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(54) Title: HIGHLY BANDWIDTH–EFFICIENT COMMUNICATIONS

(57) Abstract

A discret multitone stacked–carrier spread spectrum communication method is based on frequency domain spreading including multiplication of a baseband signal by a set of superimposed, or stacked, complex sinusoid carrier waves. In a preferred embodiment, the spreading involves energizing the bins of a large Fast Fourier transform (FFT). This provides a considerable savings in computational complexity for moderate output FFT sizes. Point–to–multipoint and multipoint–to–multipoint (nodeless) network topologies are possible. A code–nulling method is included for interference cancellation and enhanced signal separation by exploiting the spectral diversity of the various sources. The basic method may be extended to include multielement antenna array nulling methods for interference cancellation and enhanced signal separation using spatial separation. Such methods permit directive and retrodirective transmission systems that adapt or can be adapted to the radio environment. Such systems are compatible with bandwidth–on–demand and higher–order modulation formats and use advanced adaptation algorithms. In a specific embodiment the spectral and spatial components of the adaptive weights are calculated in a unified operation based on the mathematical analogy between the spectral and spatial descriptions of the airlink.

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INTERNATIONAL SEARCH REPORT

Int ational Application No
PCT/US 98/03591

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B1/707 H04B7/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JUNG P, KAMMERLANDER K, BERENS F, PLECHINGER J: "On multicarrier CDMA mobile radio systems with joint detection and coherent receiver antenna diversity" 1996 5TH IEEE INTERNATIONAL CONFERENCE ON UNIVERSAL PERSONAL COMMUNICATIONS, vol. 1, September 1996, pages 61-65, XP002073391	1,11,21, 31,41, 51,61, 71,81, 91,101, 109, 111-113, 123,125, 135,143
A	see paragraph I-III	146,147, 151,152, 156,157, 162,167, 171,176, 183,186, 191,194, 204
A		214,224, 234,240,

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 1998	11. 12. 98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bossen, M

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
		246,256

A	US 5 504 775 A (CHOULY ANTOINE ET AL) 2 April 1996	1,11,21, 31,41, 51,61, 71,81, 91,101, 109, 111-113, 123,125, 135,143
A	see column 1, line 27 - column 2, line 37	146,147, 151,152, 156,157, 162,167, 171,176, 183,186, 191,194, 204
A	see column 4, line 55 - column 5, line 24; figure 2	214,224, 234,240, 246,256

A	WO 97 05709 A (QUALCOMM INC) 13 February 1997	1,11,21, 31,41, 51,61, 71,81, 91,101, 109, 111-113, 123,125, 135,143
A	see page 3, line 29 - page 5, line 6	146,150, 151, 155-157, 162,167, 171,176, 183,186, 191,194, 204
A	see page 5, line 19 - page 6, line 21; claims 1,11,21; figure 1	214,224, 234,240, 246,256

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 22662 A (ARRAYCOMM INC) 25 July 1996 see abstract see page 2, line 31 - page 4, line 2 see page 7, line 1 - line 21; figure 1 see page 7, line 38 - page 8, line 29	1,11,21, 31,41, 51,61, 71,81, 91,101, 109, 111-113, 123,125, 135,143, 246,256
A	WO 96 39001 A (ERICSSON TELEFON AB L M) 5 December 1996 see abstract see page 4, line 3 - page 5, line 9 see page 9, line 4 - page 10, line 32; figure 2 see page 13, line 7 - line 32; figure 4 see page 15, line 10 - line 33; figure 5	146,148, 151,153, 156
A	EP 0 582 537 A (IBM) 9 February 1994 see abstract see page 2, line 11 - line 57 see page 3, line 18 - line 23 see page 4, line 49 - line 53 see page 5, line 1 - line 12 see page 5, line 39 - line 47; figure 2	157,160, 162,165, 167,169, 171,174, 176,179, 183,186, 189,191
A	WO 94 05094 A (NOKIA TELECOMMUNICATIONS OY ;POHJAKALLIO PEKKA (FI)) 3 March 1994 see page 6, line 24 - page 7, line 1 see abstract -/--	157,159, 160,162, 164,165, 167-169, 171,173, 174,176, 178,179, 183,186 188,189, 191

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 31009 A (CELSAT AMERICA INC) 3 October 1996 see abstract see page 4, line 9 - line 20 see page 7, line 5 - page 8, line 2 see page 22, line 3 - line 14 see page 23, line 3 - line 11 see page 24, line 1 - page 28, line 9 see page 33, line 4 - line 19; claims 1,5	194,204, 214,224, 234,240
A	EP 0 696 856 A (NIPPON ELECTRIC CO) 14 February 1996 see abstract see page 3, column 3, line 5 - line 23 see page 4, column 6, line 44 - page 6, column 9, line 5; figure 5	194,204, 214,224
A	EP 0 668 664 A (MATSUSHITA ELECTRIC IND CO LTD) 23 August 1995 see abstract see page 3, column 1, line 27 - column 2, line 30; figure 1 see page 3, column 2, line 50 - page 4, column 3, line 2 see page 4, column 3, line 37 - column 4, line 52; figure 2 see page 5, column 5, line 35 - line 46	234,240

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 98/03591

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

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☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 98/03591

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-145, 246-265

   multitone spread spectrum communication method with adaptive despreading using transmission spreading codes based on the despreading codes

2. Claims: 146-156

   call set up procedure

3. Claims: 157-193

   segmented message transfer

4. Claims: 194-233

   updating of the despreading codes at the base station according to functional quality and maintenance signals received from the remote station

5. Claims: 234-245

   closed loop power control

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/03591

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