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Datasheet for the decision of 21 October 2011

Case Number: T 0770/08 - 3.5.05

Application Number: 05000138.7

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Title of invention:
Receiving apparatus in OFDM transmission system

Applicant:
FUJITSU LIMITED

Headword:
Receiving apparatus in OFDM transmission system/FUJITSU

Relevant legal provisions:
EPC Art. 56, 106, 107, 108

Keyword:
"Main request - Inventive step (no)"
"Auxiliary request 1 - Inventive step (yes) - after amendment"

Decisions cited:
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Case Number: T 0770/08 - 3.5.05

D E C I S I O N
of the Technical Board of Appeal 3.5.05
of 21 October 2011

Appellant: FUJITSU LIMITED
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 16 November 2007 refusing European patent application No. 05000138.7 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: A. Ritzka
Members: M. Höhn
F. Blumer

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division, dispatched on 16 November 2007, refusing European patent application No. 05000138.7 based on Articles 52(1) and 56 EPC having regard to the disclosure of

D1: DUKHYUN KIM ET AL: "Residual ISI cancellation for OFDM with applications to HDTV broadcasting", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE INC. NEW YORK, US, vol. 16, no.8, October 1998, pages 1590-1599, ISSN: 0733-8716; and

D2: HAZY L ET AL: "Synchronization of OFDM systems over frequency selective fading channels", VEHICULAR TECHNOLOGY CONFERENCE, 1997, IEEE 47TH PHOENIX, AZ, USA 4-7 MAY 1997, NEW YORK, NY, USA, IEEE, US, 4 May 1997, pages 2094-2098, ISBN: 0-7803-3659-3.

II. The notice of appeal was received on 7 January 2008. The appeal fee was paid on the same day. The statement setting out the grounds of appeal was received on 11 March 2008. The appellant requested that the appealed decision be reversed and that a patent be granted on the basis of the sets of claims according to the main request or first or second auxiliary requests, all requests as rejected by the examining division. Oral proceedings were requested on an auxiliary basis.

III. A summons to oral proceedings to be held on 21 October 2011 was issued on 20 July 2011. In an annex accompanying the summons the board expressed the preliminary opinion that the subject-matter of the

independent claims did not appear to fulfil the requirements of an inventive step in the light of the disclosures of D1 and D2. Furthermore, the board argued on the basis of

D5: EP 1 065 855 A1 and

D6: YAMAMURA T ET AL: "High mobility OFDM transmission system by a new channel estimation and ISI cancellation scheme using characteristics of pilot symbol inserted OFDM signal", VEHICULAR TECHNOLOGY CONFERENCE, 1999; VTC 1999 - FALL; IEEE VTS 50TH AMSTERDAM, NETHERLANDS 19-22 SEPT. 1999, PISCATAWAY, NJ, USA,IEEE, US, 19 September 1999, pages 319-323, ISBN: 0-7803-5435-4

that the subject-matter of the independent claims appeared to be rendered obvious by D6 combined with either the common general knowledge or with D5.

The board gave its reasons for the objections and stated that the appellant's arguments were not convincing.

IV. With a letter dated 8 September 2011 the appellant withdrew the first auxiliary request, made the former second auxiliary request the new first auxiliary request and filed a new second auxiliary request. The appellant submitted arguments in favour of an inventive step of the independent claims of all requests.

V. Oral proceedings were held on 21 October 2011 in the course of which the appellant filed a new first auxiliary request.

Independent claim 1 according to the main request reads as follows:

"1. A receiving apparatus in an Orthogonal Frequency Division Multiplexing (OFDM) transmission system for receiving and demodulating a transmitted signal that is the result of adding a guard interval of a prescribed length onto a signal obtained by IFFT processing and then transmitting the signal, characterized in that said apparatus comprises:
an arithmetic unit (601a) for calculating correlation between the received signal and a pilot signal as a known signal;
means (601b,601c) for detecting, using a correlation value greater than a threshold value, whether a delayed wave greater than the length of the guard interval has occurred;
means (601d) for making "0" a correlation value that is equal to or less than the threshold value and outputting a delay profile if a delayed wave greater than the length of the guard interval has occurred;
an ISI replica generator (104) for detecting, from the delay profile, a delay-time portion greater than the length of the guard interval as an intersymbol interference (ISI) portion, and generating an ISI replica conforming to this ISI portion;
a subtractor (102) for subtracting the ISI replica from the received signal;
a data demodulator (106) for demodulating data by applying FFT processing to the result of subtraction."

Independent claim 1 according to the new auxiliary request I comprises the following additional features:

"means (201) for applying FFT processing to the output of said subtractor;
means (203) for applying IFFT processing to the result of the FFT processing and outputting a time waveform signal;
means (204) for generating a demodulated—signal restoration replica using the time waveform signal; and
means (205) for inserting the restoration replica into the portion of said subtractor output from which the ISI replica was removed by subtraction; and wherein said data demodulator is adapted to demodulate data by applying FFT processing to a signal that is the result of insertion of the restoration replica."

VI. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request as filed with the statement setting out the grounds of appeal, or, subsidiarily, on the basis of the new auxiliary request I as submitted during the oral proceedings before the board or on the basis of auxiliary request II as submitted with letter dated 8 September 2011.

VII. After due deliberation on the basis of the written submissions and the appellant's arguments presented during the oral proceedings, the board announced its decision.

Reasons for the Decision

1. *Admissibility*

The appeal complies with the provisions of Articles 106 to 108 EPC (see Facts and Submissions, point II above). Therefore the appeal is admissible.

Main Request

2. The board considers publication D6 to be the closest prior art on file. D6 discloses a receiving apparatus (see e.g. figure 6) in a OFDM transmission system, correlation of a received signal and a pilot signal (see correlator in figure 6; page 321, second paragraph of section B) and the use of a guard interval (see figure 2) for ISI cancelation. D6 further discloses the generating of replica of the delayed wave using an estimated delay profile by subtracting the replica from the received signal (see page 321, third paragraph of section B). Thereby the delayed waves are eliminated before FFT. D6 does not explicitly mention the use of a threshold for distinguishing between delayed waves greater or less than the guard interval.

With regard to intersymbol interference (ISI), D6 distinguishes between the INSI part and the ITSI part. ITSI is the part based on delayed waves with a delay greater than symbol duration (see page 319, left-hand column, last paragraph). In case of the use of a guard interval, the ITSI part has a delay greater than the length of the guard interval. This point of view was shared by the appellant (see e.g. letter of 8 September 2011, second paragraph of point 2.1).

2.1 The appellant argued that D6 disclosed a cancelation scheme only for the INSI part. The ITSI part which was comparable to the ISI discussed in the present application was taken care of by inserting a guard interval (see D6, page 319, right-hand column, first paragraph). D6 therefore did not disclose cancelation of the ITSI part.

2.2 The board does not share this point of view for the following reasons. It is correct that D6 discloses the inserting of a guard interval in order to avoid ITSI. However, D6 does not disclose that the guard interval is always chosen so that no ITSI can happen. In contrast, the teaching of D6 comprises a two stage approach. Firstly, it tries to avoid ITSI (by inserting a guard interval) and INSI (by inserting pilot symbols in the transmission data frame) - see D6, page 319, right-hand column, first paragraph. Secondly, for ITSI and INSI that could not be avoided there an additional cancelation scheme is proposed.

2.3 In the board's view according to D6 cancellation of ITSI works the same way as for INSI as described in and with regard to figure 6. This can be concluded in light of the following disclosure in D6 (see page 319, right-hand column, third paragraph): "Moreover, we introduce a cancellation scheme of ITSI and INSI on the basis of the proposed estimation technique. Using these schemes, it is possible to estimate and cancel the interference before FFT at the receiver." (emphasis added).

From this hint in D6 the board concludes that ITSI can happen despite the guard interval, and that the same

principle explicitly disclosed for cancelation of INSI would be applied to cancelation of ITSI.

2.4 The appellant also argued that, in contrast to the claimed subject-matter, D6 disclosed an estimation scheme in which a replica of a complete wave was used (see the sentence bridging pages 6 and 7 of the letter dated 8 September 2011).

While the board agrees that D6 uses a replica of a complete wave, this fact is considered as supporting the board's view that ITSI also is cancelled by the proposed cancelation scheme of D6. If a replica of the whole delayed wave is subtracted from the received signal (see figure 7 of D6) this will automatically effect an ITSI part as well, which is larger than the guard interval. In the board's view the cancelation scheme disclosed in D6 therefore achieves cancelation of ITSI that exceeds the guard interval at least as a bonus effect.

2.5 The distinguishing features of claim 1 with regard to the disclosure of D6 hence are:

- "means for detecting, using a correlation value greater than a threshold value, whether a delayed wave greater than the length of the guard interval has occurred" and
- "means for making "0" a correlation value that is equal to or less than the threshold value and outputting a delay profile if a delayed wave greater than the length of the guard interval has occurred" (in part since outputting a delay profile in general is known from D6) and

- "an ISI replica generator (104) for detecting, from the delay profile, a delay-time portion greater than the length of the guard interval as an intersymbol interference (ISI) portion, and generating an ISI replica conforming to this ISI portion" (in part since generating an ISI replica from a delay profile in general is known from D6).

The objective technical problem underlying the distinguishing features is considered to be adapting the receiver of D6 to only cancel ITSI interference.

2.6 To solve this problem the skilled person would look for a way to distinguish between INSI and ITSI interference. Knowing about the use of correlation values in general from D6, the skilled person further learns from D6 to distinguish between INSI and ITSI (see figures 1 and 2). The board assumes that the skilled person would consider the use of a threshold based on his/her common general knowledge as exemplified by D5 (see column 4, lines 45-55, and column 7, lines 49-55) for this purpose without the need of inventive skills. Dealing only with ITSI would naturally require eliminating the INSI part. Thus, correlation related to INSI interference would have to be neglected, i.e. to be set to zero with the consequence of no longer generating replicas for INSI, but only for the ITSI which is based on delayed waves greater than the guard interval. The skilled person would therefore come up with the solution according to the distinguishing features without the need of an inventive step.

2.7 The subject-matter of claim 1 is therefore obvious in the light of the disclosure of D6 when combined with

the skilled person's common general knowledge (Article 56 EPC).

Auxiliary Request 1

3. Claim 1 of this request is distinguished from the main request by the following features:

means (201) for applying FFT processing to the output of said subtractor;
means (203) for applying IFFT processing to the result of the FFT processing and outputting a time waveform signal;
means (204) for generating a demodulated—signal restoration replica using the time waveform signal; and
means (205) for inserting the restoration replica into the portion of said subtractor output from which the ISI replica was removed by subtraction; and wherein said data demodulator is adapted to demodulate data by applying FFT processing to a signal that is the result of insertion of the restoration replica.

3.1 Support for this amendment is found in original claim 2, in figure 10D and in paragraphs [61] and [62] of the published application.

3.2 The technical effect of the added features is that in addition to inter-symbol interference ISI inter-carrier interference ICI is also cancelled.

3.3 The underlying objective technical problem with regard to D6 can therefore be regarded as adapting the receiver of D6 to only cancel ITSI interference and to further cancel inter-carrier interference.

3.4 Prior art publication D6 neither discloses nor suggests cancelling inter-carrier interference, in particular it does not hint at inserting a restoration replica portion into the subtractor output.

3.5 As far as the disclosure of D1 is concerned, on which the decision under appeal was based, it does not render obvious the subject-matter of claim 1 according to this request.

On the one hand, D1 discloses that residual ISI, i.e. the sum of equation (30), is calculated as a sum from G+1 (i.e. the beginning of the guard interval) to M (M being an assumed maximum channel impulse response length). Even if the sum of equation (30) in D1 becomes zero in case no delays larger than the guard interval occur, this is not caused by a comparison between a delayed wave and the guard interval. D1 therefore does not disclose that the ISI replica is obtained from the delay of the delayed wave.

On the other hand, the board agrees with the appellant (see letter dated 8 September 2011, point 4.2) that D1 does not describe means for applying IFFT-processing to the result of the FFT-processed result of subtraction according to the added features of claim 1. In particular, the examining division's argument referring to step 5 of the RISIC algorithm in D1 does not convince, because this step 5 describes an iteration for cyclic reconstruction, but not a time waveform signal resulting from applying IFFT-processing.

4. Thus, the subject-matter of independent apparatus claim 1 and of corresponding independent method claim 2 is not rendered obvious when starting from publication D6, nor when starting from publication D1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with an order to grant a patent on the basis of claims 1 and 2, submitted as New Auxiliary Request I during the oral proceedings before the board, and a description and drawings to be adapted.

The Registrar The Chair

K. Götz A. Ritzka