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(54) TRAIN WHEELBASE DETECTION METHOD AND SYSTEM

(57) The present disclosure relates to a method and a system for measuring train wheelbase. The method includes: judging whether train wheels are passing by at least two non-contact sensors at present according to sensing data from the at least two non-contact sensors arranged on an outer side of a train track and arranged at intervals along the train track; in response to determination that train wheels are passing by the at least two non-contact sensors at present, calculating a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors, and calculating a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors; and calculating a wheelbase of the adjacent train wheels based on the moving speed and the first time interval. By adoption of the embodiment of the present disclosure, the adaptability of train wheelbase measurement can be improved.

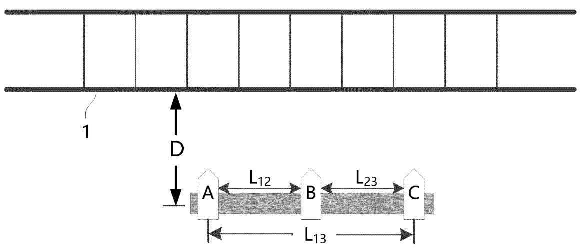

Fig.3

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Description

Cross Reference of Related Applications

[0001] The present application is based on the application of the CN application number 201810756122.1, filed on July 11, 2018, and claims the priority thereof, and the disclosure of the CN application is entirely incorporated herein.

Field of the Invention

[0002] The present disclosure relates to a method and a system for measuring train wheelbase.

Background of the Invention

[0003] In the data measurement related art of the railway field, a wheelbase of a train of a certain railway section can be measured, and the information of the train can be obtained by analysis according to the measurement data to provide necessary railway data information for the railway department.

[0004] In the related art, a method for measuring the wheelbase of the train includes: manually measuring the distance between two groups of wheels of the train through some customized measuring tools. The measurement manner is mainly suitable for trains in static states. Another method for measuring the wheelbase of the train includes: a sensor-based method for measuring the wheelbase of the moving train. In the method, a sensor mounted on a rail is used for measuring a signal when the wheels pass by, and then the wheelbase is calculated.

Summary of the Invention

[0005] The inventors have found through researches that it is difficult to apply the manual measurement method in the related art to the measurement of a wheelbase of a moving train, and the sensor-based measurement method requires the installation of a sensor on a rail, the measurement result is easily affected by the distance between the wheel and the sensor, the train speed and other factors, and certain adaptive problems also exist.

[0006] In view of this, the embodiment of the present disclosure provides a method and a system for measuring train wheelbase, which can improve the adaptability of train wheelbase measurement.

[0007] In one aspect of the present disclosure, a method for measuring train wheelbase is provided, including:

judging whether train wheels are passing by at least two non-contact sensors at present according to sensing data from the at least two non-contact sensors arranged on an outer side of a train track and arranged at intervals along the train track;
in response to determination that the train wheels are passing by the at least two non-contact sensors at present, calculating a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors, and calculating a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors; and
calculating a wheelbase of the adjacent train wheels based on the moving speed and the first time interval.

[0008] In some embodiments, judging step includes:

comparing distance values of the train wheels respectively sensed by each of the at least two non-contact sensors at present with a preset distance threshold range respectively; and
when the distance values are all within the distance threshold range, determining that train wheels are passing by the at least two non-contact sensors at present.

[0009] In some embodiments, the step of calculating the moving speed includes:

calculating a second time interval of the train wheels passing by the non-contact sensors according to moments when the train wheels respectively pass by each non-contact sensor of the at least two non-contact sensors; and
determining the moving speed of the train wheels according to the second time interval and a setting distance between the non-contact sensors.

[0010] In some embodiments, the step of determining the moving speed includes:

calculating a plurality of reference moving speeds according to the second time interval of the train wheels passing by any two non-contact sensors;
performing arithmetic averaging on the plurality of reference moving speeds to obtain an arithmetic average value of the reference moving speeds; and
using the arithmetic average value of the reference moving speeds as the moving speed of the train wheels.

[0011] In some embodiments, the step of calculating the first time interval includes:
determining the first time interval according to the moments when the adjacent train wheels respectively pass by a same non-contact sensor of the at least two non-contact sensors.

[0012] In some embodiments, the step of determining the first time interval includes:

performing arithmetic averaging on reference time intervals of the adjacent train wheels passing by each non-contact sensor to obtain an arithmetic average value of the reference time intervals; and using the arithmetic average value of the reference time intervals as the first time interval.

[0013] In some embodiments, the non-contact sensors include a photoelectric sensor.
[0014] In some embodiments, the photoelectric sensor includes a laser ranging sensor.
[0015] In some embodiments, the at least two non-contact sensors are located on a same side of the train track.
[0016] In another aspect of the present disclosure, a system for measuring train wheelbase is provided, including:

at least two non-contact sensors, arranged on an outer side of a train track, arranged at intervals along the train track and configured to sense train wheels running on the train track;
a judging unit, configured to judge whether train wheels are passing by the at least two non-contact sensors at present according to sensing data from the at least two non-contact sensors;
a first calculation unit configured to calculate a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors when the judging unit determines that train wheels are passing by the at least two non-contact sensors at present; and
a second calculation unit configured to calculate a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors and calculate a wheelbase of the adjacent train wheels based on the moving speed and the first time interval.

[0017] In some embodiments, the at least two non-contact sensors are located on a same side of the train track.
[0018] In some embodiments, the non-contact sensors include a photoelectric sensor.
[0019] In some embodiments, the photoelectric sensor includes a laser ranging sensor, and an intersection of a laser ray path of the laser ranging sensor and a vertical plane where the train track is located is within a range from an upper surface of the train track to a height of the train wheels.
[0020] In some embodiments, the laser ray path is perpendicular to the train track.
[0021] In some embodiments, the system further includes:

a mounting base arranged on the outer side of the train track at a preset distance;
wherein the at least two non-contact sensors are arranged on the mounting bases at intervals along an extension direction of the train track.

[0022] In some embodiments, a connect line of two non-contact sensors of the at least two non-contact sensors is parallel to the train track.
[0023] In some embodiments, connect lines of each other among the at least two non-contact sensors are collinear and are parallel to the train track.
[0024] In some embodiments, the at least two non-contact sensors are disposed at a same distance from the train track, or at different distances from the train track and respectively correspond to different distance threshold ranges.
[0025] In some embodiments, the at least two non-contact sensors are arranged on a same outer side of at least two train tracks, and distance values of the train wheels running on the at least two train tracks sensed by the at least two non-contact sensors respectively correspond to different distance threshold ranges.
[0026] In another aspect of the present disclosure, a system for measuring train wheelbase is provided, including:

a memory; and
a processor coupled to the memory, wherein the processor is configured to execute the aforementioned method for measuring train wheelbase based on instructions stored in the memory.

[0027] In another aspect of the present disclosure, a computer readable storage medium is provided, a computer program is stored thereon, and the program, when executed by a processor, implements the aforementioned method for measuring train wheelbase.
[0028] Therefore, according to the embodiment of the present disclosure, the train wheels are sensed by the non-contact sensors that are arranged on an outer side of a train track and arranged at intervals along the train track, the moving speed is calculated according to the sensing data, then the time interval of the adjacent train wheels passing by the non-contact sensors is calculated, and the wheelbase of the train wheels is further calculated according to the moving speed and the time interval. The wheelbase measuring manner can not only realize the wheelbase measurement of the moving train, but also can reduce the influence of other factors, thus improving the adaptability of the train wheelbase measurement.

Brief Description of the Drawings

[0029] The drawings constituting a part of the specification describe the embodiments of the present disclosure and are used for explaining the principles of the present disclosure together with the specification.
[0030] The present disclosure can be more clearly understood from the following detailed description with reference to the drawings, in which:

Fig.1 is a schematic block diagram of some embodiments according to the system for measuring train wheelbase of the present disclosure;
Fig.2 is a schematic diagram of a measuring scenar-

io of some embodiments according to the system for measuring train wheelbase of the present disclosure;

Fig.3 is a schematic setting diagram of a laser ranging sensor in the embodiment in Fig.2;

Fig.4 is a schematic diagram of judging wheels passing of in the embodiment in Fig.2;

Fig.5 is a schematic flow diagram of some embodiments according to the method for measuring train wheelbase of the present disclosure;

Fig.6 is a schematic block diagram of some other embodiments according to the system for measuring train wheelbase of the present disclosure.

[0031] It should be understood that the dimensions of various parts shown in the drawings are actually scaled. Further, the same or similar reference signs denote the same or similar members.

Detailed Description of the Embodiments

[0032] Various exemplary embodiments of the present disclosure will now be described in detail with reference to the drawings. The description of the exemplary embodiments is merely illustrative, and is in no way intended to limit the present disclosure and the application or use thereof. The present disclosure can be implemented in many different forms and is not limited to the embodiments described herein. These embodiments are provided to make the present disclosure be thorough and complete and to fully express the scope of the present disclosure to those skilled in the art. It should be noted that, unless otherwise specified, the relative arrangements, numerical expressions and numerical values of components and steps set forth in the embodiments should be construed as merely illustrative and are not used as limitations.

[0033] The words "first," "second," and similar terms used in the present disclosure do not denote any order, quantity, or importance, but are used for distinguishing different parts. The word "including" or "comprising" and other similar terms mean that elements preceding the word include the elements listed after the word, and do not exclude the possibility of including other elements. "Upper", "lower", "left", "right" and the like are only used for indicating relative position relationships, and when an absolute position of a described object is changed, the relative position relationship may also be changed accordingly.

[0034] In the present disclosure, when it is described that a particular device is located between a first device and a second device, an intermediate device may be or not be between the particular device and the first device or the second device. When it is described that a particular device is connected to other devices, the particular device can be directly connected to the other devices without the intermediate devices, or can be not directly connected to the other devices but have the intermediate devices.

[0035] All terms (including technical terms or scientific terms) used in the present disclosure have the same meanings as understood by those of ordinary skill in the art to which the present disclosure belongs, unless specifically defined otherwise. It should also be understood that the terms defined in, for example, a general dictionary, should be interpreted as having meanings consistent with their meanings in the context of the related art, and should not be interpreted by idealized or extremely formal meanings, unless explicitly stated herein.

[0036] Techniques, methods and devices known to those of ordinary skill in the related art may not be discussed in detail, but the techniques, methods and devices should be considered as a part of the specification where appropriate.

[0037] In some related arts, sensors installed on rails are used for measuring signals when wheels pass by, and then a wheelbase is calculated. However, due to the wear of the train wheels themselves or errors during the manufacturing, the vertical distances between the train wheels and the sensors on the rails may not be consistent, so that the signals received by the sensors are also different, which in turn affects the measurement result of the train wheelbase. On the other hand, when the moving speed of a train is relatively low, the signals received by the sensors are weak and are difficult to detect, so it is not suitable for the wheelbase measurement of low-speed trains.

[0038] In view of this, the embodiments of the present disclosure provide a method and a system for measuring train wheelbase, which can improve the adaptability of train wheelbase measurement.

[0039] Fig.1 is a schematic block diagram of some embodiments according to the system for measuring train wheelbase of the present disclosure. Referring to Fig.1, in some embodiments, the system for measuring train wheelbase includes at least two non-contact sensors A, B, C, a judging unit 30, a first calculation unit 40, and a second calculation unit 50. The at least two non-contact sensors A, B, C are arranged on an outer side of a train track, arranged at intervals along the train track and configured to sense train wheels running on the train track. In the present embodiment, by using the at least two non-contact sensors, the judgment of the wheels passing by and the calculation of a time interval of the wheels passing and the like can be performed according to signals respectively sensed by the non-contact sensors. The non-contact sensor can sense a measured object without touching the measured object, for example, achieve the measurement of specific parameters of the measured object based on the principles of light, sound, magnetism or rays and the like. Since the train wheels running on the train track are sensed by using the non-contact sensors, when the train in a movement state is detected, the adverse effects of factors such as wheel wear or manufacturing errors to the measurement result in the related art can be reduced; and furthermore, the wheelbase measuring of the low-speed trains can also be realized, so that the adaptability to the measurement scenarios is better.

[0040] In some embodiments, the at least two non-contact sensors are located on a same side of the train track, correspondingly, the at least two non-contact sensors can sense the train wheels on one side of the train adjacent to the non-contact sensors, thereby facilitating the arrangement of the sensors and unifying the distance sensing reference. In other embodiments, the at least two non-contact sensors can also be located on both sides (excluding the inner side of the train track, i.e., between the double tracks of the train track) of the train track. The non-contact sensors on the both sides can respectively use the train wheels at both ends of the same axle as the sensing reference.

[0041] In some embodiments, a photoelectric element can be used as the sensor of a detection element, that is, the non-contact sensors include a photoelectric sensor, which converts a sensed optical signal into an electrical signal for output by means of the photoelectric element. Further, the photoelectric sensor can include a laser ranging sensor capable of realizing a ranging function, and the laser ranging sensor can be only arranged on one side of the train track as needed. The laser ranging sensor can achieve long-distance measurement based on the characteristics of concentrated light, and can also eliminate the adverse effects of the external light environment on the measurement result. In some other embodiments, the photoelectric sensor can also include a photoelectric correlated cell or the like.

[0042] In three or more non-contact sensors, a part of the non-contact sensors can be set as redundant non-contact sensors, which can be switched with the defective non-contact sensors in the case of a fault to ensure the continuity of the detection.

[0043] In this embodiment, the judging unit 30 is configured to judge whether train wheels are passing by the at least two non-contact sensors according to sensing data from the at least two non-contact sensors. Whether the train wheels are passing by at present is determined based on the sensing data at present of the at least two non-contact sensors, therefore detection errors caused by some special situations can be avoided. For example, when other objects enter the sensing range of a certain non-contact sensor for a short time or a certain non-contact sensor has an error or a fault, the sensing data from a plurality of non-contact sensors usually are different from the regularity of the train wheels passing by the non-contact sensors in sequence, so that the situation there is no train wheel passing by can be effectively eliminated.

[0044] For the non-contact sensor capable of ranging, the judging unit 30 can compare distance values of the train wheels currently sensed by the at least two non-contact sensors with a preset distance threshold range during judging. When the distance values sensed respectively by all of the non-contact sensors are within the distance threshold range, it can be determined that the train wheels are passing by the at least two non-contact sensors at present. The distance threshold range herein can be predetermined according to the actual distances between the non-contact sensors and the train wheels entering the sensing range of the non-contact sensors.

[0045] In some embodiments, for the convenience of calculation, the at least two non-contact sensors can be made to disposed at a same distance from the train track, so that the distances between the non-contact sensors and the train wheels are also the same, and accordingly a unified distance threshold range is just set. In some other embodiments, some or all of the at least two non-contact sensors can have different distances with the train track, and it can be correspondingly set that the non-contact sensors with different distances correspond to different distance threshold ranges.

[0046] In addition, the at least two non-contact sensors are not merely limited to the detection of the train wheels passing by a single train track (including two rails), but also are applicable to the detection of the train wheels passing by a plurality of train tracks. When a train passes by a certain train track among a plurality of parallel train tracks, the train wheels running on the train track can be sensed by at least two non-contact sensors. Correspondingly, for the train wheels running on different train tracks, the distance values sensed by the non-contact sensors correspond to different distance threshold ranges. For example, for the train track on one side adjacent to the non-contact sensor, any distance threshold in the corresponding distance threshold range is relatively small, and any distance threshold in the distance range corresponding to the train track on one side away from the non-contact sensor side is relatively large.

[0047] When the judging unit 30 determines that train wheels are passing by the at least two non-contact sensors at present, the first calculation unit 40 is configured to calculate a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors. Specifically, the first calculation unit can firstly calculate a second time interval of the train wheels passing by the non-contact sensors according to the moments when the train wheels respectively pass by each non-contact sensor of the at least two non-contact sensors.

[0048] For example, if the moments when a certain wheel respectively passes by three non-contact sensors can be determined as T_1, T_2, and T_3 according to the sensing data from the non-contact sensors, the time interval T_{12} of the train wheel passing by the preceding two non-contact sensors can be further calculated by the formula: $T_{12}=T_2-T_1$, and the time interval T_{23} of passing by the latter two non-contact sensors can be calculated by the formula: $T_{23}=T_3-T_2$. The time interval T_{13} of the train wheel passing by the first non-contact sensor and the last non-contact sensor can also be calculated as needed by the formula: $T_{13}=T_3-T_1$.

[0049] Since the setting distance between the sensors has been determined when the non-contact sensors are set, then the first calculation unit 40 can calculate the moving speed of the train wheels according to the calculated second time interval and the setting distance among the non-contact sensors.

[0050] When the moving speed of the train wheels is calculated, the second time interval T_{mn} of the train wheels passing by certain two non-contact sensors m, n and the corresponding setting distance L_{mn} can be selected for calculated. Assuming that a connect line of the two non-contact sensors is parallel to the train track, then the moving speed of the train wheels v can be calculated by the formula: $v=L_{mn}/T_{mn}$.

[0051] In order to increase the reliability of the calculation of the moving speed, the step of calculating the moving speed can further include: performing arithmetic averaging on reference moving speeds calculated according to the second time interval of the train wheels passing by each two non-contact sensors, and using a calculated arithmetic average value of the reference moving speeds as the moving speed of the train wheels. For example, the second time intervals of a certain train wheel respectively passing by each two non-contact sensors in three non-contact sensors are respectively determined as T_{12}, T_{23} and T_{13}, and the setting distances of the corresponding non-contact sensors are respectively L_{12}, L_{23} and L_{13}. When the moving speed is determined, three reference moving speeds can be calculated, namely v_{12}, v_{23} and v_{13}. Then, the arithmetic average value of the reference moving speeds is calculated and is provided for the second calculation unit 50 to serve as the moving speed v when the wheelbase is calculated by the formula, that is, $v=(v_{12}+v_{23}+v_{13})/3$.

[0052] The second calculation unit 50 is configured to calculate a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors and calculate a wheelbase of the adjacent train wheels based on the moving speed and the first time interval. When the first time interval is calculated, two corresponding moments T_a and T_b when two adjacent train wheels pass by a certain non-contact sensor can be selected. Based on the two moments T_a and T_b, the time interval T_{ab} of the two adjacent train wheels passing by the non-contact sensor can be calculated by the formula: $T_{ab}=T_b-T_a$. The second calculation unit 50 can figure out the wheelbase $W=v*T_{ab}$ of the adjacent two train wheels by the formula: $W=v*T_{ab}$ based on the calculated time interval T_{ab} and the moving speed v determined by the first calculation module 40.

[0053] In order to increase the reliability of the wheelbase calculation, the step of calculating the first time interval can further include: performing arithmetic averaging on the reference time intervals of the adjacent train wheels passing by each non-contact sensor, and using the calculated arithmetic average value of the reference time intervals as the first time interval. For example, the moments when the first train wheel in the two adjacent train wheels passes by the three non-contact sensors A, B, and C are determined as T_{Aa}, T_{Ba}, and T_{Ca}, and the moments when the second train wheel passes by the three non-contact sensors A, B, and C are determined as T_{Ab}, T_{Bb}, and T_{Cb}, respectively. Further, the reference time intervals of the two adjacent train wheels passing by each of the non-contact sensors A, B, and C can be respectively calculated as T_A, T_B, and T_C. Then, the arithmetic average value T of the reference time intervals is calculated by the formula: $T=(T_A+T_B+T_C)/3$ and is used as the first time interval when the wheelbase is calculated.

[0054] Fig.2 is a schematic diagram of a measurement scenario of some embodiments according to the system for measuring train wheelbase of the present disclosure. Fig.3 is a schematic setting diagram of a laser ranging sensor in the embodiment in Fig.2. Fig.4 is a schematic diagram of judging wheels passing of in the embodiment in Fig.2. Referring to Fig.2 to Fig.4, in some embodiments, a plurality of non-contact sensors A, B, C are arranged on the outer side of the train track 1 at intervals along the train track 1 and keep a preset distance with the train track 1. The plurality of non-contact sensors A, B, and C are located on the same side of the train track 1. The non-contact sensor is a laser ranging sensor. The non-contact sensor can emit laser pulses by aligning a laser diode with a specific target, the laser is reflected by the target and scattered in various directions, and a part of the scattered laser is received by a receiver of the laser ranging sensor. The distances D_A, D_B, and D_C from the target to the laser ranging sensor can be calculated based on the laser emission time and the laser reception time. When applied to the present embodiment, the laser ranging sensor can determine whether the distances of train wheels entering the sensing range is within a preset threshold range $[D_{min}, D_{max}]$ so as to determine whether the train wheels are passing by the laser ranging sensor.

[0055] When a plurality of laser ranging sensors are provided, the laser emitting ends of the laser ranging sensors can be respectively directed to the train track. In order to effectively realize the detection of the train wheels, the intersection of a transmitting laser ray path 4 of the laser ranging sensor and a vertical plane where the train track 1 is located (i.e., the plane where one track in the train track 1, for example, the track adjacent to the one side of the laser ranging sensor, is located and is vertical to the horizontal plane) is located within a range from an upper surface of the train track 1 to the height of the train wheel 3. In other words, the train wheel 3 can sequentially pass by the sensing ranges of the laser ranging sensors when passing by the section where the laser ranging sensors are arranged.

[0056] Each axle of the train is usually provided with at least two train wheels. When the two coaxial train wheels are sensed by the laser ranging sensor at different moments, the difficulty of detection and calculation may be increased, so in some embodiments, the laser ray path emitted by the laser ranging sensor can be made to be perpendicular to the train track, in this way, the laser ranging sensor only detects the train wheels on one side of the adjacent laser ranging sensor. Of course, in some other embodiments, the laser ray path emitted by the laser ranging sensor can also be not perpendicular to the train track based on other factors.

[0057] Referring to Fig.2 and Fig.3, in some embodiments, the system for measuring train wheelbase can also include a mounting base 2. The mounting base 2 is arranged on the outer side of the train track at a preset distance, that is, arranged at positions of on the outer side of the train track 1 at a preset distance D. At least two non-contact sensors can be arranged on the mounting bases 2 at intervals along the extension direction of the train track 1. For example, the non-contact sensors A, B, and C in Fig.3 are arranged on the mounting base 2 at intervals from left to right. The distances between the installed non-contact sensors A, B, and C are L_{12}, L_{23} and L_{13} respectively. For the convenience of calculation, the distances L_{12} and L_{23} of the adjacent non-contact sensors can be set to be equal.

[0058] Additionally, in the embodiment of Fig.3, a connect line of two non-contact sensors of the at least two non-contact sensors can be set to be parallel to the train track. Further, the connect lines of each other among the at least two non-contact sensors can be collinear and are parallel to the train track. Therefore, the distances from the arrangement positions of the at least two non-contact sensors to the train track are all the same, and the same distance threshold range is adopted.

[0059] In some other embodiments, the connect line between the non-contact sensors can be non-parallel to the train track. Correspondingly, when the moving speed of the train wheels is calculated, the moving distances when the train wheels pass by the two non-contact sensors is determined according to the projection of the connect line of the two non-contact sensors onto the train track. Furthermore, the distances from the arrangement positions of the at least two non-contact sensors to the train track are different and respectively correspond to different distance threshold ranges.

[0060] In some embodiments, the at least two non-contact sensors can be arranged on the outer side of at least two train tracks in a same direction. For the non-contact sensors capable of ranging, the at least two non-contact sensors can achieve the wheelbase detection of the train running on more than two train tracks. Correspondingly, the distances between the at least two non-contact sensors and different train tracks are different, and distance values of the train wheels running on the at least two train tracks sensed by the at least two non-contact sensors respectively correspond to different distance threshold ranges.

[0061] Taking the laser ranging sensor as an example, for the train track on one side adjacent to the laser ranging sensor, any distance threshold in the distance threshold range corresponding to the distance values of the train wheels sensed by the at least two laser ranging sensors is relatively small. For the train track on one side away from the laser ranging sensor, any distance threshold in the distance threshold range corresponding to the distance values of the train wheels sensed by the at least two laser ranging sensors is relatively large. That is, the distance values of the train wheels running on the at least two train tracks sensed by the at least two non-contact sensors respectively correspond to different distance threshold ranges.

[0062] Referring to the aforementioned system for measuring train wheelbase, the present disclosure further provides a plurality of embodiments of a method for measuring train wheelbase. Fig.5 is a schematic flow diagram of some embodiments according to a method for measuring train wheelbase of the present disclosure. Referring to Fig.5, in some embodiments, the method for measuring train wheelbase includes step 100 to step 400. In the step 100, judging whether train wheels are passing by at least two non-contact sensors at present is judged according to sensing data from at least two non-contact sensors that are arranged on an outer side of a train track and arranged at intervals along the train track. For the non-contact sensors capable of ranging, distance values of the train wheels sensed by the at least two non-contact sensors at present can be compared to a preset distance threshold range, respectively. When the distance values are all within the distance threshold range, it is determined that the train wheels are passing by the at least two non-contact sensors at present.

[0063] In the step 200, in response to determination that train wheels are passing by the at least two non-contact sensors at present, a moving speed of the train wheels is calculated according to the sensing data from the at least two non-contact sensors. Specifically, a second time interval of the train wheels passing by the non-contact sensors can be calculated according to moments when the train wheels respectively pass by each non-contact sensor of the at least two non-contact sensors. Then, the moving speed of the train wheels is determined according to the second time interval and a setting distance between the non-contact sensors.

[0064] Further, the step of determining the moving speed includes: calculating a plurality of reference moving speeds according to the second time interval of the train wheels passing by any two non-contact sensors, performing arithmetic averaging on the plurality of reference moving speeds to obtain an arithmetic average value of the reference moving speeds, and then using the arithmetic average value of the reference moving speeds as the moving speed of the train wheels.

[0065] In the step 300, a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors is calculated. Specifically, the first time interval can be determined according to moments when the adjacent train wheels respectively pass by a same non-contact sensor of the at least two non-contact sensors. Further, the step of determining the first time interval includes: performing arithmetic averaging on reference time intervals of the adjacent train wheels passing by each non-contact sensor to obtain an arithmetic average value of the reference time intervals, and then using the arithmetic average value of the reference time intervals as the first time interval.

[0066] In the step 400, a wheelbase of the adjacent train wheels is calculated based on the moving speed and the first time interval. The above step can be performed by one or more local servers or a remote service platform that communicate with non-contact sensors. The distance threshold range can be pre-stored in the local servers or the remote service platforms.

[0067] Fig.6 is a schematic block diagram of some other embodiments according to a system for measuring train wheelbase of the present disclosure. Referring to Fig. 6, in some embodiments, the system for measuring train wheelbase includes a memory 60 and a processor 70 coupled to the memory. The processor 70 is configured to execute any aforementioned embodiment of the method for measuring train wheelbase based on instructions stored in the memory 60.

[0068] The embodiment of the present disclosure further provides a computer readable storage medium, a computer program is stored thereon, and the program, when executed by a processor, implements any aforementioned embodiment of the method for measuring train wheelbase.

[0069] A plurality of embodiments in the present specification are described in a progressive manner, the focus of each embodiment is different, and the same or similar parts between the various embodiments can refer to each one. For the method embodiments, since the entirety and the steps involved have a corresponding relationship with the contents in the system embodiments, the description is relatively simple, and the relevant parts can refer to a part of description of the system embodiments.

[0070] So far, various embodiments of the present disclosure have been described in detail. In order to avoid obscuring the concepts of the present disclosure, some details known in the art are not described. Those skilled in the art can fully understand how to implement the technical solutions disclosed herein according to the above description.

[0071] Although some specific embodiments of the present disclosure have been described in detail by way of example, it should be understood by those skilled in the art that the above embodiments are merely for illustration, rather than limiting the scope of the present disclosure. Those skilled in the art should understand that the above embodiments can be modified or a part of technical features can be equivalently substituted, without departing from the scope and spirit of the present disclosure. The scope of the present disclosure is defined by the appended claims.

Claims

1. A method for measuring train wheelbase, comprising:

    judging whether train wheels are passing by at least two non-contact sensors at present according to sensing data from the at least two non-contact sensors arranged on an outer side of a train track and arranged at intervals along the train track;
    in response to determination that the train wheels are passing by the at least two non-contact sensors at present, calculating a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors, and calculating a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors; and
    calculating a wheelbase of the adjacent train wheels based on the moving speed and the first time interval.

2. The method for measuring train wheelbase according to claim 1, wherein judging step comprises:

    comparing distance values of the train wheels respectively sensed by each of the at least two non-contact sensors at present with a preset distance threshold range respectively; and
    when the distance values are all within the distance threshold range, determining that train wheels are passing by the at least two non-contact sensors at present.

3. The method for measuring train wheelbase according to claim 1, wherein the step of calculating the moving speed comprises:

    calculating a second time interval of the train wheels passing by the non-contact sensors according to moments when the train wheels respectively pass by each non-contact sensor of the at least two non-contact sensors; and
    determining the moving speed of the train wheels according to the second time interval and a setting distance between the non-contact sensors.

4. The method for measuring train wheelbase according to claim 3, wherein the step of determining the moving speed comprises:

    calculating a plurality of reference moving speeds according to the second time interval of the train wheels passing by any two non-contact sensors;
    performing arithmetic averaging on the plurality of reference moving speeds to obtain an arithmetic average value of the reference moving speeds; and
    using the arithmetic average value of the refer-

ence moving speeds as the moving speed of the train wheels.

5. The method for measuring train wheelbase according to claim 3, wherein the step of calculating the first time interval comprises:
determining the first time interval according to the moments when the adjacent train wheels respectively pass by a same non-contact sensor of the at least two non-contact sensors.

6. The method for measuring train wheelbase according to claim 5, wherein the step of determining the first time interval comprises:

performing arithmetic averaging on reference time intervals of the adjacent train wheels passing by each non-contact sensor to obtain an arithmetic average value of the reference time intervals; and
using the arithmetic average value of the reference time intervals as the first time interval.

7. The method for measuring train wheelbase according to claim 1, wherein the non-contact sensors comprise a photoelectric sensor.

8. The train wheelbase measuring method according to claim 7, wherein the photoelectric sensor comprises a laser ranging sensor.

9. The method for measuring train wheelbase according to any one of claims 1-8, wherein the at least two non-contact sensors are located on a same side of the train track.

10. A system for measuring train wheelbase, comprising:

at least two non-contact sensors, arranged on an outer side of a train track, arranged at intervals along the train track and configured to sense train wheels running on the train track;
a judging unit, configured to judge whether train wheels are passing by the at least two non-contact sensors at present according to sensing data from the at least two non-contact sensors;
a first calculation unit, configured to calculate a moving speed of the train wheels according to the sensing data from the at least two non-contact sensors when the judging unit determines that train wheels are passing by the at least two non-contact sensors at present; and
a second calculation unit, configured to calculate a first time interval of adjacent train wheels passing by a same non-contact sensor of the at least two non-contact sensors and calculate a wheelbase of the adjacent train wheels based on the moving speed and the first time interval.

11. The system for measuring train wheelbase according to claim 10, wherein the at least two non-contact sensors are located on a same side of the train track.

12. The system for measuring train wheelbase according to claim 11, wherein the non-contact sensors comprise a photoelectric sensor.

13. The system for measuring train wheelbase according to claim 12, wherein the photoelectric sensor comprises a laser ranging sensor, and an intersection of a laser ray path of the laser ranging sensor and a vertical plane where the train track is located is within a range from an upper surface of the train track to a height of the train wheels.

14. The system for measuring train wheelbase according to claim 13, wherein the laser ray path is perpendicular to the train track.

15. The system for measuring train wheelbase according to any one of claims 10-14, further comprising:

a mounting base arranged on the outer side of the train track at a preset distance;
wherein the at least two non-contact sensors are arranged on the mounting base at intervals along an extension direction of the train track.

16. The system for measuring train wheelbase according to claim 15, wherein a connect line of two non-contact sensors of the at least two non-contact sensors is parallel to the train track.

17. The system for measuring train wheelbase according to claim 16, wherein connect lines of each other among the at least two non-contact sensors are collinear and are parallel to the train track.

18. The system for measuring train wheelbase according to any one of claims 10-14, wherein the at least two non-contact sensors are disposed at a same distance from the train track, or at different distances from the train track and respectively correspond to different distance threshold ranges.

19. The system for measuring train wheelbase according to any one of claims 10-14, wherein the at least two non-contact sensors are arranged on the outer side of at least two train tracks in a same direction, and distance values of the train wheels running on the at least two train tracks sensed by the at least two non-contact sensors respectively correspond to different distance threshold ranges.

20. A system for measuring train wheelbase, comprising:

a memory; and
a processor coupled to the memory, wherein the processor is configured to execute the method for measuring train wheelbase according to any one of claims 1-9 based on instructions stored in the memory.

21. A computer readable storage medium, wherein a computer program is stored thereon, and the program, when executed by a processor, implements the method for measuring train wheelbase according to any one of claims 1-9.

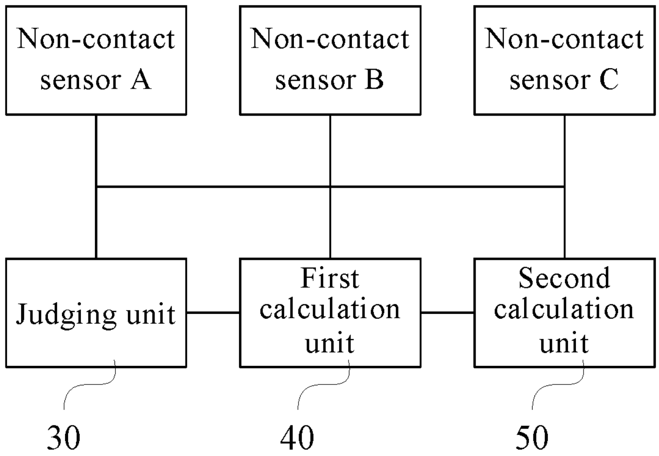

Fig.1

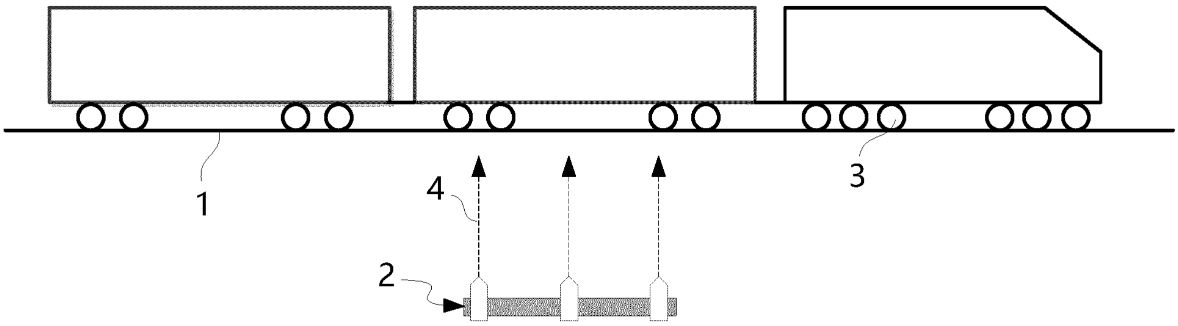

Fig.2

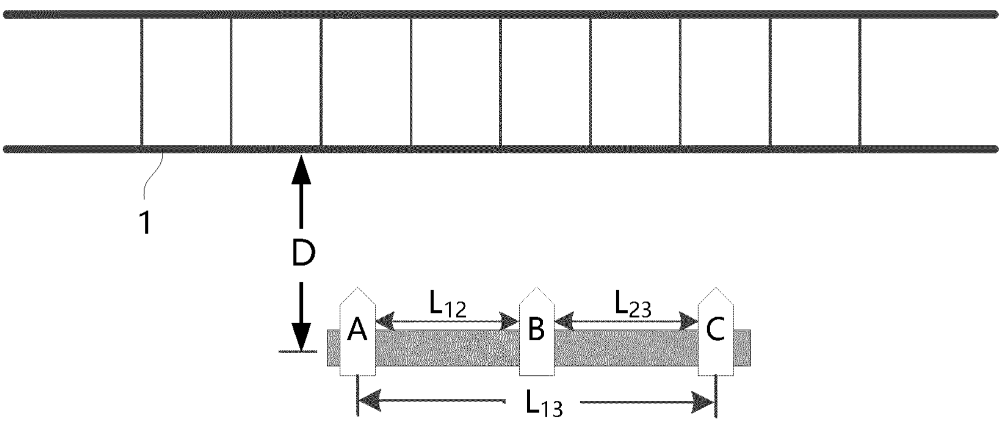

Fig.3

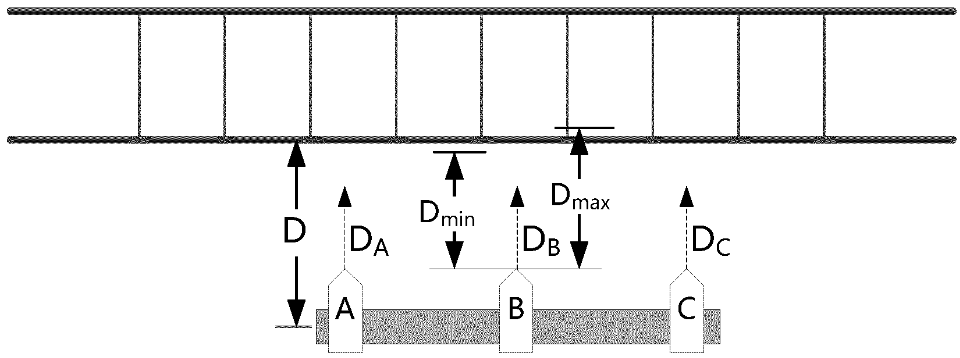

Fig.4

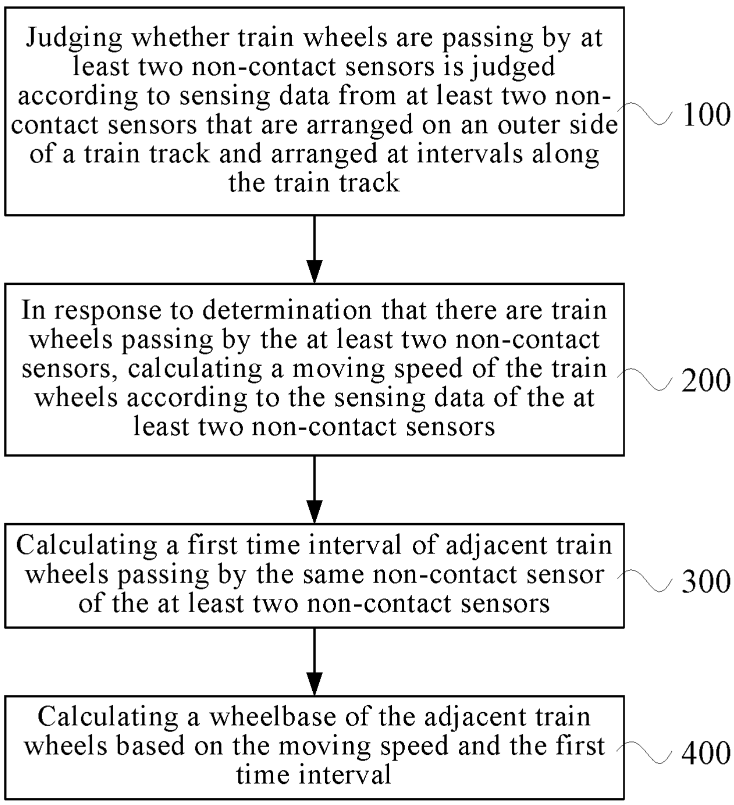

Fig.5

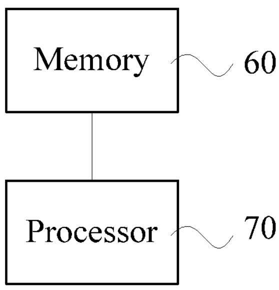

Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/089522

A. CLASSIFICATION OF SUBJECT MATTER

B61K 9/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B61K; B61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, VEN, CNKI: 测量, 轴距, 感应器, 检测, 传感器, measure, sensor, time, distance

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102765408 A (GUAN, WEI; ZHAI, YUKUN; LI, JINGRAN) 07 November 2012 (2012-11-07) description, pp. 2-5, and figures 1-4	1-21
X	CN 103661487 A (NUCTECH COMPANY LIMITED) 26 March 2014 (2014-03-26) description, pp. 2-10, and figures 1-9	1-21
X	CN 107826145 A (HARBIN RAILWAY SCIENCE RESEARCH INSTITUTE TECH CO., LTD.) 23 March 2018 (2018-03-23) description, pp. 2-4, and figures 1 and 2	1-21
PX	CN 108674442 A (NUCTECH COMPANY LIMITED) 19 October 2018 (2018-10-19) claims 1-18	1-21
PX	CN 208602495 U (NUCTECH CO., LTD.; NUCTECH BEIJING CO., LTD.) 15 March 2019 (2019-03-15) claims 1-9	10-19
A	EP 1279581 A1 (SIEMENS AG) 29 January 2003 (2003-01-29) entire document	1-21

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2019	**29 July 2019**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/089522

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☑ Claims Nos.: **21**
because they relate to subject matter not required to be searched by this Authority, namely:

[1] Claim 21 sets forth a computer readable storage medium comprising programs, which actually is a device for expressing information, and therefore falls within an excluded subject matter. The subject matter of claim 21 is expected as a corresponding detection method.

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Form PCT/ISA/210 (continuation of first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/089522

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN	102765408	A	07 November 2012	None	
CN	103661487	A	26 March 2014	None	
CN	107826145	A	23 March 2018	None	
CN	108674442	A	19 October 2018	None	
CN	208602495	U	15 March 2019	None	
EP	1279581	A1	29 January 2003	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201810756122 **[0001]**