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**(54) METHOD AND APPARATUS FOR DETERMINING THE DISTANCE BETWEEN TWO VEHICLES
RUNNING ALONG A ROAD OR MOTORWAY SECTION, PARTICULARLY IN A TUNNEL**

VERFAHREN UND VORRICHTUNG ZUM BESTIMMEN DES ABSTANDS ZWISCHEN ZWEI AUF
EINER STRASSE ODER EINEM AUTOBAHNABSCHNITT FAHRENDEN FAHRZEUGEN
INSBESONDERE IN EINEM TUNNEL

PROCÉDÉ ET APPAREIL POUR DÉTERMINER LA DISTANCE ENTRE DEUX VÉHICULES
PASSANT LE LONG D'UNE SECTION DE ROUTE OU D'AUTOROUTE, EN PARTICULIER DANS
UN TUNNEL

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Description

[0001] The present invention relates to a method for determining the distance between two vehicles running along a section of road or motorway, in particular inside a tunnel.

[0002] According to another aspect, the invention relates to an apparatus for determining the distance between two vehicles running along a section of road or motorway, in particular inside a tunnel.

[0003] A method of the type specified above is known for example from Japanese Patent Application JP11328577.

[0004] The highway code obliges vehicles running along roads and motorways to maintain a given safety distance, which varies according to road conditions and in particular according to the maximum allowable speed. Observing the safety distance contributes to improve safety and results in smoother-flowing traffic.

[0005] To check that the safety distance is being observed, it is necessary to provide for an automatic monitoring system capable of determining the distance between two running vehicles and of producing suitable documentary evidence in the event of a failure to observe the prescribed safety distance.

[0006] WO2005/069248 discloses a method for determining the distance between two vehicles moving one behind the other along a roadway section, as well as the speed of at least one vehicle, by evaluating recorded images. According to this known method, the course of the roadway section is measured and defined in relation to the location of the camera, a first photograph of the two vehicles is taken by means of a camera, at least one additional, second photograph of the vehicles is taken on the roadway section at a given interval, the angles between the location of the camera and two markings that are provided on a vehicle at a given distance are measured on both photographs, the speed of at least one of the two vehicles is determined from the perspective change of the measured angles during this interval while taking into account the given photographic angle, and a linear measure that is based on one vehicle and depends on the speed is inserted into at least one photograph, wherein this linear measure makes it possible to assess whether the distance between the two vehicles matches, lies below or exceeds a minimum distance corresponding to the measured speed.

[0007] It is an object of the present invention to provide a method for determining the distance between two vehicles running along a section of road or motorway which is simple to implement and makes it possible to easily identify a vehicle travelling without observing the safety distance prescribed on that section.

[0008] According to another aspect, it is an object of the present invention to provide an apparatus for determining the distance between two vehicles running along a section of road or motorway which is simple and reliable in operation and is not too costly.

[0009] These and other objects are fully achieved according to the invention by virtue of a method as indicated in independent Claim 1 and by virtue of an apparatus as indicated in independent Claim 12.

[0010] The features and advantages of the invention will become clear from the following detailed description, which is given purely by way of non-limiting example with reference to the appended drawings, in which:

Figure 1 schematically represents a condition of observance of the safety distance between two vehicles running along a section of road or motorway;

Figure 2 schematically represents a condition of non observance of the safety distance between two vehicles running along a section of road or motorway;

Figure 3 schematically represents a video camera forming part of the apparatus for determining the distance between two vehicles according to the invention and the associated field of view;

Figure 4 schematically represents a plurality of video cameras forming part of the apparatus for determining the distance between two vehicles according to the invention, where the section of road to be monitored is subdivided into a plurality of subsections;

Figure 5 schematically represents a subsection subdivided into a plurality of cells;

Figure 6 shows a sequence of images provided by the video cameras of the apparatus according to the invention in the event that the safety distance between two vehicles running along a section of road inside a tunnel is not observed; and

Figure 7 shows the image provided by the number plate recording video camera of the apparatus according to the invention.

[0011] Figure 1 schematically represents a section of road or motorway 10 of length S equal to the prescribed safety

distance.. The references 1 and 2 respectively indicate a first vehicle and a second vehicle running along the road section 10 in the direction indicated by the arrow A. The first vehicle 1 (referred to in the following part of the description as the trailing vehicle) which is about to enter the road section 10 to be monitored is travelling in observance of the prescribed safety distance S only if the road section 10 is free, i.e. if no other vehicle is present at the same time along this section.

[0012] If on the other hand, as shown in Figure 2, when the trailing vehicle 1 enters the road section 10 the second vehicle 2 (referred to in the following part of the description as the leading vehicle) is still within the road section 10, then the distance between the two vehicles, indicated D in Figure 2, is less than the safety distance S. The trailing vehicle 1 is therefore in contravention.

[0013] Figure 2 also shows a video camera 3 able to acquire an image of the road section S and to provide as output a video signal, and a processing unit 4 arranged to receive as input at pre-established time intervals the video signal provided by the video camera 3 and to process this video signal through digitization techniques so as to detect the possible presence of the leading vehicle 2 in the road section 10. The processing unit 4 defines at each processing event the state of the road section 10 as free or occupied, depending on whether the presence of the leading vehicle 2 within the road section 10 has been detected or not at the moment when the trailing vehicle 1 enters the road section 10.

[0014] Figure 3 shows the field of view of the video camera 3, which is installed at a height H from the road surface and is oriented so as to form with its optical axis an angle θ with respect to the horizontal. The length of the effective monitoring area of the video camera 3 is indicated T, while the height-limit for the detection of a vehicle by the artificial vision software associated with the video camera 3 is indicated Q. As brought out in Figure 3, the length T is less than the length of the portion of road actually framed by the video camera 3 and depends, in particular, on the height-limit Q.

[0015] In general, the length T is not equal to but is less than the length S of the road section 10 to be monitored, since the safety distance is often such that the road section 10 cannot be monitored using a single video camera 3. The road section 10 must therefore be subdivided into a plurality of subsections 12 of length T, each of which is monitored by a respective video camera 3.

[0016] To this end, Figure 4 illustrates how the road section 10 is preferably monitored according to the invention by a plurality of video cameras 3 (in the example illustrated, by four video cameras) linked to the processing unit 4, each of which is intended to monitor a single subsection 12 of length T (in the example illustrated, equal to a quarter of the distance S). Since the length T of the subsections 12 is less than the length of the portion of road actually framed by a single video camera 3, there is each time an overlapping of the fields of view of two adjacent video cameras.

[0017] As already mentioned earlier, at the moment when the vehicle 1 is about to enter the monitored road section 10, the vehicle 1 is not in contravention, i.e. it is observing the prescribed safety distance S, if all the subsections 12 of length T are in the state defined above as free. However, it is sufficient for any one of the subsections 12 to be in the occupied state, due to the presence of the leading vehicle 2 in this subsection, for the vehicle 1 to be judged in contravention. From a logic point of view, it can therefore be said that the free/occupied state of the monitored road section 10 is given by the OR function of the free/occupied states of all the subsections 12.

[0018] Therefore, if it is necessary simply to detect the condition of contravention due to a failure to observe the safety distance, it is sufficient for the processing unit 4 to be capable of detecting, by processing the video signals from the video cameras 3, the possible presence of the leading vehicle 2 in each of the subsections 12 monitored by the video cameras 3 at the moment of entry of the vehicle 1 into the road section 10 to be monitored.

[0019] According to a further advantageous aspect of the invention, the detection apparatus is also capable of providing a measurement of the distance kept by the trailing vehicle 1 with respect to the leading vehicle 2 at the moment when the contravention is established.

[0020] Since the measurement precision of the distance is obviously related to the length of the subsections into which the road section to be monitored is subdivided, i.e. to the number of video cameras 3 used, to improve the measurement precision the number of subsections 12 and therefore the number of video cameras 3 used could be increased. This would involve an increase in costs of the apparatus.

[0021] To remedy this problem, it is preferable to turn rather to more sophisticated video processing techniques. Each subsection 12 of length T is thus subdivided by the processing unit 4 into a plurality of cells 14 of equal length C, as shown in Figure 5, and the processing unit 4 is capable of determining not only the subsection 12, but also the cell 14 of this subsection in which the leading vehicle 2 is located at the moment when the trailing vehicle 1 enters the road section 10.

[0022] In the example illustrated in Figure 5, the road section 10 is subdivided into four subsections 12, each of which is in turn subdivided into four cells 14 of length C equal to $T/4$. The distance between the two vehicles 1 and 2 running within the road section 10 can therefore be determined on the basis of the following table:

Occupied subsection 12	Occupied cell 14	Estimated interdistance
1	1	between 0 and C metres
	2	between C and 2C metres
	3	between 2C and 3C metres
	4	between 3C and 4C metres
2	1	between 4C and 5C metres
	2	between 5C and 6C metres
	3	between 6C and 7C metres
	4	between 7C and 8C metres
3	1	between 8C and 9C metres
	2	between 9C and 10C metres
	3	between 10C and 11C metres
	4	between 11C and 12C metres
4	1	between 12C and 13C metres
	2	between 13C and 14C metres
	3	between 14C and 15C metres
	4	between 15C and 16C metres

[0023] Based on what has been explained above, the interdistance measurement error can depend on the following factors: length S of the road section 10, number of subsections 12 into which the road section 10 is subdivided, length T of each subsection 12, number of cells 14 into which each subsection 12 is subdivided and length C of each cell 14. To make the measurement of the interdistance as favourable as possible for the monitored vehicle, the interdistance must be measured by always considering the value of the upper limit of the intervals indicated in the above table. The measurement error, committed by considering the upper limit of the interval is equal to the error committed in the single subsection 12 in which the leading vehicle 2 has been detected. Within each cell 14, the measurements in the interval from 0 to C are approximated to the value C.

[0024] Indicating P the real position of the vehicle 2 in a given cell 14, the measurement error will be:

$$E = C - P \quad (1)$$

[0025] In the interval (0, C) the average measurement error can be calculated as:

$$\bar{E} = \frac{1}{C} \int_0^C (C - x) dx = \frac{1}{C} \left(Cx - \frac{1}{2} x^2 \right) \Big|_0^C = \frac{C}{2} \quad (2)$$

[0026] This error has to be normalised to the length T of the subsection 12, which is by definition equal to the number of cells 14, indicated by M, multiplied by the length C of each cell. The average measurement error is therefore given by the following relationship:

$$\overline{E_m} = \frac{\bar{E}}{T} = \frac{C}{2MC} = \frac{1}{2M} \quad (3)$$

[0027] With the method and the apparatus according to the invention, the distance between two vehicles in the road section to be monitored can therefore be estimated with an error that depends only on the number of cells that the image acquiring and processing system (video cameras 3 and processing unit 4) is capable of distinguishing within each subsection.

[0028] In addition to the video cameras 3 for acquiring the images of the individual subsections 12, a further number plate recording video camera can be provided, not shown in the drawings, intended to acquire in the event of a contravention an image of the number plate of the vehicle 1 that is not observing the prescribed safety distance, which image is to be used as documentary evidence for the subsequent notification of the contravention by the traffic police forces.

[0029] To carry out the detection method according to the invention, two characteristic events are fundamental, which are indicated for convenience as the "assessing" event and the "number plate recording" event. The "assessing" event corresponds to the moment when a vehicle enters the road section 10 monitored by the apparatus; this event triggers the execution of the procedure for assessing a possible contravention due to a failure to observe the safety distance. The "number plate recording" event corresponds to the moment when the vehicle in question reaches the optimal framing position for the number plate recording video camera; this event triggers the acquisition of the image of the number plate of the vehicle in case of a contravention.

[0030] To recognise the abovementioned two events the state of the first cell 14 of the first subsection 12 of the road section is used. The passage of a vehicle through the first cell 14 causes the state of this cell to vary in time according to a characteristic square-wave profile: the "assessing" event causes the state of the first cell to change from free to occupied, since it corresponds to the instant when the vehicle enters the first cell, while the "number plate recording" event causes the state of the first cell to change from occupied to free, since it corresponds to the instant when the vehicle comes out of the first cell. In other words, the rising edge of the square-wave profile, i.e. the transition from the free state to the occupied state, indicates that the vehicle is entering the first cell. Conversely, the falling edge of the profile, i.e. the transition from the occupied state to the free state, indicates that the vehicle is exiting the first cell. The time in which the first cell remains in the occupied state depends on the length and speed of the vehicle and on the length C of the first cell.

[0031] The "assessing" and "number plate recording" events described above can be detected either by means of a video camera, advantageously the same video camera 3 intended to acquire the image of the first subsection 12, or by means of field devices (sensors) of different type from the video cameras, such as for example induction coils, laser sensors, photocells, etc.

[0032] The processing unit 4 has fundamentally the function of receiving the video signals from the video cameras 3 and processing these signals in order to identify the conditions of failure to observe the prescribed safety distance, to indicate any contravention, to acquire and make available the necessary documentary evidence for the subsequent notification to the driver of the charged vehicle.

[0033] The processing unit 4 manages at its input the video signals as follows. The video signals from the video cameras 3 are processed by an artificial vision software to allow the identification of a vehicle within the road section 10 being monitored. In particular, the video signal from the first video camera 3 (or from another field device, as specified above) in the driving direction A is used to detect when the "assessing" and "number plate recording" events occur. The video signal from the number plate recording video camera is processed in order to acquire the number plate of the vehicle in contravention in order to identify it unambiguously. This video camera is positioned in an appropriate manner so as to frame the number plate of the vehicle at the instant when it is exiting the first cell ("number plate recording" event).

[0034] The processing algorithm of the processing unit 4 therefore comprises the following steps. At the moment when the vehicle 1 enters the road section 10 being monitored, flagged by the occurrence of the "assessing" event, the processing unit 4 starts to scan the images from the video cameras 3 in order to identify any leading vehicles 2 within the road section 10. If the vehicle 2 is detected within the road section 10, i.e. in presence of a violation due to a failure to observe the safety distance, the processing unit 4 activates the number plate recording video camera to acquire an image of the number plate of the vehicle 1 in contravention. The processing unit 4 measures the distance of the trailing vehicle 1 from the leading vehicle 2 and stores the images acquired by the video cameras 3 at the moment of entry of the vehicle 1 into the road section 10. Finally, as soon as the rear of the trailing vehicle 1 passes beyond the first cell ("number plate recording" event), the processing unit 4 acquires by means of the number plate recording video camera the image of the number plate of the vehicle in contravention. All the images stored by the processing unit are accompanied by an indication of the instant of acquisition, so as to provide complete and indisputable documentation of the contravention committed.

[0035] Naturally, the principle of the invention remaining the same, the embodiments and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the invention as defined in the appended claims.

Claims

1. A method for determining whether the distance between two vehicles (1, 2) running along a section of road or motorway (10), in particular inside a tunnel, is less than a prescribed safety distance, comprising the operations of:
 - a) acquiring an image of the road section (10) of length (S) equal to the prescribed safety distance;
 - b) verifying the entry of a first vehicle (1) into the section;
 - c) processing the image of the road section (10) in order to check whether at the moment of entry of a first vehicle (1) into the section there is present within the section a second vehicle (2) which precedes the first vehicle (1); and
 - d) acquiring and storing an image of the number plate of the first vehicle (1) if the presence of the second vehicle (2) within the road section (10) has been detected and hence if the distance between said vehicles (1, 2) is less than the safety distance.
2. A method according to Claim 1, wherein said operation a) is carried out by means of a plurality of video cameras (3) equally spaced along the road section (10), each of which is arranged to acquire the image of a respective subsection of road (12).
3. A method according to Claim 2, wherein said operation d) is carried out by means of a special video camera that is distinct from the video cameras (3) arranged to each acquire the image of a respective subsection (12).
4. A method according to either Claim 2 or Claim 3, wherein said operation b) is carried out by processing the image from a first video camera (3) arranged at the entry of the road section (10).
5. A method according to either Claim 2 or Claim 3, wherein said operation b) is carried out using a signal from a special field device or sensor that is distinct from the video cameras (3) and arranged at the entry of the road section (10).
6. A method according to any one of Claims 2 to 5, wherein said operation c) is carried out by processing the images from all the video cameras (3).
7. A method according to any one of Claims 2 to 6, wherein said operation d) is carried out when the presence of the second vehicle (2) is detected from the image provided by any one of the video cameras (3).
8. A method according to any one of Claims 2 to 7, additionally comprising the operation of
 - e) providing a measurement of the distance between the first (1) and the second vehicle (2) based on the subsection of road (12) in which the presence of the second vehicle (2) has been detected.
9. A method according to Claim 8, wherein said operation c) provides for the subdivision of each subsection (12) into a plurality of cells (14) of equal length (C) and the processing of the image of the subsection (12) in which the second vehicle (2) is present so as to determine in which cell (14) of this subsection (12) the second vehicle (2) is present, and wherein in operation e) the distance between the first (1) and the second vehicle (2) is measured on the basis of the cell (14) of the subsection of road (12) in which the presence of the second vehicle (2) has been detected.
10. A method according to Claim 9, wherein said operation b) is carried out by considering the first cell (14) of the first subsection (12) of the road section (10).
11. A method according to Claim 9, wherein said operation d) is carried out when the exit of the first vehicle (1) from the first cell (14) of the first subsection (12) of the road section (10) is detected.
12. An apparatus for determining whether the distance between two vehicles (1, 2) running along a section of road or motorway (10), in particular inside a tunnel, is less than a prescribed safety distance, comprising:
 - at least one video camera (3) arranged to acquire an image of the road section (10) of length (S) equal to the prescribed safety distance;
 - detection means for detecting the entry of a first vehicle (1) into said section;
 - a processing unit (4) arranged to process the image of the road section (10), provided by the at least one video

camera (3), to check whether at the moment of entry of a first vehicle (1) into said section there is present within the section a second vehicle (2) which precedes the first vehicle (1);
a number plate recording video camera arranged to acquire an image of the number plate of the first vehicle (1) if the presence of the second vehicle (2) within the road section (10) has been detected and hence if the distance between said vehicles (1, 2) is less than the safety distance; and
storage means arranged to store the image of the number plate of the first vehicle (1).

13. An apparatus according to Claim 12, comprising a plurality of video cameras (3) equally spaced along the road section (10), each of which is arranged to acquire the image of a respective subsection of road (12).

14. An apparatus according to Claim 13, wherein the first of the video cameras (3) serves as detection means for detecting the entry of a first vehicle (1) into the road section (10).

15. An apparatus according to Claim 12, wherein the detection means are formed by field devices or sensors that are distinct from said at least one video camera (3), such as induction coils, laser sensors or photocells.

Patentansprüche

1. Verfahren zum Bestimmen, ob der Abstand zwischen zwei Fahrzeugen (1, 2), die entlang eines Abschnitts einer Straße oder Autobahn (10), insbesondere im Inneren eines Tunnels, fahren, weniger als ein vorgeschriebener Sicherheitsabstand beträgt, umfassend die folgenden Vorgänge:

- a) Aufnehmen eines Bildes des Straßenabschnitts (10) mit einer Länge (S), die gleich dem vorgeschriebenen Sicherheitsabstand ist;
- b) Verifizieren des Eintritts eines ersten Fahrzeugs (1) in den Abschnitt;
- c) Verarbeiten des Bildes des Straßenabschnitts (10), um zu überprüfen, ob im Augenblick des Eintritts des ersten Fahrzeugs (1) in den Abschnitt innerhalb des Abschnitts ein zweites Fahrzeug (2) anwesend ist, das sich vor dem ersten Fahrzeug (1) befindet; und
- d) Aufnehmen und Speichern eines Bildes des Nummernschilds des ersten Fahrzeugs (1), wenn die Anwesenheit des zweiten Fahrzeugs (2) innerhalb des Straßenabschnitts (10) entdeckt wurde und folglich, wenn der Abstand zwischen den Fahrzeugen (1, 2) geringer als der Sicherheitsabstand ist.

2. Verfahren nach Anspruch 1, wobei der Vorgang a) mittels einer Mehrzahl von Videokameras (3) ausgeführt wird, die im gleichen Abstand voneinander entlang des Straßenabschnitts (10) positioniert sind, wobei jede von ihnen angeordnet ist, das Bild eines jeweiligen Unterabschnitts (12) der Straße aufzunehmen.

3. Verfahren nach Anspruch 2, wobei der Vorgang d) mittels einer speziellen Videokamera ausgeführt wird, die von den Videokameras (3), die angeordnet sind, das Bild eines jeweiligen Unterabschnitts (12) aufzunehmen, verschieden ist.

4. Verfahren nach Anspruch 2 oder 3, wobei der Vorgang b) ausgeführt wird, indem das Bild einer ersten Videokamera (3), die am Eingang des Straßenabschnitts (10) angeordnet ist, verarbeitet wird.

5. Verfahren nach Anspruch 2 oder 3, wobei der Vorgang b) ausgeführt wird, indem ein Signal von einem speziellen Feldgerät oder -sensor verwendet wird, das/der von den Videokameras (3) verschieden und am Eingang des Straßenabschnitts (10) angeordnet ist.

6. Verfahren nach einem der Ansprüche 2 bis 5, wobei der Vorgang c) ausgeführt wird, indem die Bilder von allen Videokameras (3) verarbeitet werden.

7. Verfahren nach einem der Ansprüche 2 bis 6, wobei der Vorgang d) ausgeführt wird, wenn die Anwesenheit des zweiten Fahrzeugs (2) auf dem Bild, das von einer der Videokameras (3) bereitgestellt wird, entdeckt wird.

8. Verfahren nach einem der Ansprüche 2 bis 7, das zusätzlich den folgenden Vorgang umfasst:

- e) Bereitstellen einer Messung des Abstands zwischen dem ersten (1) und dem zweiten Fahrzeug (2) auf der Grundlage des Unterabschnitts der Straße (12), in dem die Anwesenheit des zweiten Fahrzeugs (2) entdeckt

wurde.

9. Verfahren nach Anspruch 8, wobei der Vorgang c) die Aufteilung jedes Unterabschnitts (12) in eine Mehrzahl von Zellen (14) von gleicher Länge (C) vorsieht, und das Verarbeiten des Bildes des Unterabschnitts (12), in dem das zweite Fahrzeug (2) anwesend ist, um zu bestimmen, in welcher Zelle (14) dieses Unterabschnitts (12) das zweite Fahrzeug (2) anwesend ist, und wobei im Vorgang e) der Abstand zwischen dem ersten (1) und dem zweiten Fahrzeug (2) auf der Grundlage der Zelle (14) des Unterabschnitts der Straße (12) gemessen wird, in der die Anwesenheit des zweiten Fahrzeugs (2) entdeckt wurde.

10. Verfahren nach Anspruch 9, wobei der Vorgang b) ausgeführt wird, indem die erste Zelle (14) des ersten Unterabschnitts (12) des Straßenabschnitts (10) betrachtet wird.

11. Verfahren nach Anspruch 9, wobei der Vorgang d) ausgeführt wird, wenn der Austritt des ersten Fahrzeugs (1) aus der ersten Zelle (14) des ersten Unterabschnitts (12) des Straßenabschnitts (10) entdeckt wird.

12. Vorrichtung zum Bestimmen, ob der Abstand zwischen zwei Fahrzeugen (1, 2), die entlang eines Abschnitts einer Straße oder Autobahn (10), insbesondere im Inneren eines Tunnels, fahren, weniger als ein vorgeschriebener Sicherheitsabstand beträgt, umfassend:

zumindest eine Videokamera (3), die angeordnet ist, ein Bild des Straßenabschnitts (10) mit einer Länge (S), die gleich dem vorgeschriebenen Sicherheitsabstand ist, aufzunehmen;

Detektionsmittel zum Entdecken des Eintritts eines ersten Fahrzeugs (1) in den Abschnitt;

eine Verarbeitungseinheit (4), die angeordnet ist, das Bild des Straßenabschnitts (10) zu verarbeiten, das von der zumindest einen Videokamera (3) bereitgestellt wird, um zu überprüfen, ob im Augenblick des Eintritts des ersten Fahrzeugs (1) in den Abschnitt innerhalb des Abschnitts ein zweites Fahrzeug (2) anwesend ist, das sich vor dem ersten Fahrzeug (1) befindet;

eine Videokamera zum Aufnehmen von Nummernschildern, die angeordnet ist, ein Bild des Nummernschilds des ersten Fahrzeugs (1) aufzunehmen, wenn die Anwesenheit des zweiten Fahrzeugs (2) innerhalb des Straßenabschnitts (10) entdeckt wurde und folglich, wenn der Abstand zwischen den Fahrzeugen (1, 2) geringer als der Sicherheitsabstand ist; und Speichermittel, die angeordnet sind, das Bild des Nummernschilds des ersten Fahrzeugs (1) zu speichern.

13. Vorrichtung nach Anspruch 12, umfassend eine Mehrzahl von Videokameras (3), die im gleichen Abstand voneinander entlang des Straßenabschnitts (10) positioniert sind, wobei jede von ihnen angeordnet ist, das Bild eines jeweiligen Unterabschnitts (12) der Straße aufzunehmen.

14. Vorrichtung nach Anspruch 13, wobei die erste der Videokameras (3) als Detektionsmittel zum Entdecken des Eintritts eines ersten Fahrzeugs (1) in den Straßenabschnitt (10) dient.

15. Vorrichtung nach Anspruch 12, wobei die Detektionsmittel aus Feldgeräten oder -sensoren gebildet sind, die von der zumindest einen Videokamera (3) verschieden sind, beispielsweise Induktionsspulen, Lasersensoren oder Photozellen.

Revendications

1. Procédé pour déterminer si la distance entre deux véhicules (1, 2) circulant le long d'une section de route ou d'autoroute (10), en particulier à l'intérieur d'un tunnel, est inférieure à une distance de sécurité prescrite, comprenant les opérations consistant à :

a) acquérir une image de la section de route (10) de longueur (S) égale à la distance de sécurité prescrite ;

b) vérifier l'entrée d'un premier véhicule (1) dans la section ;

c) traiter l'image de la section de route (10) afin de vérifier si, au moment de l'entrée d'un premier véhicule (1) dans la section, un deuxième véhicule (2) qui précède le premier véhicule (1) est présent dans la section ; et

d) acquérir et mémoriser une image de la plaque d'immatriculation du premier véhicule (1) si la présence du deuxième véhicule (2) dans la section de route (10) a été détectée et ainsi si la distance entre lesdits véhicules (1, 2) est inférieure à la distance de sécurité.

2. Procédé selon la revendication 1, dans lequel ladite opération a) est effectuée au moyen d'une pluralité de caméras vidéo (3) régulièrement espacées le long de la section de route (10), chacune d'elles étant agencée pour acquérir l'image d'une sous-section de route (12) respective.
- 5 3. Procédé selon la revendication 2, dans lequel ladite opération d) est effectuée au moyen d'une caméra vidéo spéciale qui est distincte des caméras vidéo (3) agencées pour acquérir chacune l'image d'une sous-section (12) respective.
4. Procédé selon la revendication 2 ou la revendication 3, dans lequel ladite opération b) est effectuée en traitant l'image provenant d'une première caméra vidéo (3) agencée à l'entrée de la section de route (10).
- 10 5. Procédé selon la revendication 2 ou la revendication 3, dans lequel ladite opération b) est effectuée en utilisant un signal provenant d'un dispositif de terrain ou d'un capteur spécial qui est distinct des caméras vidéo (3) et agencé à l'entrée de la section de route (10).
- 15 6. Procédé selon l'une quelconque des revendications 2 à 5, dans lequel ladite opération c) est effectuée en traitant les images provenant de toutes les caméras vidéo (3).
7. Procédé selon l'une quelconque des revendications 2 à 6, dans lequel ladite opération (d) est effectuée lorsque la présence du deuxième véhicule (2) est détectée à partir de l'image fournie par l'une quelconque des caméras vidéo (3).
- 20 8. Procédé selon l'une quelconque des revendications 2 à 7, comprenant en plus l'opération consistant à :
 - e) fournir une mesure de la distance entre le premier (1) et le deuxième (2) véhicule sur la base de la sous-section de route (12) dans laquelle la présence du deuxième véhicule (2) a été détectée.
- 25 9. Procédé selon la revendication 8, dans lequel ladite opération c) prévoit la subdivision de chaque sous-section (12) en une pluralité de cellules (14) de même longueur (C) et le traitement de l'image de la sous-section (12) dans laquelle le deuxième véhicule (2) est présent de manière à déterminer dans quelle cellule (14) de cette sous-section (12) le deuxième véhicule (2) est présent, et dans lequel, au cours de l'opération e), la distance entre le premier (1) et le deuxième (2) véhicule est mesurée sur la base de la cellule (14) de la sous-section de route (12) dans laquelle la présence du deuxième véhicule (2) a été détectée.
- 30 10. Procédé selon la revendication 9, dans lequel ladite opération b) est effectuée en prenant en considération la première cellule (14) de la première sous-section (12) de la section de route (10).
- 35 11. Procédé selon la revendication 9, dans lequel ladite opération d) est effectuée lorsque la sortie du premier véhicule (1) de la première cellule (14) de la première sous-section (12) de la section de route (10) est détectée.
- 40 12. Appareil pour déterminer si la distance entre deux véhicules (1, 2) circulant le long d'une section de route ou d'autoroute (10), en particulier à l'intérieur d'un tunnel, est inférieure à une distance de sécurité prescrite, comprenant :
 - au moins une caméra vidéo (3) agencée pour acquérir une image de la section de route (10) de longueur (S) égale à la distance de sécurité prescrite ;
 - des moyens de détection pour détecter l'entrée d'un premier véhicule (1) dans ladite section ;
 - une unité de traitement (4) agencée pour traiter l'image de la section de route (10), fournie par ladite au moins une caméra vidéo (3), pour vérifier si, au moment de l'entrée d'un premier véhicule (1) dans ladite section, un deuxième véhicule (2) qui précède le premier véhicule (1) est présent dans la section ;
 - une caméra vidéo d'enregistrement de plaque d'immatriculation agencée pour acquérir une image de la plaque d'immatriculation du premier véhicule (1) si la présence du deuxième véhicule (2) dans la section de route (10) a été détectée et ainsi si la distance entre lesdits véhicules (1, 2) est inférieure à la distance de sécurité ; et
 - des moyens de mémorisation agencés pour mémoriser l'image de la plaque d'immatriculation du premier véhicule (1).
- 55 13. Appareil selon la revendication 12, comprenant une pluralité de caméras vidéo (3) régulièrement espacées le long de la section de route (10), chacune d'elles étant agencée pour acquérir l'image d'une sous-section de route (12) respective.

14. Appareil selon la revendication 13, dans lequel la première des caméras vidéo (3) sert en tant que moyens de détection pour détecter l'entrée d'un premier véhicule (1) dans la section de route (10).
- 5 15. Appareil selon la revendication 12, dans lequel les moyens de détection sont formés par des dispositifs de terrain ou des capteurs qui sont distincts de ladite au moins une caméra vidéo (3), tels que des bobines d'induction, des capteurs laser ou des cellules photoélectriques.

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FIG.1

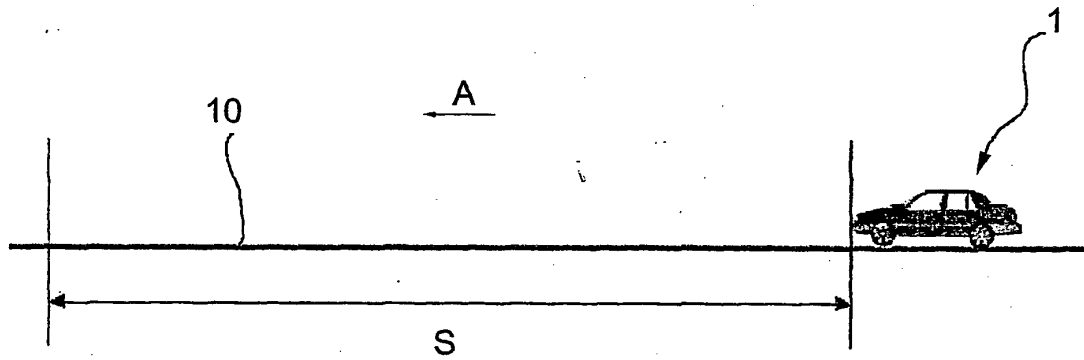
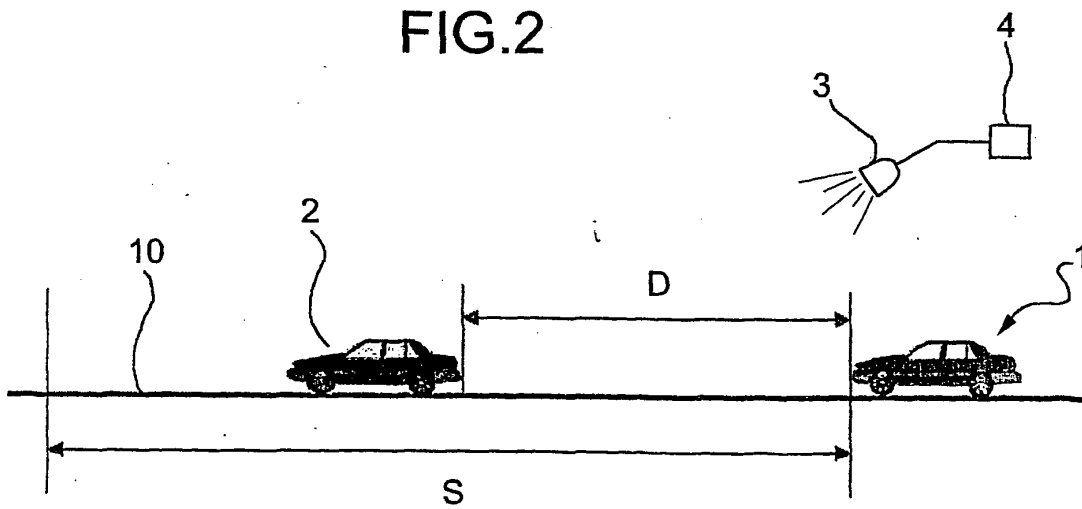


FIG.2



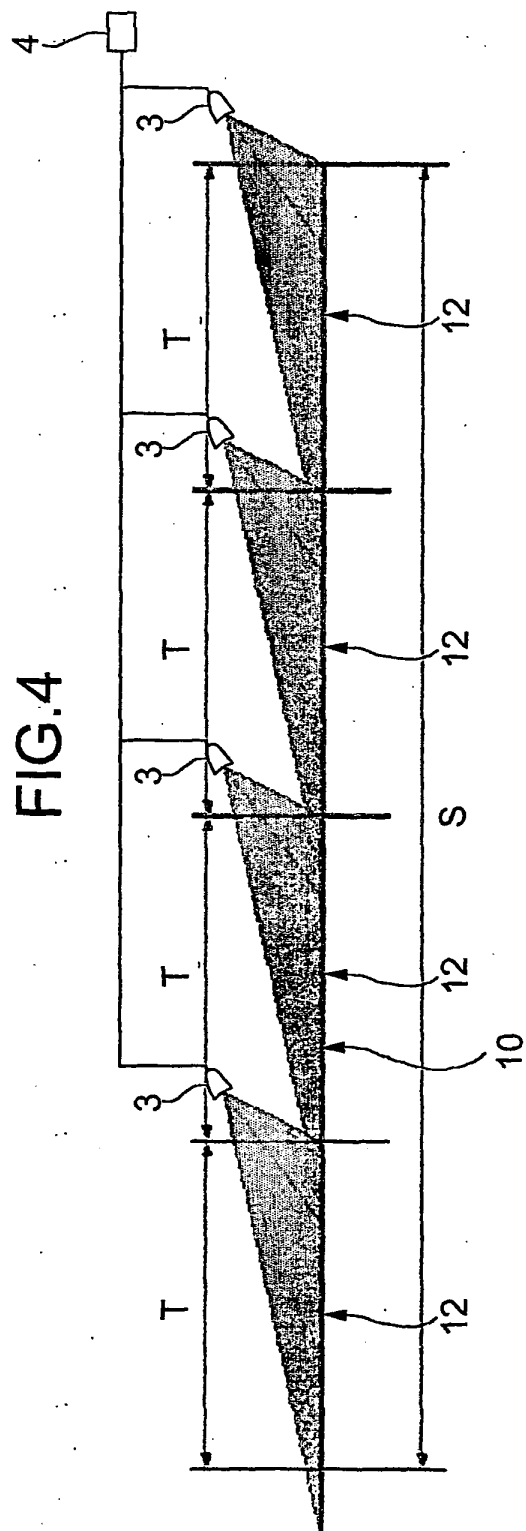
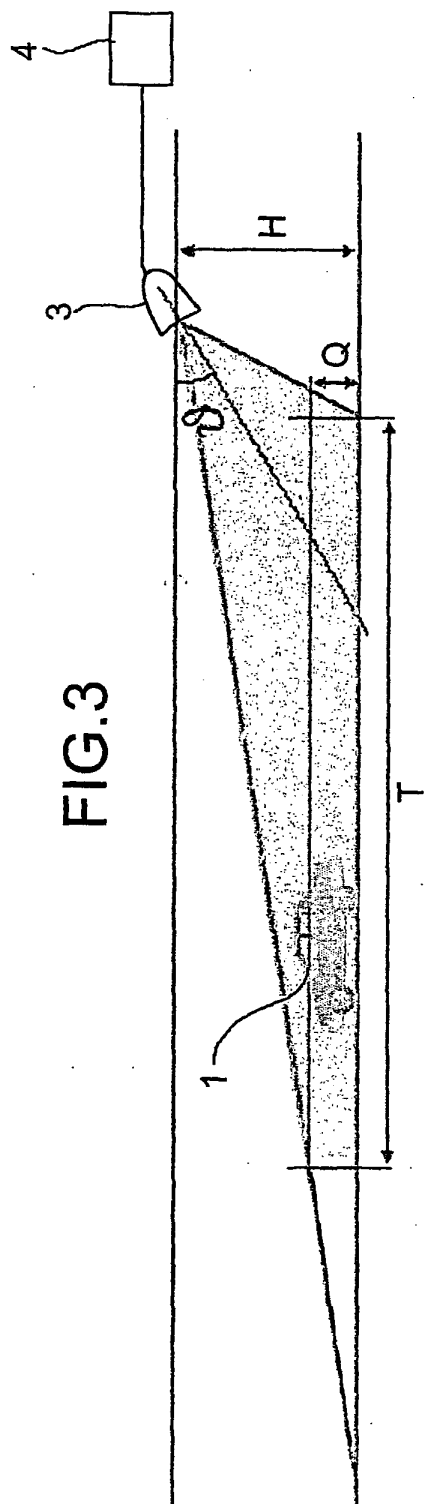


FIG.5

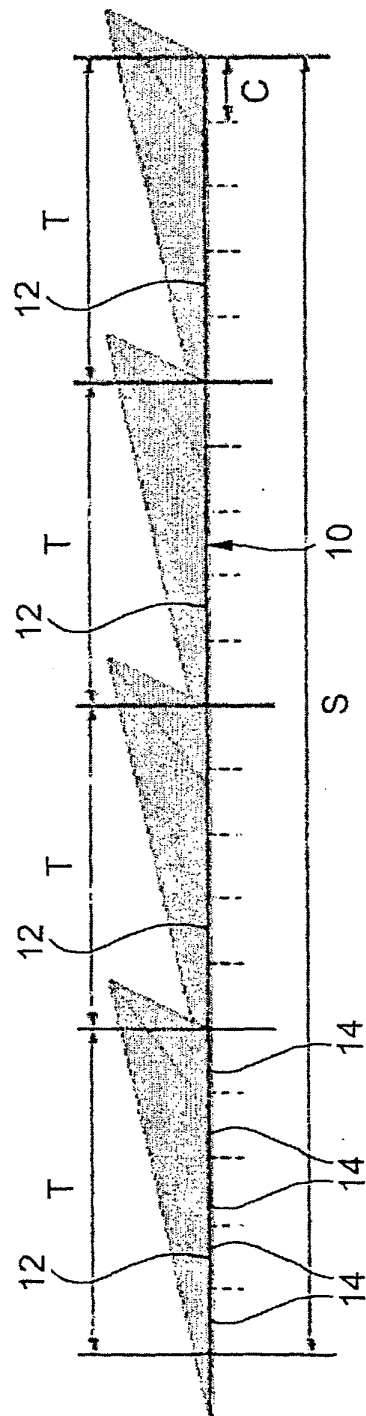


FIG.7

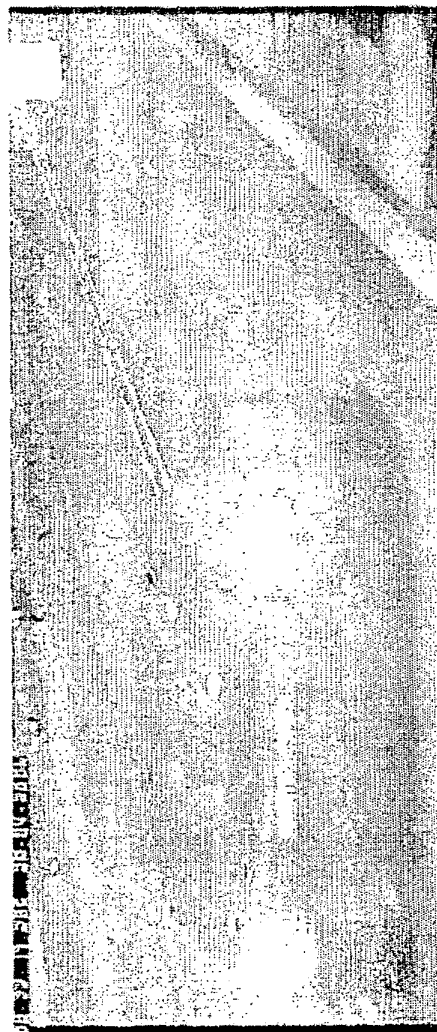
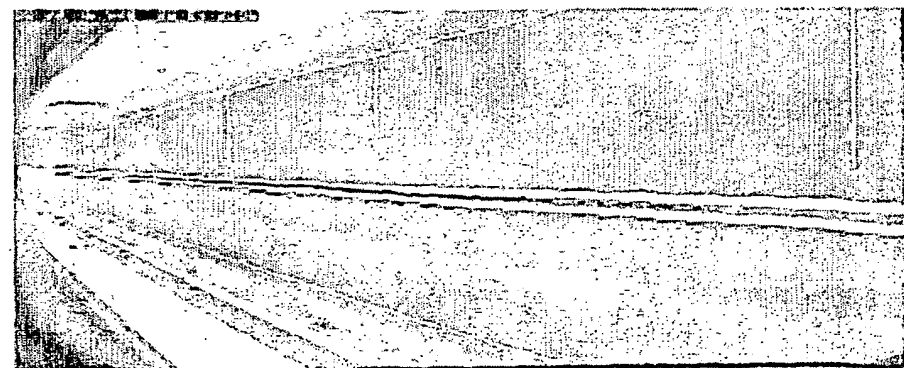
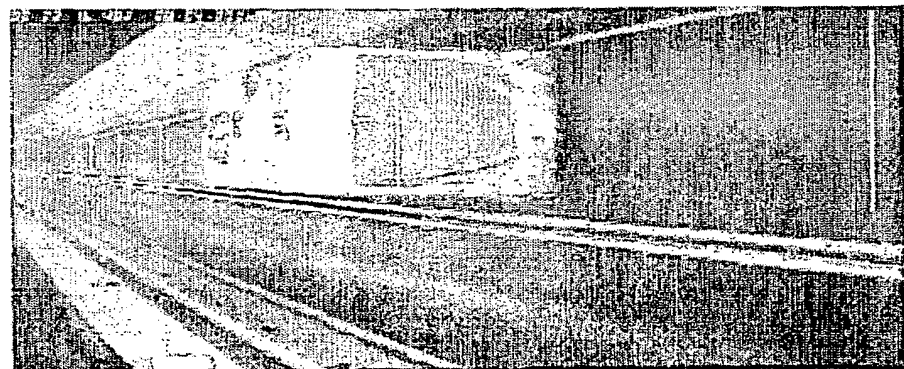
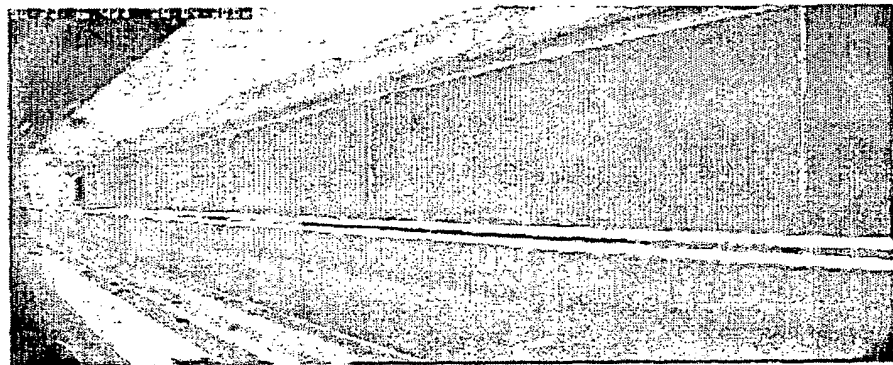
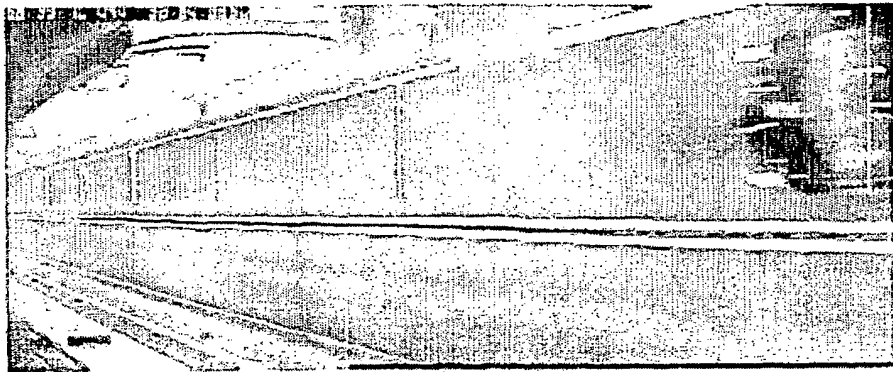


FIG.6



REFERENCES CITED IN THE DESCRIPTION

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