

Description

[0001] The present disclosure relates to a method for controlling a traffic system comprising at least a first vehicle and a second vehicle. Each of the first vehicle and the second vehicle is travelling on a road.

[0002] Moreover, the present disclosure relates to a corresponding data processing apparatus and a corresponding computer program.

[0003] Additionally, the present disclosure is directed to a method for controlling a first vehicle and a method for controlling a second vehicle.

[0004] Furthermore, the present disclosure is directed to a corresponding data processing apparatus.

[0005] Also, the present disclosure is directed to a vehicle and a traffic control system.

[0006] In general, traffic systems are operated in a manner that avoids accidents, especially collisions between vehicles. However, accidents usually cannot be completely excluded. The same applies to vehicles being stopped on the road, e.g. because they have technical problems.

[0007] In this context, accidents and vehicles stopped otherwise do not only constitute a danger for the vehicles being directly involved, but also for all other vehicles traveling on the same road. This is due to the fact, that the vehicles being involved in the accident at least partially block the road. Other vehicles need to react appropriately to this type of obstacle. This is especially challenging if a driver is prone to distraction, road conditions are poor and/or weather conditions are bad.

[0008] It is noted that this phenomenon applies to both, vehicles being driven by a human driver and vehicles operating in a fully or partially autonomous mode. In the latter case, poor road conditions or bad weather conditions affect the detection results of sensors of the vehicle driving in fully or partially autonomous mode.

[0009] It is therefore an objective of the present disclosure to further improve the control of traffic systems such that the involvement of additional vehicles in an existing accident is at least reduced.

[0010] The problem is at least partially solved or alleviated by the subject matter of the independent claims of the present disclosure, wherein further examples are incorporated in the dependent claims.

[0011] According to a first aspect, there is provided a method for controlling a traffic system comprising at least a first vehicle and a second vehicle. Each of the first vehicle and the second vehicle is travelling on a road. The method comprises:

- receiving an accident notification from the first vehicle, wherein the accident notification comprises a status information indicating that the first vehicle is involved in an accident and a location information describing a current location of the first vehicle,
- determining an amount of received accident notifications for each of the received location information

or for a group of received location information, wherein location information differing by a predefined distance measure or less from the group of received location information,

- 5 - comparing the amount of received accident notifications with a threshold amount and determining that a pile-up accident has occurred if the amount of received accident notifications equals or exceeds the threshold amount, and
- 10 - providing a pile-up accident warning to the second vehicle, if the occurrence of a pile-up accident has been determined.

[0012] In the present method, the terms first vehicle and second vehicle are only used in order to distinguish two types of vehicles. A number of vehicles is not implied. This means, that two or more first vehicles may be involved in an accident and may provide an accident notification respectively. Also, more than one second vehicle may be driving on the road and may be able to receive a pile-up accident warning. Thus, using such a method, a pile-up accident may be detected with high reliability. Due to the pile-up accident warning, the risk that the second vehicle is additionally involved in the pile-up accident, is strongly reduced. This is due to the fact that the pile-up accident warning may be provided comparatively early to the second vehicle. Especially, the pile-up accident warning may be provided to the second vehicle before a human driver of the second vehicle is actually able to see the accident in which the first vehicle is involved and/or before sensors of the second vehicle driving in a fully or partially autonomous mode are able to detect the first vehicle being involved in the accident. Consequently, due to the pile-up accident warning, the second vehicle has enough time to safely react to the accident in which the first vehicle is involved. Overall, road safety is improved.

[0013] When executing the method for controlling a traffic system, the pile-up accident warning may be provided in the form of a push message to individual second vehicles. Alternatively, the pile-up accident warning may be provided in the form of a pull message. This means that the second vehicles need to regularly withdraw such a message from a central control entity on which the method for controlling a traffic system is running. It is also possible to just broadcast the pile-up accident warning by the central control entity, i.e. to distribute the pile-up accident warning without a precise receiving entity, e.g. a second vehicle.

[0014] In an example, the method for controlling a traffic system is abandoned in case no pile-up accident is determined.

[0015] It is noted, that both the first vehicle and the second vehicle may be either one of autonomous, partially autonomous or driven by a human driver.

[0016] In an example, the accident notification may comprise an identifier of the first vehicle sending it. Consequently, a human driver of the second vehicle and/or

a sensor system of the second vehicle is able to detect the first vehicle and, thus, the accident when further traveling on the road. The identifier may be an alphanumeric code of a license plate.

[0017] In an example, the pile-up accident warning comprises the location information or a location group information characterizing a location of the group of received location information. In both cases, the pile-up accident warning indicates a location of the pile-up accident. In a first case, all first vehicles are sending the same location information. Consequently, the location information characterizing the location of the pile-up accident is identical to the location information which is received from the first vehicles. In a second case, at least some of the first vehicles send different location information. In such a situation, it may be determined, that the location information which is received from different first vehicles, actually relates to locations which are close to one another. It is, thus, determined that these first vehicles, even though sending different location information, are involved in the same accident. Consequently, these location information form a location group information. The second vehicle is just informed about a location of this group of locations. The location information characterizing the group of location information may for example be a geometric center point of the different location information received from the first vehicles. In either case, knowing the location of the pile-up accident offers the possibility to the second vehicle to react to the determined pile-up accident in an appropriate and safe manner.

[0018] In an example, the method further comprises:

- determining that the second vehicle is approaching the location being described by the location information or by the group of received location information for which the pile-up accident has been determined and/or
- determining that the second vehicle is located within a predefined distance from the location being described by the location information or the group of received location information for which the pile-up accident has been determined.

[0019] Consequently, the pile-up accident warning may only be provided to second vehicles which are approaching the pile-up accident and/or which are located within a predefined distance from the pile-up accident. Knowing that a pile-up accident has occurred is of particular importance for such vehicles. For other vehicles, the pile-up accident warning is less important. Consequently, the pile-up accident warning may be specifically provided to second vehicles for which this warning is relevant. Other vehicles do not need to handle this warning.

[0020] In an example, the accident notification comprises at least one of a travelling direction information, a lane information and a lane blocking information. At least one of a pile-up direction information, a pile-up lane information and a road blocking information is derived from

the at least one of the travelling direction information, the lane information and the lane blocking information respectively. Moreover, the pile-up accident warning comprises at least one of the pile-up direction information, the pile-up lane information and the road blocking information. In this context, the traveling direction information describes the direction into which the first vehicle is traveling. The lane information describes the lane on which the first vehicle is traveling and the lane blocking information describes whether the first vehicle is blocking the lane. Based on this information, which is provided by each first vehicle being involved in an accident, characteristics of the pile-up accident may be determined. In this context, a pile-up direction information describes the direction into which the pile-up accident extends. The pile-up lane information describes a lane on which the pile-up accident is located. The road-blocking information describes whether the road on which the pile-up accident has occurred is blocked or not. These pieces of information allow the second vehicle to take an informed decision on how to react to the pile-up accident.

[0021] In an example, the pile-up accident warning comprises the amount of received accident notifications for which the pile-up accident has been determined. In other words, the pile-up accident warning indicates how many vehicles are involved in the pile-up accident. This is also useful for a second vehicle in order to take an appropriate and safe reaction decision.

[0022] In an example, the method further comprises determining a characteristic of the determined pile-up accident. The pile-up accident warning comprises the characteristic. The characteristic of the determined pile-up accident may be a category of the pile-up accident. In an example, depending on the vehicles involved, the pile-up accident may be classified as small, normal or big. In another example, the pile-up accident may be categorized according to a risk that the second vehicle will be involved in the pile-up accident. The risk may be determined based on the number of vehicles that are already involved in the pile-up accident. In an example, the pile-up accident may be categorized as a low risk pile-up accident, if three vehicles are involved. In a case in which 4 to 10 vehicles are involved, the pile-up accident may be categorized as a high-risk pile-up accident. In a case in which 11 or more vehicles are involved in the pile-up accident, it may be characterized as very high risk pile-up accident. Knowing the category or more generally a characteristic of the determined pile-up accident allows the second vehicle which receives the pile-up accident warning to take an appropriate reaction decision.

[0023] In an example, the characteristic is determined depending on at least one of a weather information, a time of day information, a road type information, a speed limit information, and a receiving time of the accident notification. In this context, if the characteristic relates to a risk level of the pile-up accident, the risk level may be further increased, if the weather information describes that the weather comprises snow or rain. Alternatively or

additionally, the time of day information describes whether it is day or night. In case it is night, a risk level may be further increased. A road type information may for example relate to a geometric property of the road which describes whether the road is straight or curved. Also a number of lanes may be described. In such a case, a risk level may be increased if the road is curved and has only one lane. Alternatively the road type information may distinguish between city roads, rural roads and highways. The speed limit information may describe the legal speed limit on the road where the pile-up accident is located. In this context, the higher the speed limit the higher the risk associated with the pile-up accident. The receiving time of the accident notification describes the time at which a respective accident notification is received. Consequently, it is also possible to determine time intervals between the reception of accident notifications. This is an indication on how fast the pile-up accident is building up. For a pile-up accident which has been piling up or which is piling up in a comparatively quick manner, a risk level may be increased. This may be assessed by using a time threshold. In a case in which the average interval between two accident notifications is inferior to the time threshold, the risk may be increased. Otherwise the risk level may not be increased.

[0024] In an example, the characteristic of the pile-up accident may be updated in a regular manner.

[0025] According to a second aspect, there is provided a data processing apparatus comprising means for carrying out the method according to the first aspect of the present disclosure. Consequently, the second vehicle may be provided with a pile-up accident warning such that the risk that the second vehicle is additionally involved in the pile-up accident, is strongly reduced. Altogether, road safety is enhanced.

[0026] According to a third aspect, there is provided a computer program comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method according to the first aspect of the present disclosure. Also such a computer program has the effect that the second vehicle may be provided with a pile-up accident warning. Consequently, the risk that the second vehicle is additionally involved in the accident is reduced.

[0027] According to a fourth aspect, there is provided a computer-readable storage medium comprising instructions which, when executed by a computer, cause the computer to carry out the method according to the first aspect of the present disclosure. Using such a computer-readable storage medium reduces the risk that the second vehicle is additionally involved in the accident. This is due to the pile-up accident warning which is provided to the second vehicle.

[0028] According to a fifth aspect, there is provided a method for controlling a first vehicle. The first vehicle may form part of a traffic system. The method comprises:

- determining that a velocity of the first vehicle has

dropped by an amount exceeding a predefined velocity drop threshold within a time being inferior to a predefined time threshold and that an airbag system is activated, and

- providing an accident notification to a central control entity of the traffic system, wherein the accident notification comprises a status information indicating that the first vehicle is involved in an accident and a location information describing a current location of the first vehicle.

[0029] According to this method, an accident is detected if the first vehicle decelerates abruptly. The abruptness of the deceleration is defined by the velocity drop threshold which describes a velocity difference occurring over the abrupt deceleration and a time threshold which describes the time over which the deceleration occurs. An additional criterion for the determination of an accident is that the airbag system has been activated. Consequently an accident may be detected with high precision and reliability. Due to the provided accident notification, the central control entity is in a position to be informed about the accident of the first vehicle and a corresponding location. This information may be used within the central control entity and/or may be transmitted to other traffic participants, e.g. other vehicles such as the second vehicle.

[0030] As has already been noted before, the accident information may comprise an identifier of the first vehicle.

[0031] In an example, the accident notification comprises at least one of a travelling direction information, a lane information and a road blocking information. As before, the traveling direction information describes the direction into which the first vehicle is traveling. The lane information describes the lane on which the first vehicle is traveling and the lane blocking information describes whether the first vehicle is blocking the lane. Based on this information, which is provided by each first vehicle being involved in an accident, characteristics of the pile-up accident may be determined. Examples of such characteristics include a pile-up direction information, a pile-up lane information and/or a road blocking information as has already been described above.

[0032] In another example, the method further comprises receiving an input parameter from a mobile electronic device being located in the vehicle, comparing the input parameter with an input parameter threshold, and providing the accident notification only if the input parameter exceeds the input parameter threshold. Thus, in addition to the criteria for determining that an accident has occurred, also detection results of a mobile electronic device being located in the vehicle may be used. In an example, the detection results and, thus, the input parameter relates to an acceleration of the mobile electronic device which may be determined by use of an acceleration sensor. Such sensors are frequently provided in mobile electronic devices such as smart phones or smart watches. A drastic deceleration of the vehicle may also

lead to a drastic deceleration of the mobile electronic device which is located inside the vehicle. Thus, such a drastic deceleration may be determined with increased reliability. Additionally or alternatively, the mobile electronic device may have a sensor for detecting a heart rate of a user of the first vehicle, e.g. the driver. A sudden increase of the heart rate may also be used as an indicator for an accident. In a further example, a crash detection computer program or crash detection application is running on the mobile electronic device and a crash detection status is used as an input parameter. Thus, an additional criterion for determining that an accident has occurred, may be that such a crash detection application has also determined that an accident. Altogether, an accident may be detected with high reliability.

[0033] According to a sixth aspect, there is provided a method for controlling a second vehicle. The second vehicle may form part of a traffic system. The method comprises:

- receiving a pile-up accident warning from a central control entity, and
- triggering a reaction maneuver, wherein the reaction maneuver comprises at least one of selecting a travelling route circumventing the pile-up accident, reducing a travelling speed while staying on a current travelling route, and stopping.

[0034] Due to the fact that the second vehicle may receive the pile-up accident warning before the pile-up accident is visible or detectable from a position of the second vehicle, there is enough time to react appropriately to the pile-up accident. In this context, the second vehicle may trigger an appropriate reaction maneuver which may comprise circumventing the pile-up accident by traveling along a route which does not comprise the pile-up accident. Alternatively, the second vehicle may be triggered to stay on the route which comprises the pile-up accident. At the same time, a traveling speed may be reduced or the vehicle may stop until the scene of the pile-up accident is cleared. Stopping may include stopping immediately, stopping at a next possibility which includes stopping on the side of the road and stopping at a next parking space.

[0035] Reducing a traveling speed implies that the second vehicle at least approaches the location of the pile-up accident or even tries to pass by the location of the pile-up accident.

[0036] The reaction maneuvers as described above may optionally be combined with a warning activity being performed by the second vehicle. Thus, the second vehicle helps to warn other vehicles about the dangerous situation being generated by the pile-up accident. For example, the second vehicle may be triggered to switch on the hazard lights.

[0037] In the present context, triggering means that the systems of the second vehicle which are to be operated in order to perform one of the reaction maneuvers as

mentioned above, are requested to operate in a predefined manner. For example, traveling along a route may comprise triggering a steering system and a propulsion system. Furthermore, a brake system may be triggered. Reducing a traveling speed and stopping essentially relies on the activation of the brake system. In other words, the brake system needs to be triggered.

[0038] In an example, the reaction maneuver comprises trying to pass by the pile-up accident. If it turns out that passing by the pile-up accident is possible, i.e. if the pile-up accident has been passed successfully, a corresponding notification may be sent to the central control entity. In the opposite case, a notification may be sent to the central control entity stating that the road is blocked.

[0039] In another example, the method further comprises determining a distance to the pile-up accident. To this end, a navigation system may be used. The selection of the appropriate reaction maneuver may be based on the determined distance.

[0040] In all of the above examples, the reaction maneuver may be chosen as a function of a characteristic of the pile-up accident.

[0041] According to a seventh aspect, there is provided a data processing apparatus comprising means for carrying out at least one of the method according to the fifth aspect of the present disclosure and the method according to the sixth aspect of the present disclosure. Thus, a pile-up accident warning may be provided and/or received. Consequently, an appropriate and safe reaction to a detected pile-up accident is possible.

[0042] According to an eighth aspect, there is provided a vehicle comprising a data processing apparatus according to the seventh aspect of the present disclosure. This vehicle may be a first vehicle and/or a second vehicle. Thus, the vehicle is either able to provide an accident notification or to receive a pile-up accident warning. It is also possible that the vehicle has both functionalities. Overall, road safety is enhanced.

[0043] According to a ninth aspect, there is provided a traffic control system comprising a data processing apparatus according to the second aspect of the present disclosure and at least one data processing apparatus according to the seventh aspect of the present disclosure. Such a traffic control system allows to control a traffic system in a particularly safe manner since on the one hand, pile-up accidents are detected with high precision and reliability and on the other hand, traffic participants are able to timely react in a safe and appropriate manner.

[0044] The methods of the present disclosure may be at least partly computer-implemented, and may be implemented in software or in hardware, or in software and hardware. Further, the method may be carried out by computer program instructions running on means that provide data processing functions. The data processing means may be a suitable computing means, such as an electronic control module etc., which may also be a distributed computer system. The data processing means

or the computer, respectively, may comprise one or more of a processor, a memory, a data interface, or the like.

[0045] It should be noted that the above examples may be combined with each other irrespective of the aspect involved.

[0046] These and other aspects of the present disclosure will become apparent from and elucidated with reference to the examples described hereinafter.

[0047] Examples of the disclosure will be described in the following with reference to the following drawing.

Figure 1 shows a traffic situation which comprises three vehicles according to the present disclosure being involved in a pile-up accident and one vehicle according to the present disclosure which is approaching the location of the pile-up accident, wherein each vehicle comprises a data processing apparatus according to the present disclosure which is configured to perform a method of the present disclosure, wherein the traffic situation is controlled by a central control entity which comprises a data processing apparatus according to the present disclosure and a computer program according to the present disclosure which are configured to carry out a method for controlling a traffic system according to the present disclosure.

[0048] The Figures are merely schematic representations and serve only to illustrate examples of the disclosure. Identical or equivalent elements are in principle provided with the same reference signs.

[0049] Figure 1 shows a traffic situation which comprises four vehicles 10 which are involved in a pile-up accident 11.

[0050] Three out of the four vehicles 10 comprise a data processing apparatus 12.

[0051] For the ease of explanation, these three vehicles 10 will all be designated as first vehicles 14.

[0052] Each data processing apparatus 12 comprises a data processing unit 16 and a data storage unit 18. The data storage unit comprises a computer-readable storage medium 20 on which a computer program 22 is provided.

[0053] The computer-readable storage medium 20 and the computer program 22 comprise instructions which, when the program is executed by the data processing unit 16 or more generally a computer, cause the data processing unit 16 or the computer to carry out a method for controlling the first vehicle.

[0054] In other words, the data processing unit 16 and the data storage unit 18 form means 24 for carrying out the method for controlling a first vehicle.

[0055] The traffic situation of Figure 1 also comprises a second vehicle 26. For the ease of explanation, only one second vehicle 26 is provided even though it is perfectly possible that a plurality of second vehicles 26 form

part of the traffic situation. It is additionally noted, that the designation as a second vehicle does not imply any number of vehicles.

[0056] The second vehicle 26 comprises a data processing apparatus 28.

[0057] The data processing apparatus 28 comprises a data processing unit 30 and a data storage unit 32. The data storage unit 32 comprises a computer-readable storage medium 34 on which a computer program 36 is provided.

[0058] The computer-readable storage medium 34 and the computer program 36 comprise instructions which, when the program is executed by the data processing unit 30 or more generally a computer, cause the data processing unit 30 or the computer to carry out a method for controlling the second vehicle.

[0059] In other words, the data processing unit 30 and the data storage unit 32 form means 38 for carrying out the method for controlling a second vehicle.

[0060] The traffic situation of Figure 1 additionally comprises a central control entity 40 which has a data processing apparatus 42. In the present example, the central control entity 40 and the data processing apparatus 42 are formed as a cloud device.

[0061] The data processing apparatus 42 comprises a data processing unit 44 and a data storage unit 46. The data storage unit 46 comprises a computer-readable storage medium 48 on which a computer program 50 is provided.

[0062] The computer-readable storage medium 48 and the computer program 50 comprise instructions which, when the program 50 is executed by the data processing unit 44 or more generally a computer, cause the data processing unit 44 or the computer to carry out a method for controlling a traffic system.

[0063] In other words, the data processing unit 44 and the data storage unit 46 form means 52 for carrying out the method for controlling a traffic system.

[0064] Each of the data processing apparatuses 12 and the data processing apparatus 28 are communicatively connected to the data processing apparatus 42 via a wireless data connection.

[0065] Moreover, the data processing apparatuses 12, the data processing apparatus 28 and the data processing apparatus 42 together may be called a traffic control system 54.

[0066] In the following, the method for controlling the first vehicle 14, the method for controlling the second vehicle 26 and the method for controlling the traffic system will be explained in detail. The traffic situation of Figure 1 will be used to this end.

[0067] In the situation of Figure 1, all first vehicles 14 are involved in the pile-up accident 11.

[0068] All of the first vehicles 14, more precisely all of the data processing apparatuses 12 are running the method for controlling the first vehicle 14. In the following, the steps of this method will be designated with reference signs S1x.

[0069] In a first step S 11, each of the data processing apparatuses 12 determines that the corresponding first vehicle 14 is involved in an accident in that it determines that a velocity of the first vehicle 14 has dropped by an amount exceeding a predefined velocity drop threshold within a time being inferior to a predefined time threshold. In other words, it is determined that the first vehicle 14 has undergone an abrupt deceleration.

[0070] Additionally, also in step S11, it is determined, that an airbag system of the first vehicle 14 is activated.

[0071] As a consequence of the determination that the first vehicle 14 is involved in an accident, an accident notification N is provided to the central control entity 40 in a second step S12.

[0072] The accident notification N comprises a status information indicating that the first vehicle 14 is involved in an accident.

[0073] Moreover, the accident notification N comprises a location information describing a current location of the first vehicle 14.

[0074] Additionally, the accident notification N comprises a travelling direction information describing a traveling direction of the corresponding first vehicle 14, a lane information describing a lane on which the corresponding first vehicle 14 is traveling, and a road blocking information which describes whether the vehicle 14 is blocking the road.

[0075] Such an accident notification N is received in a first step S21 of the method for controlling a traffic system which is run on the data processing apparatus 42 of the central control entity 40. The steps of this method will be designated with reference signs S2x.

[0076] In the present example, in step S21, such accident notifications N are received.

[0077] In a second step S22 of the method, the amount of received accident notifications N is determined, i.e. the number of received accident notifications N is counted.

[0078] Additionally, the location information of the accident notification is evaluated.

[0079] In the present example, all three location information's relates to different locations since the three first vehicles 14 are located in different locations. However, these locations are close to one another since the three first vehicles 14 are involved in the same pile-up accident 11.

[0080] In the present example, the locations of neighboring first vehicles 14 differ by approximately 4 meters. On the data storage unit 18, a predefined distance measure of 10 m is stored. This means that accident notifications N relating to locations which are less than 10 m apart from each other are considered to relate to the same accident.

[0081] Thus, in the present example, the location information of all three first vehicles 14 are considered to be a group of location information.

[0082] Consequently, the amount of received accident notifications is counted for this group of location information.

tion.

[0083] In a third step S 23, the amount of received accident notifications N is compared with a threshold amount.

5 **[0084]** In the present example, the threshold amount is three. This means that an accident involving three or more vehicles 14 is considered to be a pile-up accident.

[0085] Consequently, for the traffic situation of Figure 1 it is determined that a pile-up accident 11 has occurred.

10 **[0086]** Consequently, in a fourth step S24, a pile-up accident warning W is provided to the second vehicle 26.

[0087] More precisely, the method evaluates whether there are vehicles which are approaching the location of the group of received location information. Furthermore, it is evaluated whether these vehicles are located within a predefined distance from the location of the pile-up accident.

15 **[0088]** In the example of the traffic situation of Figure 1, it is determined that the second vehicle 26 is both approaching the location of the pile-up accident 11 and is located within the predefined distance from the location of the pile-up accident 11.

20 **[0089]** The pre-defined distance is 1 km in the present example. Thus, pile-up accident warnings W are sent to all vehicles being located within 1 km of the location of the pile-up accident 11 and approaching the location of the pile-up accident 11.

25 **[0090]** In the present example, the pile-up accident warning W comprises a location group information characterizing a location of the group of received location information.

30 **[0091]** Moreover, the pile-up accident warning W comprises a pile-up direction information which describes a direction into which the pile-up accident is developing. This is based on the received traveling direction information of the first vehicles 14.

35 **[0092]** Furthermore, the pile-up accident warning W comprises a pile-up lane information which describes a lane on which the pile-up accident 11 has occurred. This information is determined based on the received lane information of the accident notifications N.

40 **[0093]** Additionally, the pile-up accident warning comprises a road blocking information which describes whether the road on which the pile-up accident 11 has occurred is blocked. This information is derived from the lane blocking information of the accident notifications N.

45 **[0094]** Furthermore, the pile-up accident warning comprises the amount of received accident notifications for which the pile-up accident has been determined, i.e. 3 in the present example.

50 **[0095]** Optionally, the pile-up accident warning W may also comprise a characteristic of the determined pile-up accident 11. This characteristic may be a risk characteristic which may be expressed as a risk level.

55 **[0096]** The first influencing factor on the risk level may be the amount of vehicles being involved in the pile-up accident 11.

[0097] Furthermore, an influencing factor on the risk

level may be a weather information, a time of day information, a road type information, a speed limit information, and a receiving time of the accident notifications N.

[0098] Risk levels may be provided as a function of the above influencing factors, e.g. in the form of lookup tables.

[0099] For example, a pile-up accident 11 may be categorized as high risk if three or four vehicles are involved, the weather information indicates rainy weather, the time of day information relates to nighttime, the road type information relates to a country road and the speed limit information relates to 80 km/h.

[0100] The same pile-up accident 11 may be categorized as medium risk in a case in which the weather information indicates sunny weather, the time of day information relates to daytime, the road type information relates to a country road and the speed limit information relates to 80 km/h.

[0101] Again the same pile-up accident may be categorized as low risk in a case in which the weather information relates to sunny weather, the time of day information relates to daytime, the road type information relates to a city road and the speed limit information relates to 30 km/h.

[0102] It is noted that all of the above examples are independent from the receiving time of the accident notifications N.

[0103] This pile-up accident warning W is received at the data processing apparatus 28 of the second vehicle 26.

[0104] This constitutes a first step S31 of the method for controlling a second vehicle. The steps of this method will be designated with reference signs S3x.

[0105] In a second step S32 the method a reaction maneuver of the second vehicle 26 is triggered.

[0106] The reaction maneuver may comprise selecting a new traveling route which circumvents the pile-up accident 11. This is of course only possible, if between the position of the second vehicle 26 and the position of the pile-up accident 11, there is a possibility of not entering the road segment on which the pile-up accident 11 has occurred. This means that an intersection needs to be located in between the position of the second vehicle 26 and the position of the pile-up accident 11.

[0107] Alternatively or additionally the reaction maneuver may comprise reducing a traveling speed.

[0108] In this context, the second vehicle may reduce the traveling speed and at the same time select a new traveling route as has been explained before. Alternatively, the second vehicle may reduce the traveling speed and stay on its current traveling route which includes the pile-up accident 11.

[0109] In both examples, reducing the traveling speed has the effect that a reaction time to upcoming obstacles is increased. Furthermore, vehicles traveling behind the second vehicle 26 are also forced to reduce their traveling speed. Altogether, a risk that the second vehicle 26 or vehicles behind the second vehicle 26 will be involved in

the pile-up accident is reduced.

[0110] The reaction maneuver may alternatively include triggering the second vehicle 26 to stop. In this context, the second vehicle 26 may be stopped immediately and on the road. This alternative may be chosen if a pile-up accident which is attributed with a high risk, is detected. The second vehicle 26 may also be stopped on a roadside. Additionally, it is possible to allow the second vehicle 26 to drive onto the next parking spot and stop there.

[0111] Other variations to the disclosed examples can be understood and effected by those skilled in the art in practicing the claimed disclosure, from the study of the drawings, the disclosure, and the appended claims. In the claims the word "comprising" does not exclude other elements or steps and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items or steps recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A computer program may be stored/distributed on a suitable medium such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. Any reference signs in the claims should not be construed as limiting the scope of the claims.

LIST OF REFERENCE SIGNS

[0112]

10	vehicle
11	pile-up accident
12	data processing apparatus
14	first vehicle
16	data processing unit
18	data storage unit
20	computer-readable storage medium
22	computer program
24	means for carrying out a method for controlling a first vehicle
26	second vehicle
28	data processing apparatus
30	data processing unit
32	data storage unit
34	computer-readable storage medium
36	computer program
38	means for carrying out a method for controlling a second vehicle
40	central control entity
42	data processing apparatus
44	data processing unit
46	data storage unit
48	computer-readable storage medium
50	computer program

- 52 means for carrying out a method for controlling a traffic system
 54 traffic control system

N accident notification

W pile-up accident warning

Claims

1. A method for controlling a traffic system comprising at least a first vehicle (14) and a second vehicle (26), wherein each of the first vehicle (14) and the second vehicle (26) is travelling on a road, comprising:

- receiving an accident notification (N) from the first vehicle (14), wherein the accident notification (N) comprises a status information indicating that the first vehicle (14) is involved in an accident and a location information describing a current location of the first vehicle (14) (S21),
- determining an amount of received accident notifications (N) for each of the received location information or for a group of received location information, wherein location information differing by a predefined distance measure or less form the group of received location information (S22),
- comparing the amount of received accident notifications (N) with a threshold amount and determining that a pile-up accident (11) has occurred if the amount of received accident notifications (N) equals or exceeds the threshold amount (S23), and
- providing a pile-up accident warning (W) to the second vehicle (26), if the occurrence of a pile-up accident (11) has been determined (S24).

2. The method of claim 1, wherein the pile-up accident warning (W) comprises the location information or a location group information characterizing a location of the group of received location information.

3. The method of claim 1 or 2, further comprising:

- determining that the second vehicle (26) is approaching the location being described by the location information or by the group of received location information for which the pile-up accident (11) has been determined and/or
- determining that the second vehicle (26) is located within a predefined distance from the location being described by the location information or the group of received location information for which the pile-up accident (11) has been determined.

4. The method according to any one of the preceding claims,

wherein the accident notification (N) comprises at least one of a travelling direction information, a lane information and a lane blocking information,

wherein at least one of a pile-up direction information, a pile-up lane information and a road blocking information is derived from the at least one of the travelling direction information, the lane information and the lane blocking information respectively, and wherein the pile-up accident warning (W) comprises at least one of the pile-up direction information, the pile-up lane information and the road blocking information.

5. The method of any one of the preceding claims, wherein the pile-up accident warning (W) comprises the amount of received accident notifications (N) for which the pile-up accident (11) has been determined.

6. The method according to any one of the preceding claims, further comprising determining a characteristic of the determined pile-up accident (11), wherein the pile-up accident warning (W) comprises the characteristic.

7. The method according to claim 6, wherein the characteristic is determined depending on at least one of a weather information, a time of day information, a road type information, a speed limit information, and a receiving time of the accident notification.

8. A data processing apparatus (42) comprising means for carrying out the method of any one of the preceding claims.

9. A computer program (50) comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method of any one of claims 1 to 7. Computer program

10. A method for controlling a first vehicle (14), wherein the first vehicle (14) may form part of a traffic system, comprising:

- determining that a velocity of the first vehicle (14) has dropped by an amount exceeding a predefined velocity drop threshold within a time being inferior to a predefined time threshold and that an airbag system is activated (S11), and
- providing an accident notification (N) to a central control entity (40) of the traffic system, wherein the accident notification (N) comprises a status information indicating that the first vehicle (14) is involved in an accident and a location information describing a current location of

the first vehicle (14) (S12).

11. The method of claim 10, wherein the accident notification (N) comprises at least one of a travelling direction information, a lane information and a road blocking information. 5
12. A method for controlling a second vehicle (26), wherein the second vehicle (26) may form part of a traffic system, comprising: 10
 - receiving a pile-up accident warning (W) from a central control entity (40) (S31), and
 - triggering a reaction maneuver, wherein the reaction maneuver comprises at least one of selecting a travelling route circumventing the pile-up accident, reducing a travelling speed while staying on a current travelling route, and stopping (S32). 15
13. A data processing apparatus (12, 28) comprising means for carrying out at least one of the methods of claims 10 to 12. 20
14. A vehicle (14, 26) comprising a data processing apparatus (12, 28) according to claim 13. 25
15. A traffic control system (54) comprising a data processing apparatus (42) according to claim 8 and at least one data processing apparatus (12, 28) according to claim 13. 30

Amended claims in accordance with Rule 137(2) EPC. 35

1. A method for controlling a traffic system comprising at least a first vehicle (14) and a second vehicle (26), wherein each of the first vehicle (14) and the second vehicle (26) is travelling on a road, comprising: 40
 - receiving an accident notification (N) from the first vehicle (14) at a central control entity (40), wherein the accident notification (N) comprises a status information indicating that the first vehicle (14) is involved in an accident and a location information describing a current location of the first vehicle (14) (S21), 45
 - determining an amount of received accident notifications (N) for each of the received location information or for a group of received location information, wherein location information differing by a predefined distance measure or less form the group of received location information (S22), 50
 - comparing the amount of received accident notifications (N) with a threshold amount and determining that a pile-up accident (11) has oc-

curred if the amount of received accident notifications (N) equals or exceeds the threshold amount (S23),

- determining a risk characteristic of the determined pile-up accident (11), and
- providing a pile-up accident warning (W) to the second vehicle (26), if the occurrence of a pile-up accident (11) has been determined (S24) wherein the pile-up accident warning (W) comprises the risk characteristic.

2. The method of claim 1, wherein the pile-up accident warning (W) comprises the location information or a location group information characterizing a location of the group of received location information.

3. The method of claim 1 or 2, further comprising:

- Determining, using the central control entity (40), that the second vehicle (26) is approaching the location being described by the location information or by the group of received location information for which the pile-up accident (11) has been determined and/or

- determining, using the central control entity (40), that the second vehicle (26) is located within a predefined distance from the location being described by the location information or the group of received location information for which the pile-up accident (11) has been determined.

4. The method according to any one of the preceding claims,

wherein the accident notification (N) further comprises at least one of a travelling direction information, a lane information and a lane blocking information, wherein at least one of a pile-up direction information, a pile-up lane information and a road blocking information is derived from the at least one of the travelling direction information, the lane information and the lane blocking information respectively, and

wherein the pile-up accident warning (W) comprises at least one of the pile-up direction information, the pile-up lane information and the road blocking information.

5. The method of any one of the preceding claims, wherein the pile-up accident warning (W) comprises the amount of received accident notifications (N) for which the pile-up accident (11) has been determined.

6. The method according to any one of the preceding claims, wherein the risk characteristic is determined depending on at least one of a weather information, a time of day information, a road type information, a

speed limit information, and a receiving time of the accident notification.

7. A data processing apparatus (42) comprising means for carrying out the method of any one of the preceding claims. 5

8. A computer program (50) comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method of any one of claims 1 to 6. 10

9. A method for controlling a first vehicle (14), wherein the first vehicle (14) may form part of a traffic system, comprising: 15
 - determining that a velocity of the first vehicle (14) has dropped by an amount exceeding a predefined velocity drop threshold within a time being inferior to a predefined time threshold and that an airbag system is activated (S11), and 20
 - providing an accident notification (N) to a central control entity (40) of the traffic system, wherein the accident notification (N) comprises a status information indicating that the first vehicle (14) is involved in an accident and a location information describing a current location of the first vehicle (14) (S12). 25

10. The method of claim 9, wherein the accident notification (N) comprises at least one of a travelling direction information, a lane information and a road blocking information. 30

11. A data processing apparatus (12, 28) comprising means for carrying out the method of claim 9 to 10. 35

12. A vehicle (14, 26) comprising a data processing apparatus (12, 28) according to claim 11. 40

13. A traffic control system (54) comprising a data processing apparatus (42) according to claim 7 and at least one data processing apparatus (12, 28) according to claim 11. 45

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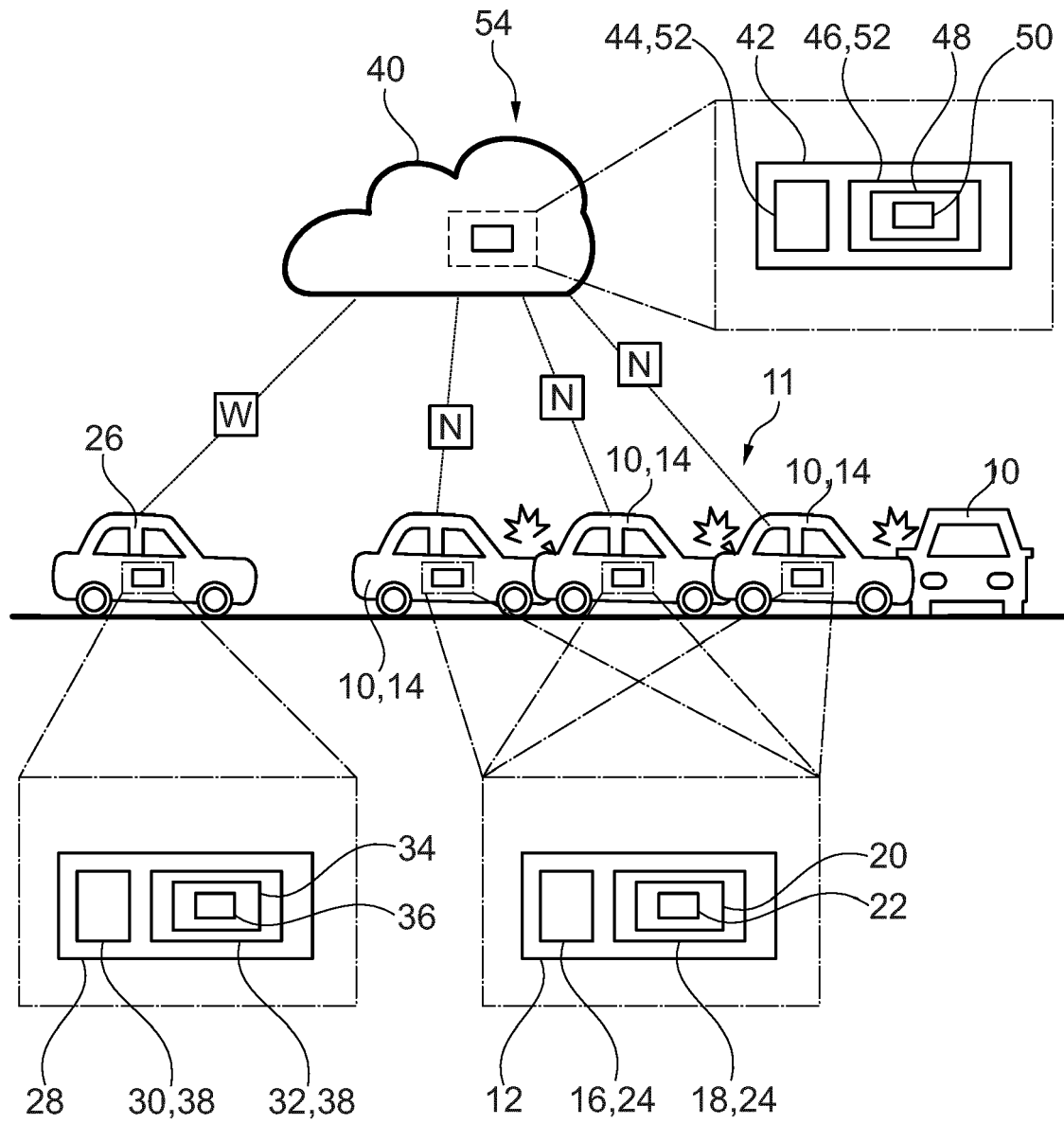


Fig. 1



EUROPEAN SEARCH REPORT

Application Number

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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	US 2017/330436 A1 (WILLIAMS REED [US] ET AL) 16 November 2017 (2017-11-16)	1-4, 6-15	INV.
Y	* paragraphs [0002], [0015], [0023], [0025], [0028] - [0032], [0040], [0043], [0046]; figure 5 *	5	G08G1/01 G08G1/0967 G01C21/34 G08G1/0968 G08G1/00
A	US 2021/287543 A1 (KARAPANTELAKIS ATHANASIOS [US]) 16 September 2021 (2021-09-16) * paragraphs [0034], [0038] *	4, 5, 11	
Y	US 2018/365983 A1 (KARAPANTELAKIS ATHANASIOS [SE] ET AL) 20 December 2018 (2018-12-20) * paragraph [0040] *	5	
			TECHNICAL FIELDS SEARCHED (IPC)
			G08G G01C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 January 2023	Examiner Fagundes-Peters, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 22 19 0936

5 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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30-01-2023

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