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TITLE OF THE INVENTION

IMAGE PROCESSING DEVICE, IMAGE PROCESSING METHOD
AND VEHICLE MONITORING SYSTEM

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an image processing device, an image processing method and a vehicle monitoring system used for traffic monitoring.

Related Background Art

10 An image processing device for automatically detecting vehicles divides a zone to be monitored in a highway or general road into a plurality of imaging areas by providing a camera for each imaging area and performing image processing based on the image signals
15 from the cameras. In the device, the detection of vehicles is performed for each imaging area, and the ID and vehicle images are transferred for tracking a certain vehicle over a plurality of imaging areas.

It is still not easy to track a vehicle over a
20 plurality of imaging areas with the above device. Referring to Fig. 10, a vehicle 100 in a position P_1 at time t_1 moves to a position P_2 at time t_2 . An image of the vehicle 100 is stored at time t_1 , and the vehicle 100 is detected when the time reaches t_2 . By a
25 template matching between the image of the detected vehicle 100 and the stored image of the vehicle 100, it

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is determined that the vehicle 100 has moved to the position P_2 . The image processing device tracks the vehicle in this way.

When the vehicle 100 has moved to the position P_3 ,
5 the device performs a template matching like one performed when the vehicle 100 moved to the position P_2 . At the position P_3 , however, the vehicle 100 is located across the first and second imaging areas 300a and 300b, and it is difficult to determine whether the detected
10 vehicle coincides with the vehicle 100 even when using the template matching. Therefore the image processing device has difficulty to assign an ID to the vehicle 100 even if the ID is transferred to a process for the second imaging area 300b, and this degrades the
15 accuracy of the vehicle tracking.

SUMMARY OF THE INVENTION

With the foregoing in view, it is an object of the present invention to increase the accuracy of the vehicle tracking.

20 In one aspect, the present invention relates to an image processing device for processing video signals from a plurality of imaging devices placed along a road to take images of the road. The image processing device comprises: extraction means for extracting an
25 image from a sampling area in each of images represented by the video signals, the sampling areas

being defined so as to divide the road along a vehicle travelling direction of the road; combiner means for combining the extracted images to produce a combined image representing the continuous road; and detection means for detecting a vehicle on the combined image.

The vehicles are detected on the combined image produced by combining the images from the different imaging devices so that the image of the road becomes continuous. Therefore the vehicle on the road will be detected in a wide image. The combined image does not include a seam between the images from the different imaging devices, and the whole vehicle is represented on the combined image even if the vehicle is located across the boundary between the imaging areas of the imaging devices. Thus the vehicle can be detected accurately on the combined image, and this increases the accuracy of tracking the vehicle based on the combined image.

The extraction means may define sampling points in each of the sampling areas to obtain pixel data of the images represented by the video signals at the sampling points and produce images representing top plan views of the sampling areas using the obtained pixel data. When these extracted images are combined along the vehicle travelling direction of the road, the continuous road can be represented on the combined

image. Such a combined image of the top plan view can be used to produce an output image of a top plan view showing the road and the vehicle. This is advantageous because an observer can easily understand the situation of the road from the output image of the top plan view.

The combiner means may combine the extracted images so that the combined image represents the continuous road extending along a vertical direction or horizontal direction of the combined image. It makes easier for the observer to understand the situation of the road from the output image produced based on the combined image.

The image processing device may further comprise: a storage for storing an image of a vehicle for an image matching with the vehicle detected on the combined image; matching means for determining if there is a match between an image of the detected vehicle and the stored image; tracking means for detecting a position of the detected vehicle on the combined image when the matching means determines there is a match; and means for pasting the stored image on a background image representing the continuous road at the position detected by the tracking means.

In this case, the image processing device produces an image representing the continuous road with the stored vehicle image corresponding to the detected

vehicle at the current position thereof. Therefore the stored vehicle image is displayed at the position moving according to the movement of the vehicle. Thus the observer can easily monitor the movement of the vehicle through the produced image.

The image processing device may further comprise a video output and a signal generator for producing a video signal at the video output. The video signal may represent an image produced by the pasting means. In this case, the image processing device can send the video signal to a display device to display the image representing the movement of the vehicle.

The storage may store the image of the detected vehicle when the matching means determines there is no match. In this case, the storage stores the image of the vehicle newly detected by the detection means. Therefore it is unnecessary to obtain the image of the vehicle before the vehicle comes to a zone monitored using the imaging devices.

The image processing device may further comprises correction means for modifying the image of the detected vehicle according to a height thereof when the matching means determines there is no match. The storage may store the modified image for the image matching. The pasting means pastes the stored modified image on the background image. In this case, natural

image of the vehicle can be drawn even if the imaging devices take the images of the vehicle downwardly at an angle.

5 The background image may be the combined image from which the image of the detected vehicle has been cut away. The image processing device may further comprise a correction means for modifying the background image according to the correction of the image of the detected vehicle. In this case, the image
10 processing device can produce natural images of both the road and the detected vehicle.

The background image may be an image representing the continuous road without a vehicle travelling thereon. In this case, it is not necessary to modify
15 the background image according to the correction of the vehicle image.

Each means and the signal generator described above may be a circuit. A processor may serve as all or some of the above means and also the signal
20 generator.

In another aspect, the present invention relates to a vehicle monitoring system comprising: a plurality of imaging devices placed along a road to take images of the road; and the above image processing device.
25 The system may further comprise a display device for displaying the image represented by the video signal

from the image processing device. An observer can accurately monitor movement of vehicles with the system because of the advantages of the image processing device.

5 The two or more imaging devices may be provided to take the images of the road for each sampling area. In this case, two or more images are taken at different angels for each sampling area. Therefore the accuracy of the vehicle detection can be improved.

10 In still another aspect, the present invention relates to an image processing method for processing video signals from a plurality of imaging devices placed along a road to take images of the road. The method comprises: extracting an image from a sampling
15 area in each of images represented by the video signals, the sampling areas being defined so as to divide the road along a vehicle travelling direction of the road; combining the extracted images to produce a combined image representing the continuous road; and detecting a
20 vehicle on the combined image.

 Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific
25 examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since

various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a diagram showing a configuration of a vehicle monitoring system according to an embodiment of the present embodiment;

 Fig. 2 is a flow chart showing an image processing in the image processing device shown in Fig. 1;

10 Fig. 3 is a diagram showing an example of an A/D converted image;

 Fig. 4 is a diagram showing an example of a sampling area;

15 Fig. 5 is a diagram illustrating the arrangement of the sampling areas;

 Fig. 6 is a diagram showing sampling points set in the sampling area;

20 Fig. 7 is a diagram showing an example of a combined image into which images extracted from the sampling areas are combined in the lateral direction;

 Fig. 8 is a diagram showing an example of a part of the combined image created without a vehicle correction process;

25 Fig. 9 is a diagram showing an example of a part of the combined image created with the vehicle correction process; and

Fig. 10 is a diagram illustrating an example of a vehicle tracking process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described below in greater detail with reference to the accompanying drawings. To facilitate understanding, identical reference numerals have been used, where possible, to designate identical or equivalent elements that are common to the figures without repeating the overlapping descriptions.

Fig. 1 is a diagram showing a configuration of a vehicle monitoring system according to the embodiment. As Fig. 1 shows, the vehicle monitoring system is for monitoring the traffic situation of a road 10, and may be used for detecting traffic abnormalities in a tunnel 1, for example.

The vehicle monitoring system has a plurality of monitoring cameras 2. The monitoring cameras 2 are analog imaging devices placed along the road 10 in a vehicle travelling direction of the road 10. The cameras take images of the road 10 and vehicles 11 travelling on the road 10 in the tunnel 1. The cameras 2 are disposed in the tunnel 1 with a predetermined interval so as to take images of the road 10 successively. The interval between the cameras 2 is about 150 - 200 meters, for example.

The monitoring cameras 2 are provided at the upper part of the tunnel 1, for example, so as to take the images of the vehicle 11 downwardly at an angle from the upper front or upper back thereof. It is not
5 necessary that all the cameras 2 are placed at the upper part of the tunnel 1. For example, one of the cameras 2 at the entrance of a monitored zone of the road 10 may be placed on the upper part of the tunnel 1 and another camera 2 on the side wall of the tunnel 1.

10 Each camera 2 is connected to a distributor 3. The distributor 3 is provided in a facility 4 built near the tunnel 1, and receives the images taken by the cameras 2 and sends them to an image processing device 5.

15 The image processing device 5 receives and processes the images taken by the cameras 2 to produce an image to be monitored by an observer using the vehicle monitoring system, and then transfers the produced image to a control center 6. The image
20 processing device 5 includes an analog-to-digital (A/D) converter, a video frame memory, a processor for image processing, a storage, and an interface for video output.

The A/D converter may be a video A/D converter,
25 for example. The A/D converter is a circuit for converting the analog video signals from the cameras 2

into digital video signals. The A/D converter is connected to the video frame memory to send the digital video signals thereto.

5 The video frame memory is a memory capable of storing a plurality of image data. Each image data represented by the video signal from the A/D converter is a set of pixels which have density values and color signals for respective coordinate points in the x-axis and y-axis. The density of a pixel is 8-bit, 256 tones,
10 for example. The video frame memory is connected to the processor.

The processor is a circuit for image processing of the image data stored in the video frame memory. The processor processes the image data to produce an image
15 to be monitored by an observer using the monitoring system. The processor is connected to the interface to send the produced image to the control center 6.

The interface is a video output of the image processing device 5. The interface is connected to the
20 control center 6 to send the image data produced by the processor to the center 6.

The control center 6 has a monitor 61. The image data from the image processing device 5 is input to a monitor 61, and an image corresponding to the input
25 image data is displayed on the monitor 61. The image represents the inside of the tunnel 1. The observer

can visually monitor the travelling situation of the vehicles 11 in the tunnel 1 through the displayed image. The monitor 61 is a display device for displaying the image data from the image processing device 5. The
5 monitor 61 preferably has a longitudinal rectangular or lateral rectangular display area. A projector may be used as the monitor 61, for example.

A vehicle height sensor may be optionally provided in the vehicle monitoring system. The vehicle height
10 sensor 7 is disposed in the tunnel 1 in this embodiment. The sensor 7 is a device for measuring the height of the vehicle 11, and is placed above the road 10. An ultrasonic sensor can be used as the vehicle height sensor 7, for example. The ultrasonic sensor detects
15 the top position of the vehicle 11 by emitting ultrasonic waves at the vehicle 11 from above the vehicle 11 to detect the ultrasonic waves reflected by the vehicle 11.

The vehicle height sensor 7 is disposed at the
20 entrance of the monitored zone of the road 10. If there is no junction in the monitored zone, it is only necessary to place one vehicle height sensor at the entrance of the monitored zone.

A sensor which performs stereoscopic image
25 processing using two imaging cameras, a laser type distance meter or radio type distance meter may also be

used as the sensor 7. Moreover, a sensor other than an ultrasonic sensor may be used as the sensor 7 if the sensor can measure the height of the vehicle 11 travelling on the road 10.

5 The operation of the vehicle monitoring system and the image processing device 5 will now be described. As shown in Fig. 1, the images of the road 10 and the vehicle 11 travelling thereon are taken by the monitoring cameras 2, and the video signal from each
10 camera 2 is sent to the distributor 3. The distributor 3 sends the video signals from the cameras 2 to the image processing device 5 whenever appropriate. The height of the vehicle 11 is measured by the vehicle height sensor 7, and the detection signal indicating
15 the measured height is sent to the image processing device 5. The device 5 performs the image processing using the video signals and the height detection signal.

Referring to Fig. 2, the image processing by the device 5 will now be described. Fig. 2 is a flow chart
20 showing the image processing. The processes shown in Fig. 2 are executed by the processor in the device 5. The image processing is performed repeatedly to track the vehicle 11.

At a step S1 in Fig. 2, each video signal sent to
25 the device 5 is A/D converted by the A/D converter. The analog image of the analog video signal is

converted into a digital image by the A/D conversion. The converted image data is stored in the video frame memory. The converted image is the very image when the road 10 is viewed from the position of the camera 2, as shown in Fig. 3. With regard to the converted image 20,
5 the pictures of the vehicles 11a - 11c travelling on the road 10 are taken downwardly at an angle from the upper back of the vehicles.

After the A/D conversion, the processing moves to a step S2 in Fig. 2, where an extraction process is performed. In this process, a sampling area is defined in each A/D converted image and an image in each sampling area is extracted from the A/D converted image. The sampling areas are defined so as to divide the road
10 10 along the vehicle travelling direction. As Fig. 4 shows, each sampling area 30 extends along the road 10 by a predetermined length so as to surround a part of the road 10. The sampling areas 30 are arranged along the vehicle travelling direction without overlapping
15 with each other, as shown in Fig. 5. Alternatively, the sampling areas 30 may overlaps with each other. In this case, the overlapping portion between the sampling areas may be cut away in the later process of the image processing.

25 The extracted image is produced by obtaining the pixel data at predetermined sampling points arranged in

the sampling area 30. Fig. 6 is a schematic diagram showing the sampling points in the sampling area 30. As Fig. 6 shows, the sampling points 31 at regular intervals are arranged in a lattice extending along both the vehicle travelling direction and the direction crossing the road 10. Since the sampling points 31 are placed in this way, a top plan view of the road 10 and the vehicles 11a - 11c can be easily created simply by rearranging the pixel data of the sampling points 31 in a coordinate system where the vehicle travelling direction and the road crossing direction are perpendicular.

After the images in the sampling areas are extracted from the A/D converted images, the processing moves to a step S3 in Fig. 2, where a combining process is performed. In this process, the extracted images produced in the step S2 are combined so that the road 10 is represented extending continuously along the vehicle travelling direction in the combined image. The extracted images may also be combined so that the image of the road 10 in the combined image extends in the vertical or horizontal direction of the combined image. Fig. 7 shows an example of the combined image in which the image of the road 10 extends in the horizontal direction.

The combined image 40 is formed by combining the extracted images of the sampling areas 30 along the vehicle travelling direction. The combined image 40 is an image where the pixel data of the extracted images obtained from the different video signals are set as the pixel data in the same coordinate system. It is preferable that the data of the combined image is produced by storing each extracted image data in one memory. Since sampling areas 30 do not overlap with each other in this embodiment, combining the extracted images can be easily performed without considering the overlapping portion between the sampling areas 30.

As Fig. 7 shows, the combined image 40 is a top plan view showing the road 10 and the vehicles 11. To obtain the combined image 40, it is necessary not only to combine the sampling areas 30 shown in Fig. 4, but also to transform each sampling area 30 into an area viewed from the top by computation. In this embodiment, however, the transformation is performed together with the extraction process because the sampling points 31 are arranged as shown in Fig. 6. Therefore separate transformation process is unnecessary.

After the combining process, the processing moves to a step S4 in Fig. 2, where a vehicle detection process is performed using the combined image 40. This process may be performed by a well-known background

subtraction method which compares the combined image 40 with a background image stored in the storage of the image processing device 5 in advance, for example. The background image is an image showing the road 10 without vehicles thereon.

Then the processing moves to a step S5, where it is determined whether the vehicle 11 detected by the vehicle detection process is a vehicle newly detected or a vehicle already detected. The processor in the device 5 compares the image of the detected vehicle 11 with images of vehicles for image matching stored in the storage. The vehicle images for image matching are stored in the storage at a step S7 in this embodiment, as will be described later in detail. The processor determines if there is a match between the image of the detected vehicle and the stored images. If the processor determines there is a match, that is, the detected vehicle image matches with one of the stored images, the detected vehicle 11 is not one newly detected, and the processing moves to a step S8. On the other hand, if the processor determines there is no match, that is, the detected vehicle image does not match with any of the stored images, the detected vehicle 11 is one newly detected, and the processing moves to a step S6.

Unless there is a junction in the monitored zone, the vehicle 11 will be newly detected near the entrance of the monitored zone on the combined image. Therefore the vehicle 11 which newly enters the monitored zone may be detected based on only the data from the camera 2 placed at the entrance. On the other hand, if there is a junction in the monitored zone, the vehicle 11 may be newly detected based on only the data from the cameras 2 placed at the entrance or the junction.

In the step S6, a vehicle correction process is performed to modify the image of the newly detected vehicle 11 according to its height. If the correction were not performed, the vehicles 11 are represented as shown in Fig. 8. The vehicles 11b and 11c far from the camera 2 tend to have larger distortion compared with the vehicle 11a near the camera 2. In particular, the distortion of the vehicle 11c with a large height, such as a truck, is significant.

This is the reason that the vehicle correction process is performed in the step S6. The correction is performed according to the height of the vehicle 11 measured by the vehicle height sensor 7. The correction lowers the height of the image of the vehicle 11 by larger amount as the measured height of the vehicle 11 increases. By performing the correction

in this way, the images of the vehicles 11a - 11c shown in Fig. 8 are modified as shown in Fig. 9.

After the correction, the processing moves to a step S7, where the corrected vehicle image and the original vehicle image before the correction of the step S6 are stored in the storage. More specifically, the images of the vehicles 11a - 11c from which the distortion is removed as shown in Fig. 9 are stored, and also the images of the vehicles 11a - 11c before removing the distortions shown in Fig. 8 are stored. As will be described later in detail, the corrected images are used to produce an output image sent to the control center 6. On the other hand, the original images are used to be compared with the detected vehicle images in the image matching at the step S4, as described above.

Then the processing moves to the step S8, where a tracking process is performed. In the tracking process, the positions of the detected vehicles 11 which have the matching images previously stored in the storage are detected on the combined image 40. On the other hand, with regard to the detected vehicles 11 whose images have been just stored in the storage at the last step S7, their position will be detected at the next step S8 after the vehicles 11 move and their image are detected again at the next step S4.

The processing moves to a step S9, where a pasting process is performed. In this process, the stored corrected images matching with the detected vehicles 11 are pasted on a background image at the positions detected at the step S8. In this way, the corrected images of the vehicles 11 are represented at the current positions of the vehicles 11. The background image is the combined image from which the images of the detected vehicles have been cut away in this embodiment. With regard to the vehicles whose images have been just stored at the last step S7, the corrected vehicle images will be pasted on the background image at the positions to which these vehicles move, at the next step S9.

The processing moves to a step S10, where a background correction process is performed. In this process, the background image is modified according to the correction of the vehicle image in the step S6. In the case of the vehicle 11c in Fig. 9, for example, a background portion in an area 50 where the image of the vehicle 11c existed before the correction is modified on the background image. This is because the background image becomes unnatural if the vehicle image is corrected and the background image is not corrected.

Thus an output image data is produced through the above processes. The output image is transferred to

the control center 6 from the processor through the interface as an output video signal, and displayed on the monitor 61. A series of processes in Fig. 2 is repeatedly performed at a predetermined interval. This enables the image processing device 5 to track the vehicle 11 on the road 10 and produce the output image representing the motion of the vehicle.

The advantages of the embodiment will now be described. As described above, the vehicle 11 is detected in the wide combined image 40 on which the image of the road 10 is continuous in the vehicle travelling direction. The combined image 40 is seamless, and this prevents a problem that a seam between the images taken by the different cameras 2 disturbs the detection of the vehicle 11. Also, the full image of the vehicle 11 is represented on the combined image 40 even if the vehicle 11 is located at the boundary between the imaging areas of the cameras 2. Thus the vehicle 11 can be detected accurately on the combined image 40, and this increases the accuracy of tracking the vehicle 11.

Since the combined image 40 is a top plan view of the road 10, the observer can easily understand the traffic situation of the road 10.

Since the stored corrected image of the vehicle 11 is continuously displayed at the different positions as

the vehicle 11 moves, the image of the vehicle 11 taken by the camera 2 need not be corrected each time the vehicle 11 is detected. This simplifies the image processing and enables the image processing device 5 to produce the output image quickly.

A mismatch between the background images before and after the correction of the vehicle image is overcome by the background correction at the step S10. Therefore unnaturalness of the output image displayed on the monitor 61 can be prevented.

The sampling points 31 in the sampling area 30 are arranged in a lattice along the vehicle travelling direction and the direction crossing the road 10. Since the transformation of the image is performed along with extracting the image from the sampling area 30, a separate transformation process is unnecessary and this simplifies the image processing.

Since the sampling areas 30 are defined without overlapping with each other, the images extracted from the sampling areas 30 can be easily combined without considering the overlapping portions. This further simplifies the image processing.

The present invention has been described specifically based on the above embodiment; however, the present invention is not limited to the embodiment. For example, when a vehicle is not detected

successfully in the vehicle detection process, an image of the vehicle on the combined image may be processed as a part of the background image and this vehicle image, which is not corrected according to its height, may be displayed on the output image, or the position of the vehicle may be estimated based on the motion vector of the vehicle in the past and the movement of other vehicles in the front and back of the vehicle and then the stored corrected image of the vehicle may be pasted on the background image at the estimated position. Two or more monitoring cameras 2 may be provided for each sampling area of the road 10. In this case, images of the road 10 in each area are taken from different angles by the cameras 2, thereby a compact car which is likely to be hidden behind a large car can be detected. As a consequence, the accuracy of detecting vehicles can be improved.

In the above embodiment, the background image on which the stored vehicle images are pasted at the step S9 is the combined image from which the images of the detected vehicles have been cut away. However, the background image used in the pasting process may be an image representing the road without a vehicle travelling thereon, that is, the template image used in the background subtraction method. In this case, it is unnecessary to correct the background image according

to the correction of the vehicle image. This simplifies the image processing and enables the image processing device 5 to produce the output image quickly.

In the above embodiment, the analog monitoring cameras 2 are used and the A/D converter is provided in the image processing device 5. Alternatively, the monitoring cameras may be digital video cameras. In this case, it is unnecessary to provide the image processing device with the A/D converter, and the device directly processes the video signals from the monitoring cameras.

From the invention thus described, it will be obvious that the embodiments of the invention may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended for inclusion within the scope of the following claims.

WHAT IS CLAIMED IS:

1. An image processing device for processing video signals from a plurality of imaging devices placed along a road to take images of the road, said
5 image processing device comprising:

extraction means for extracting an image from an sampling area in each of images represented by the video signals, the sampling areas being defined so as to divide the road along a vehicle travelling direction
10 of the road;

combiner means for combining the extracted images to produce a combined image representing the continuous road; and

detection means for detecting a vehicle on the
15 combined image.

2. The image processing device according to Claim 1,

wherein the imaging devices are analog devices,
and

20 wherein the image processing device further comprises an A/D converter connected between the imaging devices and the extraction means, the A/D converter converting the analog video signals from the imaging devices into digital video signals and sending
25 the digital video signals to the extraction means.

3. The image processing device according to Claim 1 or 2, wherein the extraction means defines sampling points in each of the sampling areas to obtain pixel data of the images represented by the video signals at the sampling points and produce images representing top plan views of the sampling areas as the extracted image using the obtained pixel data.

4. The image processing device according to Claim 1, wherein the combiner means combines the extracted images so that the combined image represents the continuous road extending along a vertical direction or horizontal direction of the combined image.

5. The image processing device according to Claim 1, further comprising:

a storage for storing an image of a vehicle for an image matching with the vehicle detected on the combined image;

matching means for determining if there is a match between an image of the detected vehicle and the stored image;

tracking means for detecting a position of the detected vehicle on the combined image when the matching means determines there is a match; and

means for pasting the stored image on a background image representing the continuous road at the position detected by the tracking means.

6. The image processing device according to Claim 5, further comprising:

a video output; and

a signal generator for producing a video signal at the video output, the video signal representing an image produced by the pasting means.

7. The image processing device according to Claim 5, wherein the storage stores the image of the detected vehicle when the matching means determines there is no match.

8. The image processing device according to Claim 7, further comprising correction means for modifying the image of the detected vehicle according to a height thereof when the matching means determines there is no match,

wherein the storage stores the modified image for the image matching, and

wherein the pasting means pastes the stored modified image on the background image.

9. The image processing device according to Claim 8,

wherein the background image is the combined image from which the image of the detected vehicle has been cut away, and

the image processing device further comprising a correction means for modifying the background image

according to the correction of the image of the detected vehicle.

10. The image processing device according to Claim 8,

5 wherein the background image is an image representing the continuous road without a vehicle travelling thereon.

11. A vehicle monitoring system, comprising:

10 a plurality of imaging devices placed along a road to take images of the road; and

 the image processing device according to Claim 1.

12. A vehicle monitoring system, comprising:

 a plurality of imaging devices placed along a road to take images of the road;

15 the image processing device according to Claim 6; and

 a display for displaying the image represented by the video signal from the image processing device.

20 13. The vehicle monitoring system according to Claim 11 or 12, wherein the two or more imaging devices are provided to take the images of the road for each sampling area.

25 14. An image processing method for processing video signals from a plurality of imaging devices placed along a road to take images of the road, said image processing method comprising:

extracting an image from an sampling area in each of images represented by the video signals, the sampling areas being defined so as to divide the road along a vehicle travelling direction of the road;

- 5 combining the extracted images to produce a combined image representing the continuous road; and
detecting a vehicle on the combined image.