

DETECTION METHOD AND SYSTEM

TECHNICAL FIELD

This invention relates generally to a detection system for automated detection of current
5 collector device (CCD) found on trains.

Background

A CCD is a component used to lead electrical power from the third rail of a train track to the
train for powering the train and equipment carried thereon. The CCD is a critical
10 component for the train's operation and constant inspection of the CCD is required in order
to enable continuous service of the train.

Japanese Patent Application No. 2008-87768 describes a method which uses noise as a
detection parameter. The problem with this method is with the difficulty in separating the
15 noise, which is generated by the defected CCD, from the sound generated by the CCD
during travel along the third rail. As noise can also arise from friction and other types of
defects on the rail, using noise as a detection parameter will lead to the false identification of
rail defect as CCD defect. As a result it is difficult to robustly determine whether defects
exist in the CCD based on noise alone. Therefore, there exists a need for a detection system
20 and/or method for detecting the existence of defect-based anomaly of the CCD.

Summary

In accordance with an aspect of the invention, there is disclosed a detection method for
detecting presence of a device on a vehicle, the detection method comprising detecting
25 physical profile of a detection region on a vehicle with the at least one region being where
the device is detectable. The detection method further comprises capturing a plurality of
images of the detection region on the vehicle and triggering an alert upon detecting an
anomaly in the physical profile. The anomaly detectable in the profile is associated with
one of absence, displacement and misshaping of the device. Wherein triggering the alert

comprises identifying at least one of the plurality of images associated with the anomaly in the physical profile.

- 5 In accordance with a second aspect of the invention, there is disclosed a detection system for detecting presence of a device on a vehicle, the detection system comprising a scanner, at least one camera and a controller wherewith the scanner and the at least one camera are coupled. The scanner is for detecting physical profile of a detection region on a vehicle where the at least one region being where the device is detectable. The at least one camera is for capturing a plurality of images of the detection region on the vehicle. The controller is
- 10 for triggering an alert upon detecting an anomaly in the physical profile, the anomaly detectable in the profile being associated with one of absence, displacement and misshaping of the device. The controller further identifies at least one of the plurality of images associated with the anomaly in the physical profile upon the alert being triggered.
- 15 The detection system uses both a vision system and a profile detection system to accurately determine the state of the CCDs. As the vision system captures the images, the profile detection system traces the profile of the CCD. A separate camera captures the images of the train number which can be used to determine which train the CCD anomaly exists.
- 20 An advantageous feature of the system is that the system computer is integrated with an intelligent AI (Artificial Intelligence) system which uses the collected data (images and profiles of the CCDs) to train the complete automated system. As a result, the invention has higher reliability and repeatability. One of the main functions of this AI system is used when the camera grabs a large number of images of the CCDs. In the grabbed images, there are
- 25 images which don't show the actual defect and there are images which show the actual defect. At this point the capabilities of the intelligent AI system can be used to pick up only those images which have the defects and send to the On-duty Officer. This capability enables the On-duty Officer to significantly decrease the time in identifying the images with the abnormal CCDs and perform instant verification and confirmation without physically
- 30 being at the location of the anomaly.

Due to the fact that the complete process of the detection method employed by the detection system is automated, except for the verification and confirmation of the defect, the system is significantly less error prone and highly reliable.

- 5 The process of the invention is to capture the CCD images and trace the profiles of the CCDs in a train. After the completion of this stage the system computer will process the received images and profiles of the CCDs and determine whether there is an anomaly or not. If there is an anomaly the system computer will then send an alert message containing the images of the abnormal CCDs via the communication device of the invention to the
10 electronic device of an On-duty Officer to verify and confirm whether there is a CCD anomaly or not.

This method yields accurate results with the combination of the vision system and the profile detection system. The additional features, such as the notification system for the On-
15 duty Officer's electronic device, identifying the location of the CCD anomaly by the train number and the intelligent AI system, further more supports the effectiveness of the invention.

20 **Brief Description of the Drawings**

FIG. 1 shows a system diagram of a detection system in accordance with an aspect of the invention; and

FIG. 2 shows a process flow diagram of a detection method according to an aspect of the
25 invention and utilized by the detection system of FIG. 1.

Detailed Description

An exemplary embodiment of the present invention, a detection system 20 utilising a detection method 100, is described hereinafter with reference to FIG. 1 and FIG. 2. The detection system 20 comprises a scanner 22 and at least one camera 24. The scanner 22 and the at least one camera 24 are preferably positioned at a fixed location and to provide line of sight to a vehicle passaging past the fixed location. The vehicle is preferably a train, for example a fixed-rail train with the fixed location being proximal a waiting platform area of a train station (not shown). The scanner 22 is for detecting physical profile of a detection region on the vehicle with the at least one region being where a device is detectable in a step 102. The device is preferably a current collector device (CCD) of the vehicle or any other device forming part of or being couplable to the vehicle for which presence is to be detected and ascertained. The scanner 22 is preferably a laser scanner for tracing the physical profile of the detection region of the vehicle. Alternatively, the scanner is a radar-based scanner or a radio frequency scanner.

The at least one camera 24 is positioned for capturing a plurality of images of the detection region on the vehicle in a step 104. A illuminator 31 is used to illuminate the detection region for improved image capture by the at least one camera 24. The at least one camera 24 is one of a closed-circuit camera, a CMOS-type camera or the like image capture apparatus. The detection system 20 further comprises a controller 32 wherewith the scanner 22 and the at least one camera 24 are coupled. The controller 32 is for triggering an alert, in a step 106, upon detecting an anomaly in the physical profile traced by the scanner 22. The anomaly detectable in the profile is preferably associated with one of absence, displacement and misshaping of the device, specifically in the case where the device is the CCD.

The controller 32 further identifies at least one of the plurality of images associated with the anomaly in the physical profile upon the alert being triggered in a step 110. Once the at least one of the plurality of images associated with the anomaly has been identified, the identified images are sent to a monitoring system 34 in a step 112. The identified images are for verification of the anomaly by a user of the monitoring system 34 in a step 114. The

identified images are sent by the controller 32 to the monitoring system 34 by one of wired and wireless means. The detection system 20 further comprises a communication module 36 for enabling wireless communication of the controller 32 with the monitoring system 34.

- 5 The monitoring system 34 is preferably a mobile device carried by the user who is a supervisor or duty officer in charge of train operation matters. Alternatively, the monitoring system is computing system, for example a notebook or a desktop console, usable by the user for visually inspecting the identified images for verification of the anomaly. Typical anomaly includes shearing, damage, displacement and dislodgement of the CCD during
10 travel of the vehicle in the normal course of usage.

Alternatively when the alert has been triggered in the step 106, the controller 32 can conduct an automated verification of the anomaly in a step 116 before deciding whether the identified images are to be sent to the monitoring system 34.

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- During automated verification of the anomaly in the step 116, the identified images are processed using image processing techniques for isolating the detection region. The image processing techniques employable comprises any type of image enhancement techniques that can be used to enhance the image, for example, histogram equalization and contrast
20 stretching. Next, the isolated detection region in the identified images are compared with at least one reference image using one of template matching and image parameter statistical distribution to verify the anomaly. An anomaly confidence level may be ascertained from the step 116 with the identified images being sent to the monitoring system 34 only if the confidence level does not achieve a pre-defined level.

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- The controller 32 is preferably one or a plurality of computing systems and may be configured as either a location specific system or a cloud-based system. Further, it is preferred that the controller 32 has an Artificial Intelligence (AI) module for learning and applying how anomalies can be more accurately identified. During verification by the user
30 in the step 114, the user may provide a respond to the monitoring system 34 that the

anomaly has been wrongly identified. This will be captured by the controller 32 as input to parameters of the AI module.

5 Upon the anomaly being verified and confirmed in the step 114, the user may proceed to initiate follow-up actions for maintenance, repair or service shut-down of the vehicle.

Further, the detection system 20 further comprises a sensor or image capture system (not shown) for identifying presence of the vehicle. Upon identifying presence or approach of the vehicle, the detection system 20 will initiate the steps of the detection method as
10 asforescribed. The image capture system may be utilized for capturing identification details of the vehicle, for example the lead car numbers, for tracking purposes and for tagging and tagging of the identified images sent from the controller 32 to the monitoring system 34. The sensor utilized is preferably one of a motion sensor, an IR sensor or a proximity sensor.

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The detection system 20 utilising the detection method 100 is applicable in the following scenario. As described, the purpose of the invention is to detect CCD anomaly by the combination of the profile detection system and the vision system and to send an alert message to the electronic device of an On-duty Officer whenever a CCD anomaly is
20 detected. In order to categorize an event as an anomaly, only the vision system or only the profile detection system can be used. But in order to gain accurate results, combination of both of these systems has to be used.

The initiation of the complete automated system is done by a sensor, which sends a signal to system computer when the train is detected by the sensor. This sensor can be of motion
25 sensor, IR sensor, proximity sensor, etc. When the signal from the sensor is detected by the system computer, the process of detection is initialized. The light source used can be of any wavelength of the light spectrum, for example visible or non-visible light such as IR. This illuminator is connected to the controller. The controller will trigger the light source to
30 switch “ON” when the train is detected and will switch “OFF” after the inspection is

completed. When the light source is switched “ON”, the vision system captures picture quality images of the CCDs and train lead car numbers. The cameras used in the vision system are of CCD, CMOS or the like type of cameras. A first camera will capture the train numbers and a second camera will capture the images of the CCDs of the train.

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The profile detection system is used to trace the detected CCDs’ profile. The profile detection system uses a contactless detection method such as, laser, radio frequency or radar. Once the process is initiated by the sensor, the system computer initiates the process for tracing the profile of the CCD. The main objective of the profile tracking system is to trace the surface of the CCD and create a contour of the surface of the CCD.

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The captured images are sent to the system computer for processing in order to enhance the image. Any type of image enhancement techniques can be used to enhance the image, such as histogram equalization or contrast stretching. Simultaneously, the profile detection data is also sent to the system computer for processing. The system computer collates the image data, profile data and then feeds the data to an intelligent AI system forming part of the controller.

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The intelligent AI system of the invention is pre-trained using a set of reference data obtained from both the vision system and the profile detection system. The reference data is used to develop a particular classifier, in which the particular classifier is used to identify the unique features of a CCD. For example, the differences between the CCD shoe and the CCD base. Firstly, when a CCD image is processed by the intelligent AI module, the unique features of the CCD are extracted from the CCD image. Secondly, a statistical distribution is created using the width, height, shape, orientation of the CCD. Finally if the statistical distribution created to the specific CCD doesn’t match the reference statistical distribution of the trained data, the intelligent AI system then determines the detected CCD as an abnormal CCD. Once the abnormal CCD is detected, the images relating to the abnormal CCD is selected from the large number of images and sent to electronic device via the communication device of the invention of the On-Duty officer, together with the

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notification, for further verification. The electronic device of the On-Duty officer can be of any type such as, PDA, mobile phone, tablet or the like mobile communications device.

Aspects of particular embodiments of the present disclosure address at least one aspect,
5 problem, limitation, and/or disadvantage associated with existing detection methods and
systems. While features, aspects, and/or advantages associated with certain embodiments
have been described in the disclosure, other embodiments may also exhibit such features,
aspects, and/or advantages, and not all embodiments need necessarily exhibit such features,
aspects, and/or advantages to fall within the scope of the disclosure. It will be appreciated
10 by a person of ordinary skill in the art that several of the above-disclosed structures,
components, or alternatives thereof, can be desirably combined into alternative structures,
components, and/or applications. In addition, various modifications, alterations, and/or
improvements may be made to various embodiments that are disclosed by a person of
ordinary skill in the art within the scope of the present disclosure, which is limited only by
15 the following claims.

Claims

1. A detection method for detecting presence of a device on a vehicle, the detection method comprising:
 - detecting physical profile of a detection region on a vehicle, the at least one

5 region being where the device is detectable;
 - capturing a plurality of images of the detection region on the vehicle; and
 - triggering an alert upon detecting an anomaly in the physical profile, the anomaly detectable in the profile being associated with one of absence, displacement and misshaping of the device,

10 wherein triggering the alert comprising identifying at least one of the plurality of images associated with the anomaly in the physical profile.
2. The detection method as in claim 1, triggering the alert comprising:
 - sending the identified at least one of the plurality of images to a monitoring

15 system for subsequent visual verification of the anomaly by a user of the monitoring system.
3. The detection method as in claim 2, the monitoring system being one of a computing system and a mobile communication device.

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4. The detection method as in claim 1, triggering the alert comprising:
 - processing the identified at least one of the plurality of images to verify the anomaly detected in the profile.
- 25 5. The detection method as in claim 4, processing the identified at least one of the plurality of images comprising:
 - comparing the at least one of the plurality of images with at least one reference image using one of template matching and image parameter statistical distribution.

6. The detection method as in claim 1, the vehicle being a train and the device being a current collector device (CCD) of the train.

7. The detection method as in claim 1, further comprising:

5 detecting presence of the vehicle prior to detecting physical profile of a detection region on a vehicle.

8. The detection method as in claim 7, further comprising:

10 illuminating at least the detection portion of the vehicle in response to the presence of the vehicle being detected.

9. The detection method as in claim 1, detecting physical profile of a detection region on a vehicle comprising:

15 detecting physical profile of a detection region on a vehicle with a laser scanner.

10. The detection method as in claim 1, capturing a plurality of images of the detection region on the vehicle comprising:

20 capturing a plurality of images of the detection region on the vehicle with at least one camera.

11. A detection system for detecting presence of a device on a vehicle, the detection system comprising:

a scanner for detecting physical profile of a detection region on a vehicle, the at least one region being where the device is detectable;

25 at least one camera for capturing a plurality of images of the detection region on the vehicle; and

a controller wherewith the scanner and the at least one camera are coupled, the controller triggering an alert upon detecting an anomaly in the physical profile, the anomaly detectable in the profile being associated with one of absence, displacement and misshaping of the device,

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wherein the controller further identifies at least one of the plurality of images associated with the anomaly in the physical profile upon the alert being triggered.

5 12. The detection system as in claim 11, the controller sending the identified at least one of the plurality of images to a monitoring system for subsequent visual verification of the anomaly by a user of the monitoring system.

10 13. The detection system as in claim 12, the monitoring system being one of a computing system and a mobile communication device.

14. The detection system as in claim 11, the controller further processing the identified at least one of the plurality of images to verify the anomaly detected in the profile in response to the alert being triggered.

15 15. The detection system as in claim 14, processing the identified at least one of the plurality of images comprising:
 comparing the at least one of the plurality of images with at least one reference image using one of template matching and image parameter statistical distribution.

20 16. The detection system as in claim 11, the vehicle being a train and the device being a current collector device (CCD) of the train.

25 17. The detection system as in claim 11, further comprising a sensor for detecting presence of the vehicle prior to detecting physical profile of a detection region on a vehicle.

18. The detection system as in claim 17, further comprising an illuminator for illuminating at least the detection portion of the vehicle in response to the presence of the vehicle being detected.

19. The detection system as in claim 11, the scanner being a laser scanner.