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(54) METHOD AND SYSTEM FOR CHECKING IF A VEHICLE HAS OVERTAKEN AT LEAST ANOTHER VEHICLE

(57) The present invention concerns a method and system for checking if a vehicle has overtaken at least another vehicle in a portion of road. The invention:
- obtains, from a first image capturing device, a first sequence of images of the vehicles,
- executes an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determines a first ordered list according to the order of the vehicles in the first sequence of images,
- memorizes the first ordered list,
- obtains, from a second image capturing device, a second sequence of images of the vehicles,
- executes an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determines a second ordered list according to the order of the vehicles in the second sequence of images,
- memorizes the second ordered,
- compares the first and second ordered lists,
- determines if a vehicle has overtaken at least another vehicle in a portion of road if the first and second ordered lists are different.

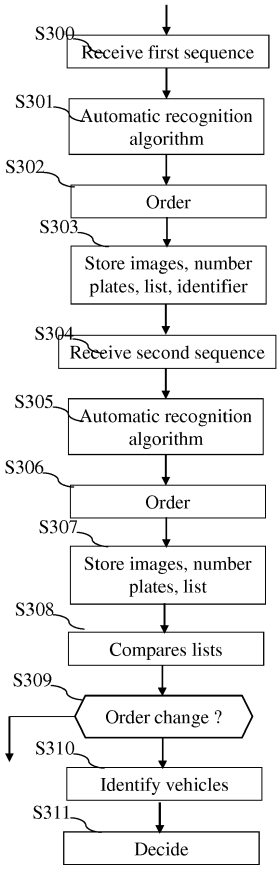

Fig. 3

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Description

[0001] The present invention relates generally to a method and a system for checking if a vehicle has overtaken at least another vehicle in a portion of road.

[0002] Overtaking or passing is the act of one vehicle going past another slower moving vehicle, travelling in the same direction, on a road. The lane used for overtaking another vehicle is almost always a passing lane further from the road shoulder which is to the left in places that drive on the right and to the right in places that drive on the left.

[0003] On a single carriageway/undivided carriageway road, the lane used for overtaking is often the same lane that is used by oncoming traffic, and it is often only advisable to overtake on long straightaways with plenty of visibility.

[0004] In some countries, the "overtaking zone" is indicated by a single broken centerline (yellow or white in most countries) if overtaking is allowed in either direction, or paired with a single solid line beside it to indicate there is no overtaking from the solid side. On a dual carriageway/divided carriageway highway/motorway or arterial road, any lane can be an overtaking lane though in many places undertaking (overtaking on the side furthest from the road centre line) is prohibited. Lanes are normally separated by broken lines (usually white) but may be a single solid white to indicate lane-changing is allowed but discouraged.

[0005] Overtaking may for example be prohibited in tunnels, in crossing, when a pedestrian crossing is marked on the carriageway.

[0006] In some areas, overtaking may also be prohibited for particular vehicles, like for example trucks.

[0007] Despite overtaking is limited in some areas, some drivers do not respect such prohibition and may cause dangerous or painful circulation conditions for other drivers.

[0008] For example, despite overtaking is prohibited on dual carriageway for trucks, some truck drivers overtake other trucks and generate circulation slowdown for other vehicles like for example cars. Such truck drivers are aware that police enforcement is not present at that time.

[0009] For example, it is sometimes allowed for trucks to overtake, but it is still pain for the cars as during overtaking, trucks speed down the traffic. Truck traffic generates more stress for the road itself than cars. In the example of highways, when big trucks use the middle lane, they create more damage on the road than when there are using the right lane. It should be then interesting to be able to detect such behaviour in order to take necessary measures, like for example, adapt the toll fee of the highway to the use of the different lanes of the highway.

[0010] The present invention aims to overcome the aforementioned problems in order to provide an automatic system that is able to detect vehicle overtaking control system.

[0011] To that end, the present invention concerns a method

[0012] for checking if a vehicle has overtaken at least another vehicle in a portion of road, characterized in that the method comprises the steps of:

- obtaining, from a first image capturing device, a first sequence of images of the vehicles,
- executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determining a first ordered list of the extracted visual characteristics according to the order of the vehicles in the first sequence of images,
- memorizing the first ordered list,
- obtaining, from a second image capturing device, a second sequence of images of the vehicles,
- executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determining a second ordered list of the extracted visual characteristics according to the order of the vehicles in the second sequence of images,
- memorizing the second ordered list,
- comparing the first and second ordered lists,
- determining if a vehicle has overtaken at least another vehicle in a portion of road if the first and second ordered lists are different.

[0013] The present invention also concerns a system for checking if a vehicle has overtaken at least another vehicle in a portion of road, characterized in that the system comprises:

- means for obtaining, from a first image capturing device, a first sequence of images of the vehicles,
- means for executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- means for determining a first ordered list of the extracted visual characteristics according to the order of the vehicles in the first sequence of images,
- means for memorizing the first ordered list,
- means for obtaining, from a second image capturing device, a second sequence of images of the vehicles,
- means for executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- means for determining a second ordered list of the extracted visual characteristics according to the order of the vehicles in the second sequence of images,
- means for memorizing the second ordered list,
- means for comparing the first and second ordered lists,
- means for determining if a vehicle has overtaken at

least another vehicle in a portion of road if the first and second ordered lists are different.

[0014] Thus, it is possible to detect overtaking of a portion of road automatically. Furthermore, the present invention may use existing camera systems classically used for monitoring traffic.

[0015] According to a particular feature, the at least one visual characteristic is the model of the vehicle and/or the colour of the vehicle and/or an equipment of the vehicle and/or a distinctive sign of the vehicle.

[0016] According to a particular feature, the at least one visual characteristic is the number plate of the vehicle.

[0017] According to a particular feature, the method further comprises the step of determining the type of vehicles in the ordered lists and the determining step determines if the vehicle has overtaken at least another vehicle in the portion of road only for one type of vehicle.

[0018] Thus, it is possible to limit the detection of overtaking only to a predetermined type of vehicles.

[0019] According to a particular feature, the method comprises further step of determining if at least one visual characteristic is not in both ordered lists plates and the determining step determines if the vehicle has overtaken at least another vehicle in the portion of road according to the result of the determining if at least one visual characteristic is not in both ordered lists.

[0020] Thus, the present invention takes into account that one vehicle may stop and avoids that false overtaking detection is performed in such situation.

[0021] According to a particular feature, the first sequence of images is obtained during a first time duration, the second sequence of images is obtained during a second time duration and the second time duration is at most 30% longer than the first time duration.

[0022] Thus, the present invention avoids that too long lists are determined.

[0023] According to a particular feature, the first and second image capturing devices are separated by a given distance and the first time duration is determined according to the given distance and an authorized speed limitation in the given distance.

[0024] Thus, the present invention avoids that too long lists are determined.

[0025] According to a particular feature, the type of each vehicle is determined according to the number plate of the vehicle.

[0026] According to a particular feature, the type of each vehicle is determined according to a vehicle shape determination step.

[0027] The characteristics of the invention will emerge more clearly from a reading of the following description of an example embodiment, the said description being produced with reference to the accompanying drawings, among which:

Fig. 1 represents a portion of road in which the present invention is implemented according to the present invention;

Fig. 2 is a diagram representing the architecture of a server in which the present invention is implemented;

Fig. 3 discloses an example of an algorithm executed by the server according to the present invention;

Fig. 4 discloses an example of an order list of vehicles determined from a first group of received images;

Fig. 5 discloses a first example of an order list of vehicles determined from a second group of received images;

Fig. 6 discloses a second example of an order list of vehicles determined from a second group of received images.

[0028] **Fig. 1** represents a portion of road in which the present invention is implemented according to the present invention.

[0029] In the example of Fig. 1, a first and a second image capturing devices CA1 and CA2 are located along a portion of road.

[0030] The image capturing devices CA1 and CA2 may be classical cameras that are used for controlling the traffic along the portion of road or may be Automatic Number Plate Recognition (ANPR) cameras.

[0031] The portion or road may be a tunnel, a crossing, a pedestrian crossing, a single or multiple carriageway.

[0032] The image capturing devices CA1 and CA2 are linked to a server Serv through a telecommunication network not shown in Fig. 1.

[0033] In the example of Fig. 1, four vehicles VH1, VH2, VH3 and VH4 are represented.

[0034] The image capturing device CA1 takes a sequence of images which comprises at least one image of a visual characteristic of the vehicle VH1, followed by at least another image of a visual characteristic of vehicle VH2, followed by at least another image of a visual characteristic of vehicle VH3 and followed by at least another image of the a visual characteristic of vehicle VH4.

[0035] The visual characteristic is the model of the vehicle and/or the colour of the vehicle and/or an equipment of the vehicle and/or a distinctive sign of the vehicle and/or the number plate of the vehicle.

[0036] The vehicles VH1 and VH2 are for example trucks and the vehicles VH3 and VH4 are for example cars.

[0037] The sequence of images captured by the image capturing device CA1 is named hereinafter the first sequence of images.

[0038] The first sequence of images is transferred to the server Serv or if the image capturing device CA1 is an Automatic Number Plate Recognition camera, a first ordered list of number plates according to the order of the vehicles in the first sequence of images is transferred to the server Serv.

[0039] If the server Serv receives the first sequence of

images, the server Serv executes an automatic recognition algorithm in order to extract a visual characteristic of each vehicle.

[0040] If the visual characteristic is a number plate, the server Serv executes an automatic number plate recognition algorithm in order to extract figures and characters of the number plate of each vehicle VH1 to VH4.

[0041] The server Serv determines a first ordered list according to the order of the vehicles in the first sequence of images.

[0042] The server Serv memorizes the first ordered list.

[0043] The first ordered list comprises at first the visual characteristic of the vehicle VH1, followed by the visual characteristic of the vehicle VH2, followed by the visual characteristic of the vehicle VH3 and followed by the visual characteristic of the vehicle VH4.

[0044] The image capturing device CA2 takes a sequence of images which comprises at least one image of the vehicle VH4, followed by at least another image of the vehicle VH3, followed by at least another image of the vehicle VH2 and followed by at least another image of the vehicle VH1.

[0045] The sequence of image captured by the image capturing device CA2 is named hereinafter the second sequence of images.

[0046] The second sequence of images is transferred to the server Serv or if the image capturing device CA2 is an Automatic Number Plate Recognition camera, a second ordered list of number plates according to the order of the vehicles in the second sequence of images is transferred to the server Serv.

[0047] If the server Serv receives the second sequence of images, the server Serv executes an automatic recognition algorithm in order to extract a visual characteristic of each vehicle.

[0048] If the visual characteristic is a number plate, the server Serv executes an automatic number plate recognition algorithm in order to extract figures and characters of the number plate of each vehicle VH1 to VH4 and determines a second ordered list according to the order of the vehicles in the second sequence of images.

[0049] The server Serv memorizes the second ordered list.

[0050] The second ordered list comprises at first the visual characteristic of the vehicle VH4, followed by the visual characteristic of the vehicle VH3, followed by the visual characteristic of the vehicle VH2 and followed by the visual characteristic of the vehicle VH1.

[0051] The server Serv compares the first and second ordered lists and determines if a vehicle has overtaken at least another vehicle in the portion of road if the vehicles in the first and second ordered lists have a different order.

[0052] For example, the first sequence of images is obtained during a first time duration, the second sequence of images is obtained during a second time duration and the second time duration is at most 30% longer than the first time duration.

[0053] For example, the first and second image capturing devices CA1 and CA2 are separated by a given distance and the first time duration is determined according to the given distance and an authorized speed limitation in the given distance.

[0054] **Fig. 2** is a diagram representing the architecture of a server in which the present invention is implemented.

[0055] The server Serv has, for example, an architecture based on components connected together by a bus 201 and a processor 200 controlled by the program as disclosed in Fig. 3.

[0056] The bus 301 links the processor 200 to a read only memory ROM 202, a random access memory RAM 203, a map module 206 and a network interface 204.

[0057] The memory 203 contains registers intended to receive variables and the instructions of the program related to the algorithm as disclosed in Fig. 3.

[0058] The read only memory 202 contains instructions of the program related to the algorithm as disclosed in Fig. 3, which are transferred, when the server Serv is powered on, to the random access memory 203.

[0059] Any and all steps of the algorithm described hereafter with regard to Fig. 3 may be implemented in software by execution of a set of instructions or program by a programmable computing machine, such as a PC (*Personal Computer*), a DSP (*Digital Signal Processor*) or a microcontroller; or else implemented in hardware by a machine or a dedicated component, such as an FPGA (*Field-Programmable Gate Array*) or an ASIC (*Application-Specific Integrated Circuit*).

[0060] In other words, the server Serv includes circuitry, or a device including circuitry, causing the server Serv to perform the steps of the algorithm described hereafter with regard to Fig. 3.

[0061] **Fig. 3** discloses an example of an algorithm executed by the server according to the present invention.

[0062] The present algorithm is disclosed in an example wherein it is executed by the processor 200 of the server Serv.

[0063] At step S300, the processor 200 receives through the network interface I/F 204 a first sequence of images which comprises at least one image of the vehicle VH1, followed by at least another image of vehicle VH2, followed by at least another image of the vehicle VH3 and followed by at least another image of the vehicle VH4.

[0064] At step S301, the processor 200 executes an automatic recognition algorithm in order to extract a visual characteristic of each vehicle VH1 to VH4 and determines at step S302 a first ordered list according to the order of the vehicles in the first sequence of images.

[0065] In a variant, if the image capturing device CA1 is an Automatic Number Plate Recognition camera, the processor 200 receives through the network interface I/F 204 a first ordered list of number plates according to the order of the vehicles in the first sequence of images.

[0066] At step S303, The server Serv memorizes the first ordered list.

[0067] At step S304, the processor 200 receives

through the network interface I/F 204 a second sequence of images which comprises at least one image of the vehicle VH4, followed by at least another image of the vehicle VH3, followed by at least another image of the vehicle VH2 and followed by at least another image of the vehicle VH1.

[0068] At step S305, the processor 200 executes an automatic number plate recognition algorithm in order to extract a visual characteristic of each vehicle VH1 to VH4 and determines at step S306 a second ordered list according to the order of the vehicles in the second sequence of images.

[0069] In a variant, if the image capturing device CA2 is an Automatic Number Plate Recognition camera, the processor 200 receives through the network interface I/F 204 a second ordered list of number plates according to the order of the vehicles in the first sequence of images.

[0070] At step S307, the processor 200 memorizes the second ordered list.

[0071] The second ordered list comprises at first the visual characteristic of the vehicle VH41, followed by the visual characteristic of the vehicle VH3, followed by the visual characteristic of the vehicle VH2 and followed by the visual characteristic of the vehicle VH1.

[0072] At step S308, the server Serv compares the first and second ordered lists and determines at step S309, if a vehicle has overtaken at least another vehicle in the portion of road if the vehicles in the first and second ordered lists have a different order.

[0073] If the vehicles in the first and second ordered lists have a different order, the processor 200 moves to step S310. Otherwise, the processor 200 returns to step S300.

[0074] At step S310, the processor 200 identifies the vehicle or the vehicles which have overtaken at least one other vehicle.

[0075] **Fig. 4** discloses an example of an order list of vehicles determined from a first group of received images.

[0076] In the first ordered list of Fig. 4, the visual characteristic of the vehicle VH1 has the first rank, the visual characteristic of the vehicle VH2 has the second rank, the visual characteristic of the vehicle VH3 has the third rank and the visual characteristic of the vehicle VH4 has the fourth rank.

[0077] **Fig. 5** discloses a first example of an order list determined from a second group of received images.

[0078] In the second ordered list of Fig. 5, the visual characteristic of the vehicle VH4 has the first rank, the visual characteristic of the vehicle VH3 has the second rank, the visual characteristic of the vehicle VH2 has the third rank and the visual characteristic of the vehicle VH1 has the fourth rank.

[0079] The processor 200 identifies the vehicle VH4 which has overtaken the vehicles VH3, VH2 and VH1.

[0080] The processor 200 identifies the vehicle VH3 which has overtaken the vehicles VH2 and VH1.

[0081] The processor 200 identifies the vehicle VH2 which has overtaken the vehicle VH1.

[0082] **Fig. 6** discloses a second example of an order list of vehicles determined from a second group of received images.

[0083] In the second ordered list of Fig. 6, the visual characteristic of the vehicle VH4 has the first rank, the visual characteristic of the vehicle VH3 has the second rank and the visual characteristic of the vehicle VH2 has the third rank. The visual characteristic of the vehicle VH1 is not in the second ordered list as it may have a stop.

[0084] The processor 200 identifies the vehicle VH4 which has overtaken the vehicles VH3, VH2.

[0085] The processor 200 identifies the vehicle VH3 which has overtaken the vehicles VH2.

[0086] The processor 200, by consulting a database comprising the number plates, determines the vehicles VH1 and VH2 as being trucks and the vehicles VH3 and VH4 as being cars.

[0087] In a variant, instead of consulting the database, a shape recognition algorithm may be applied on at least the second sequence of images in order to determine the type of vehicle.

[0088] At step S311, the processor 200 determines which vehicle has to be verbalized.

[0089] In a variant, the processor 200 determines for which vehicle an extra toll fee has to be received.

[0090] In some cases, overtaking is forbidden for only a type of vehicle, for example trucks.

[0091] According to the example of Fig. 5, if overtaking is forbidden for any kind of vehicle, the processor 200 decides to verbalize the vehicles VH4, VH3 and VH2. If overtaking is forbidden for only trucks, the processor 200 decides to verbalize the vehicle VH2.

[0092] According to the example of Fig. 6, if overtaking is forbidden for any kind of vehicle, the processor 200 decides to verbalize the vehicles VH4 and VH3. If overtaking is forbidden for only trucks, the processor 200 decides not to verbalize vehicles.

[0093] Naturally, many modifications can be made to the embodiments of the invention described above without departing from the scope of the present invention.

Claims

1. Method for checking if a vehicle has overtaken at least another vehicle in a portion of road, **characterized in that** the method comprises the steps of:

- obtaining, from a first image capturing device, a first sequence of images of the vehicles,
- executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determining a first ordered list of the extracted visual characteristics according to the order of the vehicles in the first sequence of images,
- memorizing the first ordered list,

- obtaining, from a second image capturing device, a second sequence of images of the vehicles,
- executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- determining a second ordered list of the extracted visual characteristics according to the order of the vehicles in the second sequence of images,
- memorizing the second ordered list,
- comparing the first and second ordered lists,
- determining if a vehicle has overtaken at least another vehicle in a portion of road if the first and second ordered lists are different.

2. Method according to claim 1, **characterized in that** the at least one visual characteristic is the model of the vehicle and/or the colour of the vehicle and/or an equipment of the vehicle and/or a distinctive sign of the vehicle.

3. Method according to claim 1, **characterized in that** the at least one visual characteristic is the number plate of the vehicle.

4. Method according to claim 2 or 3, **characterized in that** the method further comprises the step of determining the type of vehicles in the ordered lists and the determining step determines if the vehicle has overtaken at least another vehicle in the portion of road only for one type of vehicle.

5. Method according to any of the claims claim 1 to 4, **characterized in that** the method comprises further step of determining if at least one visual characteristic is not in both ordered lists and the determining step determines if the vehicle has overtaken at least another vehicle in the portion of road according to the result of the determining if at least one visual characteristic is not in both ordered lists.

6. Method according to any of the claims 1 to 5, **characterized in that** the first sequence of images is obtained during a first time duration, the second sequence of images is obtained during a second time duration and **in that** the second time duration is at most 30% longer than the first time duration.

7. Method according to claim 6, **characterized in that** the first and second image capturing devices are separated by a given distance and **in that** the first time duration is determined according to the given distance and an authorized speed limitation in the given distance.

8. Method according to any of the claims 4 to 7, **characterized in that** the type of each vehicle is determined according to the number plate of the vehicle.

9. Method according to claim 4, **characterized in that** the type of each vehicle is determined according to a vehicle shape determination step.

10. System for checking if a vehicle has overtaken at least another vehicle in a portion of road, **characterized in that** the system comprises:

- means for obtaining, from a first image capturing device, a first sequence of images of the vehicles,
- means for executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- means for determining a first ordered list of the extracted visual characteristics according to the order of the vehicles in the first sequence of images,
- means for memorizing the first ordered list,
- means for obtaining, from a second image capturing device, a second sequence of images of the vehicles,
- means for executing an automatic recognition algorithm in order to extract the at least one visual characteristic of each vehicle,
- means for determining a second ordered list of the extracted visual characteristics according to the order of the vehicles in the second sequence of images,
- means for memorizing the second ordered list,
- means for comparing the first and second ordered lists,
- means for determining if a vehicle has overtaken at least another vehicle in a portion of road if the first and second ordered lists are different.

9. Computer program which can be directly loadable into a programmable device, comprising instructions or portions of code for implementing the steps of the method according to claims 1 to 9, when said computer program is executed on a programmable device.

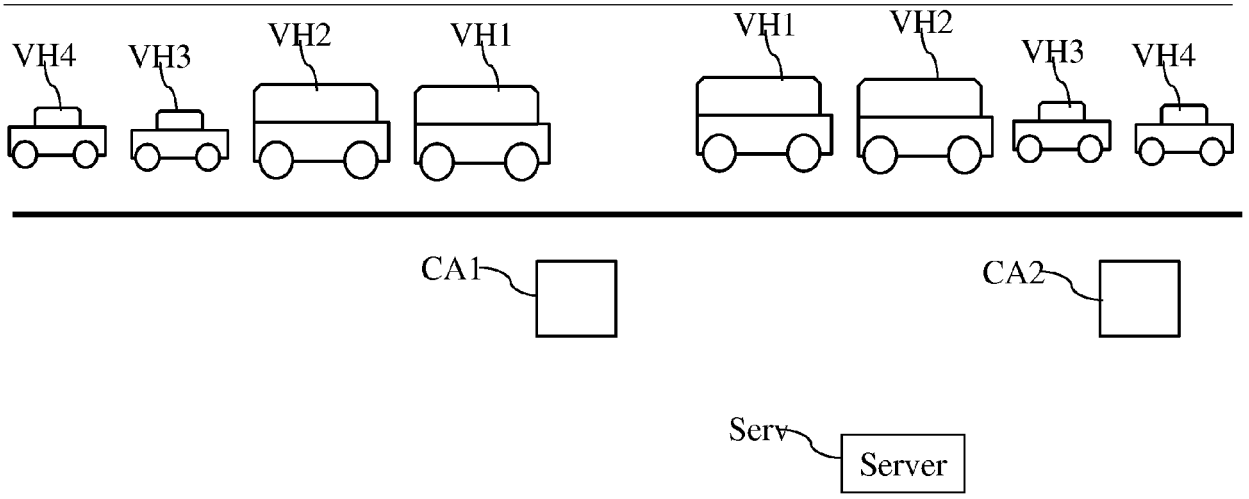
VH4
VH3
VH2
VH1
VH1
VH2
VH3
VH4
CA1
CA2
Serv
Server

Fig. 1

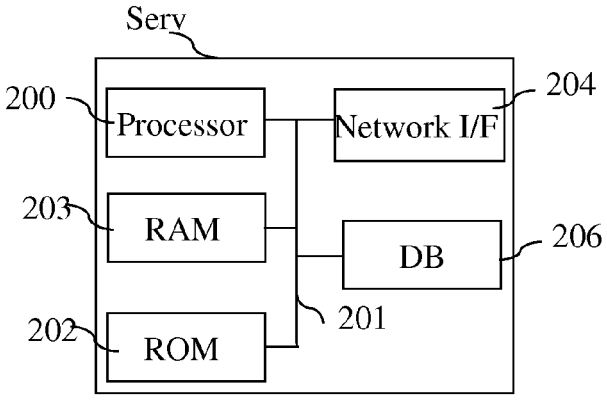
Serv
200
Processor
Network I/F
204
203
RAM
DB
206
201
202
ROM

Fig. 2

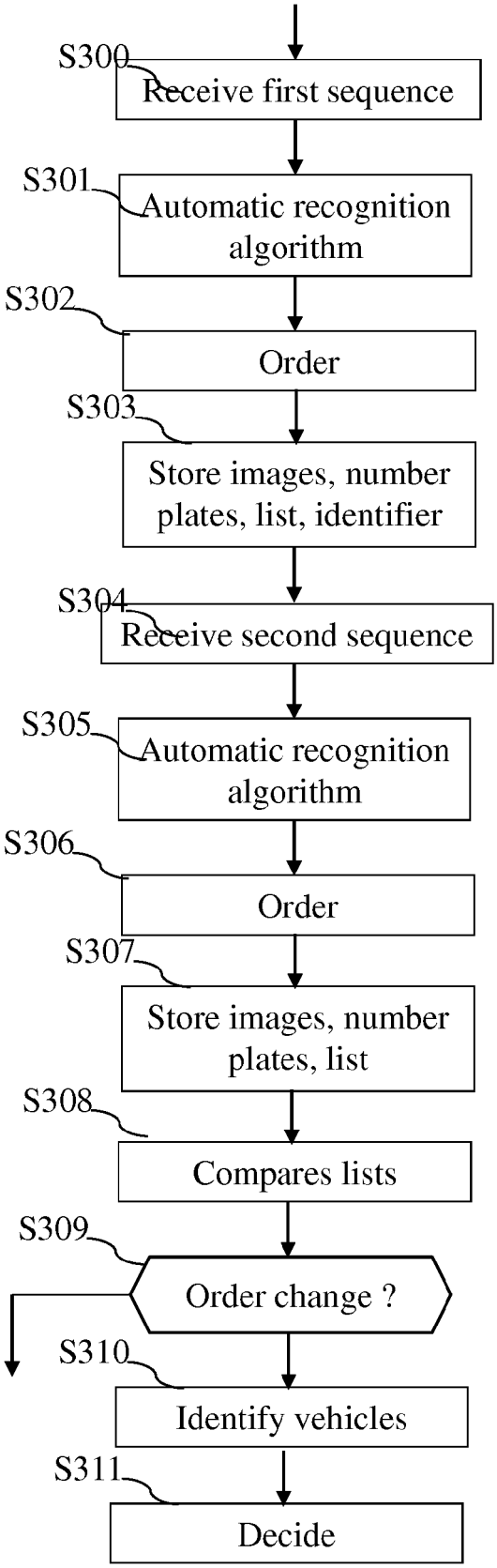
S300
Receive first sequence
S301
Automatic recognition algorithm
S302
Order
S303
Store images, number plates, list, identifier
S304
Receive second sequence
S305
Automatic recognition algorithm
S306
Order
S307
Store images, number plates, list
S308
Compares lists
S309
Order change ?
S310
Identify vehicles
S311
Decide

Fig. 3

Rank	Vehicle
1	VH1
2	VH2
3	VH3
4	VH4

Fig. 4

Rank	Vehicle
1	VH4
2	VH3
3	VH2
4	VH1

Fig. 5

Rank	Vehicle
1	VH4
2	VH3
3	VH2

Fig. 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 30 5157

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2007/058618 A1 (ST ELECTRONICS INFO COMM SYSTE [SG]; CHONG CHEE CHUNG [SG]) 24 May 2007 (2007-05-24) * page 5, line 14 - line 31 * * page 6, line 24 - page 7, line 4 * * page 9, line 25 - line 31 * * page 12, line 6 - page 13, line 28 * * figure 4 * * claims 17, 24 *	1-11	INV. G08G1/01 G08G1/015 G08G1/017
X	NL 1 005 785 C2 (TRAFFIC TEST B V [NL]; HENDRIK JOHANNES FOKKEMA [NL]) 14 October 1998 (1998-10-14) * claims 1, 5, 15 *	1-11	

TECHNICAL FIELDS SEARCHED (IPC)

G08G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 August 2018	Cornelussen, Ronald

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 30 5157

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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07-08-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82