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SYSTEM AND METHOD FOR DETECTING ROAD TRAFFIC VIOLATIONSField of the Invention

This invention relates to a system and method for
5 detecting road traffic violations.

Background of the Invention

One major cause of traffic accidents is due to sudden
lane change activity. To improve traffic safety
10 conditions, traffic planners and enforcers have
identified areas of concern, such as approaches to
traffic intersections, bridge crossings or tunnel
crossings and merging traffic coming onto or off
freeways. Lane change activities in these areas is
15 usually regulated by line markings on the roadway such
as a double white line, to indicate to a driver that it
is illegal to change lanes at these regulated areas.

Unlike enforcement of other traffic violation
20 activities, such as speed and red light violations,
which rely mostly on automatic enforcement, the
enforcement of illegal lane change activity has always
relied on visual detection by a patrol duty officer such
as a policeman.

25 Whilst technology does exist for detecting red light
violations and speed violations, the technology
generally relies on detecting vehicles at a point or
within a very small confined region so that images of
30 the vehicle can be obtained, and also an indication of
the violation recorded. However, in view of the area
over which lane change activity may be illegal, existing
traffic violation systems are not adequate to properly
provide a means of automatic enforcement.

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Summary of the Invention

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The object of a first aspect of the invention is to provide an automatic enforcement system suitable for determining whether vehicles have changed lanes in a restricted area.

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The invention provides a system for detecting traffic lane change violation, comprising:

a first detection system for monitoring a first location of a roadway having multiple lanes;

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a second detection system spaced from the first system for monitoring a second location of the roadway, with the length of roadway between the first and second locations being marked to show that lane change is not permitted; and

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a processor for receiving images from the first and second detection systems for identifying a vehicle and the lane in which the vehicle is travelling at the first location and for comparing that lane with the lane in which the identified vehicle is travelling at the second location to determine whether the vehicle has changed lanes, and therefore committed a lane change violation.

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Since the invention utilises the two detection systems which are spaced apart from one another along the length of the roadway and identifies the lanes in which vehicles are travelling so that the vehicles and the lanes in which they are travelling can be compared at the first and second locations, an automatic system for determining lane change violations is provided.

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Preferably the image of the vehicle at the first location and the image of the vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.

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Preferably the first detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

- 5 Preferably the second detection system comprises a plurality of cameras, each for monitoring one of the lanes of the roadway.

10 Preferably a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

15 Preferably the processor records the lane in which the identified vehicle is travelling and associates a reference to that lane and compares the lane reference the vehicle is travelling in, as captured by the first and second detection systems to identify whether the vehicle has changed lanes.

- 20 Preferably the vehicle identity and lane change reference captured by the first detection system is compared to the data for the identified vehicle and lane captured by the second detection system to determine whether the vehicle has changed lanes.

25 Preferably the matching of a vehicle identified by the first detection system with a vehicle identified by the second detection system takes place over a predetermined time period from when the vehicle is identified by the first detection system.

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The invention provides a method for detecting traffic lane change violation, comprising:

- 35 monitoring a first location of a roadway
having multiple lanes with a first detection system;
monitoring a second location of the roadway

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spaced from the first location with a second detection system, with the length of roadway between the first and second locations being marked to show that lane change is not permitted; and

5 identifying a vehicle and the lane in which the vehicle is travelling at the first location, from an image captured at the first location and comparing the lane in which the identified vehicle is travelling with the lane in which the vehicle is travelling at the
10 second location, from an image at the second location to determine whether the vehicle has changed lanes, and therefore committed a lane change violation.

Preferably the image of the vehicle at the first
15 location and the image of the vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.

Preferably the first detection system comprises a
20 plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

Preferably the second detection system comprises a plurality of cameras, each for monitoring a respective
25 one of the lanes of the roadway.

Preferably a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

30 Preferably the method records the lane in which the identified vehicle is travelling and associates a reference to that lane and compares the lane reference the vehicle is travelling in, as captured by the first
35 and second detection systems to identify whether the vehicle has changed lanes.

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Preferably the vehicle identity and lane change reference captured by the first detection system is compared to the data for the identified vehicle and lane
5 captured by the second detection system to determine whether the vehicle has changed lanes.

Preferably the matching of a vehicle identified by the first detection system with a vehicle identified by the
10 second detection system takes place over a predetermined time period from when the vehicle is identified by the first detection system.

The invention in a second aspect also provides a system
15 for detecting a traffic overtaking violation, comprising:

a first detection system for monitoring a first location of a roadway;

a second detection system spaced from the
20 first system for monitoring a second location of the roadway, with the length of roadway between the first and second detection systems being such that overtaking is prohibited; and

a processor for receiving images from the
25 first detection system and for identifying the order in which vehicles pass the first detection system, and from the second detection system to identify the order in which the vehicles pass the second detection system, to determine whether the order has changed at the second
30 detection system to thereby determine that an overtaking violation has occurred.

Preferably the image of the vehicle at the first location and the image of the vehicle at the second
35 location is used to provide evidence of an overtaking violation, should a violation occur.

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Preferably the first detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

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Preferably the second detection system comprises a plurality of cameras, each for monitoring one of the lanes of the roadway.

10 Preferably a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

Preferably the vehicle identity and lane change
15 reference captured by the first detection system is compared to the data for the identified vehicle and lane captured by the second detection system to determine whether the vehicle has changed lanes.

20 Preferably the matching of a vehicle identified by the first detection system with a vehicle identified by the second detection system takes place over a predetermined time period from when the vehicle is identified by the first detection system.

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The invention also provides a method of detecting a traffic overtaking violation, comprising:

monitoring a first location of a roadway with a first detection system;

30 monitoring a second location of the roadway spaced from the first location with a second detection system, with the length of roadway between the first and second detection systems being such that overtaking is prohibited; and

35 identifying the order in which the vehicles pass the first detection system and the second detection

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system from images captured by the first and second detection systems to determine whether the order has changed at the second detection system to thereby determine that an overtaking violation has occurred.

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Preferably the image of the vehicle at the first location and the image of the vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.

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Preferably the first detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

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Preferably the second detection system comprises a plurality of cameras, each for monitoring one of the lanes of the roadway.

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Preferably a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

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Preferably the vehicle identity and lane change reference captured by the first detection system is compared to the data for the identified vehicle and lane captured by the second detection system to determine whether the vehicle has changed lanes.

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Preferably the matching of a vehicle identified by the first detection system with a vehicle identified by the second detection system takes place over a predetermined time period from when the vehicle is identified by the detection camera system.

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Brief Description of the Drawings

A preferred embodiment of the invention will be

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described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a system according to the preferred embodiment of the invention;

5 Figure 2 is a block diagram of the system components of the preferred embodiment of the invention;

Figure 3 is a diagram illustrating image capture and identification in accordance with the preferred embodiment of the invention; and

10 Figure 4 is a flowchart explaining operation of the preferred embodiment of the invention.

Detailed Description of the Preferred Embodiment

15 With reference to Figure 1, a system for detecting a lane change violation is shown. A roadway 10 is marked with a double white line 12 to identify that vehicles travelling in the direction of the arrows A are not able to change lane.

20 The system comprises a first camera system for monitoring a first location L1 of the roadway 10 and a second camera system 16 spaced from the first system 14 for monitoring location L2 of the roadway 10. The roadway between the locations L1 and L2, as explained above, is marked with double white lines 12 to show that vehicles are not allowed to change lane over the length of the roadway between the locations L1 and L2. The marking of the roadway may be by methods other than by double white lines, such as sign posting or the like.

Each camera system 14 and 16 comprises a camera for monitoring one of the multiple lanes 1 and 2 of the roadway 10. Thus, the environment shown in Figure 1, the camera system 14 comprises a first camera 14a and the second camera 14b. The second camera system 16

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comprises a first camera 16a and a second camera 16b. The cameras 14a and 16a monitor lane 1 of the roadway 10 and the cameras 14b and 16b monitor lane 2 of the roadway 10.

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The cameras 14 and 16 are connected to a processor 20 which comprises a first processing unit 22 to which the cameras 14a and 14b are coupled and a second processing unit 24 to which the cameras 16a and 16b are coupled.

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Images of vehicles travelling passed the location L1, such as vehicle V in Figure 1 is captured by the camera 14a which monitors lane 1 of the roadway 10. The image data is supplied to the processing unit 22 which
15 analyses the image data by image recognition software to identify the licence plate of the vehicle V. The time the vehicle passed the location L1, the licence plate number of the vehicle and the lane in which the vehicle was travelling (such as lane 1) is recorded against the
20 vehicle. Thus, vehicle V is identified by its licence plate number and against that licence plate number is recorded the time the vehicle was detected at location L1 and the lane in which the vehicle is travelling.

25 Whilst in the preferred embodiment of the invention, the vehicle is recognised by its licence plate number, the vehicle could be recognised by other features, such as vehicle type or other characterising markings or shape of the vehicle which is sufficient to accurately
30 identify the vehicle, given the circumstances in which the system is being used.

In the embodiment shown in Figure 1, the vehicle V has changed lanes between locations L1 and L2 so that the
35 vehicle V at location L2 is now in lane 2. Thus, the vehicle has committed a lane change violation.

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When the vehicle arrives at location L2, it is detected by camera 16b which monitors lane 2 of the roadway 10. Again, the vehicle is identified by its licence plate
5 number and the time of arrival at location L2 and the lane in which the vehicle is travelling is recorded by the processing unit 22.

The data received from the processing unit 22 is
10 transferred to the processing unit 24 by link 30 so that the data captured by the camera 16b can be compared with the data relating to the same vehicle captured by the system 14. If the data identifies the vehicle V in a different lane to that captured by the system 14, then a
15 violation has occurred.

Figure 3 shows a typical example of how the vehicle is identified. The roadway shown in Figure 3 is the same as that in Figure 1. As shown in Figure 3, the vehicle
20 at location L1 is identified by its registration number, which is simply given as VX in Figure 3 and the time T1 at which the vehicle arrived at location L1 is recorded, as is the lane number (lane 1). The image of the vehicle and the time is also recorded to provide
25 evidence of which lane the vehicle is in.

At location L2, the same data is recorded which identifies the vehicle by its licence plate number, the time of arrival at location L2 and the lane, which in
30 this case is lane 2.

The two captured images shown in Figure 3 therefore provide evidence of the violation which can be used in any official proceedings as evidence of the violation so
35 that the appropriate penalty is given to the driver.

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Thus, when it is established that a violation has occurred, images of the vehicles VX at locations L1 and L2 are produced and saved to provide evidence. If no violation of a vehicle is recorded in a particular time
 5 period, the images relating to those vehicles can be deleted or recorded over.

When a vehicle is identified at location L2, the system will search through the list of identified vehicles
 10 captured at point L1 by camera system 14. In order to optimise and limit the search process, the system will limit the search to within a specified interval of time using the following calculation:

15 Distance between camera point A and B = L_{AB}

Maximum speed between A and B = V_{max}

Hence, minimum travel time from A to B, T_{minAB}

20 $T_{minAB} = L_{AB} / V_{max}$

Minimum speed between A and B = V_{min}

Hence, maximum travel time from A to B, T_{maxAB}

25 $T_{maxAB} = L_{AB} / V_{min}$

Therefore, given an identified vehicle Vx, captured at time T_2 at camera point B, the system will only search through the list of identified vehicle of point A within
 30 the following interval of time, T_1 :

$$(T_2 + T_{minAB}) < T_1 < (T_2 + T_{maxAB})$$

It will also be apparent that since the detection of the
 35 vehicles at locations L1 and L2 records the time of the vehicles at those locations, the average speed of the

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vehicle between the locations L1 and L2 can be calculated. This can also be used to identify if a vehicle is speeding, regardless of whether the vehicle changes lanes or not.

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Figure 4 is a flowchart illustrating operation of the system according to the preferred embodiment. At step 401 image sequence captured by all the cameras at location L1 are transferred to processor unit 22 where vehicle detection takes place at step 402. If a vehicle is detected at step 403, the number plate is recognised by image recognition software at step 404 and extracted. The vehicle is then labelled at step 405 to identify the vehicle. The system then returns to step 401. This continues while the system is operating.

The list of all identified vehicles is transferred at step 406 to the unit 24. At step 401' the image sequence of captured images from the camera 16 is transferred to unit 24, and at step 402' a vehicle detection routine takes place. If a vehicle is detected, as per step 403', the number plate details are extracted at step 404'. The vehicle is labelled at step 405.

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The labelling of steps 405 and 405' comprise identifying the vehicle, the time at which the vehicle passed the respective locations L1 and L2 and the lane in which the vehicle was travelling. At step 407 the data transferred at step 406 is compared to the data at step 405'. At step 408 a determination as to whether a match has been found takes place and, if so, the processor 24 determines whether a lane change has occurred at step 409. As explained above, this is done by matching the lane data of the identified vehicle at locations L1 and L2 to determine whether the lane data is the same or

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whether there is a change. A decision is then made at step 410 as to whether a violation has occurred and, if so, the images of the violation at locations L1 and L2 is saved at step 411 for use as evidence.

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The system can also be used to identify illegal overtaking along a length of roadway independent of whether a vehicle changes lane or not. This is achieved by taking the same images at location L1 as described
10 above, and the same images at location L2 as described above. However, in this embodiment, the order in which the vehicles pass through the locations L1 and L2 is determined. Thus, if the length of roadway between locations L1 and L2 does allow for lane change but
15 prevents one vehicle from overtaking another vehicle along that length of roadway, the illegal overtaking can be determined by comparing the order of the vehicles at locations L1 and L2. For example, at location L1, if vehicle X passes through the location after vehicle Y
20 and at camera location L2 vehicle X passes through the location before vehicle Y, the change in order indicates that vehicle X overtook vehicle Y between the two camera locations. When using the system for determining illegal overtaking violation enforcement, both sets of
25 captured images of vehicle X and Y at the camera locations L1 and L2 will be needed as the image evidence to prove the occurrence of the illegal overtaking activity.

30 This embodiment of the invention has application to roadways which are single lane roadways or multiple lane roadways, but obviously is more relevant for single lane roadways because that is more likely the environment where overtaking is not allowed. Thus, lane
35 identification need not take place in this embodiment and the order of the vehicles is that which is being

considered.

Since modifications within the spirit and scope of the invention may readily be effected by persons skilled
5 within the art, it is to be understood that this invention is not limited to the particular embodiment described by way of example hereinabove.

In the claims which follow and in the preceding
10 description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise", or variations such as "comprises" or "comprising", is used in an inclusive
15 sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

CLAIMS

- 5 1. A system for detecting traffic lane change violation, comprising:
a first detection system for monitoring a first location of a roadway having multiple lanes;
a second detection system spaced from the
10 first system for monitoring a second location of the roadway, with the length of roadway between the first and second locations being marked to show that lane change is not permitted; and
a processor for receiving images from the
15 first and second detection systems for identifying a vehicle and the lane in which the vehicle is travelling at the first location and for comparing that lane with the lane in which the identified vehicle is travelling at the second location to determine whether the vehicle
20 has changed lanes, and therefore committed a lane change violation.
2. The system of claim 1 wherein the image of the vehicle at the first location and the image of the
25 vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.
3. The system of claim 1 wherein the first
30 detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.
4. The system of claim 3 wherein the second
35 detection system comprises a plurality of cameras, each for monitoring one of the lanes of the roadway.

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5. The system of claim 4 wherein a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

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6. The system of claim 1 wherein the processor records the lane in which the identified vehicle is travelling and associates a reference to that lane and compares the lane reference the vehicle is travelling in, as captured by the first and second detection systems to identify whether the vehicle has changed lanes.

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7. The system of claim 6 wherein the vehicle identity and lane change reference captured by the first detection system is compared to the data for the identified vehicle and lane captured by the second detection system to determine whether the vehicle has changed lanes.

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8. The system of claim 1 wherein the matching of a vehicle identified by the first detection system with a vehicle identified by the second detection system takes place over a predetermined time period from when the vehicle is identified by the first detection system.

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9. A method for detecting traffic lane change violation, comprising:

monitoring a first location of a roadway having multiple lanes with a first detection system; monitoring a second location of the roadway spaced from the first location with a second detection system, with the length of roadway between the first and second locations being marked to show that lane change is not permitted; and

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identifying a vehicle and the lane in which

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the vehicle is travelling at the first location, from an image captured at the first location and comparing the lane in which the identified vehicle is travelling with the lane in which the vehicle is travelling at the
5 second location, from an image at the second location to determine whether the vehicle has changed lanes, and therefore committed a lane change violation.

10. The method of claim 9 wherein the image of the
10 vehicle at the first location and the image of the vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.

15 11. The method of claim 9 wherein the first detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

20 12. The method of claim 10 wherein the second detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

25 13. The method of claim 10 wherein a vehicle is identified by an image recognition technique for identifying the licence plate of the vehicle.

14. The method of claim 9 wherein the method
30 records the lane in which the identified vehicle is travelling and associates a reference to that lane and compares the lane reference the vehicle is travelling in, as captured by the first and second detection systems to identify whether the vehicle has changed
35 lanes.

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15. The method of claim 9 wherein the vehicle identity and lane change reference captured by the first detection system is compared to the data for the identified vehicle and lane captured by the second
5 detection system to determine whether the vehicle has changed lanes.

16. The method of claim 9 wherein the matching of a vehicle identified by the first detection system with
10 a vehicle identified by the second detection system takes place over a predetermined time period from when the vehicle is identified by the first detection system.

17. A system for detecting a traffic overtaking
15 violation, comprising:

 a first detection system for monitoring a first location of a roadway;

 a second detection system spaced from the first system for monitoring a second location of the
20 roadway, with the length of roadway between the first and second detection systems being such that overtaking is prohibited; and

 a processor for receiving images from the first detection system and for identifying the order in
25 which vehicles pass the first detection system, and from the second detection system to identify the order in which the vehicles pass the second detection system, to determine whether the order has changed at the second detection system to thereby determine that an overtaking
30 violation has occurred.

18. The system of claim 17 wherein the image of the vehicle at the first location and the image of the vehicle at the second location is used to provide
35 evidence of a lane change violation, should a violation occur.

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19. The system of claim 17 wherein the first
detection system comprises a plurality of cameras, each
for monitoring a respective one of the lanes of the
5 roadway.

20. The system of claim 18 wherein the second
detection system comprises a plurality of cameras, each
for monitoring one of the lanes of the roadway.

10 21. The system of claim 17 wherein a vehicle is
identified by an image recognition technique for
identifying the licence plate of the vehicle.

15 22. The system of claim 17 wherein the vehicle
identity and lane change reference captured by the first
detection system is compared to the data for the
identified vehicle and lane captured by the second
detection system to determine whether the vehicle has
20 changed lanes.

23. The system of claim 17 wherein the matching of
a vehicle identified by the first detection system with
a vehicle identified by the second detection system
25 takes place over a predetermined time period from when
the vehicle is identified by the first detection system.

24. A method of detecting a traffic overtaking
violation, comprising:
30 monitoring a first location of a roadway with
a first detection system;
monitoring a second location of the roadway
spaced from the first location with a second detection
system, with the length of roadway between the first and
35 second detection systems being such that overtaking is
prohibited; and

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identifying the order in which the vehicles pass the first detection system and the second detection system from images captured by the first and second detection systems to determine whether the order has
5 changed at the second detection system to thereby determine that an overtaking violation has occurred.

25. The method of claim 24 wherein the image of the vehicle at the first location and the image of the
10 vehicle at the second location is used to provide evidence of a lane change violation, should a violation occur.

26. The method of claim 24 wherein the first
15 detection system comprises a plurality of cameras, each for monitoring a respective one of the lanes of the roadway.

27. The method of claim 26 wherein the second
20 detection system comprises a plurality of cameras, each for monitoring one of the lanes of the roadway.

28. The method of claim 24 wherein a vehicle is identified by an image recognition technique for
25 identifying the licence plate of the vehicle.

29. The method of claim 24 wherein the vehicle identity and lane change reference captured by the first detection system is compared to the data for the
30 identified vehicle and lane captured by the second detection system to determine whether the vehicle has changed lanes.

30. The method of claim 24 wherein the matching of
35 a vehicle identified by the first detection system with a vehicle identified by the second detection system

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takes place over a predetermined time period from when the vehicle is identified by the detection camera system.