(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 October 2015 (01.10.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/147629 A1

(51) International Patent Classification:
G08G 1/01 (2006.01)

(21) International Application Number:
PCT/MY2015/050009

(22) International Filing Date:
27 February 2015 (27.02.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI2014700745 27 March 2014 (27.03.2014) MY

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(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, 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, ST, 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).

Published:

— *with international search report (Art. 21(3))*

(54) Title: VEHICLE MONITORING SYSTEM AND METHOD THEREOF

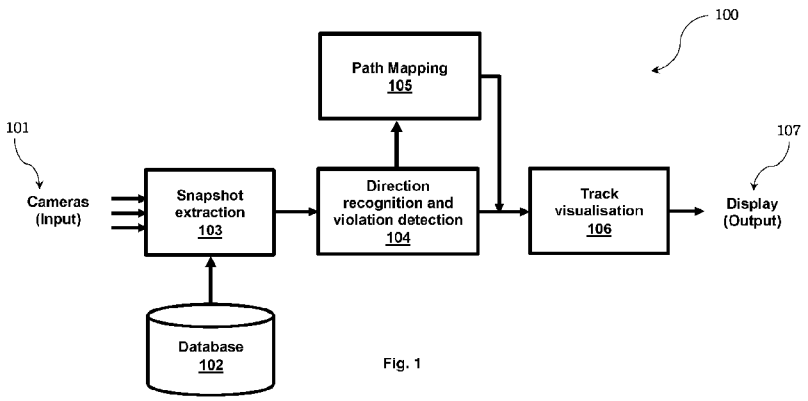

Fig. 1

(57) Abstract: A vehicle monitoring system (100) which comprises: a plurality of cameras (101), identifiers and locations of which being stored in a database (102), disposed at different locations in an area under monitoring for acquiring videos of traffic; a module (103) for extracting, from the videos, snapshots of a vehicle; a module (104) for recognising travelling direction of the vehicle, and detecting violation of the travelling direction; a module (105) for mapping travelling path of the vehicle; and a module (106) for visualising track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time. A method (200) for monitoring vehicle is also disclosed.

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VEHICLE MONITORING SYSTEM AND METHOD THEREOF

This invention relates to a monitoring system, more specifically, vehicle monitoring system which is efficient and user friendly.

BACKGROUND OF THE INVENTION

An increasing crime rate calls for safeguarding of residences and commercial areas. Despite setting up lodges in which guards are deployed for checking or spot-checking incoming and outgoing vehicles, crimes such as burglary still occurs occasionally. As a result of a large ratio of monitoring area to number of guards, the guards at services tend to oversee suspicious moves of vehicles driven by craftily disguised burglars. Catering for the demand for a more efficient system and method in monitoring vehicle within a constrained region, innovators invented various computerised vehicle monitoring systems and methods.

WO 2009030892 A2 discloses a method of monitoring traffic on a road. Said method comprises the first step of capturing a plurality of images of the road using a camera mounted on a viewing point, and associating a time of capture with each image. The second step includes determining, from the captured images, the positions of the portions of the road surface visible from the viewpoint at the front and rear extremities of the extent of a vehicle in the captured images at two different times, and determining from the positions and times of the instants at least one characteristic of the vehicle or its motion, such as the vehicle length, speed or a vehicle classification, i.e. truck, car, motorcycle, etc.

US 20100245125 A1 discloses systems, methods, and computer program products which provide for surveillance, traffic monitoring, and red light enforcement. In one embodiment, the system may monitor zones of interest; capture, time stamp, and store images of the zones of interest; determine that an event has occurred within one of the zones of interest; and request the stored images of the zone of interest during the occurring time of the event.

None of the above-mentioned inventions is tailor-made to monitor vehicles in a bounded area where traffic density is relatively low. Furthermore, existing systems employ a plurality of monitors for displaying the traffic images at locations where cameras are deployed. Guards being deployed at a lodge generally face difficulty in tracking vehicles which appear irregularly on the monitors. Besides, a large amount of monitors pose difficulty for the guards to locate occurrence of an event.

SUMMARY OF THE INVENTION

According to the invention, the problems are solved by a vehicle monitoring system which comprises: a plurality of cameras, identifiers and locations of which being stored in a database, disposed at different locations in an area under monitoring for acquiring videos of traffic; a module for extracting, from the videos, snapshots of a vehicle; a module for recognising travelling direction of the vehicle, and detecting violation of the travelling direction; a module for mapping travelling path of the vehicle; and a module for visualising track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time.

Preferably, the module for recognising travelling direction of the vehicle, and detecting violation of the travelling direction, also post-processes the snapshots, such that in each snapshot displayed the vehicle is marked with a square, labelled with the travelling direction and the status of violation of travelling direction.

Advantageously, the visual representation is rendered based on a three-dimensional map of the area under monitoring.

The invention also provides a method for monitoring vehicle, which comprises steps of: acquiring videos of traffic by a plurality of cameras disposed at different locations in an area under monitoring; extracting,

from the videos, snapshots of a vehicle; recognising the travelling direction of the vehicle, and detecting violation of travelling direction; mapping the travelling path of the vehicle; and visualising the track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time.

Advantageously, the step of recognising the travelling direction of the vehicle, and detecting violation of travelling direction, is succeeded by a step of post-processing the snapshots, such that in each snapshot displayed the vehicle is marked with a square, labelled with the travelling direction and the status of violation of travelling direction.

Preferably, the rendering of the visual representation is based on a three-dimensional map of the area under monitoring.

Advantageously, the snapshots of the vehicle are extracted from the videos by steps of: obtaining, from the database, identifiers and locations of the cameras; receiving videos from the cameras; converting the video into frames of still images; scanning the images and recognising a moving vehicle by comparing the backgrounds in the images; and extracting the snapshots of the vehicle from the images, and storing the snapshots in a memory.

Preferably, the travelling direction of the vehicle is recognised by employing a reference line virtualised transversely across the travelling path of the vehicle, said recognition comprises steps of: checking if the vehicle crosses the line; determining the travelling direction by comparing it to a predetermined direction; and caching the travelling direction of the vehicle determined in previous step.

Advantageously, the violation of travelling direction is detected by employing region analysis which comprises steps of: checking, within a predetermined region encompassing the reference line, movement sequence of the vehicle; determining if the sequence violates a

predetermined sequence of movement; and caching the status determined in previous step, of the violation of travelling direction.

Preferably, the region analysis is succeeded by a snapshot post-processing procedure which comprises steps of: obtaining a snapshot from the memory; marking the vehicle in the snapshot with a square, and labelling the snapshot with the travelling direction and the status of violation of travelling direction; and storing the post-processed snapshot in the memory.

Advantageously, the travelling path of the vehicle is mapped by steps of: obtaining information of the vehicle, including vehicle location, travelling direction, and status of violation of travelling direction and its occurring time; associating the information to locations in the visual representation, and determining the travelling path of the vehicle in the visual representation; categorising the travelling path as of travelling direction conformable or reverse to the predetermined direction; and assigning dissimilar colour to the travelling path of each category.

Preferably, the track of the vehicle is visualised by steps of: obtaining information from the path mapping module, and rendering the visual representation based on said information; and retrieving the snapshots from the memory, and displaying them sequentially according to time the vehicle passes each location where the camera acquires the videos from.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram showing a vehicle monitoring system according to the invention;

Fig. 2 is a flowchart showing a vehicle monitoring process according to the invention;

Fig. 3 is a flowchart showing a snapshot extraction process;

Fig. 4 is a flowchart showing a process for recognising travelling direction and detecting violation of travelling direction;

Fig. 5 is a schematic diagram showing recognition of travelling direction using a reference line virtualised across a travelling path, and two vehicles travelling in opposite directions conformable to predetermined directions;

Fig. 6 is a schematic diagram showing detection of travelling direction using region analysis, and a vehicle travelling in a direction which conforms to a predetermined direction;

Fig. 7 is a schematic diagram showing detection of travelling direction using region analysis, and a vehicle travelling in a direction which is not conformable to the predetermined direction;

Fig. 8 is a schematic diagram showing a process for obtaining a vehicle snapshot from still images stored in a memory;

Fig. 9 is a schematic diagram showing a process for marking the vehicle in the snapshot with a square, labelling the snapshot with the travelling direction and the status of violation of travelling direction, and storing the post-processed snapshot in the memory;

Fig. 10 is a flowchart showing a process for mapping travelling path of the vehicle;

Fig. 11 is a flowchart showing a process for visualising track of the vehicle; and

Fig. 12 is showing snapshots of the vehicle displayed sequentially, and a three-dimensional visual representation depicting travelling path of the vehicle.

As shown in Fig. 1, the vehicle monitoring system 100 comprises a plurality of cameras 101, a database 102, a snapshot extraction module 103, a module 104 for direction recognition and violation detection, a path mapping module 105, a track visualisation module 106, and displays 107.

In order to acquire videos of traffic, the cameras 101 are disposed at different locations in an area under monitoring. Identifiers and locations of the cameras 101 are stored in the database 102, allowing the snapshot extraction module 103 to identify and locate the cameras 101, and extract snapshots from the videos. After that, the subsequent module 104 recognises travelling direction and detects any violation of travelling direction. The same module 104 also post-processes the snapshots in a way such that each snapshot displayed is a post-processed snapshot, in which the vehicle is marked with a square, labelled with the travelling direction and the status of violation of travelling direction. The path mapping module 105 maps the travelling path of the vehicle, whereas the track visualisation module 106 displays the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera 101 acquires the videos from, and renders visual representation, in which vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time are denoted. The visual representation is rendered based on a three-dimensional map of the area under monitoring. A display means 107 comprised of a plurality of monitors is employed to output the track visualisation of the vehicle.

As shown in Fig. 2, the vehicle monitoring process 200 starts with a first step 201 of acquiring videos of traffic by a plurality of cameras disposed at different locations in an area under monitoring. This is followed by a second step 202 of extracting, from the videos, snapshots of a vehicle. The process is continued by a third step 203 of recognising the travelling direction of the vehicle, and detecting violation of travelling direction. This is followed by a fourth step 204 of mapping the travelling path of the vehicle. The process is continued with a fifth step 205 of visualising the track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time. The process

concludes with a sixth step 206 of outputting the vehicle track visualisation on monitors.

As shown in Fig. 3, the snapshot extraction process 202 starts with a first step 301 of obtaining, from the database, identifiers and locations of the cameras. This is followed by a second step 302 of receiving the videos from the cameras, and a third step 303 of converting the videos into frames of still images. The process is continued by a fourth step 304 of scanning the images and recognising a moving vehicle by comparing the backgrounds in the images. The process concludes with a fifth step 305 of extracting the snapshot of the vehicle from the images, and storing the snapshots in a memory.

Referring to Fig. 4 and 5, the process 203 for recognising travelling direction employs a reference line 501 which is virtualised transversely across the travelling path 502a, 502b of the vehicle 503a, 503b. The process starts with a first step 401 of checking if the vehicle 503a, 503b crosses the line. It follows with a second step 402 of determining the travelling direction 504a, 504b of the vehicle by comparing the travelling direction 504a, 504b of the vehicle to a predetermined direction 505a, 504b. The process concludes with a third step 403a, 403b of caching, in a memory, the travelling direction 504a, 504b of the vehicle determined in the previous step.

Referring to Fig. 4, 6, and 7, the process for detecting violation of travelling direction employs region analysis. The process begins with a first step of checking, within a predetermined region 600, encompassing the reference line 501, movement sequence of the vehicle 503a. This is followed by a second step 404 of determining if the sequence violates a predetermined sequence of movement. The process concludes with a third step 405a, 405b of caching the status of the violation of travelling direction.

Referring to Fig. 4, 8 and 9, the post-processing procedure comprises a first step 406 of obtaining a snapshot 801 from the memory 802. It is followed by a second step 407 of marking the vehicle 901 in the snapshot 801 with a square 902, and labelling the snapshot 801 with the travelling

direction 903 and the status of violation (not shown in Fig. 9) of travelling direction. The procedure concludes with a third step 408 of storing the post-processed snapshot 904 in the memory 905.

As shown in Fig. 10, the path mapping process 204 starts with a first step 1001 of obtaining information of the vehicle, including vehicle location, travelling direction, and status of violation of travelling direction and its occurring time. The process is continued by a second step 1002a, 1002b of associating the information to locations in the visual representation and determining the travelling path of the vehicle in the visual representation. This is followed by a third step 1003a, 1003b of categorising the travelling path into two categories, i.e. first category which contains travelling path whose travelling direction is conformable to the predetermined direction, and second category which contains travelling path whose travelling direction is reverse to the predetermined direction. The process concludes with a fourth step 1004a, 1004b of assigning green to the travelling path of the first category, and red to that of the second.

As shown in Fig. 11, the process 205 for visualising the track of the vehicle starts with a first step 1101 of obtaining information from the path mapping module. This is followed by a second step 1102 of retrieving the snapshots from the memory, and displaying them sequentially. The process concludes with a third step 1103 of rendering a three-dimensional visual representation.

As shown in Fig. 12, a plurality of monitors 1201 display the snapshots 1202 of the vehicle sequentially, said snapshots 1202 being arranged according to time the vehicle passes each location where the camera acquires the videos from. Bottom portion of the figure shows a three-dimensional visual representation 1203, in which vehicle location, travelling direction and path, status of violation of travelling direction and its occurring time are denoted.

CLAIMS

1. A vehicle monitoring system (100) comprising:

a plurality of cameras (101), identifiers and locations of which being stored in a database (102), disposed at different locations in an area under monitoring for acquiring videos of traffic;

a module (103) for extracting, from the videos, snapshots of a vehicle;

a module (104) for recognising travelling direction of the vehicle, and detecting violation of the travelling direction;

a module (105) for mapping travelling path of the vehicle; and

a module (106) for visualising track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time.

2. A system (100) as claimed in claim 1, wherein the module (104) for recognising travelling direction of the vehicle, and detecting violation of the travelling direction, also post-processes the snapshots, such that in each snapshot displayed the vehicle is marked with a square, labelled with the travelling direction and the status of violation of travelling direction.

3. A system (100) as claimed in claim 2, wherein the visual representation is rendered based on a three-dimensional map of the area under monitoring.

4. A method (200) for monitoring vehicle, comprising steps of:

acquiring (201) videos of traffic by a plurality of cameras disposed at different locations in an area under monitoring;

extracting (202), from the videos, snapshots of a vehicle;

recognising (203) the travelling direction of the vehicle, and detecting (203) violation of travelling direction;

mapping (204) the travelling path of the vehicle; and

visualising (205) the track of the vehicle by displaying the snapshots of the vehicle sequentially according to time the vehicle passes each location where the camera acquires the videos from, and rendering visual representation which denotes vehicle location, travelling direction and path, and status of violation of travelling direction and its occurring time.

5. A method (200) as claimed in claim 4, wherein the step (203) of recognising the travelling direction of the vehicle, and detecting violation of travelling direction, is succeeded by a step of post-processing the snapshots, such that in each snapshot displayed the vehicle is marked with a square, labelled with the travelling direction and the status of violation of travelling direction.

6. A method (200) as claimed in claim 5, wherein the rendering of the visual representation is based on a three-dimensional map of the area under monitoring.

7. A method (200) as claimed in claim 6, wherein the snapshots of the vehicle are extracted from the videos by steps of:

obtaining (301), from the database, identifiers and locations of the cameras;

receiving (302) videos from the cameras;

converting (303) the videos into frames of still images;

scanning (304) the images and recognising a moving vehicle by comparing the backgrounds in the images; and

extracting (305) the snapshots of the vehicle from the images, and storing (305) the snapshots in a memory.

8. A method (200) as claimed in claim 7, wherein the travelling direction (504a, 504b) of the vehicle is recognised by employing a reference line (501) virtualised transversely across the travelling path (502a, 502b) of the vehicle, said recognition comprises steps of:

checking (401) if the vehicle crosses the line;

determining (402) the travelling direction by comparing it to a predetermined direction; and

caching (403a, 403b) the travelling direction of the vehicle determined in previous step.

9. A method (200) as claimed in claim 8, wherein the violation of travelling direction is detected by employing region analysis which comprises steps of:

checking, within a predetermined region (600) encompassing the reference line (501), movement sequence of the vehicle;

determining (404) if the sequence violates a predetermined sequence of movement; and

caching (405a, 405b) the status determined in previous step, of the violation of travelling direction.

10. A method (200) as claimed in claim 9, wherein the region analysis is succeeded by a snapshot post-processing procedure which comprises steps of:

obtaining (406) a snapshot from the memory;

marking (407) the vehicle in the snapshot with a square, and labelling (407) the snapshot with the travelling direction and the status of violation of travelling direction; and

storing (408) the post-processed snapshot in the memory.

11. A method (200) as claimed in claim 10, wherein the travelling path of the vehicle is mapped by steps of:

obtaining (1001) information of the vehicle, including vehicle location, travelling direction, and status of violation of travelling direction and its occurring time;

associating (1002a) the information to locations in the visual representation, and determining (1002b) the travelling path of the vehicle in the visual representation;

categorising (1003a, 1003b) the travelling path as of travelling direction conformable or reverse to the predetermined direction; and

assigning (1004a, 1004b) dissimilar colour to the travelling path of each category.

12. A method (200) as claimed in claim 11, wherein the track of the vehicle is visualised by steps of:

obtaining (1101) information from the path mapping module, and rendering (1103) the visual representation based on said information; and

retrieving (1102) the snapshots from the memory, and displaying (1102) them sequentially according to time the vehicle passes each location where the camera acquires the videos from.

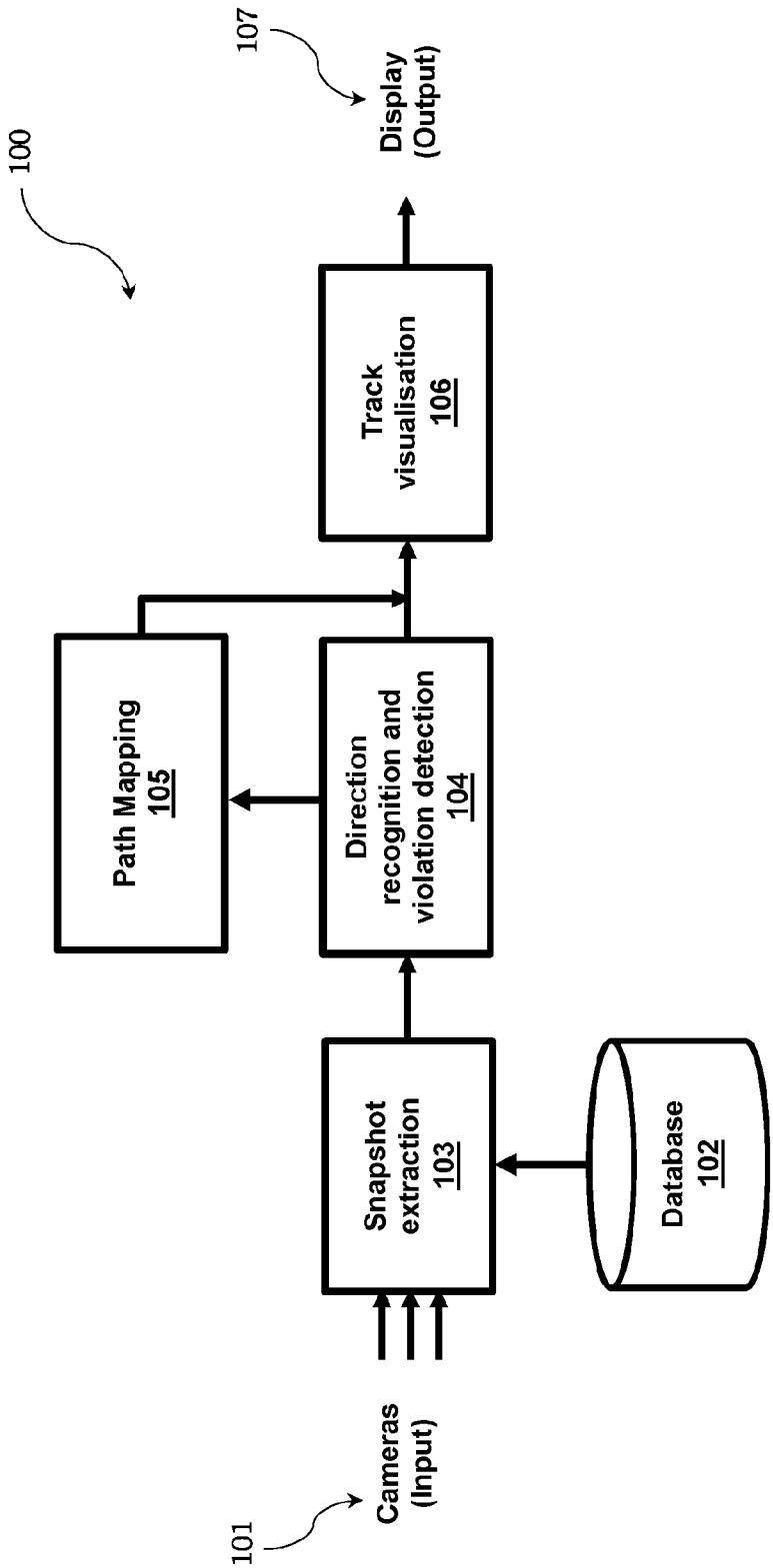
100
107
Display (Output)
Track visualisation 106
Path Mapping 105
Direction recognition and violation detection 104
Snapshot extraction 103
Database 102
101
Cameras (Input)

Fig. 1

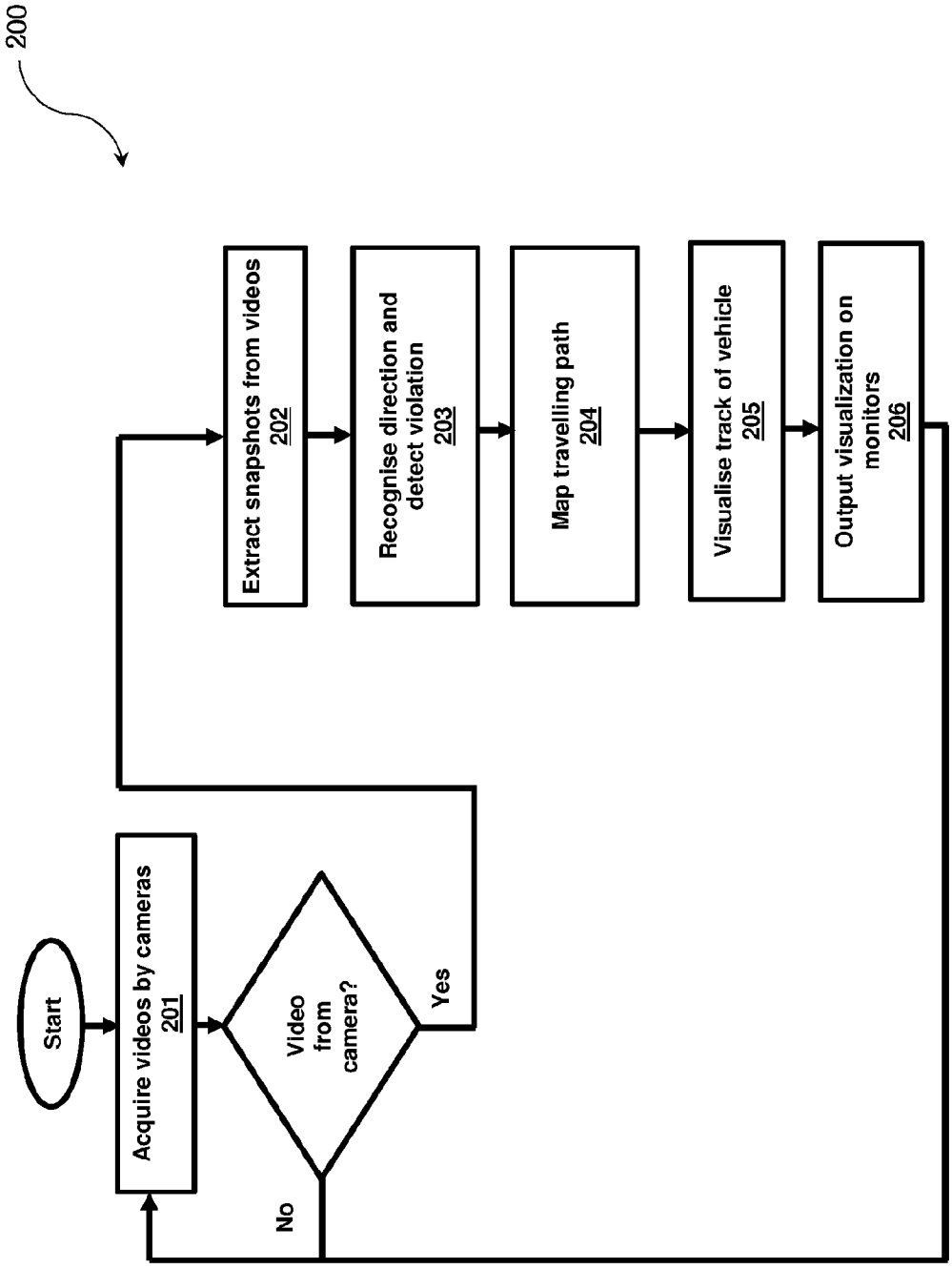
200
Start
Acquire videos by cameras 201
Video from camera?
Yes
No
Extract snapshots from videos 202
Recognise direction and detect violation 203
Map travelling path 204
Visualise track of vehicle 205
Output visualization on monitors 206

Fig. 2

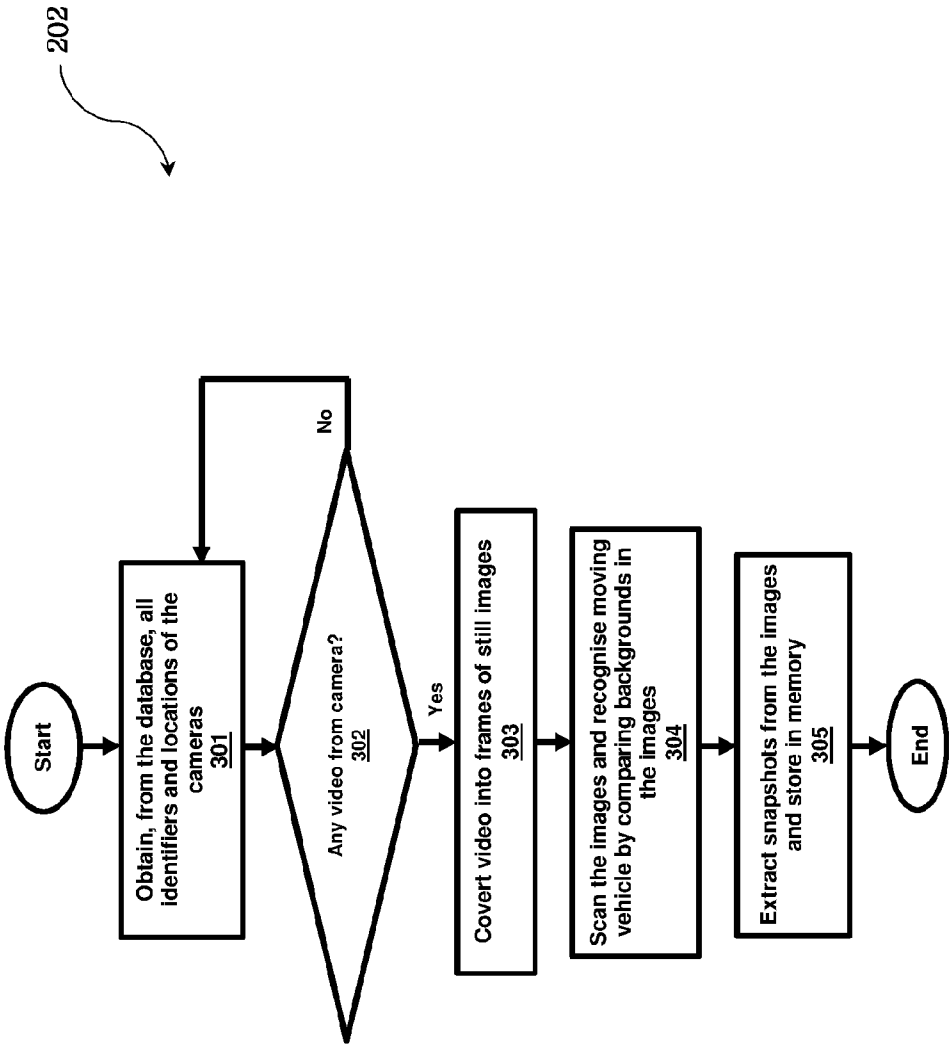
202
Start
Obtain, from the database, all identifiers and locations of the cameras
301
Any video from camera?
302
No
Yes
Covert video into frames of still images
303
Scan the images and recognise moving vehicle by comparing backgrounds in the images
304
Extract snapshots from the images and store in memory
305
End

Fig. 3

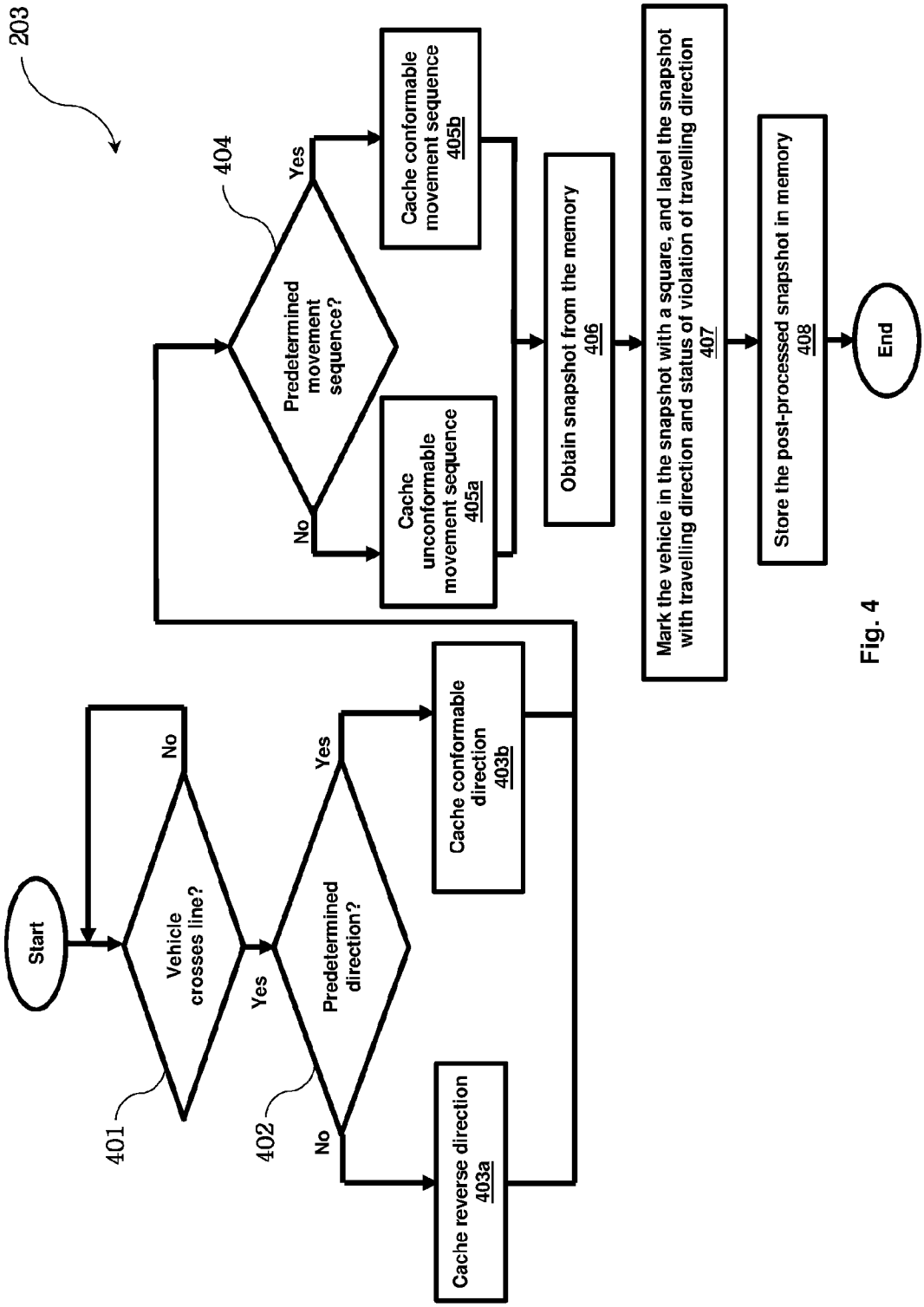
203
Start
Vehicle crosses line?
401
No
Yes
Predetermined direction?
402
No
Yes
Cache reverse direction 403a
Cache conformable direction 403b
Predetermined movement sequence?
404
No
Yes
Cache unconformable movement sequence 405a
Cache conformable movement sequence 405b
Obtain snapshot from the memory 406
Mark the vehicle in the snapshot with a square, and label the snapshot with travelling direction and status of violation of travelling direction 407
Store the post-processed snapshot in memory 408
End

Fig. 4

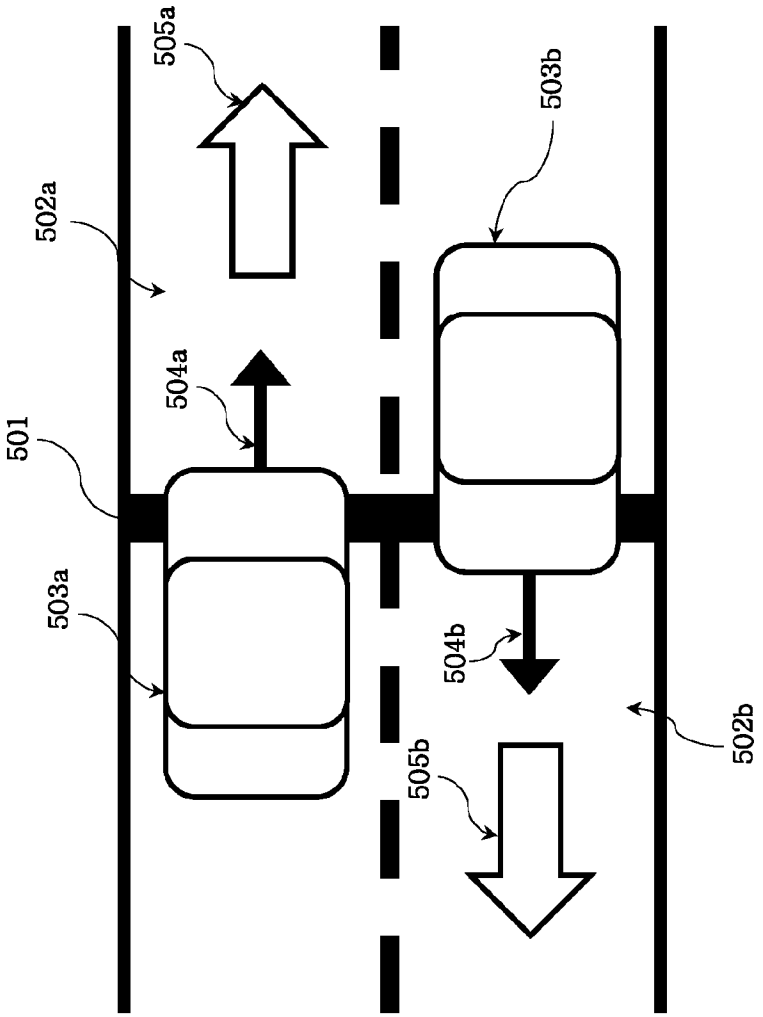

Fig. 5

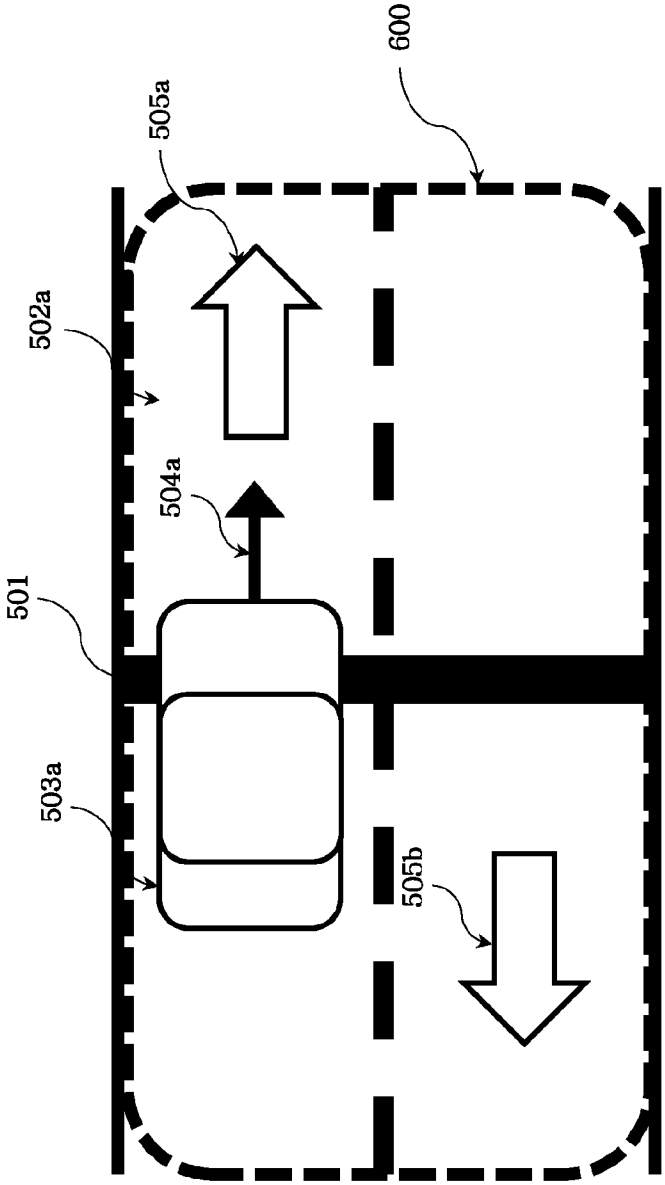

Fig. 6

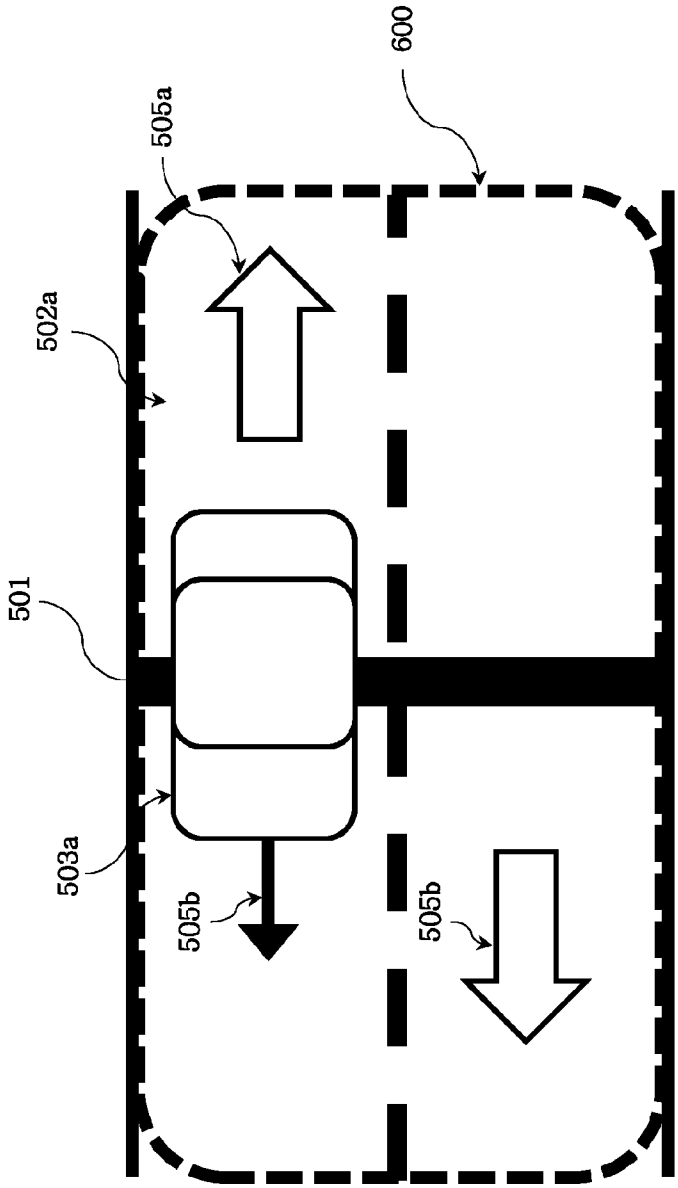

Fig. 7

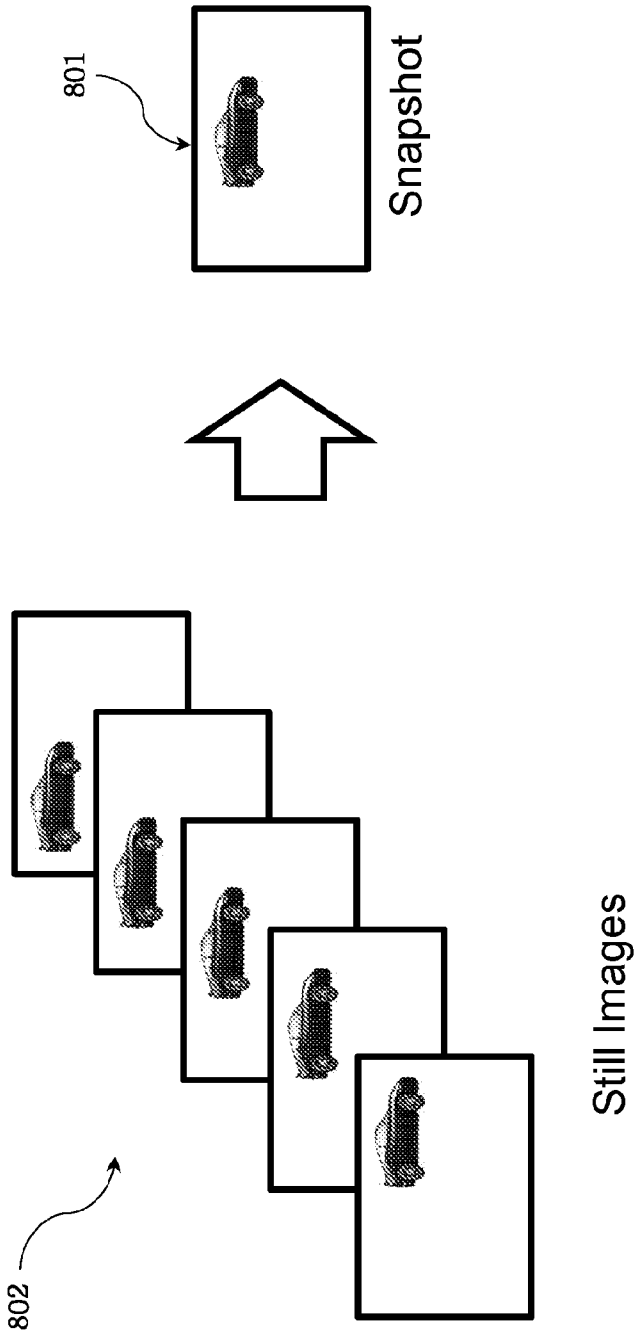

Fig. 8

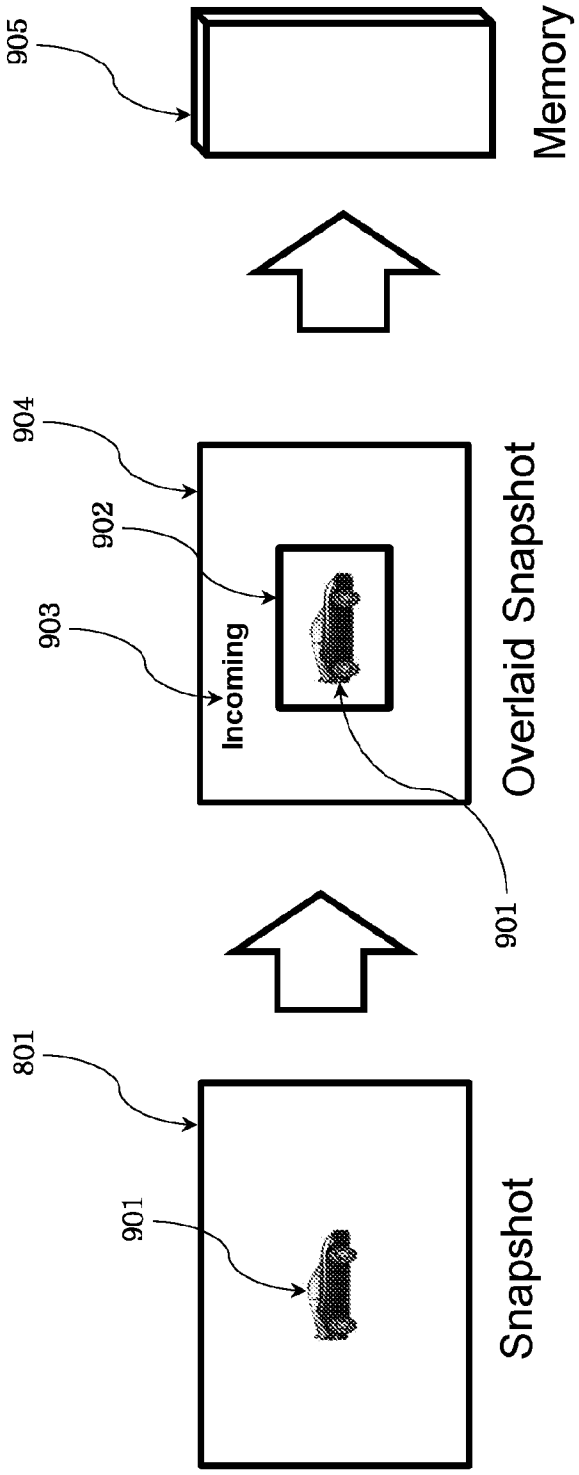
905
Memory
904
902
903
Incoming
Overlaid Snapshot
901
801
901
Snapshot

Fig. 9

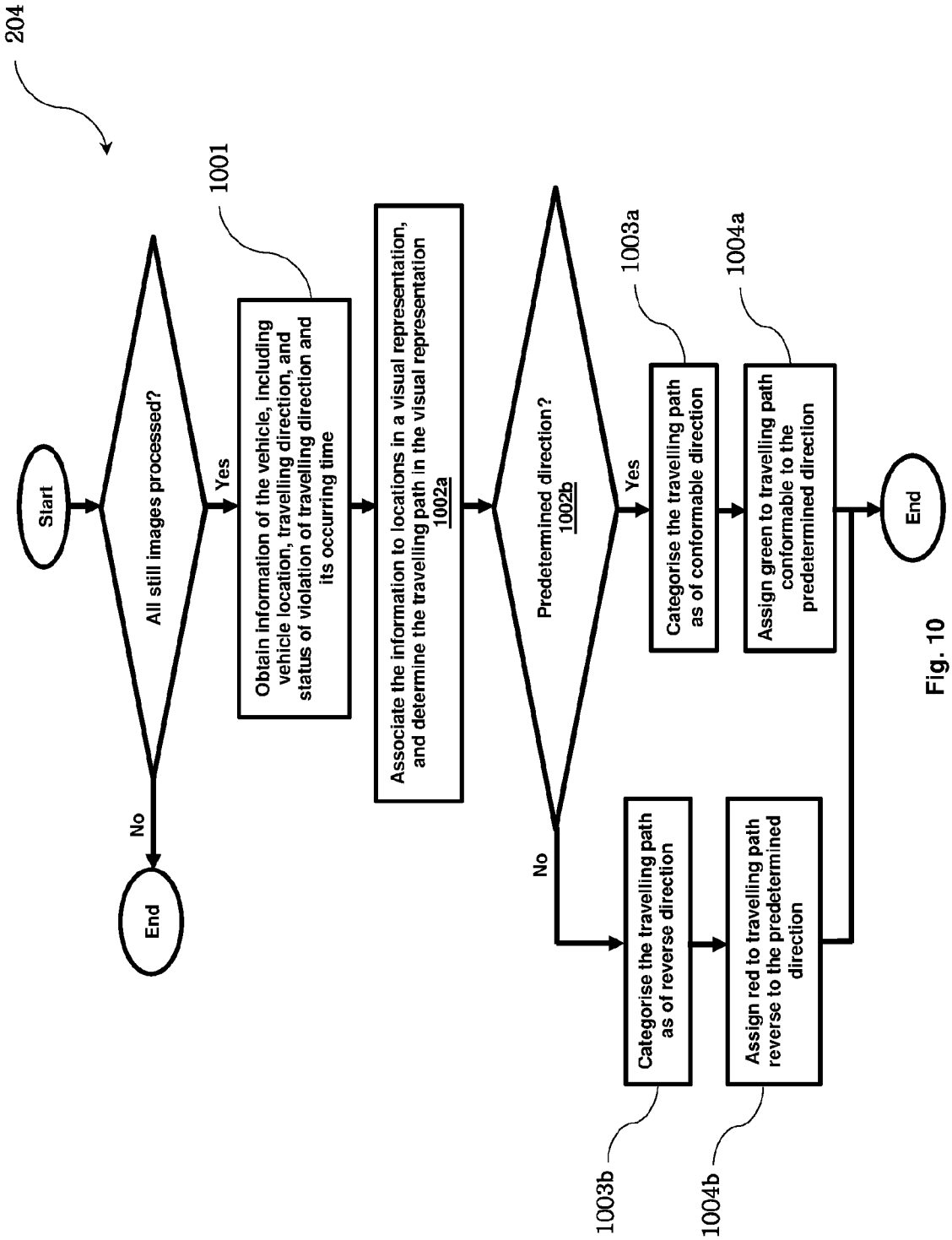
204
Start
All still images processed?
Yes
No
End
1001
Obtain information of the vehicle, including vehicle location, travelling direction, and status of violation of travelling direction and its occurring time
Associate the information to locations in a visual representation, and determine the travelling path in the visual representation 1002a
Predetermined direction? 1002b
Yes
No
1003a
Categorise the travelling path as of conformable direction
1004a
Assign green to travelling path conformable to the predetermined direction
1003b
Categorise the travelling path as of reverse direction
1004b
Assign red to travelling path reverse to the predetermined direction
End

Fig. 10

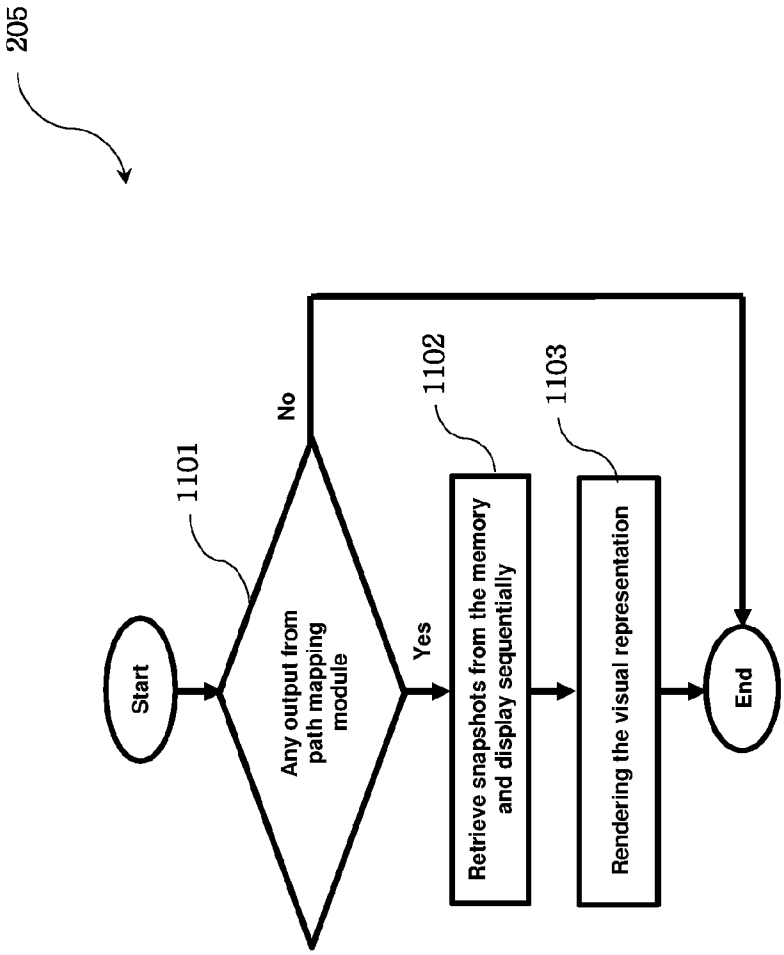
205
Start
1101
Any output from path mapping module
No
Yes
1102
Retrieve snapshots from the memory and display sequentially
1103
Rendering the visual representation
End

Fig. 11

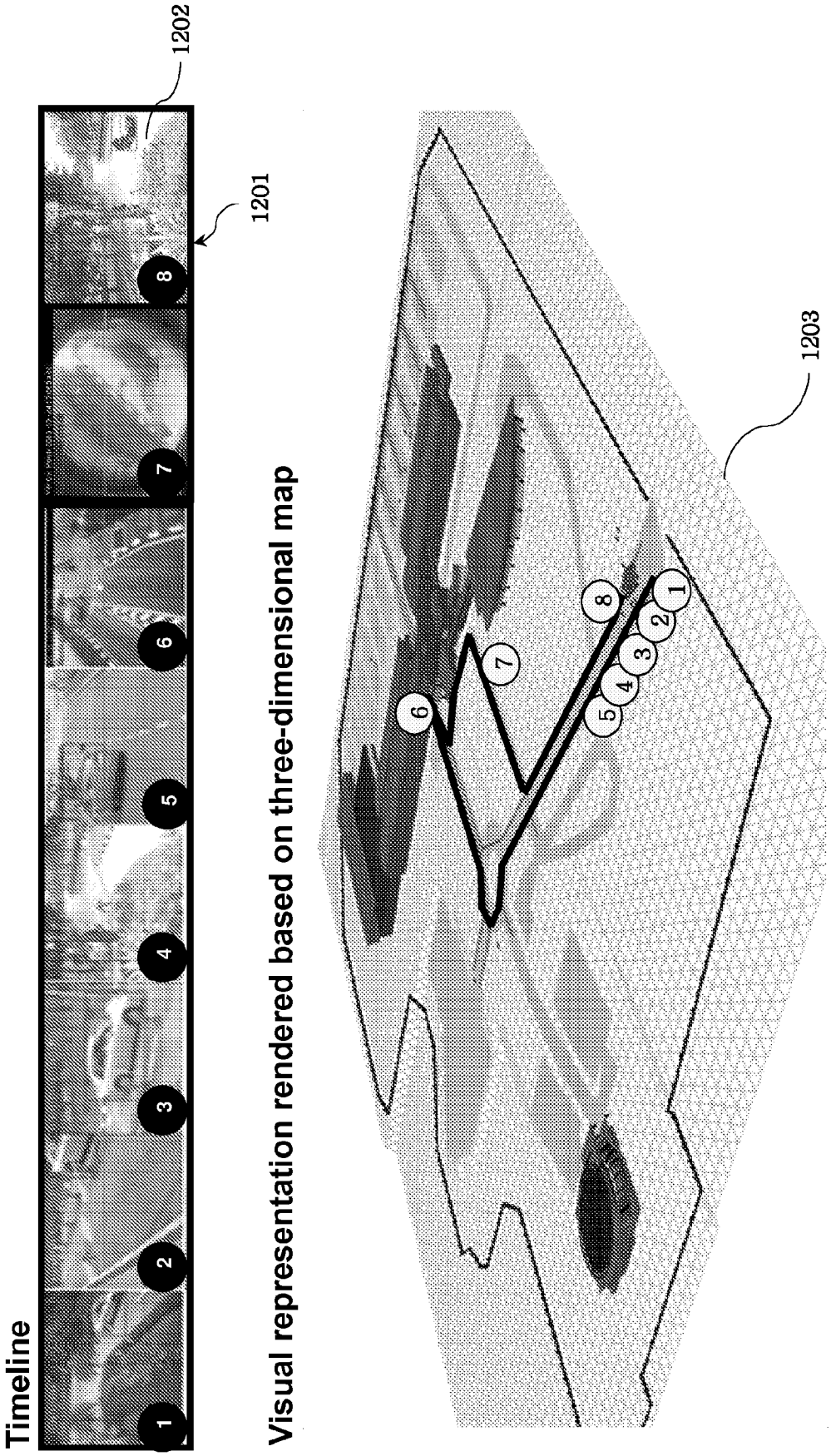
Timeline
1202
1201
Visual representation rendered based on three-dimensional map
1203
1
2
3
4
5
6
7
8

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2015/050009

A. CLASSIFICATION OF SUBJECT MATTER

G08G 1/01 (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)

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)

WPI, Espace, Google patents, EPODOC, Google scholar - IPC, Inventor & keywords- camera, monitor, sense, map, track, record, image, plot, direction, bearing, time, sequence, wrong, incorrect, violation and other like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

[X] 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

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Date of the actual completion of the international search	Date of mailing of the international search report
11 May 2015	11 May 2015
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Patrick Roberts AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262256150

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/MY2015/050009**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/007762 A1 (TAN) 09 January 2014 Whole document, especially pages 4, 10-14	1-12
X	US 6690294 B1 (ZIERDEN) 10 February 2004 Whole document, especially columns 4, 8-9	1-12
X	CN 101593422 A (WUXI JUNPEN TECHNOLOGY CO LTD [CN]) 02 December 2009 English abstract retrieved from EPODOC	1-12
X	JP H1125390 A (KOKUSAI ELECTRIC CO LTD) 29 January 1999 English abstract retrieved from EPODOC	1-12
X	CN 102622884 A (HANGZHOU DIANZI UNIVERSITY) 01 August 2012 English abstract retrieved from EPODOC	1-12

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/MY2015/050009**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2014/007762 A1	09 January 2014		
US 6690294 B1	10 February 2004	US 6914541 B1	05 Jul 2005
CN 101593422 A	02 December 2009	CN 101593422 B	01 Dec 2010
JP H1125390 A	29 January 1999		
CN 102622884 A	01 August 2012		

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.