Internal distribution code:

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

Datasheet for the decision of 14 May 2019

Case Number: T 2045/13 - 3.4.01

Application Number: 03254887.7

Publication Number: 1389734

IPC: G01R33/48

Language of the proceedings: EN

Title of invention:
Fat/water separation and fat minimization magnetic resonance imaging

Applicant:
GENERAL ELECTRIC COMPANY

Headword:
Fat/water separation in MRI - General Electric Company

Relevant legal provisions:
EPC Art. 83

Keyword:
Sufficiency of disclosure - (no)

Decisions cited:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 2045/13 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 14 May 2019

Appellant: (Applicant)	GENERAL ELECTRIC COMPANY 1 River Road Schenectady, NY 12345 (US)
Representative:	Fennell, Gareth Charles Kilburn & Strode LLP Lacon London 84 Theobalds Road London WC1X 8NL (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 2 May 2013 refusing European patent application No. 03254887.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	P. Scriven
Members:	R. Winkelhofer
	P. Fontenay

Summary of Facts and Submissions

I. The appeal is against the Examining Division's decision to refuse European patent application No. 03 254 887.

II. The refusal is by reference to a previous communication of the Examining Division, in which it objected that the claims on file contained amendments extending beyond the content of the application as filed, contrary to Article 123(2) EPC; that the subject-matter of claim 1 was not clearly defined, contrary to Article 84 EPC; and that the application did not disclose the invention in a manner sufficiently complete for it to be carried out, contrary to Article 83 EPC.

III. In the statement setting out the grounds of appeal, the appellant requested that the decision of the first instance be set aside and that a patent be granted on the basis of an amended set of claims 1 - 3 filed with the statement of grounds. This has remained the appellant's sole request during the appeal.

IV. In the statement of grounds, the appellant submitted, inter alia, that the skilled person would have been able, using common general knowledge in connection with the teaching of the patent application, to put the invention into effect. In respect, more specifically, of the various parameters appearing in equation 11 of the description, reference was made to the teachings of Guillemaud and Brady: IEEE Transaction on Medical Imaging, Vol. 16, No. 3, June 1997, pages 238-251. This document was said to correspond to the document

acknowledged, by reference to its authors only, in paragraph [0028] of the published application.

V. In a communication under Article 15(1) RPBA, the appellant was informed of the Board's preliminary view.

It was submitted that the claimed subject-matter was not clearly defined, contrary to Article 84 EPC, and that the invention did not appear to be disclosed in a manner sufficiently clear and complete to be carried out by a person skilled in the art.

It appeared questionable, in this respect, whether the teaching provided by the various documents referred to in the application (by reference to their authors) could indeed be directly implemented in the context of the claimed invention, as assumed by the appellant. It was further stressed that the teachings of Guillemaud and Brady, more specifically referred to in the statement of grounds, appeared to contradict the claim's wording. While Guillemaud and Brady suggested in the above cited article to estimate the bias field by way of an iterative process, the claimed invention specifies that said bias field is directly obtained from the log magnitude of the observed image.

VI. Oral proceedings were arranged at the appellant's request, but were later cancelled following the appellant's indication that it would not attend.

VII. The appellant did not comment on the Board's communication.

VIII. Claim 1 of the appellant's sole request reads:

A method for identifying the relative contributions of signals of a first substance and a second substance in a magnetic resonance ("MR") image ($I_{observed}$), the method characterized by:

selecting an image signal model such that:

$$I_{observed} = (I_{water} + I_{fat}e^{-i2\pi\omega_f^{TE}})\beta'$$

$$\beta' = \beta_{(x,y)}e^{-i\phi}_{(x,y)},$$

where the first substance is water, I_{water} is a water image and I_{fat} a fat image, β' being a spatially dependent bias field and

forming the bias field estimate ($\beta_{(x, y)}$) by:

taking the log magnitude of the observed image, as shown by the following equation:

$$\log(|I_{observed}|) = \log(|Iobject|) + \log(|\beta'|),$$

where I_{object} is the uncorrupted image;

choosing an echo time, TE, such that the phase inter-relationship between fat and water $2\pi\omega_f TE = \pi/2$ and wherein:

$$\angle I_{observed} = \angle(\beta' I_{water} + \beta' I_{fat}e^{-i2\pi\omega_f^{TE}})$$

$$\angle I_{observed} = \theta = \theta_{object} + \phi_{(x,y)},$$

where θ and θ_{object} are the observed and true phases, respectively;
estimating $\Phi_{(x,y)}$ using a Bayesian estimation and removing $\Phi_{(x,y)}$ to recover the true phase θ_{object} according to $\theta_{object} = \theta - \Phi_{(x,y)}$;

applying a bias correction to a complex phase image of the true phase θ_{object} generated by using the true phase θ_{object} to decouple fat and water signals from the MR image into individual components, wherein applying the bias correction comprises modeling observed phases in the phase image as Gaussian distributions according to the following equations:

$$p(\theta_i|\Gamma water, \beta_i) = G(\theta_i - \mu_{water} - \beta_i, \phi_{water})$$

$$p(\theta_i|\Gamma fat, \beta_i) = G(\theta_i - \mu_{fat} - \beta_i, \phi_{fat}),$$

wherein θ_i is the unwrapped, observed phase at pixel i, $\Gamma \in$ [water, fat] is a tissue class, μ_{water} φ_{water} and μ_{fat}, φ_{fat} are class means and variances of water and fat classes, respectively, and $G(x,\varphi)$ is a Gaussian distribution function with zero mean and φ variance, evaluated at x, in order to generate distinct water and fat images;

unwrapping the phase of the image to correct the phase image;

estimating the signal fraction of the water and the fat at each of a plurality of voxels; and

forming a suppressed image with respect to the water or the fat,

wherein the MR image is a single image acquired by single-scan imaging.

Reasons for the Decision

Sufficiency of disclosure

1. In the following, the functions *ß*, *ß'* and *Φ* will be referred to as *ß(x,y)*, *ß'(x,y)* and *Φ(x,y)* in order to take due account of their spatial dependencies and not as $\beta_{(x,y)}$, $\beta'_{(x,y)}$ and $\Phi_{(x,y)}$, as in claim 1.

2. Claim 1 includes the step of *applying a bias correction to a complex phase image of the true phase* θ_{object} *generated by using the true phase* θ_{object} *to decouple fat and water signals from the MR image into individual components.* The correction is carried out on the basis of the spatially dependent bias field *β(x,y)* which is formed by taking the log magnitude of the observed image. This appears to reflect the indication in paragraph [0032] of the published application (or the corresponding statement in paragraph [0016]) according to which *Alternatively, the β inhomogeneity field estimate may be used to correct the complex data and re-project the vector field into water and fat images.*

3. Since the magnitude of the uncorrupted image is *a priori* not known, the bias field intensity for each of the plurality of voxels cannot be determined. The equation relied on in claim 1,

$$\log(|I_{observed}|) = \log(|Iobject|) + \log(|\beta'|),$$

associates one known quantity ($I_{observed}$), which directly derives from the measurements carried out, to two unknown quantities (I_{object} and β'). As a consequence, the determination of the bias correction $\beta(x,y)$ which constitutes a prerequisite for estimating the signal fraction of fat and water, cannot be performed.

4. The appellant's arguments on this point are not persuasive.

5. The Board does not doubt that the teaching in Guillemaud and Brady provides the skilled person with the information required to determine the intensity of the spatially dependent bias field. The present application further appears to contain sufficient information to allow the skilled person to determine, on the basis of this reference, by analogy, the phase $\Phi(x,y)$ inherent to said field $\beta'(x,y)$.

6. However, the teaching in the article of Guillemaud and Brady relies on an approach that is completely different from the one followed by the claimed invention. The method disclosed in this reference relies on an iterative process, in which a first estimation of the image is calculated and then used as a basis for determining a first estimation of the bias field. This is again used to determine a corrected version of the image and so on. Nothing in the article teaches how to directly determine the bias field estimate from the complex phase image ($I_{observed}$).

7. None of the other references cited in the application appear to provide the required information.

8. In the communication of the Board under Article 15 RPBA, the appellant was informed of the Board's misgivings, essentially in the terms set out above (paragraphs 2 - 6).

9. The appellant subsequently informed the Board that it did not intend to attend oral proceedings but made no comment on the Board's observations.

10. The application is, therefore, not sufficiently complete to allow the skilled person to carry out the claimed invention. This is contrary to Article 83 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U.Bultmann P. Scriven

Decision electronically authenticated