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(54) Title: TWO-DIMENSIONAL PLANAR AND CROSSOVER-FREE BEAMFORMING NETWORK ARCHITECTURE

(57) Abstract: An antenna system has a two-dimensional field of view, yet can be implemented on a surface, such as on electronic or photonic integrated circuits. The antenna system includes an array of antennas disposed in a predetermined non-linear pattern and a two-dimensional beamforming network (BFN). The antenna system can be steered/selectively beamformed in two dimensions through beam port selection. The beamforming network is disposed entirely on a single first surface. The beamforming network has a one-dimensional array-side interface disposed on the first surface and a one-dimensional beam-side interface disposed on the first surface. The antennas of the array of antennas are individually communicably coupled to the array-side interface. Segments of the beam-side interface map to respective pixels in the two-dimensional field of view.



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. H01Q3/40 H01Q21/06 H01Q25/00 H04B7/06 ADD.		
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) H01Q H04B G01S		
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) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/263424 A1 (SANFORD JOHN R [US] ET AL) 17 September 2015 (2015-09-17) paragraphs [0003] - [0203]; figures 1-9 -----	1-7, 10-13, 15, 18, 20
X	DE 10 2014 106060 A1 (KARLSRUHER INST FÜR TECHNOLOGIE [DE]) 19 November 2015 (2015-11-19) paragraphs [0001] - [0032]; figures 1-4 -----	1-5, 8-11, 15, 17-21
X	US 2019/132534 A1 (MOEBIUS MICHAEL [US] ET AL) 2 May 2019 (2019-05-02) paragraphs [0071] - [0072]; figures 1-16 -----	1-5, 8-11, 14, 16-18, 20, 21, 32
A	US 2019/109370 A1 (HERSCOVICI NAFTALI [US] ET AL) 11 April 2019 (2019-04-11) paragraphs [0026] - [0069]; figures 1-6 -----	6, 7
☐ 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 application or patent 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 19 January 2022		Date of mailing of the international search report 23/03/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer El-Shaarawy, Heba

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2021/046944

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 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 fees, this Authority did not invite payment of additional fees.
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.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:
1-21, 32

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-21, 32

The enhancement of coupling an optical signal from the antenna system to free space

2. claims: 22-31

The increase of the transmission bit rate.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2021/046944

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