MEANS FOR SOLVING PROBLEM

[0005] According to one embodiment, in general, an imaging system for a railway vehicle includes a first imaging module and a second imaging module. The first imaging module is placed in a leading railway vehicle for capturing a stereo image of a first area in a traveling direction of the railway vehicle. The second imaging module is placed in the leading railway vehicle, and is capable of capturing a second area including a farther area than at least the first area for capturing a high-resolution image with resolution higher than resolution of the first imaging module.

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is an exemplary and schematic diagram illustrating a configuration of the forefront of a railway vehicle including an imaging system for a railway vehicle according to an embodiment;

FIG. 2 is an exemplary and schematic diagram illustrating the positional relationship between a first camera and a second camera serving as a first imaging module and a third camera serving as a second imaging module in an imaging unit of the imaging system for a railway vehicle of the embodiment;

FIG. 3 is an exemplary and schematic diagram illustrating the configuration of the imaging system for a railway vehicle of the embodiment;

FIG. 4 is an exemplary and schematic diagram illustrating the positional relationship between a first area imaged by the first imaging module and a second area imaged by the second imaging module in the imaging system for a railway vehicle of the embodiment;

FIG. 5 is an exemplary and schematic flowchart of an

the railway vehicle RV, therefore, setting the recognition area to a given limited area on or around the railway track R is basically sufficient for that purpose. The image processor 14 can decrease a processing load in terms of the obstacle detection by setting the recognition area to a limited area.

[0032] Upon incompletion of the obstacle detection with the combinations of the first camera 10a, the second camera 10b, and the third camera 10c (No at S212), the image processor 14 returns to the operation at S200.

[0033] After determining at S200 that the image (first stereo image) captured by the first camera 10a and the second camera 10b has been processed (Yes at S200) and the image (second stereo image) captured by the second camera 10b and the third camera 10c has not been processed (No at S214), the image processor 14 performs rectification conversion to the image captured by the second camera 10b and the third camera 10c (S216). That is, the image processor 14 converts the second stereo image into the one from which parallax is detectable through stereo matching. The image processor 14 then generates a second distance image containing distance information from the image (second stereo image) captured by the second camera 10b and the third camera 10c (S218) according to the detected parallax.

[0034] As in the operation to the first distance image, the image processor 14 detects the railway track R from the second distance image (S206) to set a recognition area therefor (S208). The image processor 14 performs an obstacle detection to the set recognition area of the second distance image (S210), and determines again at S212 whether the obstacle detection with the combinations of the cameras is completed (S212).

[0035] After determining at S214 that the image (second

[0040] Subsequently, the image processor 14 estimates a distance to the obstacle in the expanded area (far area 26a) (S110). As described above, the object M in the farthest part 30 of the near area (first area 24) substantially matches in size with the object N in the nearest part 32 of the far area 26a. The image processor 14 can calculate the distance to the object M accurately by processing the stereo image of the first area 24. Thus, the image processor 14 can estimate the position of the obstacle (distance to the obstacle) detected in the far area 26a from the distance to the obstacle M (obstacle N) through comparison of the sizes between the obstacle N in the far area 26a and an obstacle located farther than the obstacle N. In view of ensuring safe travelling of the railway vehicle RV, detecting an obstacle and a location thereof in the first area 24 and detecting an obstacle in the far area 26a can help the railway vehicle RV travel safely. According to another embodiment, thus, the image processor 14 may omit the operation of S110. Thereby, the image processor 14 can reduce a processing load as to the far area 26a.

[0041] The image processor 14 outputs results of the detection of the obstacle to the output 16 (S112), temporarily ending this processing. That is, after detecting an obstacle from the first area 24 (or the overlapping area between the first area 24 and the second area 26) through the stereo image processing at S104, the image processor 14 provides, through the output 16, the detected obstacle and the position thereof (distance thereto) to the operation system of the railway vehicle RV and an external system that serves to manage and monitor the travelling of the railway vehicle RV, to reflect them in the control of the railway vehicle RV.

method of the railway track R using the feature as to brightness (S122). Next, the image processor 14 sets, for the detected railway track R, a recognition area in which an obstacle is to be detected (S124). The image processor 14 detects an obstacle from the set recognition area by a known detecting method (pattern matching, for example) (S126). The image processor 14 outputs a result of the detection of an obstacle in the near area through the output 16 (S128), temporarily ending this processing. That is, the image processor 14 performs obstacle detection processing, using the two cameras capable of outputting normal image data at the moment. In the case of a malfunction of the third camera 10c, the image processor 14 performs obstacle detection in a limited area, that is, the first area 24 which the first camera 10a and the second camera 10b can normally capture. Meanwhile, irrespective of a malfunction of either the first camera 10a or the second camera 10b, the image processor 14 can detect presence or absence of an obstacle and the position thereof from the overlapping area between the first area 24 and the second area 26, and can detect an obstacle from the far area 26a, if any.

[0044] When there are no two cameras capable of normally outputting image data at S114 (No at S114), the image processor 14 determines that detection of an obstacle, if any, and the position thereof (distance thereto) is unfeasible, and performs error processing (S130). That is, the image processor 14 provides error information to the operation system of the railway vehicle RV or the external system through the output 16, to reflect the error information in the control of travelling of the railway vehicle RV. For example, the operation system or the external system causes the railway vehicle RV to

CLAIMS

1. An imaging system for a railway vehicle, comprising:

a first imaging module, placed in a leading railway vehicle, for capturing a stereo image of a first area in a traveling direction of the railway vehicle; and

a second imaging module, placed in the leading railway vehicle and capable of capturing a second area including a farther area than at least the first area, for capturing a high-resolution image with resolution higher than resolution of the first imaging module.

2. The imaging system according to claim 1, wherein
the second area captured by the second imaging module partially overlaps the first area before the farther area.

3. The imaging system according to claim 1 or 2, further comprising an image processor configured to:
calculate a first distance to a first position in the first area from the stereo image captured by the first imaging module, and
estimate a second distance to a second position in the second area from the first distance.

4. The imaging system according to any one of claims 1 to 3, wherein

the first imaging module includes a first camera and a second camera, and

the second imaging module includes a third camera, the system further comprising:

a camera controller configured to:
cause the first camera and the second camera to capture a first stereo image of the first area,

cause the second camera and the third camera to capture a second stereo image containing at least part of the first area, and

cause the third camera and the first camera to capture a third stereo image containing at least part of the first area, and

an image processor configured to perform object detection processing with respect to the first area based on the first stereo image, the second stereo image, and the third stereo image.

5. The imaging system according to claim 4, wherein

the image processor causes two of the first camera, the second camera, and the third camera to continuously capture the stereo image.