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Datasheet for the decision of 23 October 2020

Case Number: T 1155/16 - 3.2.02

Application Number: 08012420.9

Publication Number: 2014232

IPC: A61B6/03, G06T11/00

Language of the proceedings: EN

Title of invention:
X-ray computed tomography apparatus, reconstruction processing apparatus and image processing apparatus

Applicant:
Toshiba Medical Systems Corporation

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step (yes)

Decisions cited:

Catchword:

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Case Number: T 1155/16 - 3.2.02

D E C I S I O N
of Technical Board of Appeal 3.2.02
of 23 October 2020

Appellant: (Applicant)	Toshiba Medical Systems Corporation 1385, Shimoishigami, Otawara-Shi, Tochigi-Ken 324-8550 (JP)
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 30 November 2015 refusing European patent application No. 08012420.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	M. Alvazzi Delfrate
Members:	M. Stern
	Y. Podbielski

Summary of Facts and Submissions

I. The applicant lodged an appeal against the decision of the Examining Division refusing European patent application No. 08 012 420.9. The application was refused on the grounds that the subject-matter of claim 1 of the main request then on file lacked an inventive step (Article 56 EPC) over document D1 in combination with document D2, where:

D1: US-B-6 266 388

D2: Jiang Hsieh: "A Practical Cone Beam Artifact Correction Algorithm", 2000 IEEE Nuclear Science Symposium, Conference Record, Lyon, France, 15-20 October 2000, pages 15-71 to 15-74

II. In response to objections raised by the Board in its communications dated 11 May 2020 and 11 September 2020, the appellant requested by letter dated 15 October 2020 that the decision under appeal be set aside and a patent be granted on the basis of:

- claims 1 to 6 filed with letter dated 14 October 2020;

- description pages 1 to 3 and 5 to 23 filed with letter dated 14 October 2020 and description page 4 filed with letter dated 15 October 2020;

- figure sheets 1/6 to 6/6 originally filed on 9 July 2008.

III. Claim 1 reads as follows:

"1. An X-ray computed tomography imaging method comprising:

scanning a subject with cone beam X-ray using an X-ray tube (13) and an X-ray detector (14);

reconstructing input image data based on output data from the X-ray detector;

extracting a cone beam artifact component contained in the input image data based on a typical shape and typical direction of the cone beam artifact such that an intermediate image data is generated that comprises an edge component in a body axis direction of the subject as the cone beam artifact component based on at least one of the output data and the input image data, by performing high-pass filtering for the input image data in the body axis direction as the typical direction of the cone beam artifact;

performing weighting with a distribution of weights changing in accordance with positions in the body axis direction for the cone beam artifact component; and

subtracting the weighted cone beam artifact component from the input image data to generate output image data in which the cone beam artifact is reduced."

Claims 2 to 6 are dependent claims.

IV. The arguments of the appellant that are relevant for the present decision may be summarised as follows:

D1 and D2 did not disclose the feature of performing weighting with a distribution of weights changing in accordance with the positions in the body axis direction for the cone beam artifact component. D1 and D2 did not suggest performing a corresponding processing. For these reasons, the subject-matter of

claim 1 could not be obtained in an obvious manner from D1 and D2.

Reasons for the Decision

1. The application relates to an X-ray CT method comprising an algorithm for correction of cone beam artifacts.

The method of claim 1 comprises, in essence, the following three steps:

(a) reconstructing input image data based on the output data from the X-ray detector;
(b) extracting a cone beam artifact component contained in said (reconstructed) input image data, and
(c) subtracting said cone beam artifact component to generate output data in which the cone beam artifact is reduced.

The cone beam artifact component under step (b) is recited to comprise "an edge component in a body axis direction of the subject". An example of what may fall under this expression is given on page 10, lines 13 to 19, namely, a steep CT gradient in the Z direction, that is, the longitudinal axis of the subject P (see Figures 1 and 2).

Moreover, the subtracting step (c) is specified to be performed by subtracting weighted cone beam artifact components which are obtained by performing weighting with a distribution of weights changing in accordance with positions in the body axis direction for the cone beam artifact component.

2. The Board considers document D2 as the closest prior art. It discloses an X-ray CT method comprising an algorithm for correction of cone beam artifacts (see title of D2).

On page 72, left column, paragraph 5, first two sentences, D2 discloses to obtain a new image ζ of extreme-density (ED) objects. This anticipates step (a), i.e., reconstructing input image data based on the output data from the X-ray detector.

Then, as explained in D2 on page 72 in connection with equation (1), from the new image ζ, an error only image ψ is obtained, which contains the artifacts caused by the ED objects in the cone beam reconstruction (page 72, left column, paragraph 5), i.e., a "cone beam artifact component". Hence, this step anticipates step (b), i.e., extracting a cone beam artifact component contained in said (reconstructed) input image data.

Finally, as explained in D2 on page 72 in connection with equation (2), the error image ψ (containing the "cone beam artifact component") is subtracted (from the original image ρ) to generate output data (χ) in which the cone beam artifact is reduced. This step, thus, anticipates step (c).

The performance of this algorithm is evaluated in D2 on a chest phantom. In Figures 4 and 5, sagittal images of the chest phantom are presented. By definition, a sagittal plane divides the body of the chest phantom into right and left halves. Thus, in these figures, the longitudinal axis of the phantom is parallel to the vertical direction of the images. In Figure 5(c), the error-only image comprising a "cone beam artifact

component" is seen to have a strong intensity variation or CT gradient in the vertical direction, i.e., the longitudinal axis of the patient phantom. Thus, the "cone beam artifact component" shown in Figure 5(c) comprises "an edge component in a body axis direction" of the patient phantom.

3. The method of claim 1 differs from the method known from D2 in two aspects.

3.1 First, whilst the method of D2 is performed on a patient phantom, claim 1 recites the method to be performed on a subject.

However, since the skilled person knows that the aim of a method carried out on a patient phantom (as that reported in D2) is its subsequent performance on living subjects, there is no inventiveness associated with carrying out the method of D2 on a subject, rather than on a patient phantom.

3.2 Second, the method of claim 1 differs from that of D2 in that extracting a cone beam artifact component contained in the input image data is done by performing high-pass filtering for the input image data in the body axis direction as the typical direction of the cone beam artifact, in that it contains the step of performing weighting with a distribution of weights changing in accordance with positions in the body axis direction for the cone beam artifact component, and in that the subtracting step (c) is done by subtracting the weighted cone beam artifact component.

These added features are originally disclosed in claims 6 and 11 of the application as filed (see also flow diagram of Figure 9). By high-pass filtering the

input image data in the body axis direction (Z), components having a steep CT value gradient in the Z direction can be eliminated (page 21, lines 21 to 31). After weighting with weights changing in accordance with positions of the input image data in the Z direction, the subtraction process allows to eliminate, for example, cone beam artifacts which gradually decrease in intensity from the edges to the center in the Z direction, as explained on page 22, lines 19 to 26.

This results in an additional improvement of the cone beam artifact reduction process, thereby improving the image quality of the resultant image data.

4. D2 does not disclose the features of performing weighting with a distribution of weights changing in accordance with the positions in the body axis direction Z for the cone beam artifact component and carrying out the subtracting step based on said weighted cone beam artifact components. D2 provides no suggestion either that may lead the skilled person to provide these features.

5. Document D1 is a patent (by the author of D2) whose content is entirely similar to D2 (and employs even the same mathematical notation; see column 3, lines 13 to 56). Also D1 fails to disclose or suggest the aforementioned differentiating features of performing weighting with a distribution of weights changing in accordance with the positions in the body axis direction Z for the cone beam artifact component and carrying out the subtracting step based on said weighted cone beam artifact components. D1 does not suggest anything in this respect either.

6. No further documents were cited in the European search report or the examination proceedings.

7. As a consequence, the Board concludes that the method of claim 1 is not rendered obvious by the cited prior art and thus satisfies the requirements of Article 56 EPC. This holds, a fortiori, for its preferred embodiments defined in dependent claims 2 to 6.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division with the order to grant a patent in the following version:

   - claims 1 to 6 filed with letter dated 14 October 2020;

   - description pages 1 to 3 and 5 to 23 filed with letter dated 14 October 2020 and description page 4 filed with letter dated 15 October 2020;

   - figure sheets 1/6 to 6/6 originally filed on 9 July 2008.

The Registrar: The Chairman:

D. Hampe M. Alvazzi Delfrate

Decision electronically authenticated