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(54) Title: RADAR LOCATION SYSTEM AND METHOD

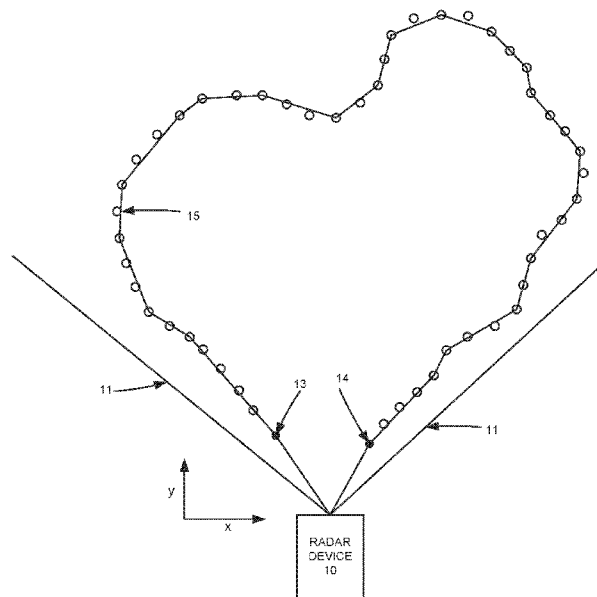


FIG. 3

(57) Abstract: Methods of defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence and/or of determining a height for a body on a surface in a region of interest use radar signals and a configuration mode and a monitoring mode are disclosed. In the configuration mode coordinates for defining a virtual fence are determined and/or a topology of a surface in the region of interest is determined. In the monitoring mode, a location of a second body on the surface is detected to determine if the second body is inside or outside the virtual fence and/or a height of for the second body relative to the determined topology is determined.



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B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G01S G08B		
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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 2003/164790 A1 (KURITA NAOYUKI [JP] ET AL) 4 September 2003 (2003-09-04)	1-3,5-7, 9,10,23, 25,30, 34-36, 38-40, 42,43, 56,58, 63,67
Y	paragraph [0028] - paragraph [0030]; figures 2,4,8	4,8, 13-15, 31,32, 37,41, 46-48, 64,65
A	paragraph [0031]; figure 11 paragraph [0032] - paragraph [0036]; figures 5,6 ----- -/--	21,22, 54,55
☒ 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		
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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 Kaleve, Abraham	

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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.
Y	US 7 463 182 B1 (MORINAGA MITSUTOSHI [JP] ET AL) 9 December 2008 (2008-12-09) column 1, line 22 - line 25 -----	4,8, 13-15, 37,41, 46-48
A	US 6 967 612 B1 (GORMAN JOHN D [US] ET AL) 22 November 2005 (2005-11-22) column 2, line 4 - line 11 -----	4,8, 13-15, 37,41, 46-48
X	KR 101 690 781 B1 (ESSENCO CO LTD [KR]) 29 December 2016 (2016-12-29)	1-6, 8-10, 13-15, 18-20, 23, 25-30, 33-36, 38,39, 41-43, 46-48, 51-53, 56, 58-63, 66,67
Y	paragraph [0016] - paragraph [0081]; figures 1-5	31,32, 64,65
A		21,22, 54,55
A	DE 10 2013 215207 A1 (BOSCH GMBH ROBERT [DE]) 5 February 2015 (2015-02-05) paragraph [0038] - paragraph [0040]; figure 2 -----	18-20, 51-53
X	US 2018/342160 A1 (KOMORI TERUMOTO [JP] ET AL) 29 November 2018 (2018-11-29)	68-79, 82-92, 95,96
A	paragraph [0058] - paragraph [0076]; figures 5,6,7 paragraph [0096] - paragraph [0100]; figure 11 paragraph [0102] - paragraph [0110]; figures 12,13 -----	21,22
A	US 2018/192919 A1 (NAKAYAMA TAKESHI [JP] ET AL) 12 July 2018 (2018-07-12) abstract paragraph [0139] -----	21,22, 54,55, 68-72, 74-86, 88-96
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INTERNATIONAL SEARCH REPORT

International application No

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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	EP 2 784 535 A1 (INSTA ELEKTRO GMBH [DE]) 1 October 2014 (2014-10-01) paragraph [0032]; figure 3 -----	26-29, 59-62
Y	US 2013/002434 A1 (CUDDIHY PAUL EDWARD [US] ET AL) 3 January 2013 (2013-01-03) paragraph [0052] -----	31,32, 64,65 80,81, 93,94

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2020/050130

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.:
1-10, 13-15, 18-23, 25-43, 46-48, 51-56, 58-96
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.:

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: 1-10, 13-15, 23, 25, 30, 34-43, 46-48, 56, 58, 63, 67

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the processor is configured to process the radar signals to identify at least one known signal signature to identify the locations associated with the at least one first body.

2. claims: 11, 44

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein, in the monitoring mode, the processor is configured to process the radar signals to detect the location of the second body traversing the surface by determining that the second body is moving and detecting the location of the moving second body.

3. claims: 12, 45

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the processor is configured to determine whether the second body is inside or outside the virtual fence by generating a projection and counting the number of times the projection crosses the virtual fence, an odd number of crossings indicating that the second body is located inside the virtual fence and an even or zero number of crossings indicating that the second body is located outside the virtual fence.

4. claims: 16, 17, 49, 50

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the processor is configured to process the identified locations of the at least one first body to define the virtual fence as a polygon by approximating a plurality of identified locations as a lesser plurality of locations with paths there between defining the polygon.

5. claims: 18-20, 51-53

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the radar signals comprise 3D radar signals, and the processor is configured to identify the locations associated

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

with the at least one first body in 3D,
 - wherein the processor is configured in the configuration mode to determine a plane of best fit to map the identified locations onto the plane for the determination of the virtual fence in the plane, and in the monitoring mode to identify locations associated with the second body in 3D and to map the locations associated with the second body onto the plane for the determination of whether the second body is inside or outside the virtual fence in the plane, or
 - wherein the processor is configured in the configuration mode to identify locations associated with the at least one first body in 3D to provide coordinates for the virtual fence in 3D and to process the identified locations to define the virtual fence in 3D, and in the monitoring mode to identify locations associated with the second body in 3D and to determine if the second body is inside or outside the 3D virtual fence.

6. claims: 21, 22, 54, 55, 68-96

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the identified locations associated with the at least one first body are associated with a single first body and are at a known height above the surface, and the processor is configured in the configuration mode to determine a topology of the surface using the identified locations associated with the at least one first body in 3D and the known height.

7. claims: 24, 57

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the processor is configured to receive an input from a user interface to modify at least some of the coordinates determined from the identified locations to define the virtual fence.

8. claims: 26-29, 59-62

A processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; wherein the processor is configured in the configuration mode to define at least one further virtual fence, and in the monitoring mode to detect the location of the second body to determine if the second body is inside or outside the at least one further virtual fence.

9. claims: 31-33, 64-66

A system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the system comprising: a radar antenna configuration to emit radiation and detect the emitted radiation reflected from the at least one first body and the second body as radar signals, and a processing system for defining a virtual fence and for detecting a body inside or outside a region of interest defined by the virtual fence, the processing system comprising: an input to receive radar signals from a radar antenna configuration; and a processor to operate in a configuration mode to process the radar signals to identify locations that lie along a boundary of a region of interest across a surface and are associated with at least one first body, and to process the identified locations to determine coordinates for defining the virtual fence, and to operate in a monitoring mode to process the radar signals to detect a location of a second body on the surface to determine if the second body is inside or outside the virtual fence; including a passive infrared sensor device for sensing a human or animal body as the second body in the proximity of the virtual fence and for outputting a detection signal,

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

wherein the processor is configured to be in a dormant low power or off state mode and to be responsive to the detection signal to switch to the monitoring mode.

INTERNATIONAL SEARCH REPORT

Information on patent family members

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