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Datasheet for the decision of 6 November 2009

Case Number: T 0932/08 - 3.4.01

Application Number: 05004895.8

Publication Number: 1580572

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Language of the proceedings: EN

Title of invention:
Digital beamforming radar apparatus

Applicant:
FUJITSU TEN LIMITED

Opponent:
-

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

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Case Number: T 0932/08 - 3.4.01

D E C I S I O N
of the Technical Board of Appeal 3.4.01
of 6 November 2009

Appellant: FUJITSU TEN LIMITED
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 27 December 2007 refusing European application No. 05004895.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: H. Wolfrum
Members: P. Fontenay
S. Hoffmann

Summary of Facts and Submissions

I. European patent application 05 004 895.8 (publication No. EP-A-1 580 572) was refused by a decision of the examining division dispatched on 27 December 2007, for the reason of lack of novelty and/or inventive step (Articles 52(1), 54(1) and (2) and 56 EPC 1973) of the subject-matter of the claims then on file.

The examining division had based its decision in particular on documents:

D6 : US-A-4 646 093;
D9 : US-A-5 986 605; and
D10 : EP-A-1 348 978.

II. The applicant lodged an appeal against the decision and paid the prescribed fee on 27 February 2008. On 2 May 2008 a statement of grounds of appeal was filed. The appellant requested the grant of a patent on the basis of an amended set of claims. An auxiliary request for oral proceedings was made.

III. On 17 July 2009 the appellant was summoned to oral proceedings.

In a communication annexed to the summons, the Board gave a preliminary opinion on the issues of novelty and inventive step and drew the appellant's attention to deficiencies concerning added subject-matter (Article 123(2) EPC) and clarity of wording (Article 84 EPC 1973).

IV. In response, the appellant filed by letter of 29 September 2009 a new set of claims 1 to 8 as a main request, and a further amended version of claim 1 as an auxiliary request.

V. Oral proceedings were held on 6 November 2009.

In reaction to objections raised by the Board as to added subject-matter which was introduced by the amendments of 29 September 2009 the appellant filed a new set of claims 1 to 5. As a result of the discussion, the appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the claims filed in the oral proceedings.

VI. Claim 1 of the appellant's request reads as follows:

"*1. A radar apparatus, comprising:*
a transmitting unit (14, 15) comprising an oscillator and a modulator for generating a transmit signal;
a transmitting antenna (11) that emits the transmit signal, in the form of a radio wave, into space;
a receiving antenna (12) receives, as a reception signal, the transmit signal that reaches a target object and is reflected at the target object;
a receiving unit comprising a mixer, a filter and an A/D converter for receiving the reception signals, converting the reception signal into digital signal; and
a signal processing unit (20) that detects a bearing of the target object, based on the digital signal by carrying out a mono-pulse process,
characterized in that
the receiving antenna comprises an array of physically distinguished elements grouped as a first set of the

antenna elements (12_2, 12_3, ...,12_N) and a second set of the antenna elements (12_1, 12_2, ...,12_{N-1}), and

the signal processing unit (20) executes

a first transaction that involves a process of combining signals output from the first set of the antenna elements (12_2, 12_3, ,..,12_N), and

a second transaction that involves a process of combining signals output from the second set of the antenna elements (12_1, 12_2,..,12_{N-1}), and

the mono-pulse process is a phase comparison mono-pulse process that detects the phase difference between a first combined signal derived from the first transaction and a second combined signal derived from the second transaction, and

the first and second sets of the antenna elements are partly shared, wherein the first set of antenna elements (12_2, 12_3, ,..,12_N) consisting of N-1 antenna elements, is formed by shifting the antenna elements by one from the second set of antenna elements (12_1, 12_2,..,12_{N-1}) also consisting of N-1 antenna elements."

Claims 2 to 5 are dependent claims.

VII. The appellant's arguments presented in support of novelty and inventive step for the subject-matter of its request can be summarised as follows:

The radar apparatus according to document D6 did not show a phase comparison mono-pulse processing according to the present invention. In particular, document D6 did not show a plurality of antenna elements grouped as a first set of antenna elements and a second set of antenna elements within the meaning of the present invention but

combined the outputs of all antenna elements arranged in four quadrants. Consequently, document D6 could not disclose the further features of the characterizing portion of claim 1 on file.

Document D9 also concerned a radar apparatus in which the antenna elements were arranged in four quadrants. From Figure 5 of D9 it became evident that the apparatus was not a phase comparison mono-pulse system. As document D6, D9 did not disclose the characterizing features of claim 1. In particular, D9 did not show the concept of shared antennas.

Document D10 concerned a system and method for detecting a radar target of interest in the presence of radar jamming interference. The antenna consisted of an array with elements arranged in plural rows and columns. Apart from the fact that D10 was not a phase comparison mono-pulse system, its antenna structure required significant space, as became particularly apparent from Figure 4 and the corresponding description in paragraph [0017] of D10. In distinction to the teaching of D10, which gave no indication as to how to get an antenna array in a small mounting space, the present invention aimed at an antenna design which was as small as possible and at the same time achieved a high yield. This became possible due to the inventive idea of sharing antenna elements to such an extent that the two sets of antenna elements differed by only one element.

For these reasons, the subject-matter of claim 1 on file was novel with respect to the teachings of any of documents D6, D9 and D10. Moreover, even if the skilled person combined these teachings in any possible manner,

he could not arrive at the claimed subject-matter without the benefit of hindsight.

Reasons for the Decision

1. In the following reference is made to the provisions of the EPC 2000, which entered into force as of 13 December 2007, unless the former provisions of the EPC 1973 still apply to pending applications.

2. The appeal complies with the requirements of Articles 106 to 108 EPC and Rule 99 EPC and is, therefore, admissible.

3. Inventive step (Article 52(1) EPC and Article 56 EPC 1973)

3.1 As is undisputed by the appellant, document D6 (see Figures 1 to 3 and the corresponding description) shows a radar apparatus according to the preamble of claim 1 on file. The known digital beam forming radar apparatus is a mono-pulse system which processes the target signals obtained on four channels from a receiving antenna which is composed of a quadrant array of four antenna elements 12a - 12d (see Figure 2). The respective signals 76a to 76d and 76a' to 76d' received in quadrature are corrected for phase and gain errors so as to become signals C_a to C_d and C_a' to C_d', respectively. These signals are combined in different transactions by way of adder 102 and adder/ subtractors 104 and 106. From the respectively combined signals *inter alia* the phase differences A and B of the target signals which occur between adjacent antenna quadrants are determined (column 10, lines 6 to 46) so as to detect a bearing, such as the azimuth or the

elevation angle (column 7, lines 1 to 8), of the target object. The fact that the apparatus is a mono-pulse system and its signal processing unit determines phase differences between adjacent antenna elements means that, contrary to the appellant's unexplained assertions, the signal processing in the known apparatus includes a phase comparison mono-pulse process in the conventionally recognized meaning of this term.

Moreover, D6 mentions the possibility that each of antenna quadrants is formed in itself by an array of elements (column 3, lines 50 to 52; column 10, lines 53 to 56) and thus constitutes a set of antenna elements. In this modification, in order to deliver a respective common signal 76a to 76d and 76a' to 76d', the signals of each antenna of a set of antenna elements forming a quadrant have to be combined in respective transactions, in analogy to forming the common signal of a phased array of antenna elements or to digital beam forming. Thus, signals C_a to C_d and C_a' to C_d', from which the phase differences A (between quadrants 12a and 12c or 12b and 12d) and B (between quadrants 12a and 12b as well as 12c and 12d) are determined, constitute combined signals that are output from the different sets of antenna elements. Therefore, contrary to the appellant's submission, the receiving antenna of the known apparatus meets the requirement of a grouping into first and second sets of physically distinguished antenna elements and the signal processing unit correspondingly executes first and second transactions, each involving a process of combining signals output from the respective set of antenna elements.

3.2 It follows from the above considerations that the subject-matter of claim 1 on file differs from the radar apparatus known from document D6 only in that the first and second sets of the antenna elements are partly shared, to the extent that one set emerges from the other set by a shifting of but one antenna element.

3.3 In the appellant's view, the claimed subject-matter solved the problem of providing an antenna design which was as small as possible and at the same time achieved a high yield.

It is noted in this respect that, whereas compact construction is indicated as a goal pursued by the present application (see page 4, lines 13 to 16 of the description as filed), high antenna yield is not addressed in the application documents as filed. Instead, a desire for a high degree of freedom in controlling the antenna beams is expressly mentioned (see page 4, lines 3 to 9 of the description as filed).

3.4 An indication that a sharing of antenna elements entails advantages for digital beam forming in a mono-pulse radar apparatus is given by document D10 (see in particular Figures 1 to 4 and the corresponding description). In fact, D10 teaches that increasing the amount by which sub-arrays of antenna elements overlap (*ie*, in the terminology of claim 1 on file, increasing the degree of sharing of antenna elements of the sets of antenna elements) increases the degree of correlation between each overlapped sub-array, and thus increases the degrees of freedom (for the beam forming) (see paragraph [0017]).

Given the fact that documents D6 and D10 concern the same narrow technical field of mono-pulse radar apparatuses employing digital beam forming and that sharing of antenna elements of the different sets as taught by document D10 would involve only straightforward modifications to the software which runs the signal processing unit in the radar apparatus of the apparatus known from document D6, no exercise of inventive skill is required to complement the teaching of document D6 by that of document D10 so as to take advantage in the former radar apparatus of an increase of the degrees of freedom for the digital beam forming. In pursuing this idea, there is apparently an innate upper limit for the maximally obtainable increase of the degrees of freedom and thus for the sharing of antenna elements, that is a shifting of the two antenna sets by but one element.

3.5 The appellant's argument that the receiving antenna of the radar apparatus of document D10 required more space than the receiving antenna of the claimed apparatus is not plausible, given the fact that claim 1 under consideration does not contain any further distinguishing feature in this respect. Moreover, the appellant's observation that D10 did not concern a phase comparison mono-pulse system is immaterial since the choice which signal component (*ie* phase or amplitude) is exploited for the evaluation of the bearing of a target is technically independent from the manner of grouping of antenna elements and of combining signals by which beam forming is established. Thus, the fact that, according to the specific example described in document D10, an amplitude comparison is made would not prevent the skilled person to benefit from an increase in the degrees of freedom for beam forming due to a sharing of antenna elements of sub-

arrays also in the radar apparatus according to document D6.

3.6 For the above reasons, the board has arrived at the conclusion that the subject-matter of claim 1 of the appellant's request on file is rendered obvious by the teachings of documents D6 and D10.

Consequently, the appellant's request is not allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar The Chairman

R. Schumacher H. Wolfrum