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(54) **SYSTEM AND METHOD FOR TRIGGERING A SENDING OF A MOVEMENT AUTHORITY FOR A GUIDED VEHICLE**

SYSTEM UND VERFAHREN ZUM AUSLÖSEN DER VERSENDUNG EINER BEWEGUNGSAUTORITÄT FÜR EIN GEFÜHRTES FAHRZEUG

SYSTÈME ET PROCÉDÉ POUR DÉCLENCHER UN ENVOI D'UNE AUTORITÉ DE MOUVEMENT À UN VÉHICULE GUIDÉ

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Description

[0001] The present invention concerns a system and a method for safely and efficiently managing the movement of a guided vehicle on a railway network.

[0002] The present invention is essentially related to the control of the movement of guided vehicles within a railway network and the issuance of a movement authority (i.e. a permission to proceed with moving forward) by trackside Radio Block Centre (RBC), wherein "guided vehicle" refers to public transport means such as subways, trains or train subunits, etc., as well as load transporting means such as, for example, freight trains, for which safety is a very important factor and which are guided along a route or railway by at least one rail, in particular by two rails. Such a control system is disclosed in US 2009/1084212 A1 for example.

[0003] Actual rail systems such as the European Rail Traffic Management System (ERTMS)/European Train Control System (ETCS) Level 2 or 3 or any CBTC system allow to manage guided vehicle movement authority on the basis of radio signals exchanged between the guided vehicle and trackside devices of a railway network. For example, a fitted guided vehicle (i.e. comprising equipment fitting the guided vehicle for radio-based signaling) comprises devices enabling the determination of its position by reading track-mounted reference beacons and measuring a travelled distance from these reference beacons using on-board odometry. The guided vehicle then reports periodically its position to trackside devices, for example the RBC, and receives from the latter movement authorities based on its position.

[0004] The RBC has to determine when, where and under which conditions a movement authority can be issued so that a guided vehicle may operate safely. When issuing the first movement authority to a guided vehicle (the first movement authority is in particular the movement authority sent to a fitted guided vehicle when the latter starts reporting its position to a wayside unit or the RBC for the first time or the movement authority sent to said fitted guided vehicle after the latter received a previous movement authority that was invalid), the RBC shall not rely on any guided vehicle separation distance hypothesis. This is based on the following facts: (a) unfitted guided vehicles which are not able to report its position to the RBC may be moving on the railway network too and (b) two guided vehicles may occupy the same track circuit at the same time.

[0005] To prevent such situations, different techniques have been developed. One technique proposes a "Track Ahead Free" process handled on-board by the driver. In this case, the driver of the guided vehicle shall confirm that the track section between the position of the head of the guided vehicle and the position of the next signal or board marking signal is free. In this process, the driver has the responsibility to acknowledge if conditions to receive the movement authority are fulfilled. Nevertheless, human failures occur and additional safety measures are required. Another process is an automatic Track Ahead Free process called "Prove Clear Ahead" (PCA). According to this process, if the distance separating the front of the guided vehicle from the next clear track section is smaller than the smallest length of guided vehicles operating on the railway network, then the RBC can consider that the track portion ahead the guided vehicle up to the next clear track section is free of any guided vehicle and the RBC can start sending movement authorities to this train, at least up to this next clear track section. Nevertheless, the above-mentioned distance is sometimes very small which causes problems for high speed trains which have notably to decrease their speed, and PCA can usually only occur close to the border between two consecutive track sections. Additionally infrastructure failures may also occur, requiring therefore complementary systems for ensuring the safety of the guided vehicle movement.

[0006] An objective of the present invention is to propose a system and a method for safely and efficiently triggering the sending of movement authorities to a guided vehicle, specifically for issuing the first movement authority in a manner free of any driver input, wherein the first movement authority is the movement authority issued to a guided vehicle when the latter enters for the first time an operating part of a railway network or the first movement authority issued by an RBC after issuance by the latter of an invalid movement authority, and requiring for instance re-initialization of the RBC.

[0007] For achieving said objective, the present invention proposes to use a video sieving technique as disclosed by the objects of independent claims. Other advantages of the invention are presented in the dependent claims.

[0008] Indeed, the present invention proposes in particular a method for automatically triggering a sending of a movement authority to a guided vehicle moving on a track of a railway network, wherein said guided vehicle is moving from a first section of said track towards a second section of said track. As said before, the RBC shall not rely on any separation hypothesis when starting issuances of movement authorities to a guided vehicle and thus it shall assume that the area between the front end of the guided vehicle and a boundary between the first and the second track section is not free of a guided vehicle. The proposed method advantageously allows the RBC to send a valid movement authority that authorizes the guided vehicle to reach said boundary between the first and second section of track free of any driver confirmation or input, and/or already when the train is far away from said boundary. The method according to the invention comprises notably the following steps:

- acquiring images of the first track section by means of a camera system of a trackside device, said camera system being configured for capturing images of the first track section including its boundary with the second track section. In particular said camera sys-

tem is configured for pointing to said first track section so as to take images wherein the track extends, and preferentially is continuously visible within the field of view of the camera system, from said boundary until an area of said first track section wherein the guided vehicle moving on the first track section towards the second track section has to travel through in order to reach the second track section by crossing said boundary. In other words, said camera system is preferentially configured for pointing to a portion of track within the first track section, wherein in said portion of track, the track extends and is continuously visible for the camera system from the boundary to said area;

- analyzing by means of a processing unit each image acquired by the camera system in order to detect a presence of the guided vehicle in the acquired images of the first track section;

- if the presence of said guided vehicle is detected, then the processing unit is configured for identifying the guided vehicle. For instance, the processing unit might be configured for determining from the acquired image if the guided vehicle comprises an identification key, wherein said identification key is configured for enabling an unequivocal identification of the guided vehicle, said identification key differentiating for instance the guided vehicle (A) from any other guided vehicle of the railway network. According to the present invention, each identification key is unique. For instance, each identification key installed on and/or displayed by the guided vehicle of the railway network is different from another identification key installed on and/or displayed by another guided vehicle of the railway network so that an unequivocal relation exists between the guided vehicle and its identification key. The identification key is for instance a code installed and/or displayed on the guided vehicle, typically displayed at the front end of the guided vehicle, which uniquely identifies the guided vehicle. For instance, a marker board might be installed in front of the guided vehicle, wherein said marker board is a guided vehicle on-board equipment configured for being installed in front of the guided vehicle and comprising said identification key configured for uniquely identifying the guided vehicle carrying the marker board from images taken by the camera system; and

- if the guided vehicle has been identified, for instance if an identification key is detected in front of the guided vehicle and is identifiable by the processing unit in the image of the guided vehicle acquired by the camera system, then the processing unit is further configured for determining if the track extending from the front end of the guided vehicle until the boundary is free of any obstacle notably by checking a continuity of each rail of the track between the guided vehicle and the boundary. Said checking of the continuity of each rail allows thus to determine an availability of the portion of track extending in front of a guided vehicle until the boundary with the next track section when said guided vehicle is moving toward said boundary; and

- if each rail is continuous from the boundary until the guided vehicle and the guided vehicle has been identified, for example if the identification key has been identified, then the processing unit is configured for triggering a sending of a movement authority to the guided vehicle, said movement authority authorizing the guided vehicle to move on the portion of track extending in front of him until said boundary. Otherwise, if an obstacle has been identified on the portion of track extending in front of the guided vehicle until the boundary, the processing unit is preferentially configured for sending a prevention signal configured for preventing a movement of the guided vehicle on said portion of track extending in front of the guided vehicle. For instance, the prevention signal is configured for preventing an issuance of a movement authority by the RBC. Preferentially, as soon as an identification key has been identified and the continuity of each rail positively verified, then the processing unit sends an authorization signal to a trackside device in charge of managing movement authorities for guided vehicles within the first track section (said trackside device in charge of managing movement authorities is typically the Radio Block Center - RBC. Hereafter RBC will refer to any trackside device in charge of managing movement authorities for guided vehicles within sections of track of a railway network), said authorization signal comprising for instance a data comprising the identified identification key and being configured for triggering the sending by the RBC of the movement authority to the guided vehicle, notably only if such a movement authority was not already sent by the RBC. According to the present invention and preferentially, the RBC receiving said authorization signal from the processing unit is capable to determine for which guided vehicle it has to send a movement authority from the data comprising said identification key.

[0009] According to the present invention, the processing unit is thus configured for triggering the sending of a movement authority to the guided vehicle A only if specific conditions are met. Said conditions are notably the identification of the identification key which allows to uniquely identify the guided vehicle in the acquired image and the determination of the continuity of each rail between the boundary and the incoming guided vehicle which allows to determine an availability state of the track for the moving of the guided vehicle towards said boundary. Otherwise, if at least one of the above-mentioned specific con-

dition is not met, for instance if the rail is discontinuous between the guided vehicle A and the boundary and/or if a marker board and/or an identification key cannot be detected and/or identified in the acquired image, then the process of triggering said movement authority is stopped, in other words, in this case the processing unit is configured for not triggering any movement authority.

[0010] The present invention also concerns a video sieving system for automatically triggering the sending of a movement authority to a guided vehicle moving on a first track section towards a second track section notably according to a predefined path, wherein said video sieving system comprises:

- optionally, an identification key configured for being installed on the guided vehicle and visible from outside said guided vehicle, said identification key allowing to differentiate or distinguish said guided vehicle from all other guided vehicles of the railway network when taking an image of the front end of the guided vehicle, allowing thus an identification of the guided vehicle carrying said identification key. In particular, the system according to the invention may comprise a marker board configured for being installed in front of the guided vehicle, said marker board comprising the identification key configured for enabling a unique identification of the guided vehicle by means of a camera system;
- a trackside device comprising said camera system, wherein the camera system is preferentially configured for being installed in the surrounding of a boundary of the first track section with the second track section, the camera system being further configured for acquiring an image of the first track section including the boundary of said first track section with the second track section and a portion of track that has in particular to be followed by the guided vehicle in order to travel according to said predefined path, wherein in said portion of track, the track extends and is continuously visible from the boundary until an area of the first track section that is remotely located compared to the location of the camera system. In other words, the camera system is configured for having its field of view, and thus imaging, the track portion that has to be followed by the guided vehicle in order to travel from the first track section to the second track section according to the predefined path;
- a processing unit configured for analyzing each image acquired by the camera system. Said processing unit is configured for automatically detecting a guided vehicle in the acquired image, and automatically identifying each detected vehicle. For instance, the processing unit is configured for determining if said guided vehicle comprises an identification key, for instance displayed on a marker board, and in the affirmative for identifying the identification key. The processing unit is further configured for determining a portion of track availability for the detected and identified guided vehicle. In particular, the processing unit is configured for determining a continuity of each rail of the track between the detected guided vehicle and the boundary if the detected guided vehicle has been identified, for instance if the identification key has been identified/determined for the detected guided vehicle. The processing unit is further configured for triggering a sending of a movement authority to the guided vehicle if the guided vehicle has been identified and it has determined that each rail is continuous between the boundary and the guided vehicle.

[0011] Further aspects of the present invention will be better understood through the following drawings, wherein like numerals are used for like and corresponding parts:

Figure 1 schematic representation of a method for triggering a sending of a movement authority according to the invention in the particular case of a track free ahead.

Figure 2 schematic representation of a method for triggering a sending of a movement authority according to the invention in the particular case of an occupied track ahead.

[0012] Figures 1 and 2 illustrate a preferred embodiment of the method according to the invention wherein a video sieving system 3 is used for triggering (Fig. 1), and optionally preventing (Fig. 2), a sending of a movement authority to a guided vehicle A, wherein said movement authority is configured for authorizing the guided vehicle A to move from a first track section 10 wherein it is located to a next track section, called second track section 11. A track section according to the present invention is a section (i.e. part or area) of a track 1 that comprises a detection device for detecting if the section (i.e. if said part or area) of the track it equips, is occupied or vacant, i.e. if a guided vehicle is respectively present or not on said track section, said detection device being usually a track circuit 13 managed by a track side device called RBC 4.

[0013] The track 1 might be divided into a plurality of sections, like the first section 10 of track and the second section 11 of track, which have a boundary 15 with one another, and wherein for each track section, movement authorities are managed by the RBC 4. In figure 1, the guided vehicle A is moving on the first section 10 towards the second section 11. One issue that has to be resolved is to determine if the part of track 1 of the first section 10 located ahead the guided vehicle A is free of any other guided vehicles. As shown in Fig. 1, such part that is identified by the reference "d" is free from any other guided vehicle, while Fig. 2 shows an embodiment wherein said part of track is occupied by a guided vehicle B located between the front of guided vehicle A and the boundary

15. In this case, notably when the RBC has to issue a movement authority for the first time (for instance when launching the RBC), it cannot determine, in particular considering only the information from track circuit 13, if the part d of the first track section 10 comprises only the guided vehicle A as shown in Fig. 1 or comprises said guided vehicle A and another guided vehicle, for instance an unfitted guided vehicle that does not report its position to the RBC (for instance a short guided vehicle like guided vehicle B) as shown in Fig. 2. This situation can be problematic for instance for high speed trains which have to strongly decrease their speed until clarification of the availability of said part d of the track is made.

[0014] Preferentially, each section of track comprises a detection device for determining its occupancy state, i.e. either vacant or occupied. Each detection device is preferentially connected, for instance wirelessly connected to a RBC 4 wherein each RBC 4 is in charge of managing movement authorities for one or several track sections, and is therefore configured for issuing or for preventing an issuance of a movement authority for guided vehicles that are moving or going to move on the track section it is responsible for. For instance, the RBC 4 of Fig. 1 and 2 is responsible for issuing or not a movement authority to the guided vehicle A moving from the first section 10 to the second section 11. Due to the presence of two guided vehicles on the same track section 10 in Fig. 2, there is a risk that the detection device does not distinguish the guided vehicle A from the guided vehicle B and considers that there is only one guided vehicle on the first track section 10. Each track section might comprise also a device enabling a guided vehicle to determine its position, like for example a beacon 14 that is able to communicate with the guided vehicle in order to exchange information, like position on the track or track section. Each track section is separated from the next track section by a boundary, like the boundary 15 separating the first track section 10 from the second track section 11, a guided vehicle being authorized to pass said boundary 15 for entering the next track section only if the next track section has been proved clear, i.e. has a vacant state. The present invention uses video sieving to clear the part d of track located between the boundary 15 and an incoming guided vehicle (guided vehicle A) whose predefined path goes through the boundary 15 in order to enter the second section 11.

[0015] The guided vehicle A comprises typically an on-board system 20 configured for managing a movement of the guided vehicle A on the track 1, said on-board system 20 comprising a position determination unit for determining the position of the guided vehicle A on the track 1. Preferentially, said position determination unit is able to communicate with beacons 14 for determining the position of the guided vehicle A according to techniques known in the art. Preferentially, said position determination unit may also comprise, additionally or alternately, a GPS system and/or an odometry system for determining said position of the guided vehicle A. The on-board system 20 further comprises a communication device 21 for communicating with a communication device 41 of the RBC 4 in order to exchange, via a communication channel 23, messages or information, notably about the position of the guided vehicle A and occupancy state of the track sections.

[0016] According to the present invention, a video sieving system 3 is used for improving the management of movement authority of guided vehicles by means of the RBC 4. Said video sieving system 3 comprises notably a camera system 31 configured for acquiring images of the first track section 10 including its boundary with the second track section 11, detecting and identifying incoming guided vehicles, and a processing unit 32 configured for analyzing the images acquired by the camera system 31. Optionally, an identification key might be installed on the guided vehicle, for instance displayed by a marker board 33 configured for being installed in front of the guided vehicle A, said identification key helping in the identification of the detected incoming guided vehicle.

[0017] The identification key is configured for allowing an identification in a unique manner of the guided vehicle on which said identification key is installed and/or displayed, for instance displayed by the marker board 33. To each identification key corresponds one and only one guided vehicle, each identification key being unique. Preferentially, the marker board 33 is an on-board device designed for being installed in front of the guided vehicle A so as to be identifiable by the processing unit 32 in images of the guided vehicle A acquired by the camera system 31. At least the identification key of the marker board 33, preferentially the marker board 33 and its identification key are visible from outside the guided vehicle. The identification key is for instance a code comprising one or several letters or numbers that might be displayed on said marker board and/or a distinctive sign allowing an identification of the guided vehicle carrying the identification key. In particular, the marker board 33 may comprise a display for displaying the identification key. According to other embodiments, the marker board might comprise a thin piece of material wherein the identification key is inscribed so as to be identifiable in images of the guided vehicle taken by the camera system 31. Preferentially, the identification key might be displayed using thermal radiations so that the identification key might be easily identifiable in bad weather conditions using an infrared camera of the camera system 31.

[0018] The camera system 31 is preferentially installed at a trackside location, for instance close to the boundary of two consecutive sections, like for instance in the surroundings of the boundary 15, so that incoming guided vehicles that are going to travel from the first section 10 through the boundary 15 in order to enter the second section 11 might be frontally imaged by the camera system 31. Additionally, the camera system 31 is preferentially configured for taking images of the first section so that a portion of track of said first section is imaged, wherein the track in said portion of track is continuously

visible by means of the camera system from said boundary 15 to an area remotely located from said boundary 15 and wherein new incoming guided vehicles that desire to travel through the boundary 15 in order to reach the second track section 11 have to pass. Optionally, the camera system 31 might comprise one or several cameras, and/or redundant cameras, each camera being capable of taking day and/or night images. The camera system 31 might also comprise an infrared camera designed for cooperating with identification key capable of radiating thermal radiations. For instance, the marker boards may comprise a thermal radiation of the identification key. Preferentially, the camera system 31 comprises a set of cameras wherein at least two cameras are installed at two different locations along the track 1 so that a longer portion of track 1 might be continuously visible for the camera system 31, allowing therefore the processing unit 32 to determine the availability (occupied or vacant state) of a longer portion of track in front of the incoming guided vehicle compared to the case wherein a camera system comprising one or several cameras located at a single location is used. Indeed, according to this last preferred embodiment, each set of cameras of the camera system 31 is configured for imaging a different part of the track 1 of the first section, wherein each of said different parts intersects with each of its adjacent parts so as to increase the continuously visible portion of track of the first track section. In this case, the length of the part d that is under viewing of the camera system 31 is increased by the use of the different set of cameras installed at different locations along the track 1 of the first section and movement authorities might be given for guided vehicles A located far away from the boundary 15.

[0019] The processing unit 32 of the video sieving system 3 according to the invention is connected to the camera system 31 for receiving video data from the latter. Said video data are the images the acquired by the camera system 31. The processing unit 32 is configured for analyzing said video data, i.e. the acquired images. It performs in particular the following tasks:

- a detection of a presence of a guided vehicle A within the images transmitted by the camera system 31. This task is performed in particular continuously or discontinuously, for instance each time a number x of images is received, or according to a period of time T. For this task, the processing unit (32) might use known methods and techniques, like comparing the acquired image with a reference image stored in the database of the processing unit, wherein said reference image is an image of the first track section including the boundary when the track is free of any obstacle. Comparing the reference image with newly acquired image allows to detect a presence of a guided vehicle, and may also be used for determining if an obstacle is present on the portion of track located in front of the detected guided vehicle. In particular, the processing unit 32 is capable of isolating from the acquired image features located on the track that were not present in the reference image, and to identify said features by comparing their image to other images stored in said database. Boosting techniques and learning algorithm might be used by the processing unit for detecting and/or identifying features/objects appearing on the track in the images acquired by the camera system;
- for each guided vehicle detected, the processing unit 32 is configured for identifying the detected guided vehicle, for instance by comparing an image of the detected guided vehicle to images of guided vehicles stored in a database of the processing unit 32, wherein each image of the database is associated to an identification data of the guided vehicle represented by said image. In this case, a guided vehicle is identified as soon as its image matches an image of the database. Optionally, the processing unit is configured for detecting and identifying an identification key installed and/or displayed on the guided vehicle. For instance the processing unit 32 is configured for detecting if a marker board 33 comprising the identification key is installed in front of the guided vehicle;
- for each guided vehicle detected that has been identified, for instance by identifying the identification key or by comparing the detected vehicle to guided vehicle images stored in said database, then the processing unit 32 is configured for determining if the portion of track comprised between the front of the detected guided vehicle and the boundary is free of any obstacle, in particular free of another guided vehicle, notably by checking a continuity of each rail of the track 1 between said boundary and the front of the detected guided vehicle;
- for each detected guided vehicle that has been identified and for which the portion of track comprised between the front of the guided vehicle and the boundary 15 has been determined to be continuous, i.e. free of any obstacle, automatically sending an authorization signal configured for triggering the sending of a movement authority to the detected guided vehicle. In particular, the authorization signal is sent to the RBC 4 by the processing unit 32 and is configured for triggering the sending of a movement authority to the identified guided vehicle by the RBC. In the case wherein the guided vehicle has been identified but the portion of track comprised between the front of the detected vehicle and the boundary comprises an obstacle, then the processing unit 32 is preferentially configured for sending a prevention signal to the RBC 4, wherein the prevention signal is configured for preventing an issuance of a movement authority, notably by the RBC 4, for the identified guided vehicle. In the other case, i.e. if the guided vehicle is not identifiable, then preferentially no signal is sent by the processing unit 32 to the RBC 4, and the management of movement au-

thority for the non-identified incoming guided vehicle takes place according to a usual way, i.e. free of an input of the video sieving system 3.

[0020] According to the present invention, the processing unit 32 may comprise a database and/or a communication device 321 for communicating with the communication device 41 of the RBC 4 in order to enable the sending of the prevention signal or the authorization signal for each detected and identified incoming guided vehicle. According to other embodiments, the authorization signal or the prevention signal might be sent by the processing unit 32 directly to the identified guided vehicle, wherein in this case, the processing unit 32 is further capable of exchanging data directly with the identified guided vehicle.

[0021] In particular, the authorization signal and the prevention signal both comprise an identification data related to the identified guided vehicle and configured for enabling the RBC to determine to which guided vehicle it has to send a movement authority or respectively for which guided vehicle it has to prevent the issuance of the movement authority. Said identification data is for instance the identified identification key or a data encoding or related to the identification key that allows the RBC to send the movement authority to the correct guided vehicle or prevent its sending to the identified guided vehicle. Upon reception of the authorization signal, the RBC is preferentially configured to determine which guided vehicle is concerned by said authorization signal by reading and, if necessary, decoding the identification data comprised in said authorization signal, and is then further configured for automatically issuing a movement authority for the determined guided vehicle, unless a movement authority was already issued for said guided vehicle. Upon reception of a prevention signal, the RBC is preferentially configured to determine which guided vehicle is concerned by said prevention signal by reading and, if necessary, decoding the identification data, comprised in said prevention signal, and is then further configured for automatically blocking an issuance of a movement authority for the determined guided vehicle. Preferentially, the guided vehicle (A) is only allowed to move forward on the first track section (10) until the boundary (15) upon reception of the movement authority sent by the RBC (4).

[0022] To summarize, the present invention proposes to use a camera system for enabling a video sieving, wherein a determination of the availability of a portion of track located in front of a guided vehicle travelling from a first track section to a second track section is performed by analyzing images acquired by the camera system, and wherein the result of this analysis automatically triggers the sending of a prevention signal or an authorization signal as soon as a guided vehicle has been detected and identified. The use of the camera system allows to increase the length of the portion of track for which the availability is checked.

Claims

1. Method for triggering a sending of a movement authority to a guided vehicle (A) moving on a track (1) of a railway network from a first track section (10) towards a second track section (11) limited by a boundary (15), the method comprising:

   - acquiring an image of the first track section (10) including the boundary (15) by means of a camera system (31) of a trackside device;
   - analyzing by means of a processing unit (32) the image acquired by the camera system (31) in order to detect a presence of the guided vehicle (A) in the acquired image of the first track section (10);
   - if the presence of the guided vehicle (A) is detected by the processing unit (32), then identifying the guided vehicle (A) by means of said processing unit (32);
   - if the detected guided vehicle (A) has been identified by the processing unit (32), then determining if a portion of track (1) separating a front end of the detected guided vehicle (A) from the boundary (15) is free of any obstacle;
   - if the detected guided vehicle has been identified and if the portion of track (1) has been determined to be free of any obstacle by the processing unit (32), then triggering a sending of a movement authority to the detected and identified guided vehicle (A) by means of said processing unit (32).

2. Method according to claim 1, wherein the processing unit (32) is configured for comparing the acquired image to a reference image of the first track section (10) including its boundary (15) in order to detect said presence of the guided vehicle (A).

3. Method according to claim 1 or 2, wherein identifying the guided vehicle (A) by means of said processing unit (32) comprises detecting and identifying an identification key displayed on the guided vehicle (A), wherein each identification key is unique and configured for uniquely identifying the guided vehicle (A) on which it is displayed.

4. Method according to one of the claims 1 to 3, wherein determining if the portion of track (1) separating the front end of the detected guided vehicle (A) from the boundary (15) is free of any obstacle comprises checking a continuity of each rail of the track (1) for said portion of track (1).

5. Method according to one of the claims 1 to 4, wherein triggering the sending of the movement authority to the detected and identified guided vehicle (A) comprises sending an authorization signal to a device in

charge of managing the movement authority for guided vehicles on said first track section (10), wherein said authorization signal comprises an identification data related to the detected and identified guided vehicle, and is configured for triggering the sending of the movement authority by said device in charge of managing the movement authority.

6. Method according to one of the claims 1 to 5, wherein the processing unit (32) is configured for preventing an issuance of a movement authority for the detected and identified guided vehicle (A) if it has determined that said portion of track comprises an obstacle.

7. Video sieving system (3) for triggering a sending of a movement authority to a guided vehicle (A) moving on a track (1) of a railway network from a first track section (10) towards a second track section (11) limited by a boundary (15), said video sieving system (3) comprising:

- a trackside device comprising a camera system (31), wherein the camera system is configured for acquiring an image of the first track section (10) including the boundary (15) of said first track section (10) with the second track section (11);
- a processing unit (32) configured for

i. analyzing the image acquired by the camera system (31); and
ii. automatically detecting a presence of the guided vehicle (A) in the acquired image; and
iii. automatically identifying the detected guided vehicle (A); and
iv. automatically determining if a portion of track (1) separating a front end of the detected and identified guided vehicle (A) from the boundary (15) is free of any obstacle, and if this is true, then it is further configured for triggering a sending of a movement authority to the detected and identified guided vehicle (A).

8. Video sieving system (3) according to claim 7, wherein the processing unit (32) is configured for comparing the acquired image to a reference image of the first track section (10) including its boundary (15) in order to detect said presence of the guided vehicle (A).

9. Video sieving system (3) according to claim 7 or 8, comprising a display of an identification key on the guided vehicle (A), wherein each identification key is unique and configured for uniquely identifying the guided vehicle (A) on which it is displayed by means of the processing unit (32).

10. Video sieving system (3) according to one of the claims 7 to 9, wherein the processing unit (32) is configured for checking a continuity of each rail of the track (1) for said portion of track (1) in order to determine if said portion of track is free of any obstacle.

11. Video sieving system (3) according to one of the claims 7 to 10, wherein the processing unit (32) is configured for sending either an authorization signal or a prevention signal to a device managing movement authorities for guided vehicles on said first track section (10), wherein the prevention signal and the authorization signal comprise both an identification data related to the detected and identified guided vehicle (A).

12. Video sieving system (3) according to claim 11, wherein the authorization signal is configured for triggering an issuance of a movement authority for the detected and identified guided vehicle by means of said device managing movement authorities.

13. Video sieving system (3) according to claim 11 or 12, wherein the prevention signal is configured for preventing the device managing movement authorities to issue a movement authority for the detected and identified guided vehicle.

14. Video sieving system (3) according to one of the claims 7 to 13, wherein the camera system (31) comprises several sets of cameras, wherein each set is located at a different location along the track (1) of the first section (10) so as to image different parts of the first track section (10), wherein each of the imaged different parts intersects with each of its adjacent imaged parts.

Patentansprüche

1. Verfahren zum Auslösen der Versendung einer Bewegungsautorität an ein geführtes Fahrzeug (A), das sich auf einer Strecke (1) eines Schienennetzes von einem ersten Streckenabschnitt (10) zu einem durch eine Begrenzung (15) begrenzten zweiten Streckenabschnitt (11) bewegt, wobei das Verfahren Folgendes umfasst:

- Aufnehmen eines Bildes des ersten Streckenabschnitts (10) einschließlich der Begrenzung (15) mittels eines Kamerasystems (31) mittels einer streckenseitigen Vorrichtung,
- Analysieren des von dem Kamerasystem (31) aufgenommenen Bildes mittels einer Verarbeitungseinheit (32), um eine Anwesenheit des geführten Fahrzeugs (A) auf dem aufgenommenen Bild des ersten Streckenabschnitts (10) zu

detektieren,
- wenn die Anwesenheit des geführten Fahrzeugs (A) von der Verarbeitungseinheit (32) detektiert wird, Identifizieren des geführten Fahrzeugs (A) mittels der Verarbeitungseinheit (32),
- wenn das detektierte geführte Fahrzeug (A) von der Verarbeitungseinheit (32) identifiziert worden ist, Bestimmen, ob ein Stück Strecke (1), das ein vorderes Ende des detektierten geführten Fahrzeugs (A) von der Begrenzung (15) trennt, frei von jeglichen Hindernissen ist,
- wenn das detektierte geführte Fahrzeug identifiziert worden ist und wenn das Stück Strecke (1) von der Verarbeitungseinheit (32) als frei von jeglichen Hindernissen bestimmt worden ist, Auslösen der Versendung einer Bewegungsautorität an das mittels der Verarbeitungseinheit (32) detektierte und identifizierte geführte Fahrzeug (A).

2. Verfahren nach Anspruch 1, wobei die Verarbeitungseinheit (32) zum Vergleichen des aufgenommenen Bildes mit einem Referenzbild des ersten Streckenabschnitts (10) einschließlich seiner Begrenzung (15) eingerichtet ist, um die Anwesenheit des geführten Fahrzeugs (A) zu detektieren.

3. Verfahren nach Anspruch 1 oder 2, wobei das Identifizieren des geführten Fahrzeugs (A) mittels der Verarbeitungseinheit (32) das Detektieren und Identifizieren eines auf dem geführten Fahrzeug (A) angezeigten Identifikationsschlüssels umfasst, wobei jeder Identifikationsschlüssel eindeutig und zum eindeutigen Identifizieren des geführten Fahrzeugs (A), auf dem er angezeigt wird, eingerichtet ist.

4. Verfahren nach einem der Ansprüche 1 bis 3, wobei das Bestimmen, ob das Stück Strecke (1), das das vordere Ende des detektierten geführten Fahrzeugs (A) von der Begrenzung (15) trennt, frei von jeglichen Hindernissen ist, das Prüfen einer Kontinuität jeder Schiene der Strecke (1) für das Stück Strecke (1) umfasst.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei das Auslösen der Versendung der Bewegungsautorität an das detektierte und identifizierte geführte Fahrzeug (A) das Senden eines Autorisierungssignals an eine Vorrichtung umfasst, die für das Verwalten der Bewegungsautorität für geführte Fahrzeuge auf dem ersten Streckenabschnitt (10) zuständig ist, wobei das Autorisierungssignal Identifikationsdaten bezüglich des detektierten und identifizierten geführten Fahrzeugs umfasst und eingerichtet ist zum Auslösen der Versendung der Bewegungsautorität durch die für das Verwalten der Bewegungsautorität zuständigen Vorrichtung.

6. Verfahren nach einem der Ansprüche 1 bis 5, wobei die Verarbeitungseinheit (32) eingerichtet ist zur Verhinderung der Ausgabe einer Bewegungsautorität für das detektierte und identifizierte geführte Fahrzeug (A), wenn bestimmt worden ist, dass das Stück Strecke ein Hindernis aufweist.

7. Video-Siebsystem (3) zum Auslösen der Versendung einer Bewegungsautorität an ein geführtes Fahrzeug (A), das sich auf einer Strecke (1) eines Schienennetzes von einem ersten Streckenabschnitt (10) zu einem durch eine Begrenzung (15) begrenzten zweiten Streckenabschnitt (11) bewegt, wobei das Video-Siebsystem (3) Folgendes umfasst:

- eine streckenseitige Vorrichtung mit einem Kamerasystem (31), wobei das Kamerasystem eingerichtet ist zum Aufnehmen eines Bildes des ersten Streckenabschnitts (10) einschließlich der Begrenzung (15) des ersten Streckenabschnitts (10) mit dem zweiten Streckenabschnitt (11),
- eine Verarbeitungseinheit (32), die eingerichtet ist zum

i. Analysieren des von dem Kamerasystem (31) aufgenommenen Bildes und
ii. automatischen Detektieren einer Anwesenheit des geführten Fahrzeugs (A) auf dem aufgenommenen Bild und
iii. automatischen Identifizieren des detektierten geführten Fahrzeugs (A) und
iv. automatischen Bestimmen, ob ein Stück Strecke (1), das das vordere Ende des detektierten und identifizierten geführten Fahrzeugs (A) von der Begrenzung (15) trennt, frei von jeglichen Hindernissen ist, und wenn dies wahr ist, ist sie ferner eingerichtet zum Auslösen der Versendung einer Bewegungsautorität an das detektierte und identifizierte geführte Fahrzeug (A) .

8. Video-Siebsystem (3) nach Anspruch 7, wobei die Verarbeitungseinheit (32) zum Vergleichen des aufgenommenen Bildes mit einem Referenzbild des ersten Streckenabschnitts (10) einschließlich seiner Begrenzung (15) eingerichtet ist, um die Anwesenheit des geführten Fahrzeugs (A) zu detektieren.

9. Video-Siebsystem (3) nach Anspruch 7 oder 8, das eine Anzeige eines Identifikationsschlüssels auf dem geführten Fahrzeug (A) umfasst, wobei jeder Identifikationsschlüssel eindeutig und zum eindeutigen Identifizieren des geführten Fahrzeugs (A), auf dem er angezeigt wird, mittels der Verarbeitungseinheit (32) eingerichtet ist.

10. Video-Siebsystem (3) nach einem der Ansprüche 7 bis 9, wobei die Verarbeitungseinheit (32) eingerichtet ist zum Prüfen einer Kontinuität jeder Schiene der Strecke (1) für das Stück Strecke (1), um zu bestimmen, ob das Stück Schiene frei von jeglichen Hindernissen ist.

11. Video-Siebsystem (3) nach einem der Ansprüche 7 bis 10, wobei die Verarbeitungseinheit (32) eingerichtet ist zum Senden von entweder einem Autorisierungssignal oder einem Verhinderungssignal an eine Vorrichtung, die Bewegungsautoritäten für geführte Fahrzeuge auf dem ersten Streckenabschnitt (10) verwaltet, wobei sowohl das Verhinderungssignal als auch das Autorisierungssignal Identifikationsdaten bezüglich des detektierten und identifizierten geführten Fahrzeugs (A) umfasst.

12. Video-Siebsystem (3) nach Anspruch 11, wobei das Autorisierungssignal eingerichtet ist zum Auslösen der Ausgabe einer Bewegungsautorität für das detektierte und identifizierte geführte Fahrzeug mittels der Vorrichtung, die Bewegungsautoritäten verwaltet.

13. Video-Siebsystem (3) nach Anspruch 11 oder 12, wobei das Verhinderungssignal eingerichtet ist zum Verhindern, dass die Vorrichtung, die Bewegungsautoritäten verwaltet, eine Bewegungsautorität für das detektierte und identifizierte geführte Fahrzeug ausgibt.

14. Video-Siebsystem (3) nach einem der Ansprüche 7 bis 13, wobei das Kamerasystem (31) mehrere Gruppen von Kameras umfasst, wobei jede Gruppe sich an einem anderen Ort entlang der Strecke (1) des ersten Abschnitts (10) befindet, um somit verschiedene Teile des ersten Streckenabschnitts (10) abzubilden, wobei jeder der verschiedenen abgebildeten Teile sich mit jedem seiner benachbarten abgebildeten Teile überschneidet.

Revendications

1. Procédé de déclenchement d'un envoi d'une autorisation de mouvement à un véhicule guidé (A) se déplaçant sur une voie (1) d'un réseau ferroviaire d'une première section de voie (10) vers une deuxième section de voie (11) limitées par une frontière (15), le procédé comprenant les étapes consistant :

- à acquérir une image de la première section de voie (10) comportant la frontière (15) au moyen d'un système de caméra (31) d'un dispositif côté voie ;
- à analyser au moyen d'une unité de traitement (32) l'image acquise par le système de caméra (31) afin de détecter la présence du véhicule guidé (A) dans l'image acquise de la première section de voie (10) ;
- si la présence du véhicule guidé (A) est détectée par l'unité de traitement (32), à identifier alors le véhicule guidé (A) au moyen de ladite unité de traitement (32) ;
- si le véhicule guidé (A) détecté a été identifié par l'unité de traitement (32), à déterminer alors si une partie de la voie (1) séparant une extrémité avant du véhicule guidé (A) détecté de la frontière (15) est exempte de tout obstacle ;
- si le véhicule guidé détecté a été identifié et si la partie de la voie (1) a été déterminée comme étant exempte de tout obstacle par l'unité de traitement (32), à déclencher alors un envoi d'une autorisation de mouvement au véhicule guidé (A) détecté et identifié au moyen de ladite unité de traitement (32).

2. Procédé selon la revendication 1, dans lequel l'unité de traitement (32) est configurée pour comparer l'image acquise à une image de référence de la première section de voie (10) comportant sa frontière (15) afin de détecter ladite présence du véhicule guidé (A).

3. Procédé selon la revendication 1 ou 2, dans lequel l'identification du véhicule guidé (A) au moyen de ladite unité de traitement (32) comprend la détection et l'identification d'une clé d'identification affichée sur le véhicule guidé (A), où chaque clé d'identification est unique et est configurée pour identifier de manière unique le véhicule guidé (A) sur lequel elle est affichée.

4. Procédé selon l'une des revendications 1 à 3, dans lequel la détermination du fait que la partie de la voie (1) séparant l'extrémité avant du véhicule guidé (A) détecté de la frontière (15) est exempte de tout obstacle comprend la vérification d'une continuité de chaque rail de la voie (1) pour ladite partie de la voie (1).

5. Procédé selon l'une des revendications 1 à 4, dans lequel le déclenchement de l'envoi de l'autorisation de mouvement au véhicule guidé (A) détecté et identifié comprend l'envoi d'un signal d'autorisation à un dispositif chargé de la gestion de l'autorisation de mouvement pour des véhicules guidés sur ladite première section de voie (10), où ledit signal d'autorisation comprend des données d'identification relatives au véhicule guidé détecté et identifié, et est configuré pour déclencher l'envoi de l'autorisation de mouvement par ledit dispositif chargé de la gestion de l'autorisation de mouvement.

6. Procédé selon l'une des revendications 1 à 5, dans

lequel l'unité de traitement (32) est configurée pour empêcher une émission d'une autorisation de mouvement pour le véhicule guidé (A) détecté et identifié si elle a déterminé que ladite partie de la voie comprend un obstacle.

7. Système d'analyse vidéo (3) pour déclencher un envoi d'une autorisation de mouvement à un véhicule guidé (A) se déplaçant sur une voie (1) d'un réseau ferroviaire d'une première section de voie (10) vers une deuxième section de voie (11) limitées par une frontière (15), ledit système d'analyse vidéo (3) comprenant :

- un dispositif côté voie comprenant un système de caméra (31), où le système de caméra est configuré pour acquérir une image de la première section de voie (10) comportant la frontière (15) de ladite première section de voie (10) avec la deuxième section de voie (11) ;
- une unité de traitement (32) configurée pour

i. analyser l'image acquise par le système de caméra (31) ; et
ii. détecter automatiquement la présence du véhicule guidé (A) dans l'image acquise ; et
iii. identifier automatiquement le véhicule guidé (A) détecté ; et
iv. déterminer automatiquement si une partie de la voie (1) séparant une extrémité avant du véhicule guidé (A) détecté et identifié de la frontière (15) est exempte de tout obstacle, et si cela est vrai, alors elle est en outre configurée pour déclencher un envoi d'une autorisation de mouvement au véhicule guidé (A) détecté et identifié.

8. Système d'analyse vidéo (3) selon la revendication 7, dans lequel l'unité de traitement (32) est configurée pour comparer l'image acquise à une image de référence de la première section de voie (10) comportant sa frontière (15) afin de détecter ladite présence du véhicule guidé (A).

9. Système d'analyse vidéo (3) selon la revendication 7 ou 8, comprenant l'affichage d'une clé d'identification sur le véhicule guidé (A), où chaque clé d'identification est unique et configurée pour identifier de manière unique le véhicule guidé (A) sur lequel elle est affichée au moyen de l'unité de traitement (32).

10. Système d'analyse vidéo (3) selon l'une des revendications 7 à 9, dans lequel l'unité de traitement (32) est configurée pour vérifier une continuité de chaque rail de la voie (1) pour ladite partie de la voie (1) afin de déterminer si ladite partie de la voie est exempte de tout obstacle.

11. Système d'analyse vidéo (3) selon l'une des revendications 7 à 10, dans lequel l'unité de traitement (32) est configurée pour envoyer soit un signal d'autorisation ou un signal d'interdiction à un dispositif gérant des autorisations de mouvement pour des véhicules guidés sur ladite première section de voie (10), où le signal d'interdiction et le signal d'autorisation comprennent tous deux des données d'identification relatives au véhicule guidé (A) détecté et identifié.

12. Système d'analyse vidéo (3) selon la revendication 11, dans lequel le signal d'autorisation est configuré pour déclencher une émission d'une autorisation de mouvement pour le véhicule guidé détecté et identifié au moyen dudit dispositif gérant des autorisations de mouvement.

13. Système d'analyse vidéo (3) selon la revendication 11 ou 12, dans lequel le signal d'interdiction est configuré pour interdire au dispositif gérant des autorisations de mouvement d'émettre une autorisation de mouvement pour le véhicule guidé détecté et identifié.

14. Système d'analyse vidéo (3) selon l'une des revendications 7 à 13, dans lequel le système de caméra (31) comprend plusieurs ensembles de caméras, où chaque ensemble est situé à un emplacement différent le long de la voie (1) de la première section (10) de manière à imager différentes parties de la première section de voie (10), où chacune des différentes parties imagées croise chacune de ses parties imagées adjacentes.

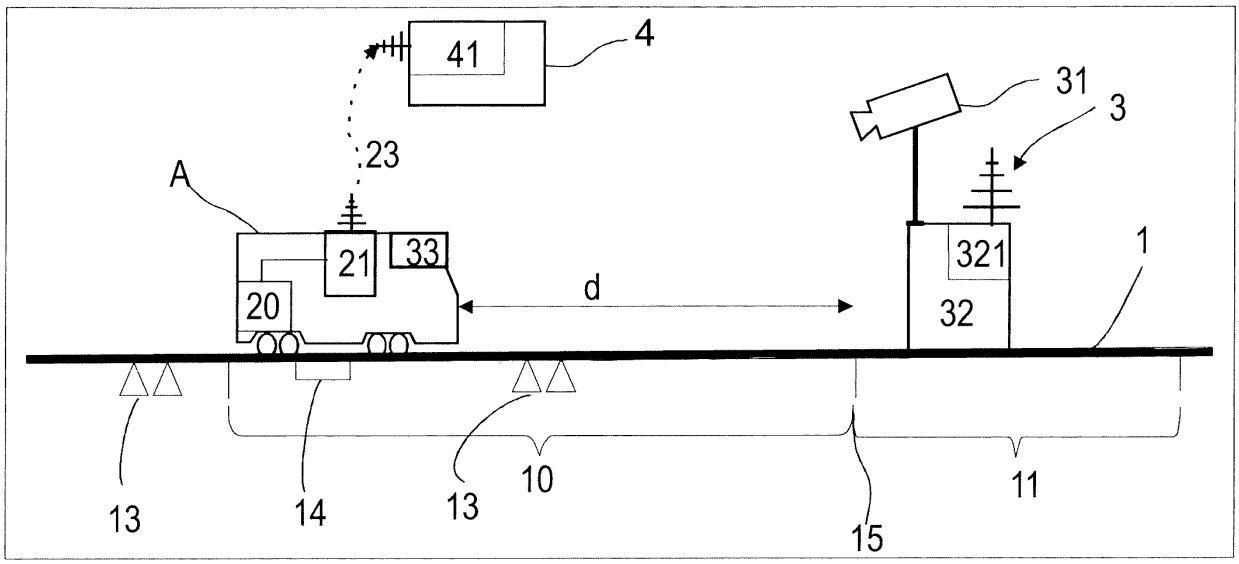
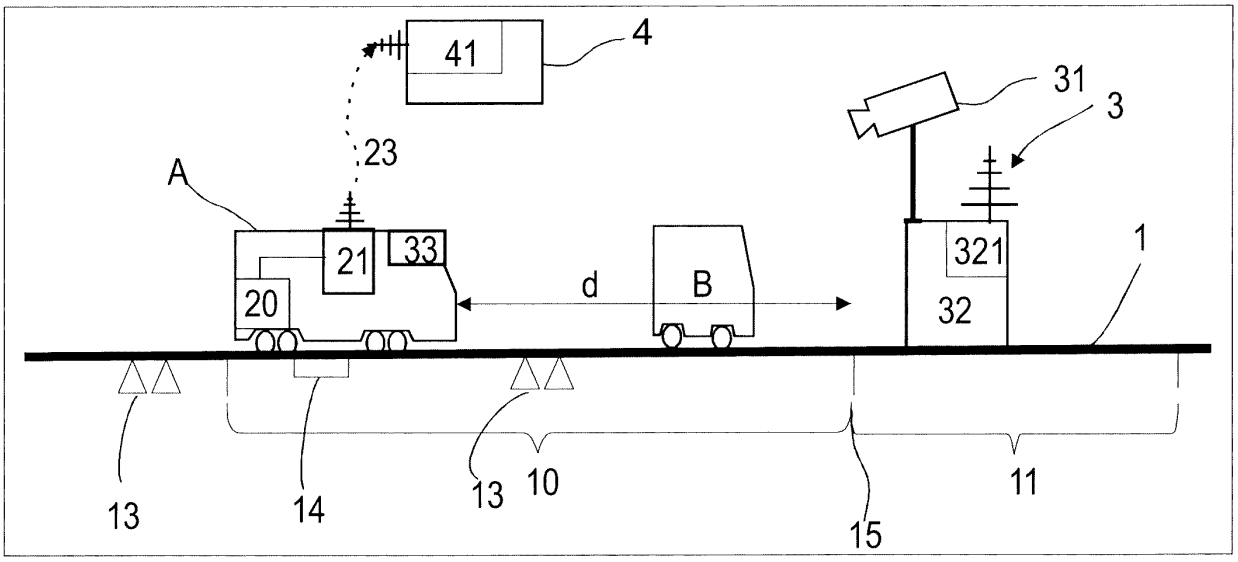

41
4
31
3
23
A
21
33
20
d
321
32
1
13
14
13
10
11
15

FIG 1


41
4
31
3
23
A
21
33
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d
B
321
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11
15

FIG 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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