BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [ ] To Chairmen
(D) [X] No distribution

D E C I S I O N
of 30 April 2002

Case Number: T 0990/98 - 3.2.2

Application Number: 90107327.0

Publication Number: 0398029

IPC: A61B 6/03

Language of the proceedings: EN

Title of invention:
An X-ray image processing device

Patentee:
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.

Opponent:
Takao Fujiwara

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (any request) - no"

Decisions cited:
T 0162/88

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0990/98 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 30 April 2002

Appellant: (Proprietor of the patent)
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
1006, Oaza-Kadoma
Kadoma-shi
Osaka 571-8501 (JP)

Representative:
Eisenführ, Speiser & Partner
Martinistrasse 24
D-28195 Bremen (DE)

Respondent: (Opponent)
Takao Fujiwara
1-31-6 Shimotakaido
Suginami-Ku
Tokyo (JP)

Representative:
Klunker, Hans-Friedrich
Klunker Schmitt-Nilson Hirsch
Winzererstrasse 106
D-80797 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 12 August 1998 revoking European patent No. 0 398 029 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiss
Members: M. G. Noël
J. C. M. De Preter

Summary of Facts and Submissions

I. By decision of 12 August 1998 the Opposition Division revoked European patent No. 0 398 029 on the grounds of lack of inventive step vis a vis the state of the art.

II. The appellant (patentee) lodged an appeal against this decision on 9 October 1998. Its statement of grounds was filed on 22 December 1998.

III. In a communication of the Board dated 7 December 2001 sent following a summons to attend oral proceedings, the parties were informed that the discussion would turn on the question of inventive step of the claimed subject-matter in particular vis a vis prior art documents E3 and

E5: "Measurement - Dependent Filtering: A Novel Approach to Improved SNR" IEEE Transactions on Medical Imaging , Vol. M1-2, No. 3, September 1983, pages 122 to 127, by A. Macovski et al.,

having regard to the state of the art presented in the application as filed.

IV. The appellant replied on 21 March 2002 and filed amended claims according to a main and two auxiliary requests. Its line of arguments was silent about document E5.

V. Oral proceedings were held on 30 April 2002, during which the independent claims according to the different requests were discussed. At the end of the oral proceedings the requests of the parties were as follows:

The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of claims 1 to 4 submitted as main request by letter of 21 March 2002 or on the basis of claim 1 of one of the two auxiliary requests submitted by the same letter.

The respondent requested that the appeal be dismissed.

VI. The parties submitted the following arguments:

(i) the appellant

- The logarithmic conversion of the image information of the penetration images obtained by low and high energy X-rays and the order of the subtraction processes for achieving at first a soft tissue image and then a bone image, are not disclosed by any document. The present invention is suitable to provide more bone-fine structure information in the final bone image compared to the prior art imaging systems.

- Document E5 is not relevant. In particular, both the selective image and the non-selective image are combinations of images, contrary to the solution according to Figure 3 in the present patent.

- Claim 1 according to the second auxiliary request incorporates features related to the X-ray tube and to the X-ray sensor which is designed to take different energy pictures through only one picture taking in order to save time. These features are not disclosed in the cited prior art.

(ii) the respondent

- Document E5 discloses a filtering system similar to the embodiment according to Figure 3 of the patent in suit. The order in which the two processed images are successively produced, only depends on appropriate coefficients selected by the practitioner without the exercise of any inventive skill, in order to obtain a final image of the body material of interest. This is simply a matter of choice.

- The different components forming an X-ray dual energy device such as X-ray tubes or X-ray sensors or variations thereof are well known to the person skilled in the art and cannot support the presence of any inventive step. Moreover, these features fail to add any contribution to the solution of the problem as originally stated.

VII. The independent claims at issue read as follows:

Claim 2 (main request)

"An X-ray image processing device comprising:
means for obtaining a low energy image information (1) which is a logarithmic conversion image information of a penetration image of an object radiated by low energy X-ray,
means for obtaining a high energy image information (2) which is a logarithmic conversion image information of a penetration image of an object radiated by high energy X-ray,

means for subtracting the low energy image and the high energy image to output a first image (11),
characterised by means (10) for suppressing high frequency component of the first image (11) to output a high frequency suppressed image, means (9) for enhancing high frequency component of the low energy image (1) to output a high frequency enhanced image, and
means (8) for subtracting between the high frequency suppressed image and the high frequency enhanced image to output a second image (12)."

Claim 1 (first auxiliary request)

"An X-ray image processing device comprising:
means for obtaining a low energy image information (1) which is a logarithmic conversion image information of a penetration image of an object radiated by low energy X-ray,
means for obtaining a high energy image information (2) which is a logarithmic conversion image information of a penetration image of an object radiated by high energy X-ray,
means for subtracting the low energy image and the high energy image to output a first image (11) of soft tissue,
characterised by means (10) for suppressing high frequency component of the first image (11) to output a high frequency suppressed soft tissue image,
means (9) for enhancing high frequency component of the low energy image (1) to output a high frequency enhanced low energy image, and
means (8) for subtracting the high frequency suppressed soft tissue image from the high frequency enhanced low energy image to output a second image of the

bones (12)."

Claim 1 (second auxiliary request)

"An X-ray image processing device using a dual energy projection radiography method comprising:
a X-ray tube (100) for irradiating X-ray of high energy and low energy to an object (101) to be diagnosed by radiography,
an X-ray sensor (103) for sensing a penetration X-ray image which has penetrated the object (101), the X-ray sensor (103) having a function of energy discrimination to take the different energy pictures through one time picture,
means for obtaining a low energy image information (1) which is a logarithmic conversion image information of the penetration image of the object (101) radiated by low energy X-ray,
means for obtaining a high energy image information (2) which is a logarithmic conversion image information of the penetration image of the object (101) radiated by high energy X-ray,
means (10) for suppressing high frequency component of the first image (11) to output a high frequency suppressed soft tissue image,
means (9) for enhancing high frequency component of the low energy image (1) to output a high frequency enhanced low energy image,
means for subtracting the low energy image and the high energy image to output a first image (11) of soft tissue, and
means (8) for subtracting the high frequency suppressed soft tissue image from the high frequency enhanced low energy image to output a second image of the bones (12)."

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

All the modifications introduced in the claims are clear and fairly supported by the application as filed. Therefore, they are not open to formal objection.

3. *Main request*

The substantive merits of independent claim 1 may not be investigated since the independent claim 2 is anyway unallowable for the reasons set out below (see T 162/88, 9.7.1990, unpublished).

3.1 The subject-matter of claim 2 is based on the embodiment illustrated by Figure 3, which differs from that one of Figure 2 by the incorporation of two filtering units 9, 10 placed at the respective inputs of the second subtraction processing unit 8.

Like Figure 2, the second subtraction processing unit 8, generally performs subtraction between the low energy X-ray image 1 and the first processed image 11 of a first body material (here soft tissue), which itself results from a first subtraction processing 7 between the low energy X-ray image 1 and the high energy X-ray image 2. This arrangement provides for obtaining a second processed image 12 of a second body material (here bone) with low noise. Since, as generally known (cf. patent specification, page 2, lines 47 to 50 and page 3, lines 42 to 45) in the image

by the high energy X-ray the contrast is low and the signal-to-noise ratio (SNR) is much deteriorated, by performing a second subtraction processing 8 between the first processed image 11 and the image 1 from the low energy X-ray, a second processed image 12 having high frequency components can be obtained without increasing noise, ie having better quality (cf. page 3, lines 46 to 50).

This result is still improved by the arrangement of Figure 3 in which a pair of filtering elements is provided, namely one space filter processing unit 10 (low-pass filter) to suppress the high space frequency components of the first processed image 11 (ie essentially noise components of high frequency) and one space filter processing unit 9 (high-pass filter) to enhance the high space frequency components contained in the low energy X-ray image 1 (ie the energy level at which the noise components are not so high, as previously mentioned) (cf. from page 4, line 56 to page 5, line 1).

3.2 The state of the art coming closest to the invention is referred to in the application as filed with reference to Figure 1 and partly to Figure 2.

Having regard to Figure 1 and related text (cf. patent specification page 2, lines 17 to 30) an X-ray image processing device is known, comprising means for obtaining both low and high energy image information which is a logarithmic conversion image information of a penetration image of an object radiated by low and high energy X-ray, respectively, and means for subtracting the low energy image 1 from the high energy image 2 to output a first processed image 5 or 6. The

use of the energy subtraction method or dual energy projection radiography is clearly acknowledged as belonging to the state of the art. Therefore, it is known that X-ray images of different energies are subjected to logarithmic conversion and then subjected to differentiation or subtraction between each other (cf. page 2, lines 17 to 21).

Having regard to Figure 2, it is clearly stated (cf. page 3, lines 29 to 33) that all illustrated components starting from the production of the X-ray energies up to the obtention of the low and high energy images 1 and 2 are conventional to persons skilled in the art, including the arrangement for producing logarithmically converted X-ray image information of the radiated object (cf. page 3, lines 26 to 28). Moreover, it has to be mentioned that the known subtracting means 3 of Figure 1 for obtaining the first processed image 5, are again to be seen in Figures 2 and 3 under the reference signs 7 and 11, respectively.

Therefore, all the precharacterising features of claim 2 are known from the background of the invention.

3.3 Also Document E5 discloses the features mentioned above yet in more general terms, stating that (cf. Abstract and Introduction, page 122) a variety of medical imaging systems are known, in which a number of independent measurements using different X-ray energies (cf. dual-energy CT, page 124, right column) are combined to provide a selective (subtraction) image, ie using measurements made of different X-ray energy spectra to eliminate and/or enhance different body materials (eg soft tissues or bones). These subtraction studies provide images of improved conspicuity where

undesired structures are eliminated.

Document E5 observes however that subtraction operations in such sytems result in a degradation of the SNR (signal-to-noise ratio), as compared to the individual measurements. The object of document E5 is, therefore, to introduce a novel filtering system that significantly improves the SNR of the selective image. Therefore, like the present patent, this state of the art aims at improving the picture quality.

According to the solution as generally disclosed in document E5 (cf. Abstract) the low spatial frequencies are derived from the selective image and the high frequencies from a non-selective combination of the measurements which have a greater SNR. More specifically (cf. Introduction, last paragraph), corresponding features of claim 2 being added into brackets for the sake of comparison, in E5 the basis algorithm involves combining (substraction processing 8) the low frequency components of the selective image (first image 11) with the high frequency components of the non-selective, high SNR image (low energy image 1) in order to provide an improved SNR selective image (second image 12). Since each component of the final image (second image 12), ie the low-pass filtered (filter 10) selective image (first image 11) and the high-pass filtered (filter 9) non-selective image (low energy image 1) comprises relatively low noise, the resultant image similarly has a reduced noise.

The principle of this solution corresponds exactly to that of the claimed solution as explained above (point 3.1) which solves the same technical problem. Consequently the subject-matter of independent claim 2 according to the main request does not involve an inventive step vis a vis the teaching of document E5, having regard to the general knowledge of the skilled person as recited in the patent itself. The requirements of Article 56 EPC are, therefore, not met.

4. *First auxiliary request.*

Claim 1 according to the first auxiliary request differs from claim 2 according to the main request in that the "first image (11)" is a "soft tissue" image, in that the "second image (12)" is an image of the "bones" and in that the "high frequency enhance image" is "low energy".

The last difference is implicitly disclosed by document E5, in which it is specified (cf. Introduction, last paragraph) that the combination processing involved in the filtering system implies the use of high frequency components of the non-selective, high SNR image. Since it is generally admitted (cf. point 3.1 above and patent specification, page 2, lines 47 to 50) that the X-ray image which offers the better SNR is precisely the low energy image, said "non-selective, high SNR image" referred to in document E5 must necessarily be the low energy image.

Document E5 discloses further (cf Description, page 122 and Applications, page 124, left column) that a selective image (S) is formed by an array of measurements at low and high energies where the weights

ki (coefficients k1 to k4 in the patent) are chosen to select desired image components and reject undesired image components. In other words, the selection or the elimination of one body material (soft tissues or bones) in order to provide a first image depends only on the choice of these coefficients, which was already known from the background of the patent specification (cf. page 2, lines 28 to 34 and page 4, lines 43 to 45). As a matter of fact, in the system of two equations (1) and (2), one image can be eliminated by using appropriate coefficients and by subjecting both X-ray images to a substraction processing.

The sequence of first providing a processed image of soft tissues and then a processed image of bones is only a matter of choice depending on the objectives of the practitioner and the patient's demand. As is further mentioned in document E5 (cf page 124, right column) in dual-energy CT, all projections are taken at two energies and then processed to reconstruct images of two basis components. The selective (S) images can be either of these combinations. Therefore, in the Board's judgement, there is no invention in outputting soft tissues as a first image and as a second or final image the bones. In any case, the essential functions of the arrangement, ie two successive substraction processes and double-filtering steps applied before and after the first substraction processing, respectively, remain the same.

Moreover, whatever the nature of the second image may be, the double-filtering system disclosed in document E5 (cf page 123, paragraph bridging the two columns) also provides for preserving fine structures, for example by adjusting ("threshold") the low-pass

filtered version (Sl) of the selective image (S) (cf. page 122, bottom of the right column).

It results therefrom that the subject-matter of claim 1 according to the first auxiliary request does not involve an inventive step vis a vis the disclosure of document E5 in combination with the general knowledge as stated in the background of the patent specification.

5. *Second auxiliary request*.

Claim 1 according to the second auxiliary request differs from the previous auxiliary request in that its subject-matter is drafted in a one-part form and by the incorporation of features related to the use of an X-ray tube of different energies and an X-ray sensor having a function of energy discrimination.

While these features are fairly supported by the patent specification, they have, however, no connection with the problem as originally stated and its solution, which is essentially based on successive substraction processes associated with double-filtering as explained above. Further, the incorporated features are all parts of known devices at the disposal of a person skilled in the art, either as a basis equipment as mentioned in above point 3.2 or as alternative equipment (cf. patent, page 6, lines 3 to 7).

Therefore, the incorporated features fail to add anything inventive to the claimed subject-matter, contrary to the requirements of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare W. D. Weiß