

METHOD AND APPARATUS FOR DETERMINING MOVEMENT AUTHORITY, DEVICE, AND MEDIUM

TECHNICAL FIELD

5 **[0001]** The present application relates to the technical field of rail transit, and in particular to a method and an apparatus for determining a movement authority, a device, and a medium.

BACKGROUND

10 **[0002]** Communication-based train control (CBTC) uses communication technology to realize train operation control. CBTC includes automatic train protection (ATP), automatic train operation (ATO), and an active perception system. ATP is responsible for calculating the movement authority (MA) based on the forward safety detection distance recognized by the active perception subsystem and providing safety protection for the train, while ATO is responsible for calculating the motion trajectory of the train based on the MA and controlling
15 the automatic driving of the train.

20 **[0003]** The active perception system usually uses lidar or a camera as the main detection device. However, due to the influence of harsh environments, such as heavy fog, rain, snow, or dust, the forward safety detection distance recognized by the active perception system is inaccurate, which leads to an inaccurately calculated movement authority and affects the safety driving of the train.

SUMMARY

25 **[0004]** Embodiments of the present application provide a method and an apparatus for determining a movement authority, a device, and a medium, which can improve the safety of train driving.

30 **[0005]** In a first aspect, some embodiments of the present application provide a method for determining a movement authority applicable to a first train provided with an active perception system that includes a perception device. The method includes: acquiring position information of a plurality of perception tags perceived by the perception device within a visual range of the perception device, the plurality of perception tags being disposed on a track bed of a traveling track of the first train; determining an effective detection distance of the active perception system based on the position information; determining a safety detection distance of the active

perception system based on the effective detection distance; and determining a train movement authority based on the safety detection distance.

[0006] In a second aspect, some embodiments of the present application provide an apparatus for determining a movement authority applicable to a first train provided with an active perception system that includes a perception device. The apparatus includes: an acquisition module, configured to acquire position information of a plurality of perception tags perceived by the perception device within a visual range of the perception device, the plurality of perception tags being disposed on a track bed of a traveling track of the first train; a first determination module, configured to determine an effective detection distance of the active perception system based on the position information; a second determination module, configured to determine a safety detection distance of the active perception system based on the effective detection distance; and a third determination module, configured to determine a train movement authority based on the safety detection distance.

[0007] In a third aspect, some embodiments of the present application provide an electronic device. The electronic device includes a processor and a memory storing a program or instructions executable on the processor, and the program or the instructions, when executed by the processor, implement steps of the method for determining a movement authority provided by the embodiments of the present application.

[0008] In a third aspect, some embodiments of the present application provide a readable storage medium storing a program or instructions. The program or instructions, when executed by a processor, implement steps of the method for determining a movement authority provided by the embodiments of the present application.

[0009] According to the embodiments of the present application, by providing the perception tags on the track bed of the traveling track of the train, the position information of the perception tags perceived by the perception device within the visual range of the perception device in the active perception system mounted on the train is acquired, and the effective detection distance of the active perception system is determined based on the position information; the safety detection distance of the active perception system is determined based on the effective detection distance; and the train movement authority is determined based on the safety detection distance. Since the plurality of perception tags are provided on the track bed, even when the train is traveling in harsh environments such as heavy fog, rain, snow, or dust, the perception device can timely detect these perception tags and quickly and accurately

determine the safety detection distance of the active perception system, which improves the accuracy of the safety detection distance, thereby improving the precision of movement authority and ensuring the safety of train driving.

5 BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Hereinafter, features, advantages, and technical effects of exemplary embodiments of the present application will be described with reference to the accompanying drawings.

[0011] FIG. 1 is a flowchart of a method for determining a movement authority provided by some embodiments of the present application;

10 **[0012]** FIG. 2 is a schematic diagram of a train body protection distance provided by some embodiments of the present application;

[0013] FIG. 3 is a first schematic diagram of a safety detection distance provided by some embodiments of the present application;

15 **[0014]** FIG. 4 is a second schematic diagram of a safety detection distance provided by some embodiments of the present application;

[0015] FIG. 5 is a schematic diagram of a train movement authority under a same route condition provided by some embodiments of the present application;

20 **[0016]** FIG. 6 is a first schematic diagram of a train movement authority under a condition that lights on adjacent routes are both red provided by some embodiments of the present application;

[0017] FIG. 7 is a second schematic diagram of a train movement authority under a condition that lights on adjacent routes are both red provided by some embodiments of the present application;

25 **[0018]** FIG. 8 is a first schematic diagram of a train movement authority under a condition that lights on adjacent routes are both green provided by some embodiments of the present application;

[0019] FIG. 9 is a second schematic diagram of a train movement authority under a condition that lights on adjacent routes are both green provided by some embodiments of the present application;

30 **[0020]** FIG. 10 is a schematic diagram of an apparatus for determining a movement authority provided by some embodiments of the present application; and

[0021] FIG. 11 is a schematic diagram of an electronic device provided by some

embodiments of the present application.

DETAILED DESCRIPTION

[0022] The technical solutions in the embodiments of the present application will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present application. Obviously, the described embodiments are a part of the embodiments of the present application, but not all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by those of ordinary skill in the art without creative efforts fall within the protection scope of the present application.

[0023] The terms "first", "second" and the like in the specification and claims of the present application are used to distinguish similar objects and are not used to describe a particular order or sequence. It should be understood that the data thus used can be exchanged under appropriate circumstances so that the embodiments of the present application can be implemented in an order other than those illustrated or described herein, and that the objects distinguished by "first", "second", and the like are generally belong to a same class, and the number of these objects is not limited. For example, the number of the first object can be one or more than one. In addition, in the specification and claims, "and/or" indicates at least one of the connected objects, and the character "/" generally indicates that the associated objects before and after are in an "or" relationship.

[0024] Hereinafter, a method and an apparatus for determining a movement authority, a device, and a medium provided by the embodiments of the present application will be described in detail with reference to the accompanying drawings through specific embodiments and application scenarios thereof.

[0025] It should be noted that the method and the apparatus for determining a movement authority provided by the embodiments of the present application are applicable to a train. An active perception system is installed on the train, and the active perception system includes a perception device. The perception device includes but is not limited to a lidar.

[0026] FIG. 1 is a flowchart of a method for determining a movement authority applicable to a first train provided by some embodiments of the present application. The method for determining a movement authority applicable to the first train can include following steps 101-104.

[0027] In step 101, position information of a plurality of perception tags perceived by the

perception device within a visual range of the perception device is acquired. The perception tags are disposed on a track bed of a traveling track of the first train.

[0028] In some possible implementations of the embodiments of the present application, the perception tags in the embodiments of the present application are marks provided on the track bed for perception of the perception device.

[0029] In some possible implementations of the embodiments of the present application, the perception tags in the embodiments of the present application can be passive, that is, the perception tags are passive markers provided on the track bed for perception of the perception device.

[0030] In some possible implementations of the embodiments of the present application, a plurality of perception tags can be provided on the track bed of the track in advance, and the perception device perceives and recognizes the perception tags provided on the track bed during the train travelling process. It can be understood that the perception tags in the embodiments of the present application are different from the signboards provided around the track.

[0031] In some possible implementations of the embodiments of the present application, the visual range is a range that can be perceived by the perception device, which can also be referred to as a perception range.

[0032] In some possible implementations of the embodiments of the present application, after providing the perception tags on the track bed of the track is completed, the train can be controlled to travel on the track at a low speed, the three-dimensional space of the whole trace can be scanned by the perception device, and an offline semantic map can be constructed using collected feature information of the perception tags based on the traveling track of the train. The feature information of the perception tags includes but is not limited to a shape and a position of the perception tag, a distance between two adjacent perception tags. In the train traveling process, scanning of the perception device continuously performs to obtain the feature information of all the perception tags in the visual range, and the feature information of all the perception tags in the visual range obtained by the perception device in the train traveling process are matched with the offline semantic map to obtain the position information of all the perception tags in the visual range of the perception device in the train traveling process.

[0033] In step 102, an effective detection distance of the active perception system is determined based on the position information.

[0034] In some possible implementations of the embodiments of the present application,

the step 102 in the embodiments of the present application can include: taking a distance from a locomotive of the first train to a first perception tag as the effective detection distance. The first perception tag is one of the plurality of perception tags that is farthest from the locomotive.

[0035] In some possible implementations of the embodiments of the present application, the locomotive in the embodiments of the present application can be an unsafe locomotive. The unsafe locomotive is a virtual safe locomotive obtained by considering a speed measurement error and distance measurement error of the train.

[0036] In some possible implementations of the embodiments of the present application, assuming that a distance between the perception tag farthest from the locomotive perceived by the perception device and the perception device is l , and a height between the perception device and a plane of the track bed of the traveling track of the train is H , the distance between the locomotive and the perception tag farthest from the locomotive is $\sqrt{l^2 - H^2}$.

[0037] In step 103, a safety detection distance of the active perception system is determined based on the effective detection distance.

[0038] In some possible implementations of the embodiments of the present application, step 103 in the embodiments of the present application can include: acquiring train status information within the visual range, the train status information including at least one train being within the visual range or no train being within the visual range; and determining the safety detection distance based on the effective detection distance and the train status information.

[0039] In some possible implementations of the embodiments of the present application, the determining the safety detection distance based on the effective detection distance and the train status information can include: determining a train body protection distance based on the effective detection distance in response to a second train being within the visual range, the train body protection distance being a distance from a rear of the second train to a second perception tag, and the second perception tag being one of the plurality of perception tags that is below the second train and farthest from a locomotive of the first train; taking a difference between the effective detection distance and the train body protection distance as the safety detection distance.

[0040] In some possible implementations of the embodiments of the present application,

due to a certain distance between a train chassis and the track bed, when the perception device on the following train recognizes the perception tag, a part of the train body at the rear of the train in front may still be above the perception tag, indicating that the train in front has not yet fully crossed the perception tag. In order to ensure that an end point of the safety detection distance does not cross the rear of the train in front, at this time, it is necessary that the safety detection distance is reduced by a certain distance on the basis of the effective detection distance, and the certain distance is the train body protection distance in the embodiments of the present application.

[0041] In some possible implementations of the embodiments of the present application, the determining a train body protection distance based on the effective detection distance can include: calculating a product of the effective detection distance and a first height, the first height being a distance between the train chassis and the track bed; and taking a ratio of the product to a second height as the train body protection distance, the second height being a distance between the perception device and the track bed.

[0042] In some possible implementations of the embodiments of the present application, the train body protection distance can be determined based on the following formula (1):

$$\text{[0043]} \quad x = hL/H \quad (1)$$

[0044] In formula (1), x denotes the train body protection distance, h denotes the distance between the train chassis and the track bed, L denotes the effective detection distance, and H denotes the distance between the perception device and the track bed.

[0045] Exemplarily, as shown in FIG. 2, which is a schematic diagram of a train body protection distance provided by some embodiments of the present application. In FIG. 2, x denotes the train body protection distance, h denotes the distance between the train chassis and the track bed, L denotes the effective detection distance, and H denotes the distance between the perception device and the track bed.

[0046] After determining the train body protection distance, the effective detection distance is reduced by the train body protection distance to obtain the safety detection distance. Exemplarily, as shown in FIG. 3, which is a first schematic diagram of a safety detection distance provided by some embodiments of the present application. In FIG. 3, L denotes the effective detection distance, x denotes the train body protection distance, and d denotes the safety detection distance.

[0047] In some possible implementations of the embodiments of the present application, the determining a safety detection distance based on the effective detection distance and the train status information can include determining the effective detection distance as the safety detection distance in response to no train being within the visual range.

5 **[0048]** In some possible implementations of the embodiments of the present application, in a condition that no train is within the visual range of the first train, the effective detection distance at this time is the safety detection distance.

[0049] In some possible implementations of the embodiments of the present application, in a condition that no train is within the visual range of the first train, the train body protection
10 distance can also be determined based on the above formula (1), and the effective detection distance can be reduced by the train body protection distance to obtain the safety detection distance.

[0050] Exemplarily, as shown in FIG. 4, which is a second schematic diagram of a safety detection distance provided by some embodiments of the present application. In FIG. 4, L
15 denotes the effective detection distance, x denotes the train body protection distance, and d denotes the safety detection distance.

[0051] In step 104, a train movement authority is determined based on the safety detection distance.

[0052] In some possible implementations of the embodiments of the present application,
20 step 104 can include: determining a train reversing protection distance in response to a third train being within the visual range; determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information. The route status information includes the third train being on a same route as the first train, or the third train and the first train being on adjacent routes.

25 **[0053]** In some possible implementations of the embodiments of the present application, the train reversing protection distance can be determined based on a train reversing maximum speed, a train reversing maximum traction acceleration, a traction removal time, a traction brake transition inert time, a train reversing area slope acceleration, a rotation mass coefficient, and a maximum allowable reversing distance.

30 **[0054]** In some possible implementations of the embodiments of the present application, the train reversing protection distance can be determined based on the following formula (2):

$$S = \frac{1}{2} \frac{[V + a_1(T_1 + T_2)]^2}{a_1 + a_2 / k} + s_0 \quad (2)$$

[0056] In formula (2), S denotes the train reversing protection distance, V denotes the train reversing maximum speed, a_1 denotes the train reversing maximum traction acceleration, T_1 denotes the traction removal time, T_2 denotes the traction brake transition inert time, a_2 denotes the train reversing area slope acceleration, k denotes a rotation mass coefficient, and s_0 denotes the maximum allowable reversing distance.

[0057] In some possible implementations of the embodiments of the present application, the determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information can include taking a position at a first distance from the locomotive as an end point of the train movement authority in response to the third train being on a same route as the first train, the first distance being a difference between the safety detection distance and the train reversing protection distance.

[0058] As shown in FIG. 5, which is a schematic diagram of a train movement authority under a same route condition provided by some embodiments of the present application. In FIG. 5, L denotes the effective detection distance, x denotes the train body protection distance, d denotes the safety detection distance, M denotes the train reversing protection distance, MA is the movement authority, and the position point M denotes the end point of the MA .

[0059] In some possible implementations of the embodiments of the present application, the determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information can include: determining the train movement authority based on the safety detection distance, the train reversing protection distance, and signal status information in response to the third train and the first train being on adjacent routes. The signal status information includes a passage prohibited status or a passage permitted status.

[0060] In some possible implementations of the embodiments of the present application, the passage prohibited status can be a status in which the signal has a red light, and the passage permitted status can be a status in which the signal has a green light.

[0061] In some possible implementations of the embodiments of the present application, the determining the train movement authority based on the safety detection distance, the train

reversing protection distance, and signal status information can include: taking a position point closest to a locomotive of the first train among a first position and a second position as an end point of the train movement authority in response to a status of a signal in front of the first train being the passage prohibited status, the first position being a position at a second distance from the locomotive, the second distance being a difference between the safety detection distance and the train reversing protection distance, and the second position being a position of the signal; and taking a position point farthest from the locomotive among the first position and the second position as the end point of the train movement authority in response to the status of the signal in front of the first train being the passage permitted status.

[0062] In some possible implementations of the embodiments of the present application, the position of the signal in the embodiments of the present application can be a position of a protective axle counter of the signal.

[0063] As shown in FIGS. 6 to 9, FIG. 6 is a first schematic diagram of a train movement authority under a condition that lights on adjacent routes are both red provided by some embodiments of the present application; FIG. 7 is a second schematic diagram of a train movement authority under a condition that lights on adjacent routes are both red provided by some embodiments of the present application; FIG. 8 is a first schematic diagram of a train movement authority under a condition that lights on adjacent routes are both green provided by some embodiments of the present application; and FIG. 9 is a second schematic diagram of a train movement authority under a condition that lights on adjacent routes are both green provided by some embodiments of the present application.

[0064] In FIGS. 6 to 9, L denotes the effective detection distance, x denotes the train body protection distance, d denotes the safety detection distance, M denotes the train reversing protection distance, MA denotes the movement authority, a position point M denotes a position of a signal 601, and a position point N denotes a position point at a distance of $d-m$ from the locomotive.

[0065] In FIG. 6, two trains are on adjacent routes, and a red light is ahead of the following train, and a distance from the position point M to a locomotive of the train is smaller than a distance from the position point N to the locomotive of the train, and the position point M is taken as the end point of the movement authority.

[0066] In FIG. 7, two trains are on adjacent routes, and a red light is ahead of the following train, and the distance from the position point M to the locomotive of the train is greater than

the distance from the position point N to the locomotive of the train, and the position point N is taken as the end point of the movement authority.

[0067] In FIG. 8, two trains are on adjacent routes, and a green light is ahead of the following train, and the distance from the position point M to the locomotive of the train is smaller than the distance from the position point N to the locomotive of the train, and the position point N is taken as the end point of the movement authority.

[0068] In FIG. 9, two trains are on adjacent routes, and a green light is ahead of the following train, and the distance from the position point M to the locomotive of the train is greater than the distance from the position point N to the locomotive of the train, and the position point M is taken as the end point of the movement authority.

[0069] After determining the end point of the train movement authority, when calculating a target-distance speed curve, a distance from the end point of the train movement authority to the locomotive of the train and a distance from a position of an obstacle to the locomotive are compared, a position point closest to the locomotive among the end point of the train movement authority and the position of the obstacle is taken as a target point, the target-distance speed curve is calculated based on the target point and the train operation is controlled based on the target-distance speed curve.

[0070] In FIGS. 2 to 9, the perception tag 201 is represented by a diamond whose vertexes are connected.

[0071] According to the embodiments of the present application, by providing the perception tags on the track bed of the traveling track of the train, the position information of the perception tags perceived by the perception device within the visual range of the perception device in the active perception system mounted on the train is acquired, and the effective detection distance of the active perception system is determined based on the position information; the safety detection distance of the active perception system is determined based on the effective detection distance; and the train movement authority is determined based on the safety detection distance. Since the perception tags have very high reflectivity, the perception tags are easily perceived by the perception device, which will not be affected by the harsh environments such as heavy fog, rain, snow, or dust. The safety detection distance of the active perception system can be accurately determined through the perception tags, which improves the accuracy of the safety detection distance, thereby improving the precision of movement authority and ensuring the safety of train driving.

[0072] In some possible implementations of the embodiments of the present application, the perception tag in the embodiments of the present application can be a highly reflective spike. Since the highly reflective spike has a relatively high reflectivity, it is easily perceived by the perception device on the train, and will not be affected by harsh environments such as heavy fog, rain, snow, or dust. The safety detection distance of the active perception system can be timely and accurately determined through the highly reflective spike, which improves the accuracy of the safety detection distance, thereby improving the accuracy of movement authority and ensuring the safety of train driving.

[0073] Some embodiments of the present application also provide an apparatus for determining a movement authority, as shown in FIG. 10, which is a schematic diagram of an apparatus for determining a movement authority provided by some embodiments of the present application. The apparatus for determining a movement authority 1000 can include an acquisition module 1001, a first determination module 1002, a second determination module 1003, and a third determination module 1004.

[0074] The acquisition module 1001 is configured to acquire position information of a plurality of perception tags perceived by the perception device within the visual range of the perception device, the plurality of perception tags being disposed on a track bed of a traveling track of the first train.

[0075] The first determination module 1002 is configured to determine an effective detection distance of the active perception system based on the position information.

[0076] The second determination module 1003 is configured to determine a safety detection distance of the active perception system based on the effective detection distance.

[0077] The third determination module 1004 is configured to determine a train movement authority based on the safety detection distance.

[0078] In the embodiment of the present application, by providing the perception tags on the track bed of the traveling track of the train, the position information of the perception tags perceived by the perception device within the visual range of the perception device in the active perception system mounted on the train is acquired, and the effective detection distance of the active perception system is determined based on the position information; the safety detection distance of the active perception system is determined based on the effective detection distance; and the train movement authority is determined based on the safety detection distance. Since the perception tags have very high reflectivity, the perception tags are easily perceived by the

perception device, which will not be affected by the harsh environments such as heavy fog, rain, snow, or dust. The safety detection distance of the active perception system can be accurately determined through the perception tags, which improves the accuracy of the safety detection distance, thereby improving the precision of movement authority and ensuring the safety of train driving.

[0079] In some possible implementations of embodiments of the present application, the first determination module 1002 is specifically configured to take a distance from a locomotive of the first train to a first perception tag as the effective detection distance, the first perception tag being one of the plurality of perception tags that is farthest from the locomotive.

[0080] In some possible implementations of embodiments of the present application, the second determination module 1003 includes an obtaining sub-module and a first determination sub-module.

[0081] The obtaining sub-module is configured to acquire train status information within the visual range, the train status information including at least one train being within the visual range or no train being within the visual range;

[0082] The first determination sub-module is configured to determine a safety detection distance based on the effective detection distance and the train status information.

[0083] In some possible implementations of embodiments of the present application, the first determination sub-module is specifically configured to determine the effective detection distance as the safety detection distance in response to no train being within the visual range.

[0084] In some possible implementations of embodiments of the present application, the first determination sub-module includes a first determination unit and a second determination unit.

[0085] The first determination unit is configured to determine a train body protection distance based on an effective detection distance in response to a second train being within a visual range, the train body protection distance being a distance from a rear of the second train to a second perception tag, and the second perception tag being one of the plurality of perception tags that is located below the second train and farthest from the locomotive of the first train.

[0086] The second determination unit is configured to take a difference between the effective detection distance and the train body protection distance as the safety detection distance.

[0087] In some possible implementations of the embodiments of the present application, the first determination unit is specifically configured to:

[0088] calculate a product of the effective detection distance and a first height, the first height being a distance between a train chassis and the track bed; and

5 **[0089]** take a ratio of the product to a second height as the train body protection distance, the second height being a distance between the perception device and the track bed.

[0090] In some possible implementations of embodiments of the present application, the third determination module 1004 includes a second determination sub-module and a third determination sub-module.

10 **[0091]** The second determination sub-module is configured to determine a train reversing protection distance in response to a third train being within a visual range; and

[0092] The third determination sub-module is configured to determine the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information, the route status information including the third train being on a same
15 route as the first train or the third train and the first train being on adjacent routes.

[0093] In some possible implementations of the embodiments of the present application, the third determination sub-module is specifically configured to take a position at a first distance from the locomotive as an end point of the train movement authority in response to the third train being on a same route as the first train, the first distance being a difference
20 between the safety detection distance and the train reversing protection distance.

[0094] In some possible implementations of the embodiments of the present application, the third determination sub-module is specifically configured to determine the train movement authority based on the safety detection distance, the train reversing protection distance, and signal status information in response to the third train and the first train being on adjacent routes,
25 the signal status information including a passage prohibited status or a passage permitted status.

[0095] In some possible implementations of the embodiments of the present application, the third determination sub-module is specifically configured to:

[0096] take a position point closest to the locomotive of the first train among the first position and the second position as the end point of the train movement authority in response
30 to a status of a signal in front of the first train being a passage prohibited status, the first position is a position at a second distance from the locomotive, the second distance being the difference between the safety detection distance and the train reversing protection distance, and the second

position being a position of the signal; and

[0097] take the position point farthest from the locomotive among the first position and the second position as the end point of the train movement authority in response to the status of the signal in front of the first train being the passage permitted status.

5 **[0098]** FIG. 11 is a schematic diagram of an electronic device provided by some embodiments of the present application.

[0099] The electronic device can include a processor 1101 and a memory 1102 storing computer program instructions.

10 **[0100]** Specifically, the processor 1101 can include a central processing unit (CPU), an application specific integrated circuit (ASIC), or one or more integrated circuits configured to implement embodiments of the present application.

[0101] The memory 1102 can include mass storage for data or instructions. By way of example and not limitation, the memory 1102 can include a hard disk drive (HDD), a floppy disk drive, a flash memory, an optical disk, a magneto-optical disk, a magnetic tape, or a
15 universal serial bus (USB) drive, or a combination of two or more of these. Where appropriate, the memory 1102 can include a removable or non-removable (or fixed) medium. Where appropriate, the memory 1102 can be internal or external to the electronic device. In some particular embodiments, the memory 1102 is a non-transitory solid-state memory.

[0102] In some particular embodiments, the memory can include read-only memory
20 (ROM), random access memory (RAM), magnetic disk storage media devices, optical storage media devices, flash memory devices, or electrical, optical, or other physical/tangible memory storage devices. Thus, in general, the memory includes one or more tangible (non-transitory) computer-readable storage media (e.g., memory devices) encoded with software including computer-executable instructions, and when the software is executed (e.g., by one or more
25 processors), it is operable to perform the operations described with reference to the method for determining a movement authority provided by the present application.

[0103] The processor 1101 reads and executes computer program instructions stored in the memory 1102 to implement the method for determining a movement authority provided by the embodiment of the present application.

30 **[0104]** In an example, the electronic device can further include a communication interface 1103 and a bus 1110. Here, as shown in FIG. 11, the processor 1101, the memory 1102, and the communication interface 1103 are connected via the bus 1110 to communicate with each other.

[00105] The communication interface 1103 is mainly used for realizing communication between modules, devices, units, and/or devices in the embodiments of the present application.

[00106] The bus 1110 includes hardware, software, or both, coupling components of the electronic device together with each other. By way of example and not limitation, the bus can include an accelerated graphics port (AGP) or other graphics bus, an extended industry standard architecture (EISA) bus, a front side bus (FSB), a hyper transport (HT) interconnect, an industry standard architecture (ISA) bus, an infinite bandwidth Interconnect, a low pin count (LPC) bus, a memory bus, a micro channel architecture (MCA) bus, a peripheral component interconnect (PCI) bus, a PCI-express(PCI-X) bus, a serial advanced technology attachment (SATA) bus, a video electronics standards association local bus (VLB), or other suitable bus, or a combination of two or more thereof. Where appropriate, the bus 1110 can include one or more buses. Although embodiments of the present application describe and illustrate particular buses, the present application contemplates any suitable bus or interconnect.

[00107] The electronic device can execute the method for determining a movement authority provided by the embodiments of the present application, thereby achieving the corresponding technical effect of the method for determining a movement authority provided by the embodiments of the present application.

[00108] In addition, in combination with the method for determining a movement authority in the above embodiments, some embodiments of the present application also provide a computer-readable storage medium to implement it. Computer program instructions are stored on the computer-readable storage medium. When executed by the processor, the computer program instructions implement the method for determining a movement authority provided by the embodiments of the present application. Examples of the computer-readable storage media include non-transitory computer-readable media such as ROM, RAM, and magnetic or optical disks.

[00109] Some embodiments of the present application provide a computer program product, and when the instructions in the computer program product are executed by the processor of the electronic device, the electronic device can execute the method for determining a movement authority provided by the embodiments of the present application, and the same technical effect can be achieved, which are not repeated herein to avoid repetition.

[00110] It is to be clear that the present application is not limited to the particular configurations and processes described above and illustrated in the drawings. For brevity, a

detailed description of known methods is omitted herein. In the above-described embodiments, several specific steps are described and illustrated as examples. However, the process of the present application is not limited to the specific steps described and shown, and those skilled in the art can make various changes, modifications, and additions, or change the order between the steps after understanding the gist of the present application.

[00111] The functional blocks shown in the structural block diagrams described above can be implemented as hardware, software, firmware, or a combination thereof. When implemented in hardware, it may be, for example, an electronic circuit, an application-specific integrated circuit (ASIC), appropriate firmware, plug-in, or function cards. When implemented in software, an element of the present application is a program or code segment used to perform a desired task. The program or the code segment can be stored in a machine-readable medium or transmitted over a transmission medium or communication link via a data signal carried in a carrier wave. A "machine-readable medium" can include any medium capable of storing or transmitting information. Examples of machine-readable media include electronic circuits, semiconductor memory devices, ROMs, flash memory, erasable read only memory (EROM), floppy disks, compact disc read-only memory (CD-ROM), optical disks, hard disks, fiber optic media, radio frequency (RF) links, and the like. The code segment can be downloaded via a computer network such as the internet, an intranet, or the like.

[00112] It should also be noted that the exemplary embodiments mentioned in the present application describe some methods or systems based on a series of steps or apparatuses. However, the present application is not limited to the order of the above-described steps, that is, the steps can be executed in the order mentioned in the embodiment, the order can be different from the order in the embodiment, or a plurality of steps can be executed simultaneously.

[00113] It should also be noted that, herein, the terms "comprise", "include" or any other variation thereof are intended to encompass a non-exclusive inclusion such that a process, method, article, or apparatus including a list of elements includes not only those elements, but also other elements not explicitly listed, or elements inherent to such a process, method, article, or apparatus. Without further limitation, an element defined by the statement "comprises a..." does not exclude the presence of additional identical elements in a process, method, article, or apparatus that includes the element. In addition, it should be noted that the scope of the methods and apparatuses in the embodiments of the present application is not limited to performing

functions in the order shown or discussed, but can also include performing functions in a substantially simultaneous manner or in a reverse order depending on the functions involved. For example, the described methods can be performed in a different order than that described, and various steps can also be added, omitted, or combined. Additionally, features described with reference to certain examples can be combined in other examples.

[00114] From the above description of the embodiments, those skilled in the art can clearly understand that the method of the above embodiments can be implemented by means of software plus a necessary general hardware platform. It can also be implemented by hardware, but in many cases, the former is preferred implementation. Based on such an understanding, the technical solution of the present application can be embodied in the form of a computer software product, which is stored in a storage medium (such as ROM/RAM, magnetic disk, or optical disk), and includes several instructions for causing a terminal (which can be a computer, server, or network device, etc.) to execute the methods described in various embodiments of the present application.

[00115] The embodiments of the present application have been described above in conjunction with the accompanying drawings, but the present application is not limited to the above-mentioned specific embodiments, and the above-mentioned specific embodiments are merely schematic, rather than limiting. Under the inspiration of the present application, those skilled in the art can make many modifications without departing from the gist of the present application and the scope protected by the claims, all of which fall within the protection of the present application.

What is claimed is:

1. A method for determining a movement authority, applicable to a first train provided with an active perception system that comprises a perception device, the method comprising:

acquiring position information of a plurality of perception tags perceived by the perception device within a visual range of the perception device, wherein the plurality of perception tags are disposed on a track bed of a traveling track of the first train;

determining an effective detection distance of the active perception system based on the position information;

determining a safety detection distance of the active perception system based on the effective detection distance; and

determining a train movement authority based on the safety detection distance.

2. The method of claim 1, wherein the determining a safety detection distance of the active perception system based on the effective detection distance comprises:

acquiring train status information within the visual range, wherein the train status information comprises at least one train being within the visual range or no train being within the visual range; and

determining the safety detection distance based on the effective detection distance and the train status information.

3. The method of claim 2, wherein the determining the safety detection distance based on the effective detection distance and the train status information comprises:

determining a train body protection distance based on the effective detection distance in response to a second train being within the visual range, wherein the train body protection distance is a distance from a rear of the second train to a second perception tag, and the second perception tag is one of the plurality of perception tags that is located below the second train and farthest from a locomotive of the first train; and

taking a difference between the effective detection distance and the train body protection distance as the safety detection distance.

4. The method of claim 3, wherein the determining a train body protection distance based on the effective detection distance comprises:

calculating a product of the effective detection distance and a first height, wherein the first height is a distance between a train chassis and the track bed; and

taking a ratio of the product to a second height as the train body protection distance, wherein the second height is a distance between the perception device and the track bed.

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5. The method of claim 2, wherein the determining the safety detection distance based on the effective detection distance and the train status information comprises:

determining the effective detection distance as the safety detection distance in response to no train being within the visual range.

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6. The method of claim 1, wherein the determining an effective detection distance of the active perception system based on the position information comprises:

taking a distance from a locomotive of the first train to a first perception tag as the effective detection distance, wherein the first perception tag is one of the plurality of perception tags that is farthest from the locomotive.

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7. The method of claim 1, wherein the determining a train movement authority based on the safety detection distance comprises:

determining a train reversing protection distance in response to a third train being within the visual range; and

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determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information, wherein the route status information comprises the third train being on a same route as the first train, or the third train and the first train being on adjacent routes.

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8. The method of claim 7, wherein the determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information comprises:

taking a position at a first distance from a locomotive of the first train as an end point of the train movement authority in response to the third train being on a same route as the first train, wherein the first distance is a difference between the safety detection distance and the train reversing protection distance.

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9. The method of claim 7, wherein the determining the train movement authority based on the safety detection distance, the train reversing protection distance, and route status information comprises:

5 determining the train movement authority based on the safety detection distance, the train reversing protection distance, and signal status information in response to the third train and the first train being on adjacent routes, wherein the signal status information comprises a passage prohibited status or a passage permitted status.

10 10. The method of claim 9, wherein the determining the train movement authority based on the safety detection distance, the train reversing protection distance, and signal status information comprises:

15 taking a position point closest to a locomotive of the first train among a first position and a second position as an end point of the train movement authority in response to a status of a signal in front of the first train being the passage prohibited status, wherein the first position is a position at a second distance from the locomotive, the second distance is a difference between the safety detection distance and the train reversing protection distance, and the second position is a position of the signal; and

20 taking a position point farthest from the locomotive among the first position and the second position as the end point of the train movement authority in response to the status of the signal in front of the first train being the passage permitted status.

11. An apparatus for determining a movement authority, applicable to a first train provided with an active perception system that comprises a perception device, the apparatus comprising:

25 an acquisition module, configured to acquire position information of a plurality of perception tags perceived by the perception device within a visual range of the perception device, wherein the plurality of perception tags are disposed on a track bed of a traveling track of the first train;

30 a first determination module, configured to determine an effective detection distance of the active perception system based on the position information;

 a second determination module, configured to determine a safety detection distance of the active perception system based on the effective detection distance; and

a third determination module, configured to determine a train movement authority based on the safety detection distance.

5 12. An electronic device, comprising a processor and a memory storing a program or instructions executable on the processor, wherein the program or the instructions, when executed by the processor, implement the steps of the method for determining a movement authority according to any one of claims 1 to 10.

10 13. A readable storage medium, storing a program or instructions, wherein the program or the instructions, when executed by a processor, implement the steps of the method for determining a movement authority according to any one of claims 1 to 10.