

TRAIN POSITION CORRECTING METHOD, APPARATUS, DEVICE, AND MEDIUM

TECHNICAL FIELD

5 **[0001]** The present application relates to the field of rail transit technology, and in particular to a train position correcting method, apparatus, device, and medium.

BACKGROUND

10 **[0002]** Real-time and accurate acquisition of train position information is essential for ensuring safe and efficient train operation.

15 **[0003]** After the initial positioning of the train is completed, the speed of the train is measured by detecting the rotational speed of the train wheels with speed sensors. The distance traveled by the train is obtained by integrating the speed over time, and the position of the train is determined based on the initial positioning and the traveled distance. However, as the traveled distance increases, the speed measurement and distance measurement positioning error of the train gradually accumulates, which affects train positioning. Therefore, it is necessary to correct the position of the train during operation, i.e., to re-position the train.

20 **[0004]** In related art, position correcting is primarily achieved by identification signboards. However, under adverse environmental conditions such as heavy fog, rain, snow, or dust, the positioning results obtained by identification signboards are inaccurate, compromising train operation safety.

SUMMARY

25 **[0005]** Embodiments of the present application provide a train position correcting method, apparatus, device, and medium, which can improve train operation safety.

30 **[0006]** In a first aspect, embodiments of the present application provide a train position correcting method, including:

30 **[0007]** identifying, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels;

30 **[0008]** matching first feature information of one of the perception tags currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, wherein the partial offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device

when the train is at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning;

5 **[0009]** determining, in a case where only one of the perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, a first position of the train based on a position of a first perception tag identified by the perception device, wherein the perception tag combination comprises a plurality of the perception tags, and the first perception tag is one of the perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information;
10 and

[0010] correcting a current position of the train to the first position.

[0011] In a second aspect, embodiments of the application provide a train position correcting apparatus, comprising:

15 **[0012]** an identifying module, configured to identify, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels;

[0013] a matching module, configured to match first feature information of one of the perception tags currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, wherein the partial
20 offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device when the train is at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning;

25 **[0014]** a first determining module, configured to, in a case where only one of the perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, determine a first position of the train based on a position of a first perception tag identified by the perception device, wherein the perception tag combination comprises a plurality of the perception tags, and the first perception tag is any one of the
30 perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information; and

[0015] a correcting module, configured to correct a current position of the train to the first position.

[0016] In a third aspect, embodiments of the present application provide an electronic device comprising: a processor and a memory, the memory storing a program or instructions executable by the processor, wherein the program or instructions, when executed by the processor, implement the steps of the train position correcting method according to
5 embodiments of the application.

[0017] In a fourth aspect, embodiments of the present application provide a readable storage medium, storing a program or instructions therein, wherein the program or instructions, when executed by a processor, implement the steps of the train position correcting method according to embodiments of the application.

[0018] In embodiments of the present application, the perception tags disposed on a ballast of a track along which a train travels are identified by a perception device mounted on the train; the first feature information of the perception tag currently identified by the perception device is matched the feature information of a plurality of perception tag combinations in a partial
10 offline semantic map, in a case where only one of the perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, a first position of the train is determined based on a position of a first perception tag identified
15 by the perception device, wherein the first perception tag is one of the perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information; and a current position of the train is corrected to the first position. Since a plurality
20 of perception tags are disposed on the ballast, even under adverse environmental conditions such as heavy fog, rain, snow, or dust, the perception device can promptly perceive the perception tags, quickly and accurately determine the position of the train, and thereby use the determined position to correct the current position of the train, ensuring the operation safety of the train.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The features, advantages, and technical effects of exemplary embodiments of the present application will now be described with reference to the accompanying drawings.

[0020] Fig. 1 is a schematic flowchart of a train position correcting method according to
30 an embodiment of the present application;

[0021] Fig. 2 is a schematic diagram of perception tags disposed on a ballast according to an embodiment of the present application;

[0022] Fig. 3 is a schematic diagram of a perception tag combination according to an

embodiment of the present application;

[0023] Fig. 4 is a schematic diagram of a point cloud map according to an embodiment of the present application;

[0024] Fig. 5 is a schematic diagram of a perception tag point cloud according to an embodiment of the present application;

[0025] Fig. 6 is a structural diagram of a train position correcting apparatus according to an embodiment of the present application; and

[0026] Fig. 7 is a schematic diagram of an electronic device according to an embodiment of the present application.

DETAILED DESCRIPTION

[0027] The technical solutions of the embodiments of the application will be clearly and completely described below with reference to the accompanying drawings. Obviously, the described embodiments are only some embodiments of the application, not all embodiments.

Based on the embodiments of the application, all other embodiments obtained by those skilled in the art without creative effort are within the scope of protection of the application.

[0028] The terms "first," "second," etc., used in the specification and claims of the application are used to distinguish similar objects and not to describe a specific order or sequence. It should be understood that such use of data can be interchanged where appropriate so that embodiments of the application can be implemented in orders other than those illustrated or described herein, and the objects distinguished by "first," "second," etc., are generally of the same class and the number of objects is not limited; for example, a first object can be one or more. Furthermore, in the specification and claims, "and/or" indicates at least one of the connected objects, and the character "/" generally indicates that the preceding and following objects are in an "or" relationship.

[0029] The train position correcting method, apparatus, device, and medium provided in the application will be described in detail below with reference to the accompanying drawings and through specific embodiments and application scenarios.

[0030] It should be noted that the train position correcting method and apparatus provided in the application are applied to trains equipped with perception devices (including but not limited to lidar).

[0031] Fig. 1 is a schematic flowchart of the train position correcting method provided in an embodiment of the present application. The train position correcting method may include

the following steps.

[0032] Step 101 comprises identifying, by a perception device mounted on a train, the perception tags disposed on a ballast of a track along which the train travels.

[0033] In some embodiments of the present application, the perception tags are markers disposed on the ballast to be sensed by the perception device.

[0034] In some embodiments of the present application, the perception tags may be passive, that is, the perception tags are passive markers disposed on the ballast to be sensed by the perception device.

[0035] In some embodiments of the present application, the perception tags can be pre-deployed on the ballast. During train operation, the perception device detects and identifies the perception tags on the ballast. It is understood that, in embodiments of the present application, the perception tags differ from the signboards placed around the track.

[0036] As shown in Fig. 2, which is a schematic diagram of perception tags disposed on a ballast according to an embodiment of the present application. In Fig. 2, the perception tags 203 are disposed on the ballast 202 of the track 201.

[0037] In some embodiments of the present application, multiple perception tags can be combined into a perception tag combination, with different spacing between the perception tags within the same perception tag combination. When set on the ballast, the perception tags within the same perception tag combination are set according to the prescribed spacing between perception tags.

[0038] For example, as shown in Fig. 3, which is a schematic diagram of a perception tag combination provided in an embodiment of the present application. In Fig. 3, the perception tag combination includes four perception tags, the distance from the first perception tag to the second perception tag is S1, the distance from the second perception tag to the third perception tag is S2, and the distance from the third perception tag to the fourth perception tag is S3.

[0039] Step 102 comprises matching first feature information of the perception tag currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, the partial offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device when the train is at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning.

[0040] In some embodiments of the present application, after the perception tags are installed on the ballast, the train can be controlled to travel at low speed on the track. Three-dimensional spatial point cloud information during the train movement is collected in real time by the perception device. The collected three-dimensional spatial point cloud information is then used to construct an offline point cloud map according to the train trajectory. As shown in Fig. 4, which is a schematic diagram of the point cloud map provided in an embodiment of the application. The perception tag point cloud is shown in Fig. 5, which is also a schematic diagram of the perception tag point cloud provided in an embodiment of the application. Then, an offline semantic map is constructed based on the offline point cloud map and the feature information of the perception tags. The feature information includes, but is not limited to, the position of the perception tags and the distance between adjacent perception tags. In embodiments of the present application, the feature information of a perception tag combination is considered as a set of semantic information.

[0041] In some embodiments of the present application, the perceivable range is a range that the perception device can perceive, and it can also be referred to as the perception range.

[0042] After the train is initially positioned, the rotational speed of the train wheels is measured using speed sensors. Based on the rotational speed of the train wheels measured by the speed sensors and the running duration of the train, the travel distance of the train can be determined. Then, based on the initial positioning position of the train (i.e., the third position in this embodiment) and the travel distance, the position that the train should reach after the corresponding running duration (i.e., the second position in this embodiment) can be determined.

[0043] During train operation, the perception device collects point cloud information of the three-dimensional space along the train route and sends this information to the host of the active perception system on the train. The host analyzes the point cloud information and calculates the distance between two adjacent perception tags identified by the perception devices. The feature information of the currently identified perception tags is then matched the feature information of multiple sets of perception tags in a pre-constructed offline semantic map corresponding to the portion of the semantic map within the perceivable range of the perception device when the train is at its second position.

[0044] Step 103 comprises determining, in a case where only one of the perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, a first position of the train based on a position of a first perception tag

identified by the perception device, the perception tag combination comprises a plurality of perception tags, and the first perception tag is one of the perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information.

[0045] In a case where only one perception tag combination in the partial offline semantic map comprises feature information matching the first feature information, it indicates that the feature information of the currently identified perception tag is unique, and the currently identified perception tag can be used to determine the position of the train. In this case, any one of the perception tags in the combination that matches the feature information of the currently identified perception tag can be used to determine the position of the train.

[0046] In some embodiments of the present application, in step 103, a distance from the perception device to the perception tag can be obtained by the perception device, and then based on this distance, a distance from the train to the perception tag can be determined, so as to obtain the position of the train.

[0047] When feature information of at least two perception tag combinations in a partial semantic map match the feature information of the perception tag currently identified by the perception device, it indicates that the feature information of the perception tag currently identified by the perception device is not unique, and the position of the train cannot be accurately determined by using the perception tag currently identified by the perception device.

[0048] Step 104 comprises correcting the current position of the train to the first position.

[0049] In some embodiments of the present application, step 104 may include: in a case where the first position satisfies a second condition, correcting the current position of the train to the first position, wherein the second condition is a condition for controlling whether to correct the position of the train.

[0050] In some embodiments of the application, the second condition may include the difference between the position of the train determined based on the position of the perception tag and the position of the train determined based on the position obtained from the initial positioning of the train being less than or equal to the speed measurement and distance measurement positioning error corresponding to the running duration of the train after the initial positioning. Accordingly, in a case where the first position satisfies the second condition, the correcting the current position of the train to the first position may include: updating the current position of the train from the second position to the first position in a case where the difference between the first position and the second position is less than or equal to the speed measurement and distance measurement positioning error corresponding to the first time

duration.

[0051] The application does not limit the ways used to obtain the speed measurement and distance measurement positioning error corresponding to the running duration of the train after initial positioning. Any available ways can be applied to the application.

5 **[0052]** In embodiments of the application, a perception device installed on the train identifies perception tags disposed on the ballast. The first feature information of the perception tag currently identified by the perception device is matched feature information of multiple perception tag combinations in a partial offline semantic map. In a case where feature information of only one perception tag combination in the partial offline semantic map matches
10 the first feature information, the first position of the train is determined based on the position of the first perception tag identified by the perception device. The first perception tag is any one of the perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information. The current position of the train is then corrected to the first position. Because multiple perception tags are disposed on the ballast, even in the
15 case that the train is traveling in adverse environments such as heavy fog, rain, snow, or dust, the perception device can promptly detect the perception tags, quickly and accurately determine the position of the train, and then use the determined position to correct the current position of the train, thus ensuring train driving safety.

[0053] In some embodiments of the application, after the initial positioning of the train is
20 completed, the speed measurement and distance measurement positioning error will gradually increase as the train travels further. When the speed measurement and distance measurement positioning error exceeds a certain range, the active sensing system of the train determines that the positioning has been lost, and the position needs to be re-initialized and corrected during train operation. Based on this, step 101 in an embodiment of the application may include: in a
25 case where the speed measurement and distance measurement positioning error of the train exceeds a first threshold, identifying the perception tag by the perception device.

[0054] In some embodiments of the application, the first threshold can be determined by the initial ranging error, the measured distance between the perception tag combinations, the ranging error rate, and the perception tag installation error.

30 **[0055]** In some embodiments of the application, the first threshold can be determined by the following formula (1) :

$$x = e1 + d \times r + e2 \quad (1)$$

[0056] In formula (1), x is the first threshold, $e1$ is the initial ranging error, d is the measured distance between perception tag combinations, r is the ranging error rate, and $e2$ is the perception tag installation error.

[0057] In some embodiments of the application, during train operation, the attitude of the perception device may change due to train vibration or other reasons. Therefore, it is necessary to correct the attitude of the perception device. In view of this, the train position correcting method provided in the embodiments of the application may further include: determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration measured by a sensor, the first condition is a condition for controlling whether to determine the attitude of the perception device; and correcting a current attitude of the perception device to the first attitude.

[0058] The application does not elaborate on the process of determining the first attitude of the perception device based on the angular acceleration and/or linear acceleration measured by the sensor. For details, please refer to related technologies for the process of determining attitude through angular acceleration and/or linear acceleration. The attitude of the perception device in the application embodiment may include: roll angle, pitch angle, and yaw angle. The attitude of the perception device can be the attitude of the perception device relative to the geocentric coordinate system.

[0059] In some embodiments of the application, the first condition comprises a distance between a position of a perception tag combination in a pre-constructed offline point cloud map and a position of the perception tag combination in a real-time point cloud currently acquired by the perception device being less than or equal to a first distance; the determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration measured by a sensor comprises: determining, in a case where a distance between a fourth position and a fifth position is less than or equal to the first distance, the first attitude based on the angular acceleration and/or the linear acceleration, wherein the fourth position is a position of a third perception tag in the offline point cloud map, the fifth position is a position of a second perception tag in the real-time point cloud, and the second perception tag is any one of the perception tags in the first perception tag combination.

[0060] In some embodiments of the application, the point cloud data of the perception tag

in the offline point cloud map and the point cloud data of the perception tag extracted from the point cloud collected in real time by the perception device can be compared in the same three-dimensional coordinate system. The attitude of the perception device is measured by the distance between the positions of the same perception tag in the offline point cloud map and the positions in the real-time point cloud. When the distance is less than or equal to a set distance threshold (i.e., the first distance), the current attitude of the perception device is corrected to the first attitude.

[0061] In some embodiments of the application, the first condition comprises a spacing deviation between a distance between two adjacent perception tags in a pre-constructed offline point cloud map and a distance between the two adjacent perception tags in a real-time point cloud currently acquired by the perception device being within a first spacing deviation range; correspondingly, the determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration measured by a sensor comprises: determining, in a case where a spacing deviation between a first perception tag spacing and a second perception tag spacing is within the first spacing deviation range, the first attitude based on the angular acceleration and/or the linear acceleration, wherein the first perception tag spacing is a distance between a third perception tag and a fourth perception tag in the offline point cloud map, the second perception tag spacing is a distance between the third perception tag and the fourth perception tag in the real-time point cloud, and the third perception tag and the fourth perception tag are two adjacent perception tags in the first perception tag combination.

[0062] In some embodiments of the application, the point cloud data of the perception tags in the offline point cloud map and the point cloud data of the perception tags extracted from the point cloud collected in real time by the perception device can be compared in the same three-dimensional coordinate system. The attitude of the perception device is measured by the deviation of the distance between two adjacent perception tags in the same perception tag combination in the offline point cloud map and the real-time point cloud, respectively. When the deviation value is within the set distance deviation range (i.e., the first distance deviation range), the current attitude of the perception device is corrected to the first attitude.

[0063] In some embodiments of the application, the train position correcting method provided in the embodiments of the application further includes: outputting an alarm message in a case where the perception tags in the first perception tag combination do not satisfy the first condition, wherein the alarm message is for instructing a train control system of the train

to guide it to a safe side for protection.

[0064] In some embodiments of the application, in a case where the distance between the fourth position and the fifth position is greater than a set distance threshold (i.e., the first distance) or the distance deviation between the first perception tag spacing and the second perception tag spacing is not within the first distance deviation range, it indicates that the posture of the perception device has changed significantly. At this time, an alarm message is output to instruct the train control system to guide the safety side for protection.

[0065] In some embodiments of the application, two perception devices can be installed at each end of the train. After receiving data sent by the two perception devices, the host of the perception sensing system on the train performs a binary-selection-two-output process on the data to ensure data reliability. This binary-selection-two-output process enables the Communication-Based Train Control (CBTC) system of the train to reach the highest Safety Integrity Level (SIL).

[0066] In some embodiments of the application, the perception tag can be a high-reflectivity rail spike. Because high-reflectivity rail spikes have a high reflectivity, they are easily detected by the sensing equipment on the train and are not affected by adverse environments such as heavy fog, rain, snow, and dust. The position of the train can be determined in a timely and accurate manner by high-reflectivity rail spikes, ensuring the safety of train driving.

[0067] The application further provides a train position correcting device. As shown in Fig. 6, which is a structural schematic diagram of the train position correcting device provided in an embodiment of the application. The train position correcting device 600 may include:

[0068] an identifying module 601, configured to identify, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels;

[0069] a matching module 602, configured to match first feature information of one of the perception tags currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, the partial offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device when the train is at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning;

[0070] a first determining module 603, configured to, in a case where only one of the

perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, determine a first position of the train based on a position of a first perception tag identified by the perception device, the perception tag combination comprises a plurality of the perception tags, and the first perception tag is any one of the perception tags in the first perception tag combination in the partial offline semantic map that matches with the first feature information; and

[0071] a correcting module, configured to correct a current position of the train to the first position.

[0072] In this embodiment, the perception device installed on the train identifies the perception tag disposed on the ballast. The first feature information of the perception tag currently identified by the perception device is matched feature information of multiple perception tag combinations in a partial offline semantic map. In a case where only one perception tag combination in the partial offline semantic map matches the first feature information, the first position of the train is determined based on the position of the first perception tag identified by the perception device. The first perception tag is any one of the perception tags in the first perception tag combination in the partial offline semantic map that matches the first feature information. The current position of the train is then corrected to the first position. Because multiple perception tags are disposed on the ballast, even when the train is traveling in adverse environments such as heavy fog, rain, snow, or dust, the perception device can promptly detect the perception tags, quickly and accurately determine the position of the train, and then use the determined position to correct the current position of the train, thus ensuring train driving safety.

[0073] In some embodiments of the application, the train position correcting device 600 provided in the embodiments of the application may further include:

[0074] a second determining module, configured to determine the first attitude of the perception device based on the angular acceleration and/or linear acceleration of the perception device measured by the sensor in a case where the perception tag in the first perception tag combination satisfies the first condition, the first condition is a condition for controlling whether to determine the attitude of the perception device; and

[0075] a second correcting module, configured to correct the current attitude of the perception device to the first attitude.

[0076] In some embodiments of the application, the first condition may include that the distance between the position of the perception tag in the perception tag combination in the

pre-constructed offline point cloud map and its position in the real-time point cloud currently collected by the perception device is less than or equal to a first distance; correspondingly, the second determining module is specifically configured to:

[0077] in a case where the distance between the fourth and fifth positions is less than or equal to the first distance, determine the first attitude based on the angular acceleration and/or linear acceleration; the fourth position is the position of the third perception tag in the pre-constructed offline point cloud map, the fifth position is the position of the second perception tag in the real-time point cloud currently collected by the perception device, and the second perception tag is any one of the first perception tag combination.

[0078] In some embodiments of the application, the first condition may include a spacing deviation between a distance between two adjacent perception tags in a pre-constructed offline point cloud map and a distance between the two adjacent perception tags in a real-time point cloud currently acquired by the perception device being within a first spacing deviation range; correspondingly, the second determining module is specifically configured to: determine, in a case where a spacing deviation between a first perception tag spacing and a second perception tag spacing is within the first spacing deviation range, the first attitude based on the angular acceleration and/or the linear acceleration; the first perception tag spacing is a distance between a third perception tag and a fourth perception tag in the offline point cloud map, the second perception tag spacing is a distance between the third perception tag and the fourth perception tag in the real-time point cloud, and the third perception tag and the fourth perception tag are two adjacent perception tags in the first perception tag combination.

[0079] In some embodiments of the application, the train position correcting device 600 provided in the embodiments of the application may further include:

[0080] an output module, configured to output an alarm message in a case where the first condition is not satisfied, the alarm message is for instructing a train control system of the train to guide it to a safe side for protection.

[0081] In some embodiments of the application, the first correction module 604 is specifically configured to:

[0082] in a case where the first position satisfies the second condition, correct the current position of the train to the first position, where the second condition is a condition for controlling whether to correct the position of the train.

[0083] In some embodiments of the application, the second condition may include the difference between the position of the train determined based on the positions of the perception

tags and the position of the train determined based on the position obtained from the initial positioning of the train being less than or equal to the speed measurement and distance measurement positioning error corresponding to the running duration of the train after the initial positioning. Accordingly, the first correction module 604 is specifically configured to:

5 **[0084]** in a case where the difference between the first position and the second position is less than or equal to the speed measurement and distance measurement positioning error corresponding to the first time duration, update the current position of the train from the second position to the first position.

10 **[0085]** In some embodiments of the application, the identifying module 601 is specifically configured to:

[0086] in a case where the speed measurement and distance measurement positioning error of the train exceeds the first threshold, identify the perception tag by the perception device.

[0087] In some embodiments of the application, the spacing between the perception tags in the perception tag combination is different.

15 **[0088]** Fig. 7 is a schematic structural diagram of an electronic device provided in an embodiment of the application.

[0089] The electronic device may include a processor 701 and a memory 702 storing computer program instructions.

20 **[0090]** Specifically, the processor 701 may include a central processing unit (CPU), an application-specific integrated circuit (ASIC), or one or more integrated circuits that can be configured to implement the embodiments of the application.

25 **[0091]** The memory 702 may include mass storage for data or instructions. For example, with no limitations, the memory 702 may include a hard disk drive (HDD), floppy disk drive, flash memory, optical disk, magneto-optical disk, magnetic tape, or Universal Serial Bus (USB) drive, or a combination of two or more thereof. Where appropriate, the memory 702 may include removable or non-removable (or fixed) media. Where appropriate, the memory 702 may be internal or external to an electronic device. In some specific embodiments, the memory 702 is a non-volatile solid-state memory.

30 **[0092]** In some specific embodiments, the memory may include read-only memory (ROM), random access memory (RAM), disk storage media devices, optical storage media devices, flash memory devices, and electrical, optical, or other physical/tangible memory storage devices. Therefore, typically, 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 processors), it is operable to perform the operations described with reference to the train position correcting method according to the application.

[0093] The processor 701 reads and executes computer program instructions stored in the memory 702 to implement the train position correcting method provided in the embodiments of the application.

[0094] In one example, the electronic device may further include a communication interface 703 and a bus 710. As shown in Fig. 7, the processor 701, the memory 702, and the communication interface 703 are connected and communicate with each other via the bus 710.

[0095] The communication interface 703 is mainly used to realize communication between various modules, devices, units, and/or equipment in the embodiments of the application.

[0096] The bus 710 includes hardware, software, or both, and couples components of the electronic device together. For example, with no limiting, the bus may 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) bus, or other suitable buses, or a combination of two or more thereof. Where appropriate, the bus 710 may include one or more buses. Although specific buses are described and illustrated in the embodiments of the application, the application considers any suitable bus or interconnection.

[0097] The electronic device can execute the train position correcting method provided in the embodiments of the application, thereby achieving the corresponding technical effects of the train position correcting method provided in the embodiments of the application.

[0098] In addition, in conjunction with the train position correcting method in the above embodiments, the application further provides a computer-readable storage medium for implementation. The computer-readable storage medium stores computer program instructions; when the computer program instructions are executed by a processor, the train position correcting method provided in the application is implemented. Examples of the computer-readable storage media include non-transitory computer-readable media, such as ROM, RAM, magnetic disks, or optical disks.

[0099] The application further provides a computer program product storing instructions

therein, the instructions, when executed by a processor of an electronic device, implement the train position correcting method provided in the application and achieve the same technical effect. To avoid repetition, it will not be described again here.

[00100] It should be clarified that the application is not limited to the specific configurations and processes described above and shown in the figures. For the sake of brevity, detailed descriptions of known methods are omitted here. In the above embodiments, several specific steps are described and shown as examples. However, the method process of the application is not limited to the specific steps described and shown. Those skilled in the art can make various changes, modifications, and additions, or change the order of steps, after understanding the spirit of the application.

[00101] The functional blocks shown in the above-described block diagram can be implemented as hardware, software, firmware, or a combination thereof. When implemented in hardware, they can be, for example, electronic circuits, application-specific integrated circuits (ASICs), appropriate firmware, plug-ins, function cards, etc. When implemented in software, the elements of the application are programs or code segments used to perform the required tasks. Programs or code segments can be stored on a machine-readable medium or transmitted over a transmission medium or communication link via data signals carried on a carrier wave. Machine-readable medium may include any medium capable of storing or transmitting information. Examples of machine-readable media include electronic circuits, semiconductor memory devices, ROM, 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, etc. Code segments can be downloaded via computer networks such as the Internet, intranets, etc.

[00102] It should also be noted that the exemplary embodiments mentioned in the application describe methods or systems based on a series of steps or apparatus. However, the application is not limited to the order of the above steps; that is, the steps can be performed in the order mentioned in the embodiments, or in a different order, or several steps can be performed simultaneously.

[00103] It should also be noted that, herein, the terms "comprise", "include" or any other variations thereof are intended to cover non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements includes not only those elements but also other elements not expressly listed, or elements inherent to such a process, method, article, or apparatus. Without further limitations, an element defined by the phrase "comprising one..."

does not exclude the presence of other identical elements in the process, method, article, or apparatus that includes that element. Furthermore, it should be noted that the scope of the methods and apparatuses in the embodiments of the application is not limited to performing functions in the order shown or discussed, but may also include performing functions substantially simultaneously or in the reverse order, depending on the functions involved. For example, the described methods may be performed in a different order than described, and various steps may be added, omitted, or combined. Additionally, features described with reference to certain examples may be combined in other examples.

[00104] Through the above description of the embodiments, those skilled in the art can clearly understand that the methods of the above embodiments can be implemented by means of software plus necessary general-purpose hardware platforms. Of course, they can also be implemented by hardware, but in many cases, the former is a better implementation method. Based on this understanding, the technical solution of the application, in essence, or the part that contributes to the prior art, can be embodied in the form of a computer software product. This computer software product is stored in a storage medium (such as ROM/RAM, magnetic disk, optical disk) and includes several instructions to cause a terminal (which may be a computer, server, or network device, etc.) to execute the methods described in the various embodiments of the application.

[00105] The embodiments of the application have been described above with reference to the accompanying drawings. However, the application is not limited to the specific embodiments described above. The specific embodiments described above are merely illustrative and not restrictive. Those skilled in the art can make many other forms under the guidance of the application without departing from the spirit and scope of the claims, and all of these forms are within the protection scope of the application.

What is claimed is:

1. A train position correcting method, comprising:

identifying, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels;

5 matching first feature information of one of the perception tags currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, wherein

the partial offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device when the train is
10 at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning;

determining, in a case where only one of the perception tag combinations in the partial
15 offline semantic map comprises feature information matching the first feature information, a first position of the train based on a position of a first perception tag identified by the perception device, wherein

each of the perception tag combinations comprises a plurality of the perception tags, and the first perception tag is one of the perception tags in a first perception tag
20 combination in the partial offline semantic map that matches the first feature information; and

correcting a current position of the train to the first position.

2. The method according to claim 1, further comprising:

25 determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration of the perception device measured by a sensor, wherein the first condition is a condition for controlling whether to determine the attitude of the perception device; and

30 correcting a current attitude of the perception device to the first attitude.

3. The method according to claim 2, wherein the first condition comprises a distance between a position of at least one of the perception tags in the first perception tag combination

in a pre-constructed offline point cloud map and a position of the at least one perception tag in a real-time point cloud currently acquired by the perception device being less than or equal to a first distance;

the determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration of the perception device measured by a sensor comprises:

determining, in a case where a distance between a fourth position and a fifth position is less than or equal to the first distance, the first attitude based on the angular acceleration and/or the linear acceleration, wherein

the fourth position is a position of a third perception tag in the offline point cloud map, the fifth position is a position of a second perception tag in the real-time point cloud, and the second perception tag is any one of the perception tags in the first perception tag combination.

4. The method according to claim 2, wherein the first condition comprises a spacing deviation between a distance between adjacent two of the perception tags in a pre-constructed offline point cloud map and a distance between the two adjacent perception tags in a real-time point cloud currently acquired by the perception device being within a first spacing deviation range;

the determining, in a case where the perception tags in the first perception tag combination satisfy a first condition, a first attitude of the perception device based on angular acceleration and/or linear acceleration of the perception device measured by a sensor comprises:

determining, in a case where a spacing deviation between a first perception tag spacing and a second perception tag spacing is within the first spacing deviation range, the first attitude based on the angular acceleration and/or the linear acceleration, wherein

the first perception tag spacing is a distance between a third perception tag and a fourth perception tag in the offline point cloud map, the second perception tag spacing is a distance between the third perception tag and the fourth perception tag in the real-time point cloud, and the third perception tag and the fourth perception tag are adjacent two of the perception tags in the first perception tag combination.

5. The method according to claim 2, further comprising:

outputting an alarm message in a case where the perception tags in the first perception tag combination do not satisfy the first condition, wherein the alarm message is for instructing a train control system of the train to guide the train to a safe side for protection.

5 6. The method according to claim 1, wherein the correcting a current position of the train to the first position comprises:

 correcting a current position of the train to the first position in a case where the first position satisfies a second condition, wherein the second condition is a condition for controlling whether to correct a position of the train.

10 7. The method according to claim 6, wherein the second condition comprises a position difference between a position of the train determined based on positions of the perception tags and a position of the train determined based on the third position being less than or equal to a speed measurement and distance measurement positioning error corresponding to the first
15 duration after the initial positioning of the train;

 the correcting a current position of the train to the first position in a case where the first position satisfies the second condition comprises:

 updating, in a case where a position difference between the first position and the second position is less than or equal to the speed measurement and distance measurement positioning
20 error corresponding to the first duration, the current position of the train from the second position to the first position.

 8. The method according to claim 1, wherein the identifying, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels
25 comprises:

 identifying, by the perception device, the perception tags in a case where a speed measurement and distance measurement positioning error of the train is greater than a first threshold.

30 9. The method according to claim 1, wherein distances between the perception tags in each of the perception tag combinations are different.

 10. A train position correcting apparatus, comprising:

an identifying module, configured to identify, by a perception device mounted on a train, perception tags disposed on a ballast of a track along which the train travels;

a matching module, configured to match first feature information of one of the perception tags currently identified by the perception device with feature information of a plurality of perception tag combinations in a partial offline semantic map, wherein

the partial offline semantic map is a portion of a pre-constructed offline semantic map corresponding to a perceivable range of the perception device when the train is at a second position, the second position is a position calculated based on a third position and a first duration, the third position is a position obtained by performing an initial positioning of the train, and the first duration is a running duration of the train after the initial positioning;

a first determining module, configured to, in a case where only one of the perception tag combinations in the partial offline semantic map comprises feature information matching the first feature information, determine a first position of the train based on a position of a first perception tag identified by the perception device, wherein

each of the perception tag combinations comprises a plurality of the perception tags, and the first perception tag is any one of the perception tags in a first perception tag combination in the partial offline semantic map that matches the first feature information; and

a correcting module, configured to correct a current position of the train to the first position.

11. An electronic device, comprising: a processor and a memory, the memory storing a program or instructions executable by the processor, wherein the program or instructions, when executed by the processor, implement the steps of the train position correcting method according to any one of claims 1-9.

12. A readable storage medium, storing a program or instructions therein, wherein the program or instructions, when executed by a processor, implement the steps of the train position correcting method according to any one of claims 1-9.