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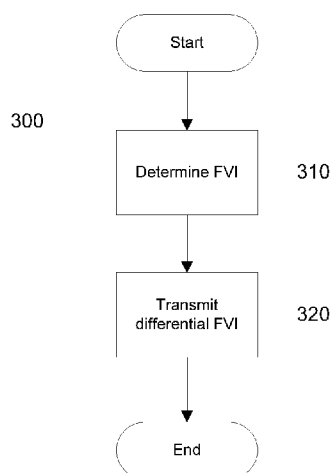


Fig. 3

(57) Abstract: Embodiments of the present invention provide a method (300, 400) of determining following vehicle information, comprising determining (310, 430), by one or more sensing means (230, 240) associated with a first vehicle (110), following vehicle information associated with any further vehicles (130, 140) following a second vehicle (120), and transmitting (320, 450), from first communication means (250) associated with the first vehicle (110) to second communication means (250) associated with the second vehicle (120), a representation of the following vehicle information.



Apparatus and Method for Determining Following Vehicle Information

TECHNICAL FIELD

Aspects of the invention relate to a method, to a module, a system and a vehicle. In particular, although not exclusively, aspects of the invention relate to a method of determining following vehicle information, a following vehicle information module for a vehicle, a system for determining following vehicle information, a vehicle and computer software.

BACKGROUND

It is desired to provide increased situational awareness concerning vehicles. Situational awareness includes information relating to vehicles in a vicinity of a vehicle. Such situational awareness may be provided to traffic infrastructure for example to manage a flow of traffic. The situational awareness may also be used by the vehicles themselves, for example to reduce a likelihood of accidents. The situational awareness may relate to a number or length of vehicles following a vehicle, which may be a lead vehicle i.e. at a head of a train of vehicles, or may be part of the train of vehicles. However it is often difficult for a vehicle to determine information about following vehicles. This may be due, in part, to following vehicles obscuring one-another.

It is an object of embodiments of the invention to at least mitigate one or more of the problems of the prior art.

SUMMARY OF THE INVENTION

According to aspects of the present invention, there is provided a method of determining following vehicle information, comprising determining, by one or more sensing means associated with a first vehicle following vehicle information associated with one or more further vehicles following a second vehicle, and transmitting, from first communication means associated with the first vehicle to second communication means associated with the second vehicle, a representation of the following vehicle information.

According to an aspect of the present invention, there is provided a method comprising determining, by one or more sensing means, following vehicle information associated with one or more vehicles following a first vehicle, and transmitting, from first communication means to second communication means associated with the first vehicle, a representation of the following vehicle information. Advantageously the first vehicle is provided with information about following vehicles.

According to an aspect of the present invention, there is provided a method, comprising determining, by one or more sensing means associated with a first vehicle, following vehicle information associated with one or more vehicles following a second vehicle, and transmitting, from first communication means associated with the first vehicle to second communication means associated with the second vehicle, a representation of the following vehicle information.

Advantageously the second vehicle is provided with following vehicle information from another source, such as the first vehicle, which reduces a need for the second vehicle to comprise rearward facing sensors and improves a reliability of assessing information about the following vehicles.

According to an aspect of the present invention, there is provided a method of determining following vehicle information, comprising determining, by one or more sensing means associated with a first vehicle, following vehicle information associated with any further vehicles following a second vehicle, and transmitting, from first communication means associated with the first vehicle to second communication means associated with the second vehicle, a representation of the following vehicle information.

A method as described above, wherein:

- the sensing means may comprise one or more sensing devices;
- the first communication means may be a communication module or unit; and
- the second communication means may be communication module or unit.

Optionally the method comprises transmitting from the second communication means, a request for the following vehicle information. Advantageously computation and communication may be reduced by the following vehicle information only being determined on request. The method may comprise receiving at the first

communication means the request for the following vehicle information. The method may be performed in dependence on the request.

5 The request may comprise a representation of existing following vehicle information associated with the second vehicle. Advantageously the second vehicle provides information about its state of knowledge of following vehicles.

10 The method optionally comprises comparing the received existing following vehicle information with the determined following vehicle information to determine differential following vehicle information. Advantageously only the differential following vehicle information may need to be processed.

15 The transmitting the representation of the following vehicle information may comprise transmitting a representation of the differential following vehicle information to the second communication means associated with the second vehicle. Advantageously the amount of data to be communicated may be reduced.

20 The method may comprise transmitting the representation of the following vehicle information from the second communication means to a communication means associated with transport infrastructure. Advantageously the following vehicle information may be provided for use by more than other vehicles.

25 The communication means associated with the transport infrastructure is optionally associated with one or more traffic flow control means. The, or each, traffic flow control means may be one or more traffic lights. Advantageously the following vehicle information may be used to improve a flow of traffic. The traffic flow control means may be one or more of: a level crossing, a drawbridge, bascule bridge, swing bridge, vertical lift bridge, for example. Advantageously, the following vehicle information may be used to improve a flow of traffic of two or more different types of vehicle.

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The following vehicle information may be indicative of a number of vehicles following the second vehicle. Advantageously the existence and amount of following vehicles is provided.

35 The following vehicle information may be indicative of a length of vehicles following the second vehicle. Advantageously the length of the following vehicles may be used, such as in determining whether a manoeuvre is possible, for example over-taking.

The following vehicle information may be indicative of a time for the any further vehicles to pass. Optionally the time is a time to pass a stationary point. Advantageously the time to pass may be of assistance in traffic flow control, such as
5 operating traffic lights according to the time to pass a stationary point.

The sensing means associated with the first vehicle may be forward-facing sensing means with respect to the first vehicle. Advantageously the sensing means may ascertain information about approaching vehicles.

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Optionally the determining the following vehicle information is performed as the second vehicle and the any further vehicles following the second vehicle pass proximal to the first vehicle. Advantageously the sensing means may only require a short range of operation as the vehicles pass.

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The determining the following vehicle information may be performed as the second vehicle and the one or more vehicles following the second vehicle travel in an opposing direction to the first vehicle.

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According to an aspect of the present invention, there is provided a following vehicle information module for a vehicle, comprising input means for receiving data from one or more sensing means associated with a first vehicle indicative of a presence of any further vehicles following a second vehicle, control means for determining following vehicle information indicative of the any further vehicles following the second vehicle,
25 and output means for outputting to a communication means a representation of the following vehicle information for wireless transmission.

The module as described above, wherein:

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the input means comprises an electrical input for receiving data;
the control means comprises one or more electronic processing devices; and
the output means comprises an electrical output for outputting data.

Optionally the control means is arranged to receive via the input means a request for the following vehicle information from the second vehicle. The control means may be
35 arranged to determine the following vehicle information in dependence on the request.

The request may comprises a representation of existing following vehicle information associated with the second vehicle.

5 The control means may be arranged to compare the received existing following vehicle information with the determined following vehicle information to determine differential following vehicle information.

The control means is optionally arranged to output via output means a representation of the differential following vehicle information for wireless transmission.

10

The following vehicle information may be indicative of a number of vehicles following the second vehicle.

15 The following vehicle information may be indicative of a length of vehicles following the second vehicle.

The following vehicle information may be indicative of a time for the following vehicles to pass. The time may be a time to pass a stationary point.

20 According to an aspect of the present invention, there is provided a system for determining following vehicle information, comprising one or more sensing means for outputting data indicative of a presence of a vehicle, and a following vehicle information module arranged to receive the data from the sensing means and to determine following vehicle information indicative of any vehicles following a vehicle
25 and to output a representation of the following vehicle information.

The system as described above, wherein:

the one or more sensing means comprise one or more sensing devices; and
the vehicle information module comprises one or more electronic processing
30 devices.

The one or more sensing means may comprise an acoustic, radiation or optical sensing means for determining a distance to an object.

35 The one or more sensing means may comprise an imaging device for outputting image data.

According to an aspect of the present invention, there is provided a vehicle, comprising one or more sensing means for outputting data indicative of a presence of a vehicle, a following vehicle information module arranged to receive the data from the sensing means and to determine following vehicle information indicative of any further vehicles following a vehicle and to output a representation of the following vehicle information, and communication means arranged to receive the representation from the following vehicle information module and to wirelessly transmit the representation.

- 10 The vehicle as described above, wherein:
- the one or more sensing means comprise one or more sensing devices;
 - the vehicle information module comprises one or more electronic processing devices; and
 - the communication means comprises a communication module or unit.

- 15 The sensing means are associated with a first vehicle, the sensing means are forward-facing sensing means with respect to the first vehicle.

- 20 According to an aspect of the present invention, there is provided computer software which, when executed by a computer, is arranged to perform a method according to an aspect of the invention. Optionally the computer software is stored on a computer-readable medium. The computer software may be tangibly stored on the computer-readable medium. The computer-readable may be non-transitory.

- 25 According to an aspect of the present invention, there is provided a vehicle arranged to perform a method according to aspect of the invention, or comprising a module or system according to an aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

- 30 Embodiments of the invention will now be described by way of example only, with reference to the accompanying figures, in which:

Figure 1 illustrates example vehicular situations;

- 35 Figure 2 shows a vehicle and apparatus according to an embodiment of the invention;

Figure 3 shows a method according to an embodiment of the invention; and

Figure 4 shows a method according to another embodiment of the invention.

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DETAILED DESCRIPTION

Figure 1 illustrates example vehicle situations where a first vehicle 110 is in proximity to a second vehicle 120. Embodiments of the present invention provide the second vehicle 120 with improved situational awareness as will be explained.

In Figure 1(a) the first vehicle 110 is moving in a generally opposing direction to the second vehicle 120, as indicated by respective arrows 111, 121. It will be appreciated that it is not necessary for the first vehicle 110 to be in motion and it may alternatively be stationary. At some point in time, the second vehicle 120 passes alongside the first vehicle 110. In Figure 1(a) the first vehicle 110 is generally facing the oncoming second vehicle 120.

In Figure 1(b) the first vehicle 110 is generally perpendicular to the second vehicle 120 as it passes in front of the first vehicle 110. The first vehicle 110 may be waiting at a junction or intersection as illustrated. In both situations illustrated in Figures 1(a) & (b), as will be explained, sensing means associated with the first vehicle 110 is able to assess a situation of the second vehicle 120 whilst the two vehicles 110, 120 are proximal. In particular, forward-facing sensing means of the first vehicle 110 are able to assess the situation of the second vehicle 120. It will also be appreciated that the first vehicle 110 may alternatively or additionally have sensing means arranged to assess the second vehicle 120, and other vehicles, passing a side of the first vehicle 110.

As illustrated in both Figures 1(a) and (b) one or more further vehicles 130, 140 are following the second vehicle 120. Although two following vehicles 130, 140 are illustrated it will be appreciated that this is merely an example. In other examples, there may be more vehicles or no vehicles following the second vehicle 120. It is desired for the second vehicle 120 to obtain situational awareness regarding whether there are vehicles following the second vehicle 120 and, if so, information about the following vehicle(s) 130, 140. The situational awareness may comprise following vehicle information indicative of the one or more vehicles 130, 140 following the

second vehicle 120. In embodiments of the invention the following vehicle information is provided by the first vehicle 110. The following vehicle information is determined by sensing means associated with the first vehicle 110 whilst the vehicles are in proximity, such as in the situations illustrated in Figures 1(a) and (b) with arrow 115
5 indicative of sensing of the vehicles 120, 130, 140. The following vehicle information is information about the one or more vehicles 130, 140 following the second vehicle 120. In some embodiments the following vehicle information is indicative of one or more of a number of vehicles following the second vehicle 120, a total length of vehicles 130, 140 following the second vehicle 120, and a time for the vehicles 130,
10 140 following the second vehicle 120 to pass. The time may be a time for the vehicles 130, 140 following the second vehicle 120 to pass a stationary point i.e. a roadside point.

Figure 2 illustrates a vehicle 110 according to an embodiment of the invention. The
15 vehicle 110 may be the first vehicle 110 illustrated in Figure 1. The vehicle shown may also be the second vehicle 120. The vehicle 110 comprises a following vehicle information (FVI) means in the form of an FVI module 200 according to an embodiment of the invention. The FVI module 200 is arranged to determine and to provide following vehicle information. The following vehicle information may be
20 provided to another vehicle such as, as described above, the second vehicle 120.

The FVI module 200 comprises a control means 210 which may comprise one or more processing devices. The one or more processing devices may, in use, execute computer instructions in the form of computer software. The FVI module 200
25 comprises memory means 220 which may comprise one or more electronic memory devices communicably coupled to the one or more processing devices. The memory device(s) may store the computer software operably executed by the processing device(s) and may store data during execution of the computer software, such as data relating to the FVI of the second vehicle 120.

30 The vehicle 110 comprises one or more sensing means 230, 240. The sensing means are suitable for determining information about other vehicles proximal to the vehicle 110. The one or more sensing means 230, 240 illustrated in Figure 2 are forward-facing, although it will be realised that use of otherwise directed sensing
35 means may be envisaged. For example, one or more sensing means may be arranged to determine information about other vehicles generally alongside the vehicle 110 i.e. side-sensing means. The sensing means 230, 240 comprises one or

more sensing devices 230, 240 for determining one or more attributes of an environment proximal to the vehicle 110. The environment may be that within a predetermined distance of the vehicle, such as within 500m or 250m of the vehicle, although it will be realised that other distances may be envisaged and that each
5 respective sensing means 230, 240 may be associated with a respective i.e. different sensing distance. The sensing means 230, 240 may be existing sensing means of the vehicle 110 i.e. used for other purposes such as safety or vehicle driving purposes. At least some of the one or more sensing means 230, 240 may be arranged at a front of the vehicle 110, such as one or more being mounted behind a
10 grille at a front of the vehicle 110 or in a region of a windscreen of the vehicle 110. It will be appreciated that where a plurality of sensing means 230, 240 are used they do not need to be collocated.

The sensing means 230, 240 may also be associated with one or more of an
15 emergency vehicle braking system of the vehicle 110, or a cruise control system of the vehicle, for example. A first sensing means 230 may be a first device 230 such as a radar or laser device for determining a distance to an object, such as another vehicle, generally in front of the vehicle 110. It will be understood that generally in front of the vehicle 110 may also encompass objects in front of the vehicle 110 i.e.
20 forward of, but in a different lane of a multi-lane road or highway, such as the second vehicle 120.

The first device 230 is arranged, in use, to emit radiation and to receive radiation reflected from the object or vehicle to firstly allow an existence of the object or vehicle
25 to be determined, and secondly to determine a distance thereto. A second sensing means 240 may be a second device 240 such as an imaging device 240. The imaging device 240 may be arranged to determine image data, for example comprising a series of images which may form video data, of a region of the environment proximal to the vehicle 110. The image data provided by the imaging
30 device 240 may be used, for example, to determine road signs such as speed limit information and to determine an existence of humans i.e. pedestrians in a path of the vehicle 110, although it will be realised that other uses of the imaging device 240 are envisaged. Other sensing means may be arranged to determine the presence of another vehicle generally alongside the vehicle 110. It will be understood that
35 generally in alongside of the vehicle 110 may also encompass objects in alongside but not aligned with the vehicle 110 i.e. forward or rearwards of, but in a different lane of a multi-lane road or highway, such as the second vehicle 120.

The vehicle 110 comprises a communication means 250. The communication means allows wireless communication of a representation of the following vehicle information to another vehicle, such as the second vehicle 120. The communication means 250 does not necessarily need to communicate directly with a communication means of the second vehicle 120. The communication means 250 may operatively communicate with one or more intermediary communication systems, networks or computer systems. For example the communication means 250 of the vehicle 110 may be arranged, in use, to communicate with a communication means associated with transport infrastructure, which may comprise one or more server computers arranged to control the transport infrastructure including one or more traffic flow control means. For example, the traffic flow control means may be one or more traffic lights, although it will be realised that other traffic flow control means may be used including the server computers being arranged to provide instructions to vehicles within a predetermined region or zone regarding how those vehicles should move through the zone i.e. a speed of travel etc. of those vehicles.

Returning to Figure 1(b) arrow 180 is indicative of communication of information from second vehicle 120 to infrastructure which is, in this case, traffic lights 190. Further description of said communication will be provided below.

In further described embodiments of the invention, the communication means 250 will be described as operatively communicating directly with a corresponding communication means of another vehicle, although it will be appreciated from the foregoing that this is not essential. The communication means 250 may operate according to a wireless communication protocol. The wireless communication protocol may be Wi-Fi or a protocol based thereon. For example, the communication means may operate according to a vehicle-to-vehicle (V2V) protocol which may be a form of vehicular ad hoc networking (VANET). For example the wireless communication protocol may be IEEE 802.11p or a standard based thereon. Whilst some specific protocols are identified it will be appreciated that these are merely for illustration and that the communication means 250 may operate according to another protocol. The communication means 250 may be formed by a communication module or unit of the vehicle associated with one or more antennas mounted about the vehicle 110 for wireless communication.

The one or more sensing devices 230, 240 and communication unit 250 are communicably coupled to the FVI module 200. The coupling may be achieved by a communication bus (not shown) of the vehicle 110. The communication bus of the vehicle may be an IP-based communication bus wherein components and systems of the vehicle 110 represent nodes on a local area network (LAN) of the vehicle to allow data communication there-between. The communication bus of the vehicle may be Ethernet-based although it will be realised that the bus may be based on other LAN protocols.

In use the FVI module 200 is arranged to receive data from the one or more sensing devices 230, 240 indicative of one or more attributes of the environment proximal to the vehicle. From the received data, the FVI module 200 is arranged to determine following vehicle information associated with one or more further vehicles 130, 140 following another vehicle, such as the second vehicle 120 illustrated in Figure 1. The FVI module 200 is further arranged to communicate via the communication unit 250 of the vehicle 110 a representation of the following vehicle information. The representation is communicated to the another vehicle, such as the second vehicle 120, either directly or indirectly, as described above. The representation may be communicated in response to a request received from the second vehicle 120 for the following vehicle information.

Figure 3 illustrates a method 300 according to an embodiment of the invention. The method 300 is a method of determining following vehicle information according to an embodiment of the invention.

The method 300 comprises a step 310 of determining the following vehicle information (FVI). Step 310 is performed when the first vehicle 110 is within a sensing distance of the second vehicle 120. It will be understood that the sensing distance refers to a distance over which sensing means are capable of sensing the existence or presence of the second vehicle 120 and any following vehicle(s).

Referring to Figure 1, in the situation illustrated in Figure 1(a) as the first and second vehicles 110, 120 approach one another, or as the second vehicle 120 approaches the stationary first vehicle 110, the FVI module 200 of the first vehicle 110 is arranged to determine the FVI relating to the one or more vehicles 130, 140 following the second vehicle 120. In the situation illustrated in Figure 1(b) the FVI module 200 of the first vehicle 110 is arranged to determine the FVI as the second vehicle 120

and following vehicles 130, 140 move toward and then pass the first vehicle 110 as indicated by arrow 115.

In step 310 the FVI module 200 receives data from the one or more sensing devices 230, 240 indicative of the one or more following vehicles 130, 140. From the data provided by the sensing means 230, 240 the FVI module 200 may determine an existence of one or more vehicles following the second vehicle 120 i.e. that there are following vehicles 130, 140. In some embodiments the FVI module 200 may determine a number of vehicles following the second vehicle 120. The number of vehicles may be determined based on an existence of gaps between each of the following vehicles 130, 140 data indicative of which may be provided by, for example, the radar or laser device 230, or the imaging device 240. In some embodiments, the FVI module 200 may determine the total length of the following vehicles 130, 140 i.e. a distance from a front of a first of the following vehicles 130 to a rear of a last of the following vehicles 140 or a time taken for the following vehicles 130, 140 to pass a stationary point i.e. a time in seconds taken for the following vehicles to pass the stationary point.

In step 320 the representation of the FVI is communicated from the first vehicle 110. As discussed above, the representation may be communicated from the first vehicle 110 via the communication unit 250 from the FVI module 200. The representation may be a message comprising the FVI. The message may comprise information indicative of one or more of the number of vehicles 130, 140 following the second vehicle 120, a total length of following vehicles 130, 140 and a time for the vehicles 130, 140 following the second vehicle 120 to pass. The time may be a time for the vehicles 130, 140 following the second vehicle 120 to pass a stationary point i.e. a roadside point. Step 320 may be performed when the first vehicle 110 is in communication range of the second vehicle 120 i.e. within a distance at which direct wireless communication there-between is effective. However, in some embodiments where indirect communication is utilised, step 320 may be performed following step 310 i.e. without the first and second vehicles 110, 120 being capable of direct communication using one or more intermediary communication systems.

As a result of the method 300 the second vehicle 120 is provided with information about any following vehicle(s). The second vehicle 120 may utilise this information itself. For example, the second vehicle may determine a driving performance based on the FVI, such as determining a braking force to apply dependent on the number of

following vehicles. The second vehicle 120 may also provide the FVI to a transport infrastructure system.

As illustrated in Figure 1(b), the second vehicle 120 may transmit via connection 180 the FVI to a receiving device associated with traffic infrastructure 190. The traffic infrastructure may comprise one or more traffic flow control means such as traffic lights 190 as illustrated. The FVI may inform the infrastructure 190 how many following vehicle(s) 130, 140 there are or how long it will take the following vehicles 130, 140 to pass. In this way the traffic infrastructure may adapt according to the FVI. For example, in Figure 1(b) the traffic lights may change state based on the received FVI. The change in state may be to determine a period on green to allow the following vehicles 130, 140 to pass through the traffic lights 190.

Figure 4 illustrates a method 400 according to an embodiment of the invention. The method 400 is a method of determining following vehicle information according to an embodiment of the invention.

The method 400 comprises a step 410 in which a request is transmitted. The request is transmitted in response to a desire for improved situational awareness. The request may be transmitted from a vehicle, in particular from the second vehicle 120. The request is transmitted from a wireless communication unit of the vehicle 120. The request is for following vehicle information (FVI). The request may, in some embodiments, include a representation of existing or currently held following vehicle information (cFVI). The cFVI may be obtained from a memory associated with the vehicle 120, such as the memory 220 of the VFI module 200. The cFVI provides information about currently following vehicles accessible to the vehicle 120. For example, the cFVI may identify a number of vehicles believed to be following the vehicle 120. As will be appreciated, the cFVI may be outdated having been previously obtained, such as received, by the second vehicle 120. Therefore the FVI module 200 of the second vehicle 120 may seek to update the FVI. The request may also comprise information identifying the second vehicle 120 in order that updated FVI may be provided for the second vehicle 120.

In step 420 the request is received. The request may be received in step 420 at the first vehicle 110. The request may be indirectly received from the second vehicle 120 having been through one or more intermediary communication networks or systems and then transmitted to the first vehicle 110. The first vehicle 110 receives the

request via the communication unit 250 and the request is provided to the FVI module 200. The FVI module 200 may identify from which vehicle the request originated from information contained in the request.

- 5 In step 430 the first vehicle 110 determines FVI for the second vehicle 120 as described above. The FVI module 200 of the first vehicle 110 may determine the existence of any following vehicles, such as one or more vehicles 130, 140 following the second vehicle 120 i.e. that there are following vehicles 130, 140. The FVI module 200 may determine that there are no vehicles following the second vehicle. In
- 10 some embodiments the FVI module 200 may determine the number of vehicles following the second vehicle 120. In some embodiments, the FVI module 200 of the first vehicle 110 may determine the total length of the following vehicles 130 i.e. the distance from a front of the first of the following vehicles 130 to the rear of a last of the following vehicles 140, or a time to for the following vehicles 130, 140 to pass a
- 15 stationary point i.e. the time taken in seconds for the following vehicles 130, 140 to pass the stationary point. As described above the FVI module 200 determines the FVI based on data received from one or more sensing devices 230, 240 associated with the first vehicle 110.
- 20 In step 440 it is determined whether the newly determined FVI, as determined in step 430, matches, i.e. is the same as, the cFVI received in step 420. If the newly determined FVI is the same as the received cFVI then the method 400 may end as the second vehicle 120 has correct or current FVI. In some embodiments the FVI module 200 of the first vehicle 110 may communicate a confirmation to the second
- 25 vehicle 120 indicative of the cFVI being correct or up-to-date. If the newly determined FVI is not the same as or equal to the cFVI received in step 420 the method moves to step 450.

30 In step 450 the FVI module 200 of the first vehicle 110 determines differential following vehicle information (dFVI). The dFVI represents a difference between the newly FVI determined in step 430 and the received cFVI from step 420. The dFVI may be determined as:

$$\text{dFVI} = \text{nFVI} - \text{cFVI}$$

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where nFVI is the new FVI i.e. the FVI determined in step 430.

In step 450 the dFVI is communicated from the FVI module 200 to the communication unit 250 of the first vehicle 110 and transmitted to the second vehicle 120. In this way, the second vehicle is provided with information to update the existing FVI held by the second vehicle 120 i.e. that the cFVI previously sent to the first vehicle 110 and deemed not to be up-to-date by the first vehicle 11 is replaced or updated. Subsequently the second vehicle 120 may provide the FVI to one or more receiving devices such as a receiving device associated with traffic infrastructure 190, for example traffic lights 190, as described above.

It will be appreciated that embodiments of the present invention allow improved situational awareness of vehicles to be obtained, in particular information about following vehicles, which may be used by the vehicles or traffic infrastructure.

Whilst described herein in relation to road-going vehicles, it will be appreciated that the invention is not limited in this sense. Rather, it is explicitly intended (and will be apparent to the skilled reader) that the present invention may be realised in relation to any vehicle, be that a land vehicle, waterborne vehicle or otherwise. Furthermore, it will be appreciated that traffic infrastructure is intended to cover both on-road infrastructure (as described herein) but also infrastructure for controlling traffic flow of other vehicle types, for example off-road or waterborne vehicle.

It will be appreciated that embodiments of the present invention can be realised in the form of hardware, software or a combination of hardware and software. Any such software may be stored in the form of volatile or non-volatile storage such as, for example, a storage device like a ROM, whether erasable or rewritable or not, or in the form of memory such as, for example, RAM, memory chips, device or integrated circuits or on an optically or magnetically readable medium such as, for example, a CD, DVD, magnetic disk or magnetic tape. It will be appreciated that the storage devices and storage media are embodiments of machine-readable storage that are suitable for storing a program or programs that, when executed, implement embodiments of the present invention. Accordingly, embodiments provide a program comprising code for implementing a system or method as claimed in any preceding claim and a machine readable storage storing such a program. Still further, embodiments of the present invention may be conveyed electronically via any medium such as a communication signal carried over a wired or wireless connection and embodiments suitably encompass the same.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

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Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic

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series of equivalent or similar features.

The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed. The claims should not be construed to cover merely the foregoing embodiments, but also any embodiments which fall within the scope of the claims.

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CLAIMS

1. A method of determining following vehicle information, comprising:

5 determining, by one or more sensing means associated with a first vehicle, following vehicle information associated with any further vehicles following a second vehicle; and

10 transmitting, from first communication means associated with the first vehicle to second communication means associated with the second vehicle, a representation of the following vehicle information.

2. The method of claim 1, comprising:

15 transmitting from the second communication means, a request for the following vehicle information; and

receiving at the first communication means the request for the following vehicle information.

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3. The method of claim 2, wherein the request comprises a representation of existing following vehicle information associated with the second vehicle.

4. The method of claim 3, comprising:

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comparing, by a control means associated with the first vehicle, the received existing following vehicle information with the determined following vehicle information to determine differential following vehicle information; and

30 wherein the transmitting the representation of the following vehicle information comprises transmitting a representation of the differential following vehicle information to the second communication means associated with the second vehicle.

- 35 5. The method of any preceding claim, comprising transmitting the representation of the following vehicle information from the second

communication means to a communication means associated with transport infrastructure.

5 6. The method of claim 5, wherein the communication means associated with the transport infrastructure is associated with one or more traffic flow control means; optionally the traffic flow control means is one or more traffic lights.

7. The method of any preceding claim, wherein the following vehicle information is indicative of a number of vehicles following the second vehicle.

10 8. The method of any preceding claim, wherein the following vehicle information is indicative of a length of vehicles following the second vehicle.

15 9. The method of any preceding claim, wherein the following vehicle information is indicative of a time for the any further vehicles to pass; optionally the time is a time to pass a stationary point.

20 10. The method of any preceding claim, wherein the sensing means associated with the first vehicle are forward-facing sensing means with respect to the first vehicle.

25 11. The method of any preceding claim, wherein the determining, by one or more sensing means the following vehicle information is performed as the second vehicle and the any further vehicles following the second vehicle pass proximal to the first vehicle.

30 12. The method of any of claims 1 to 11, wherein the determining, by one or more sensing means, the following vehicle information is performed as the second vehicle and the one or more vehicles following the second vehicle travel in an opposing direction to the first vehicle.

13. A following vehicle information module for a vehicle, comprising:

35 input means for receiving data from one or more sensing means associated with a first vehicle indicative of a presence of any further vehicles following a second vehicle;

control means for determining following vehicle information indicative of the any further vehicles following the second vehicle; and

output means for outputting to a communication means a representation of the following vehicle information for wireless transmission.

5 14. The module of claim 13, wherein the control means is arranged to receive via the input means a request for the following vehicle information from the second vehicle and to determine the following vehicle information in dependence on the request.

10 15. The module of claim 14, wherein the request comprises a representation of existing following vehicle information associated with the second vehicle.

16. The module of claim 15, wherein the control means is arranged to compare the received existing following vehicle information with the determined
15 following vehicle information to determine differential following vehicle information.

17. The module of claim 16, wherein the control means is arranged to output via
20 output means a representation of the differential following vehicle information for wireless transmission.

18. The module of any of claims 13 to 17 wherein the following vehicle information is indicative of one or more of:

25 a number of vehicles following the second vehicle;

a length of vehicles following the second vehicle; and

30 a time for the following vehicles to pass; optionally the time is a time to pass a stationary point.

19. A system for determining following vehicle information, comprising:

35 one or more sensing means for outputting data indicative of a presence of a vehicle; and

a following vehicle information module arranged to receive the data from the sensing means and to determine following vehicle information

indicative of any vehicles following a vehicle and to output a representation of the following vehicle information.

- 5 20. The system of claim 19, wherein the one or more sensing means comprise one or more of:

an acoustic, radiation or optical sensing means for determining a distance to an object; and

10 an imaging device for outputting image data.

21. A vehicle, comprising:

15 one or more sensing means for outputting data indicative of a presence of a vehicle;

20 a following vehicle information module arranged to receive the data from the sensing means and to determine following vehicle information indicative of any further vehicles following a second vehicle and to output a representation of the following vehicle information; and

communication means arranged to receive the representation from the following vehicle information module and to wirelessly transmit the representation.

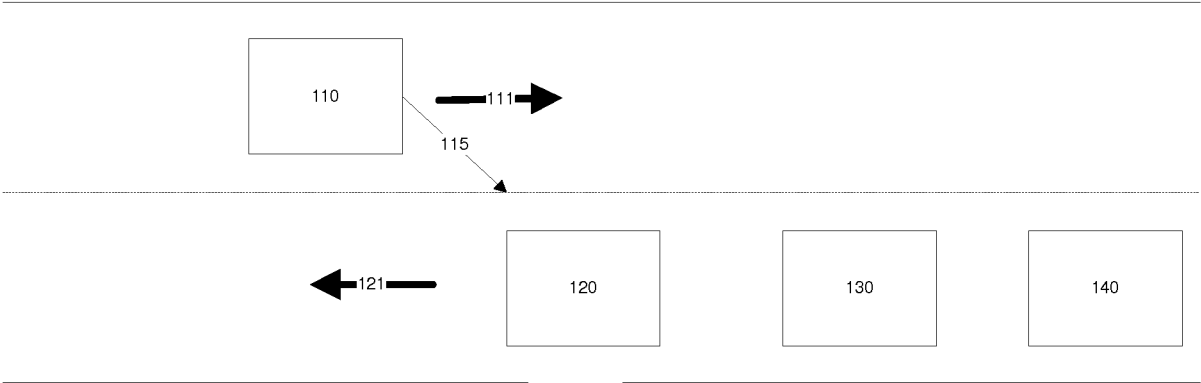
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22. The vehicle of claim 21, wherein, when the sensing means are associated with the vehicle, the sensing means are forward-facing sensing means with respect to the vehicle.

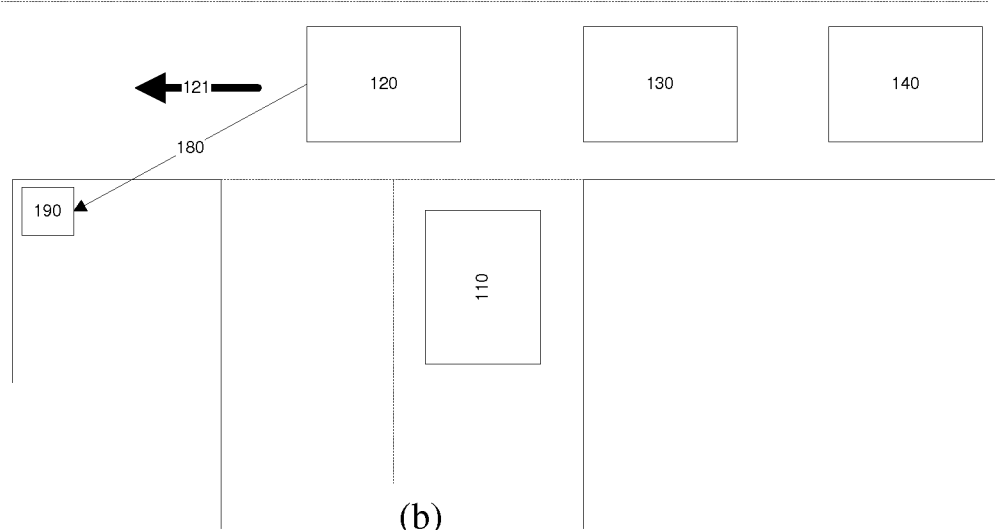
30 23. Computer software which, when executed by a computer, is arranged to perform a method according to any of claims 1 to 11; optionally the computer software is stored on a computer-readable medium.

35 24. A vehicle arranged to perform a method according to any of claims 1 to 11, comprising a following vehicle information module according to any of claims 12 to 18 or a system according to any of claims 19 or 20.

25. A method, following vehicle information module, system, vehicle or computer software substantially as described hereinbefore with reference to the accompanying drawings.



(a)



(b)

Fig. 1

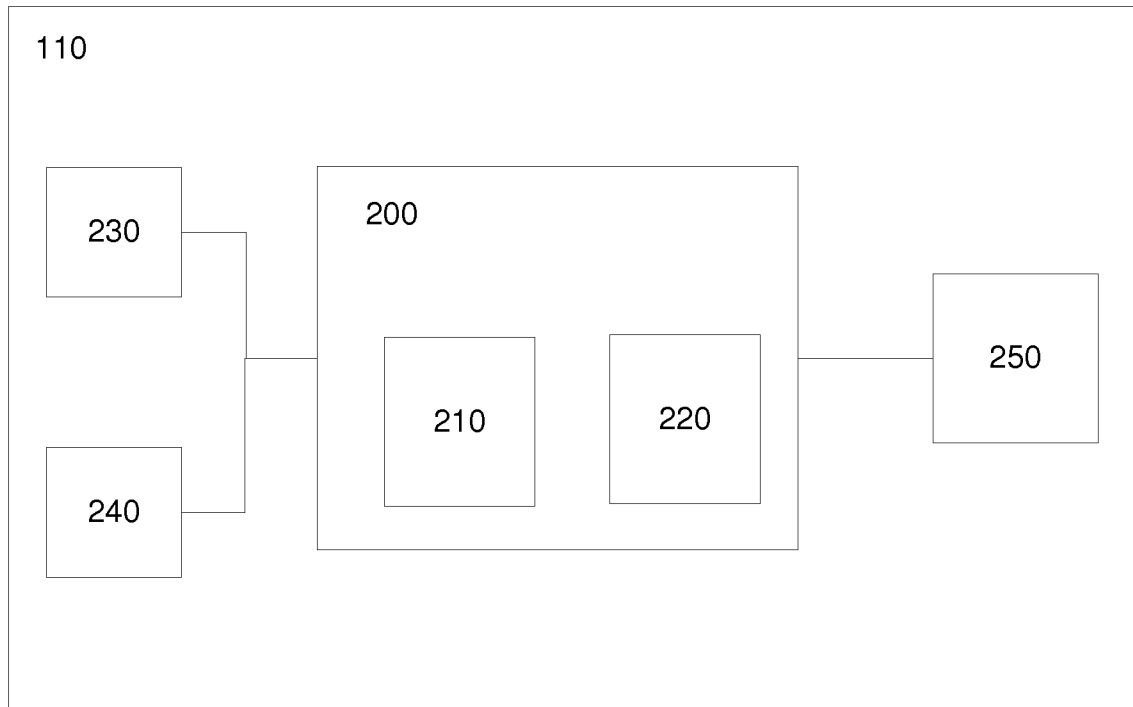


Fig. 2

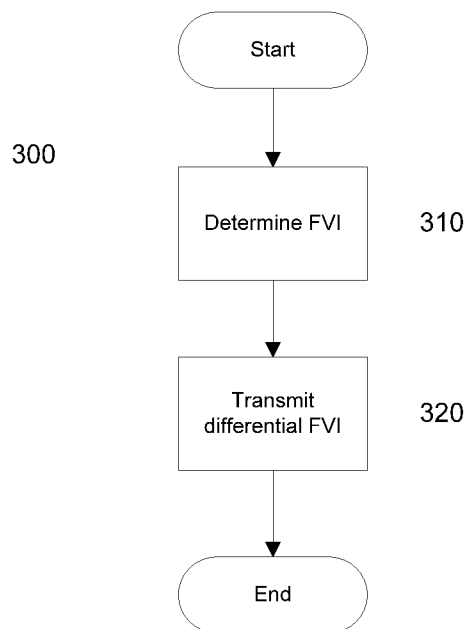


Fig. 3

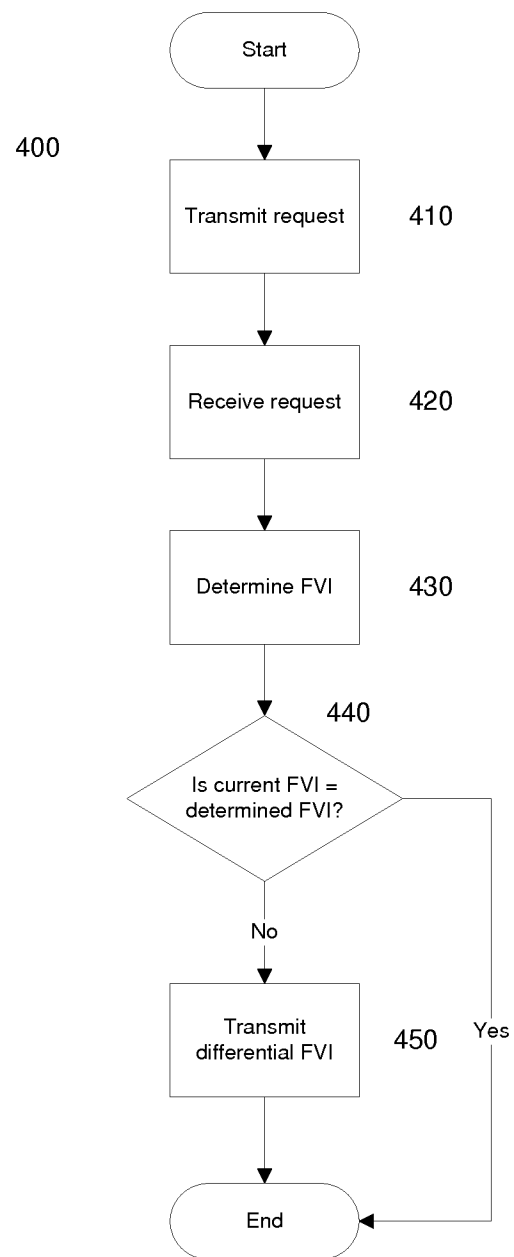


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/074995

A. CLASSIFICATION OF SUBJECT MATTER
INV. G08G1/0967
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)
G08G

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 2015/310739 A1 (BEAUREPAIRE JEROME [DE] ET AL) 29 October 2015 (2015-10-29)	1-3,5-9, 13-16, 18,19, 21,23,24 4,17
A	paragraph [0033] paragraph [0035] - paragraph [0036] paragraph [0079] paragraph [0083] - paragraph [0084] -----	
X	US 2016/210853 A1 (KORAVADI KRISHNA [US]) 21 July 2016 (2016-07-21)	19-22
A	paragraph [0021] paragraph [0016] - paragraph [0017] -----	1,10-12, 23,24



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

16 January 2018

Date of mailing of the international search report

24/01/2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2017/074995

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.: 25
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:
see FURTHER INFORMATION sheet PCT/ISA/210
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:

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.:

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

Continuation of Box II.2

Claims Nos.: 25

The subject matter of claim 25 is not established in terms of technical features of which a scope of protection requested could be derivable. The claim has been excluded from this search.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/074995

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015310739	A1	29-10-2015	NONE
US 2016210853	A1	21-07-2016	NONE