumes" (see paragraph [0087], last sentence). In the board's view, the skilled person would have understood this indication as an incentive to go and look for known

registration techniques "using contours, discrete points, surfaces or volumes".

5.2 The skilled person would therefore have regarded prior-art document D6 as particularly relevant because it relates to surface registration techniques for medical imaging (see title and abstract of D6).

D6's relevant teachings include:

- In order to register an intra-operative 3D ultrasound image of a liver with a preoperative (i.e. pre-acquired) CT/MR 3D image, a **model of the blood vessels** should be preoperatively **extracted** from the CT/MR 3D image (see, for instance, section 1, first paragraph, lines 9 to 13, and section 2, first sentence, and section 2.2, first sentence) so that the model can be used in the intra-operative phase for fast registration (see the two sentences reading "Hybrid approaches [...] yielding fast intraoperative registration" near the end of the penultimate paragraph of section 1).

- The registering of the two 3D images is performed by matching of the models of the same blood vessel(s) in the two images (see, for instance, section 2.2, first paragraph).

- The matching of the blood vessels may be done in a known manner by determining corresponding points of reference on the surfaces of the blood vessels; however, it may also advantageously be performed by comparing points of reference on the centre lines of the blood vessels (see section 2.2, first paragraph, in particular the sentence "In contrast to the standard ICP algorithm in each iteration corresponding vessel

center line points of reference and model data are determined instead of corresponding points between surfaces.").

From the above, the board considers that D6 teaches the distinguishing features of claim 1 (extracting a three dimensional image model of the tubular organ before the registering step and using this model for carrying out said registering step).

5.3 The appellant argued that the method of D6 used only the centre lines of the vessels for the registering step, not a three dimensional image model.

5.4 The board disagrees. The procedure is clearly stated in the first two sentences of section 2.2 of D6: first, a 3D model of a tubular organ, such as a blood vessel, is created (see the word "segmented" which has the meaning of extracting a model); then, the centre line of the vessel is automatically extracted. In other words, a 3D model of the tubular organ is created. The determination of the centre line of the tubular organ is then derived from this 3D model. Hence, irrespective of whether the surface or the centre line of the vessel is used for the registration with the 3D model from the 2D ultrasound images, the matching is performed based on the extracted 3D model of the tubular organ.

In any case, the wording of claim 1 only states that the two models are matched, which does not exclude the possibility that the matching is performed on the centre lines of the models of the tubular organ.

Moreover, even if the wording of claim 1 were considered to exclude a matching of the models based on the centre lines, D6 presents the matching of centre

lines of blood vessels as a good alternative to the matching of surfaces of blood vessels, but does not clearly state that this alternative gives better results. The board therefore considers that D6 teaches that either the centre lines or the surfaces of the blood vessels may be used for the registering.

6. For the above reasons, the board considers that the subject-matter of claim 1 according to the main request does not involve an inventive step in view of documents D1 and D6.

Accordingly, the appellant's main request is not allowable.

First auxiliary request - inventive step (Article 56 EPC)

7. Compared with claim 1 of the main request, claim 1 of the first auxiliary request comprises the additional feature that "said two dimensional coordinate system, said three dimensional coordinate system, and said medical positioning system coordinate system are three different coordinate systems".

8. Since this additional feature was implicitly assumed in the above discussion of the main request, the board holds that the subject-matter of claim 1 according to the first auxiliary request does not involve an inventive step for the same reasons as those given for the main request.

Accordingly, the appellant's first auxiliary request is not allowable.

Second auxiliary request - inventive step (Article 56 EPC)

9. Amendments

Claim 1 according to the second auxiliary request differs from claim 1 of the main request in that, essentially, the acquiring step has been amended as follows:

"acquiring ~~at least one~~ a two dimensional image of a volume of interest, said volume of interest including ~~at least one~~ a tubular organ within the body of a patient".

According to the appellant, these amendments make unambiguously clear that the whole tubular organ is contained in a single 2D image, which is a feature that document D1 neither discloses nor suggests.

10. Closest prior art

10.1 The board concurs with the appellant that these amendments render document D1 significantly less relevant because there is little incentive for the skilled person to replace the 2D ultrasound imaging from the catheter inside the tubular organ by 2D imaging of the whole tubular organ from outside the tubular organ (e.g. from outside the body).

10.2 In the communication annexed to the summons to oral proceedings, the board had informed the appellant that the subject-matter of claim 1 appeared also to lack inventive step when starting from prior-art document D5 for essentially the same reasons as when starting from document D1.

10.3 In view of the above amendments to claim 1, the board considers that, instead of document D1, document D5 should be regarded as the closest prior art for the following reasons:

D5, which was published approximately ten months before the priority date of the present application, is a US patent application filed by the appellant on what appears to be a precursor to the present invention.

D5's disclosure is essentially the same as that of the present application regarding all described features relating to the medical positioning system (MPS), the 2D imaging system, the registration of the MPS and 2D coordinate systems and the creation therefrom of a volumetric model of a tubular organ (see, for instance, 132 in figures 1 and 2F).

D5 also discloses the step of acquiring a two dimensional image (such as an X-ray image) of the **whole** tubular organ (see paragraphs [0020] and [0022], first sentence) and the step of estimating a volumetric model of said tubular organ from said two dimensional image (see paragraph [0022], first sentence).

D5, however, does not mention that the thus obtained volumetric model 132 could be registered with a 3D image pre-acquired by, for instance, CT or MRI.

Hence, both D1 and D5 are from the same technical field as the present invention and both disclose essentially the same number of features as the subject-matter of claim 1. However, for the reasons given under point 10.1 *supra*, document D1 has become a less promising starting point than document D5 for an obvious development leading to the claimed invention.

In accordance with the established jurisprudence of the boards of appeal, D5 should thus be regarded as being the closest prior art (see Case Law of the Boards of Appeal of the European Patent office, 8th edition 2016, section I.D.3.4).

10.4 The appellant argued that document D5 was not the most promising springboard to the claimed invention, and thus was not the closest prior art, because it only related to a method and system for determining a three dimensional representation of a tubular organ (see title of D5), but there was no mention of using a pre-acquired 3D image/model of the tubular organ. D5 did not disclose the purpose or objective of registering the three coordinate systems specified in claim 1.

The board concurs that document D5 contains no mention of using a pre-acquired 3D image/model of the tubular organ. However, the absence of this feature does not impact on the above conclusion that document D1 is less promising than document D5 as a starting point. Moreover, since D5 discloses the registration of two coordinate systems, it is also a promising starting point for the registration of a further coordinate system.

11. Disclosure of D5 and distinguishing features

The disclosures of D5 and of the present application are very similar. (In this respect the board notes that two of the three inventors behind the present application are also the inventors behind D5.) The appellant has not disputed that document D5 discloses all the features of claim 1, except for all those mentioning the three dimensional pre-acquired image, model or coordinate system.

12. Objective technical problem

The objective technical problem may be formulated in general terms, without pointers to the solution, as how to improve the intra-operative medical imaging system shown in figure 1 of D5.

13. Obviousness

13.1 Document D6 teaches that intra-operative images may be "augmented" with pre-operative models from pre-acquired 3D images in order to provide accurate navigation, orientation aid for the surgeon and additional information helping the surgeon to differentiate various anatomical structures (see, for instance, the title, the Abstract and section 1 "Introduction").

D6 further teaches that the anatomical features of interest to the surgeon, such as "veins" and "blood vessels", should advantageously be pre-operatively extracted from the pre-acquired 3D image (see, for instance, in section 1, lines 9 to 13 and the two sentences reading "Hybrid approaches, ... yielding fast intraoperative registration" near the end of the section, the first sentence of section 2 and the first sentence of section 2.2).

In other words, D6 teaches that a **model** of each feature of interest should be pre-operatively **extracted** from the pre-acquired 3D image because of the following advantages: (1) the pre-operative extraction of a model significantly improves the intra-operative differentiation of the various anatomical structures; and (2) the lack of a time constraint in the pre-

operative phase allows for precise feature extraction yielding fast intra-operative registration.

Moreover, as already explained under point 5.2 *supra*, D6 also teaches the following as to how the model of a tubular organ extracted from the pre-acquired 3D image and the corresponding volumetric model estimated from 2D images may be matched for registration:

- The registering of the two 3D images may be performed by matching of the models of the same blood vessel(s) in the two images (see, for instance, section 2.2, first paragraph).

- The matching of the blood vessels may be done in a known manner by determining corresponding points of reference on the surfaces of the blood vessels; however, it may also advantageously be performed by comparing points of reference on the centre lines of the blood vessels (see section 2.2, first paragraph, in particular the sentence "In contrast to the standard ICP algorithm in each iteration corresponding vessel center line points of reference and model data are determined instead of corresponding points between surfaces.").

Hence, for the reasons already given under points 5.2 to 5.4 *supra*, the board considers that the skilled person would have arrived at the subject-matter of claim 1 by applying the teachings of D6 to the system and method of D5.

13.2 The appellant argued that even if document D5 were the closest prior art, the skilled person would have had no incentive to combine it with document D6 because of incompatibilities between their methods and because the

teachings of D6 would not have improved the method of D5.

More specifically, the appellant submitted the following arguments:

(a) The system of D5 does not display 2D images. It only displays a 3D model (132 in figures 1 and 2F) of a tubular organ created from the centre line of this organ. There is thus no 2D image in D5 which could be "augmented" with a pre-acquired 3D image as described in D6.

(b) By combining the teachings of D5 and D6, the skilled person would first create a model of a tubular organ from the centre line of that organ, as described in D5, only to then derive the centre line from that model as taught by D6. It would thus make no sense for the skilled person to combine them.

13.3 The board did not find the above arguments persuasive for the following reasons:

Re argument(a)

The medical imaging system of D5 takes "at least one 2D image" of the tubular organ (see paragraph [0020]). A volumetric model of the tubular organ is then created from the "at least one 2D image" and from the positions of the catheter in the MPS coordinate system indicating the centre line of the tubular organ (see paragraphs [0020] and [0021]). Although only the thus created volumetric model 132 is shown on display unit 122 of figure 1, it is clear from the description that the volumetric model should be superimposed on the 2D image (see paragraph [0002], the last sentence of paragraph

[0026] and paragraphs [0036] and [0041]). Hence, the appellant's argument that only the volumetric model 132 is displayed in D5 is not correct.

Re argument(b)

Since, as explained in the previous paragraph, D5 already teaches augmenting a 2D image of a tubular organ with a 3D model, it would have been quite natural for the skilled person to want to further "augment" the 2D image with a model of the tubular organ from a pre-acquired 3D image, as disclosed in D6. In the board's view, the skilled person would have regarded a 3D model extracted from a pre-acquired MR/CT image, as disclosed in D6, as superior to the simplified 3D model used in D5. The skilled person would thus have had a clear incentive to apply the teachings of D6 to improve the system of D5.

The appellant's argument that the skilled person would not want to derive the centre line from the pre-acquired 3D model of D6 because the centre line is already known in the system of D5 is not persuasive either. Indeed, the fact the centre line of the volumetric model of the tubular organ D5 is already known in D5 would only make it easier to compare it to the corresponding centre line of the model extracted from the pre-acquired 3D model taught in D6. Moreover, as explained under points 5.2 to 5.4 *supra*, D6 discloses matching the two models of the tubular organ by comparing either their centre lines or their surfaces. In the latter case, it could be done easily by comparing the surfaces of the volumetric model of D5 with the model extracted from the pre-acquired 3D image of D6.

Nor did the argument that the artificial model (132) of a tubular organ in D5 was not compatible with the pre-operative model based on image segmentation of D6 convince the board, because the general teaching of D6 (see point 13.1 above) is based on the existence of a pre-acquired model and not limited to a particular way of generating this model.

Hence the board cannot see any reason why the skilled person would have been dissuaded from applying the teachings of D6 to the system/method of D5.

14. For the above reasons, the board considers that the subject-matter of claim 1 according to the second auxiliary request does not involve an inventive step in view of documents D5 and D6.

Accordingly, the appellant's second auxiliary request is not allowable.

Third auxiliary request - inventive step (Article 56 EPC)

15. Claim 1 according to the third auxiliary request has been further amended, as compared with claim 1 according to the second auxiliary request, to specify that the extracted 3D image model and the estimated volumetric model are three dimensional triangulated mesh representations of the tubular organ.

16. The board considers that it was common general knowledge in 3D imaging to represent surfaces of a 3D object as a 3D triangular mesh. Such a representation had the known advantage of saving memory space and computing time because only a small subset of the surface points had to be stored and operated on. Such a mesh representation is mentioned, for instance, in

paragraph [0089] of D1 (see term "wire-mesh"). The skilled person would therefore have wanted to use such a representation for the extracted 3D image model and the estimated volumetric model of D5 and D6 in order to obtain the above known advantages.

17. The appellant did not dispute that three dimensional triangulated mesh representations had been commonly used for representing surfaces of 3D objects. However, it argued that a three dimensional triangulated mesh representation could not be used in the method of document D6 because D6 taught using the centre line of the tubular organ. Hence there was no need to model the surface of the tubular organ and thus no need to use a three dimensional triangulated mesh representation.

18. The board did not find this argument persuasive because, as already explained under point 5.4 *supra*, a 3D model of the tubular organ is always created, even in cases in which only the organ's centre line is used for matching the models.

19. For the above reasons, the board considers that the subject-matter of claim 1 according to the third auxiliary request does not involve an inventive step in view of documents D5 and D6 and common general knowledge.

Accordingly, the appellant's third auxiliary request is not allowable.

Conclusion

20. Since none of the appellant's requests are allowable, the appeal is to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

K. Boelicke C. Kunzelmann

Decision electronically authenticated