

(51) International Patent Classification:
H04W 24/08 (2009.01)(21) International Application Number:
PCT/US2014/016011(22) International Filing Date:
12 February 2014 (12.02.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/763,804	12 February 2013 (12.02.2013)	US
61/768,851	25 February 2013 (25.02.2013)	US
61/769,463	26 February 2013 (26.02.2013)	US
61/770,705	28 February 2013 (28.02.2013)	US
61/777,664	12 March 2013 (12.03.2013)	US
61/807,647	2 April 2013 (02.04.2013)	US
61/812,459	16 April 2013 (16.04.2013)	US
61/817,657	30 April 2013 (30.04.2013)	US
14/177,547	11 February 2014 (11.02.2014)	US

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(71) Applicant: **TEXAS INSTRUMENTS INCORPORATED** [US/US]; P. O. Box 655474, Mail Station 3999, Dallas, TX 75265-5474 (US).

(71) Applicant (for JP only): **TEXAS INSTRUMENTS JAPAN LIMITED** [JP/JP]; 24-1, Nishi-Shinjuku 6-chome, Shinjuku-ku Tokyo, 160-8366 (JP).

(72) Inventors: **ONGGOSANUSI, Eko**; 1430 McClure Drive, Allen, TX 75013 (US). **CHEN, Runhua**; 7613 Finch Drive, Plano, TX 75024 (US). **BENDLIN, Ralf**; 3605 Dahoma Drive, Plano, TX 75074 (US).

(74) Agents: **FRANZ, Warren, L.** et al.; Texas Instruments Incorporated, Deputy General Patent Counsel, P.O. Box 655474, Mail Station 3999, Dallas, TX 75265-5474 (US).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

[Continued on next page]

(54) Title: 4TX CODEBOOK ENHANCEMENT IN LTE

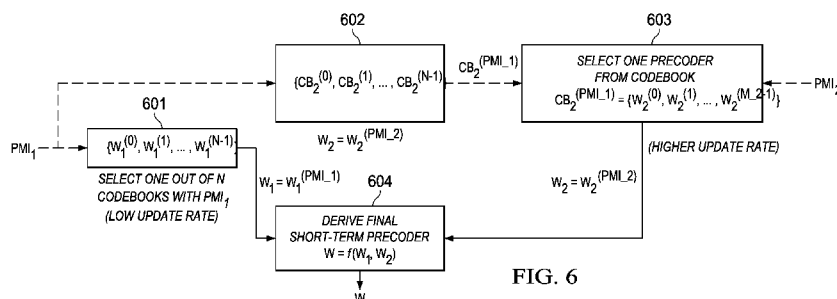


FIG. 6

(57) Abstract: Channel state information (CSI) feedback in a wireless communication system is disclosed. A precoding matrix is generated for multi-antenna transmission based on precoding matrix indicator (PMI) feedback, wherein the PMI indicates a choice of precoding matrix derived from a matrix multiplication of two matrices from a first codebook W_1 and a second codebook W_2 . In one embodiment, the first codebook W_1 comprises at least a first precoding matrix PMI_1 constructed with a first group of adjacent Discrete-Fourier-Transform (DFT) vectors. In another embodiment, the first codebook W_1 comprises at least a second precoding matrix PMI_2 constructed with a second group of uniformly distributed non-adjacent DFT vectors. In yet another embodiment, the first codebook W_1 comprises at least a first precoding matrix PMI_1 and a second precoding matrix PMI_2 , where said first precoding matrix PMI_1 is constructed with a first group of adjacent DFT vectors, and said second precoding matrix PMI_2 is constructed with a second group of uniformly distributed non-adjacent DFT vectors.



(88) Date of publication of the international search report:
18 December 2014

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2014/016011

A. CLASSIFICATION OF SUBJECT MATTER		
H04W 24/08 (2006.01) H03M 13/01 (2006.01) 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)		
H04W 24/00, 24/08, H03M 13/00, 13/01		
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 practicable, search terms used) PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/046144 A1 (ALCATEL LUCEN et al.) 12.04.2012, abstract, p. 1, 3, 4, 9	1-18
A	US 20120219042 A1 (TEXAS INSTRUMENTS INCORPORATED) 30.08.2012	1-18
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
10 October 2014 (10.10.2014)		30 October 2014 (30.10.2014)
Name and mailing address of the ISA/RU: FIPS, Russia, 123995, Moscow, G-59, GSP-5, Berezhkovskaya nab., 30-1 Facsimile No. +7 (499) 243-33-37		Authorized officer V. Aleksandrov Telephone No. 499-240-25-91