POSITIONING DEVICE, AUTOMATIC GUIDED VEHICLE, WAREHOUSING SYSTEM, POSITIONING METHOD AND COMPUTER-READABLE STORAGE MEDIUM

TECHNICAL FIELD

[0001] The present disclosure generally relates to the field of warehouse technology, and in particular to a positioning device for an automatic guided vehicle, an automatic guided vehicle, a warehousing system, a positioning method for an automatic guided vehicle and a computer-readable storage medium.

BACKGROUND

[0002] Automated guided vehicles are key equipment in the field of logistics automation. They are designed to efficiently perform the storage, pick-up and handling tasks of goods in warehouse shelf systems. Automatic guided vehicles are highly automated and flexible and can move in multiple directions, thereby optimizing the use of warehouse space and improving work efficiency.

[0003] Some automatic guided vehicles use methods such as two-dimensional code recognition or photoelectric sensors to achieve positioning. The two-dimensional code recognition method has the disadvantages such as slow recognition speed, high code laying cost, and susceptibility to dirt and damage. The positioning method with the photoelectric sensor suffers from the disadvantages such as inability to identify map locations, susceptibility to light interference, and poor reliability. Therefore, how to improve the anti-interference, easy recognition and accuracy of positioning is a technical problem that needs to be solved in this application.

[0004] The contents of the background section are only technologies known to the inventor and does not necessarily represent the existing technologies in the art.

SUMMARY

[0005] In view of one or more of the problems existing in the existing technologies, the present disclosure provides a positioning device for an automatic guided vehicle, including:

[0006] a sensor module, including:

[0007] an RFID antenna; and

[0008] a magnetic sensor group including a plurality of magnetic sensors, the magnetic sensors being configured to sense magnetic field strength; and

[0009] a control module communicatively connected to the RFID antenna and configured to read first position information stored in an RFID electronic tag via the RFID antenna; the control module being communicatively connected to the magnetic sensor group to receive magnetic field strength information output by the magnetic sensors and determine second position information, and being configured to determine a position of the automatic guided vehicle based on the first position information and the second position information.

[0010] According to an aspect of the present disclosure, the control module includes a first control module, a second control module and a third control module, wherein the first control module is communicatively connected to the RFID antenna and configured to read the first position information stored in the RFID electronic tag via the RFID antenna, the second control module is communicatively connected to the magnetic sensor group to receive the magnetic field strength information output by the magnetic sensors and determine the second position information, and the third control module is configured to determine the position of the automatic guided vehicle based on the first position information and the second position information.

[0011] According to an aspect of the present disclosure, the positioning device further includes a magnetic member which is arranged on a shelf around the automatic guided vehicle, the magnetic sensors are configured to sense magnetic field strength of the magnetic member, and the position information includes position information of the magnetic member.

[0012] According to an aspect of the present disclosure, the shape of the RFID antenna includes one or more of a circular or polygonal shape, and the magnetic sensor group is arranged on the inside or outside of the RFID antenna.

[0013] According to an aspect of the present disclosure, the magnetic sensor group includes a plurality of groups of magnetic sensors which include a first group of magnetic sensors and a second group of magnetic sensors, wherein the second group of magnetic sensors are distributed around the outside of the first group of magnetic sensors.

[0014] According to an aspect of the present disclosure, the plurality groups of magnetic sensors also include a third group of magnetic sensors, wherein the third group of magnetic sensors are distributed around the outside of the second group of magnetic sensors.

[0015] According to an aspect of the present disclosure, the magnetic sensor group includes nine magnetic sensors, wherein the first group of magnetic sensors includes the first magnetic sensor, the second group of magnetic sensors includes the second magnetic sensor, the third magnetic sensor, the fourth magnetic sensor and the fifth magnetic sensor, and the third group of magnetic sensors includes the sixth magnetic sensor, the seventh magnetic sensor, the eighth magnetic sensor and the ninth magnetic sensor.

[0016] According to an aspect of the present disclosure, the second magnetic sensor and the third magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along an X axis, the fourth magnetic sensor and the fifth magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along a Y axis, the sixth magnetic sensor and the seventh magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along the X axis, the eighth magnetic sensor and the ninth magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along the Y axis, wherein the X axis is perpendicular to the Y axis.

[0017] According to an aspect of the present disclosure, the magnetic sensor group is arranged on the inside of the RFID antenna, and the first magnetic sensor is distributed at a center of the RFID antenna.

[0018] According to an aspect of the present disclosure, the positioning device further includes: a connector connecting the sensor module and the control module; the connector includes a coaxial cable and an IIC bus, wherein the coaxial cable connects the RFID antenna and the control module, and the IIC bus connects the magnetic sensor group and the control module.

[0019] According to an aspect of the present disclosure, the first control module includes an RFID radio frequency unit and an RFID processing unit, wherein the RFID radio frequency unit is communicatively connected to the RFID antenna via the coaxial cable and is communicatively connected to the RFID processing unit via an SPI bus, and the RFID processing unit is configured to control the RFID radio frequency unit to read the first position information stored in the RFID electronic tag via the RFID antenna.

[0020] According to an aspect of the present disclosure, the RFID electronic tag is arranged along a track of the automatic guided vehicle; the RFID processing unit is configured to send a read command to the RFID radio frequency unit; the RFID radio frequency unit is configured to send the read command to the RFID electronic tag via the RFID antenna; the RFID

electronic tag is configured to receive the read command and send the first position information to the RFID radio frequency unit via the RFID antenna; and the RFID radio frequency unit is configured to receive and process the first position information and send the processed first position information to the RFID processing unit.

[0021] According to an aspect of the present disclosure, the IIC bus includes a first IIC bus, the second control module includes a magnetic sensor processing unit, and the first magnetic sensor and the magnetic sensor processing unit are connected via the first IIC bus.

[0022] According to an aspect of the present disclosure, the IIC bus includes a second IIC bus and a third IIC bus, and the second control module further includes a first switching module and a second switching module, wherein the first switching module is connected to the second group of magnetic sensors and the magnetic sensor processing unit via the second IIC bus, and is configured to select a magnetic sensor, which communicates with the magnetic sensor processing unit, from the second group of magnetic sensors, and the second switching module is connected to the third group of magnetic sensors and the magnetic sensor processing unit via the third IIC bus, and is configured to select a magnetic sensor, which communicates with the magnetic sensor processing unit, from the third group of magnetic sensors.

[0023] According to an aspect of the present disclosure, the control module is configured to: select a magnetic sensor, which is located in front of the first group of magnetic sensors, from the second group of magnetic sensors or the third group of magnetic sensors; detect magnetic field strength information output by the selected magnetic sensor; determine the second position information when the output magnetic field strength information reaches a peak value, wherein the second position information includes the alignment of the selected magnetic sensor with the magnetic member; and determine the position of the automatic guided vehicle based on the first position information and the position of the selected magnetic sensor on the automatic guided vehicle.

[0024] According to an aspect of the present disclosure, the positioning device further includes: a first circuit board and a second circuit board, wherein the sensor module is arranged on the first circuit board, the control module is arranged on the second circuit board, and the first circuit board is not covered with copper.

[0025] According to an aspect of the present disclosure, the positioning device further includes: a non-metallic shell, wherein the sensor module, the control module and the connector are located in the non-metallic shell.

[0026] The present disclosure further provides an automatic guided vehicle, including the positioning device described above.

[0027] The present disclosure further provides a warehousing system, including:

[0028] an automatic guided vehicle including the positioning device described above;

[0029] a track, on which an RFID electronic tag is arranged, wherein the automatic guided vehicle travels on the track; and

[0030] a shelf, on which a magnetic member is arranged.

[0031] The present disclosure further provides a positioning method for an automatic guided vehicle, including:

[0032] reading first position information stored in an RFID electronic tag by an RFID antenna;

[0033] sensing magnetic field strength by a magnetic sensor to determine second position information; and

[0034] determining a position of the automatic guided vehicle based on the first position information and the second position information.

[0035] According to an aspect of the present disclosure, the positioning method is implemented by the positioning device described above.

[0036] The present disclosure further provides a computer-readable storage medium including computer executable instructions stored thereon, and the executable instructions, when executed by a processor, implement the positioning method described above.

[0037] A positioning device of the present disclosure determines first position information by reading information of an RFID electronic tag via an RFID antenna, determines second position information by the magnetic field strength, and determines a position of an automatic guided vehicle from the first position information and the second position information, thereby realizing the positioning of the automatic guided vehicle. Compared with the existing technologies, the recognition speed is faster, the anti-interference is stronger, it is not easy to get dirty and damaged, and the recognition result is more accurate, which can improve the effectiveness, accuracy and reliability of the positioning result, and is conducive to the automatic guided vehicle to perform the delivery task more accurately and efficiently.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The accompanying drawings, which are used to provide further understanding of the present disclosure and constitute a part of the specification, are used together with the embodiments of the present disclosure to explain the present disclosure and do not constitute a limitation on the present disclosure. In the accompanying drawings:

[0039] FIG. 1 shows a schematic diagram of a positioning device according to some embodiments of the present disclosure.

[0040] FIG. 2 shows a schematic diagram of a positioning device according to other embodiments of the present disclosure.

[0041] FIG. 3 shows a partial schematic diagram of a positioning device according to some embodiments of the present disclosure.

[0042] FIG. 4 shows a partial schematic diagram of a positioning device according to other embodiments of the present disclosure.

[0043] FIG. 5 shows a partial schematic diagram of a positioning device according to still other embodiments of the present disclosure.

[0044] FIG. 6 shows a schematic diagram of a positioning device according to yet still other embodiments of the present disclosure.

[0045] FIG. 7 shows a schematic diagram of an automatic guided vehicle according to some embodiments of the present disclosure.

[0046] FIG. 8 shows a schematic diagram of a warehousing system according to some embodiments of the present disclosure.

[0047] FIG. 9 shows a flow chart of a positioning method for an automatic guided vehicle according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0048] In the following, only certain exemplary embodiments are briefly described. As can be appreciated by those skilled in the art, the described embodiments can be modified in various different ways without departing from the spirit or scope of the present disclosure. Therefore, the drawings and descriptions are considered to be illustrative in nature and not restrictive.

[0049] In the description of the present disclosure, it should be understood that the terms "center", "longitudinal", "transverse", "length", "width", "thickness", "up", "down", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer", "clockwise",

"counterclockwise" and the like indicate the orientation or positional relationship based on the orientation or position relationship shown in the drawings, which is only for the convenience of describing the present disclosure and simplifying the description, rather than indicating or implying that the device or element referred to must have a specific orientation, be constructed and operated in a specific orientation, and therefore cannot be understood as a limitation of the present disclosure. In addition, the terms "first" and "second" are used only for descriptive purposes and cannot be understood as indicating or implying relative importance or implicitly indicating the number of technical features indicated. Thus, the features defined by "first" and "second" may explicitly or implicitly include one or more of the stated features. In the description of the present disclosure, "multiple" means two or more, unless otherwise clearly defined.

[0050] In the description of the present disclosure, it should be noted that, unless otherwise clearly defined and limited, the terms "installation", "connection", "connection to each other", and “coupling” should be understood in a broad sense. For example, it can be a fixed connection, a detachable connection, or an integral connection, or it can be a mechanical connection, an electrical connection, or a mutual communication, or it can be a direct connection or an indirect connection through an intermediate medium, or it can be the internal connection of two elements or the interaction relationship between two elements. For an ordinary skilled persion in the art, the specific meanings of the above terms in the present disclosure can be understood according to specific circumstances.

[0051] In the present disclosure, unless otherwise clearly specified and defined, the first feature being "on" or "beneath" the second feature may include the first and second features being in direct contact, or the first and second features being not in direct contact but in contact via another feature between them. Moreover, the first feature "on", "above", and "over" the second feature includes the first feature being directly above and obliquely above the second feature, or simply indicates that the level of the first feature is higher than that of the second feature. The first feature " beneath", "below" and "under" the second feature includes the first feature being directly below and obliquely below the second feature, or simply indicates that the level of the first feature is lower than that of the second feature.

[0052] The disclosure below provides many different embodiments or examples for implementing different structures of the present disclosure. In order to simplify the disclosure, the components and settings of specific examples are described below. Of course, they are only

examples and are not intended to limit the present disclosure. In addition, the present disclosure may repeat reference numbers and/or reference letters in different examples. Such repetition is for the purpose of simplification and clarity, and does not itself indicate the relationship between the various embodiments and/or settings discussed. In addition, the present disclosure provides examples of various specific processes and materials, but a person of ordinary skill in the art may be aware of the application of other processes and/or the use of other materials.

[0053] The preferred embodiments of the present disclosure are described below in conjunction with the accompanying drawings. It should be understood that the preferred embodiments described herein are only used to illustrate and explain the present disclosure, and are not intended to limit the present disclosure.

[0054] The present disclosure provides a positioning device for an automatic guided vehicle. FIG. 1 shows a schematic diagram of a positioning device 100 according to some embodiments of the present disclosure, which is at least partially mounted on an automatic guided vehicle. As shown in FIG. 1, the positioning device 100 includes a sensor module 10, a control module 20 and a connector 30. The connector 30 connects the sensor module 10 and the control module 20. The sensor module 10 includes an RFID antenna 11 and a magnetic sensor group 12. The magnetic sensor group 12 includes a plurality of magnetic sensors. The magnetic sensor can sense the magnetic field strength. The control module 20 is communicatively connected to the RFID antenna 11, and is configured to read the first position information stored in the RFID electronic tag via the RFID antenna 11. The control module 20 is also communicatively connected to the magnetic sensor group 12 to receive the magnetic field strength information output by the magnetic sensors and determine the second position information, and is configured to determine the position of the automatic guided vehicle based on the first position information and the second position information.

[0055] According to an embodiment of the present disclosure, the control module 20 includes a plurality of sub-control modules, such as a first control module 21, a second control module 22, and a third control module 23 described below. The first control module 21 is communicatively connected to the RFID antenna 11 (via the connector 30, for example), and the first control module 21 can read the information of the RFID electronic tag via the RFID antenna 11 (the RFID tag is, for example, fixedly disposed on a position such as the ground, the shelf, or the track in the warehouse), and is configured to read the first position information stored in the RFID electronic tag via the RFID antenna 11. The second control module 22 is communicatively

connected to the magnetic sensor group 12 (for example, via the connector 30) to receive the magnetic field strength information output by the magnetic sensors and determine the second position information. The third control module 23 is connected to the first control module 21 and the second control module 22. The third control module 23 may be configured to determine the position of the automatic guided vehicle based on the first position information and the second position information to achieve the positioning of the automatic guided vehicle.

[0056] In addition, it is easy for those skilled in the art to understand that the connector 30 is not necessary. The sensor module 10 and the control module 20 may be connected directly, or the corresponding connection conversion module may be integrated in the sensor module 10 or the control module 20, as long as the communication connection between the two is achieved.

[0057] The control module 20 reads the first position information stored in the RFID electronic tag via the RFID antenna 11, which can be implemented in different ways. For example, according to one embodiment of the present disclosure, the position coordinate information is directly encoded and stored in the RFID electronic tag. According to another embodiment of the present disclosure, a unique identification code is stored in the RFID electronic tag, and a matching table is stored in the control module 20 and contains position coordinates uniquely corresponding to each identification code. Therefore, after the control module 20 reads the identification code stored in the RFID electronic tag, the corresponding position information can be obtained from the matching table as the first position information, which fall within the scope of the present disclosure.

[0058] The positioning device of the present disclosure determines the first position information by reading the information of the RFID electronic tag via the RFID antenna, determines the second position information from the magnetic field strength, and determines the position of the automatic guided vehicle based on the first position information and the second position information, thereby realizing the positioning of the automatic guided vehicle. Compared with the existing technologies, the recognition speed is faster, the anti-interference is stronger, it is not easy to get dirty and damaged, and the recognition result is more accurate, which can improve the effectiveness, accuracy and reliability of the positioning result, and is conducive to the automatic guided vehicle to perform the delivery task more accurately and efficiently.

[0059] FIG. 2 shows a schematic diagram of a positioning device 200 according to some other embodiments of the present disclosure. As shown in FIG. 2, the connector 30 includes a

coaxial cable 301 and an IIC bus (integrated circuit bus). The RFID antenna 11 and the control module 20 are connected via the coaxial cable 301. The magnetic sensor group 12 and the control module 20 are connected via the IIC bus. Specifically, the RFID antenna 11 and the first control module 21 are connected via the coaxial cable 301 to transmit the RFID analog signal. The magnetic sensor group 12 and the second control module 22 are connected via the IIC bus. The positioning device 200 further includes a first circuit board B1 and a second circuit board B2. The sensor module 10 is arranged on the first circuit board B1, and the control module 20 is arranged on the second circuit board B2. The first circuit board B1 is not covered with copper, which can reduce radio frequency interference and reduce RFID radio frequency signal absorption, facilicating improvement of the accuracy and reliability of the positioning result. The positioning device 200 further includes a non-metallic shell H, and the sensor module 10, the control module 20 and the connector 30 are located in the non-metallic shell H, which can improve the integration of the positioning device, reduce costs, and improve the convenience of use.

[0060] In some embodiments, the shape of the RFID antenna 11 includes one or more of a circle or a polygon. The magnetic sensor group 12 can be arranged on the inside or outside of the RFID antenna 11. FIG. 3 shows a partial schematic diagram of a positioning device according to some embodiments of the present disclosure. As shown in FIG. 3, the RFID antenna 11 is in a shape of a circle. The magnetic sensor group 12 is arranged on the inside of the RFID antenna 11. FIG. 4 shows a partial schematic diagram of a positioning device according to some other embodiments of the present disclosure. As shown in FIG. 4, the RFID antenna 11 is in a shape of a polygon, for example, a rectangle. The magnetic sensor group 12 is arranged on the inside of the RFID antenna 11. FIG. 5 shows a partial schematic diagram of a positioning device according to some other embodiments of the present disclosure. As shown in FIG. 5, the RFID antenna 11 is in a shape of a polygon, for example, a rectangle. The magnetic sensor group 12 is arranged on the outside of the RFID antenna 11. Although not shown, the RFID antenna can also be in other shapes such as a triangle, a pentagon, a hexagon, etc.

[0061] As shown in FIGs. 3 to 5, the magnetic sensor group 12 includes multiple groups of magnetic sensors. For example, the multiple groups of magnetic sensors include a first group of magnetic sensors 121 (a middle sensor group), a second group of magnetic sensors 122 (a second outermost magnetic sensor group), and a third group of magnetic sensors 123 (an outermost magnetic sensor group). The second group of magnetic sensors 123 is distributed

around the outer side of the first group of magnetic sensors 121. The third group of magnetic sensors 123 is distributed around the outer side of the second group of magnetic sensors 122.

[0062] As shown in FIGs. 3 to 5, the magnetic sensor group 12 includes nine magnetic sensors. The first group of magnetic sensors 121 includes a first magnetic sensor S1. The second group of magnetic sensors 122 includes a second magnetic sensor S2, a third magnetic sensor S3, a fourth magnetic sensor S4, and a fifth magnetic sensor S5. The second magnetic sensor S2 and the third magnetic sensor S3 are symmetrically distributed on both sides of the first magnetic sensor S1 along an X axis. For example, the second magnetic sensor S2 is distributed along the positive direction of the X-axis, and the third magnetic sensor S3 is distributed along the negative direction of the X-axis. The fourth magnetic sensor S4 and the fifth magnetic sensor S5 are symmetrically distributed on both sides of the first magnetic sensor S1 along the Y-axis. For example, the fourth magnetic sensor S4 is distributed along the positive direction of the Y-axis, and the fifth magnetic sensor S5 is distributed along the negative direction of the Y-axis. The third group of magnetic sensors 123 includes the sixth magnetic sensor S6, the seventh magnetic sensor S7, the eighth magnetic sensor S8, and the ninth magnetic sensor S9. The sixth magnetic sensor S6 and the seventh magnetic sensor S7 are symmetrically distributed on both sides of the first magnetic sensor S1 along the X-axis. For example, the sixth magnetic sensor S6 is distributed along the positive direction of the X-axis, and the seventh magnetic sensor S7 is distributed along the negative direction of the X-axis. The eighth magnetic sensor S8 and the ninth magnetic sensor S9 are symmetrically distributed on both sides of the first magnetic sensor S1 along the Y-axis. For example, the eighth magnetic sensor S8 is distributed along the positive direction of the Y-axis, and the ninth magnetic sensor S9 is distributed along the negative direction of the Y-axis. The X-axis is perpendicular to the Y-axis and is the same as the XY coordinate axis of the shelf track.

[0063] As shown in FIGs. 3 and 4, the magnetic sensor group 12 is arranged on the inside of the RFID antenna 11, and the first magnetic sensor S1 is distributed in the center of the RFID antenna 11, which is conducive to improving the accuracy of the positioning result.

[0064] Preferably, the back of the RFID antenna can be attached with a material such as a ferrite film, which is beneficial to improve the RFID signal recognition strength, thereby improving the reliability of the positioning result.

[0065] It should be noted that FIGs. 3 to 5 exemplarily introduce that the magnetic sensor group 12 includes three groups of magnetic sensors, the three groups of magnetic sensors include

nine magnetic sensors, and how these nine magnetic sensors are distributed, but the present disclosure is not limited thereto. In practical applications, the magnetic sensor group 12 can include more or fewer groups of magnetic sensors, each group of magnetic sensors may include another number of magnetic sensors, and each group of magnetic sensors and the distribution of magnetic sensors in each group can be set according to needs, which are all within the scope of protection of the present disclosure.

[0066] According to one embodiment of the present disclosure, the magnetic sensor group 12 includes two groups of magnetic sensors, such as the first group of magnetic sensors 121 (including the first magnetic sensor S1) and the second group of magnetic sensors 122 (including the second magnetic sensor S2, the third magnetic sensor S3, the fourth magnetic sensor S4 and the fifth magnetic sensor S5) shown in FIGs. 3-5.

[0067] FIG. 6 shows a schematic diagram of a positioning device 300 according to still other embodiments of the present disclosure. The same parts of the positioning device 300 and the positioning device 100/200 are not described herein. The following focuses on the differences between the positioning device 300 and the positioning device 100/200.

[0068] As shown in FIG. 6, the first control module 21 includes an RFID radio frequency unit 211 and an RFID processing unit 212. The RFID radio frequency unit 211 is communicatively connected to the RFID antenna 11 via a coaxial cable 301, and is communicatively connected to the RFID processing unit 212 via an SPI bus. The RFID processing unit 212 can control the RFID radio frequency unit 211 to read the first position information stored in the RFID electronic tag via the RFID antenna 11.

[0069] In some embodiments, the automatic guided vehicle operates in a warehousing environment. The RFID electronic tag is, for example, fixedly disposed in the warehouse, such as on the ground, on a shelf, or on a track. As shown in FIG. 8, the automatic guided vehicle 400 can move along a track 510 to transport goods. The RFID electronic tag 520 can be disposed along the track of the automatic guided vehicle, and the RFID electronic tag can store position information (for example, coordinate information or map information, etc.). In addition, the RFID electronic tag may also be disposed at the center of the track (not shown). The RFID processing unit 212 can send a read command (for example, a digital signal and digital logic), and the read command is transmitted to the RFID radio frequency unit 211 via the SPI bus. The RFID radio frequency unit 211 can convert a read command (e.g., a digital signal and digital logic) into an RFID analog radio frequency signal. The RFID radio frequency unit 211 can send

the read command (e.g., an RFID analog radio frequency signal) to the RFID antenna 11 via the coaxial cable 301, and then send it to the RFID electronic tag via the RFID antenna 11. The RFID electronic tag receives the read command (e.g., an RFID analog radio frequency signal), and sends the information stored therein (e.g., location coordinate information, etc., as the first location information) to the RFID radio frequency unit 211 through the RFID antenna 11 via the coaxial cable 301. The RFID radio frequency unit 211 receives (e.g., an RFID analog radio frequency signal) and processes the information (e.g., converting the RFID analog radio frequency signal into a digital signal and digital logic), and sends the processed information (e.g., a digital signal and digital logic) to the RFID processing unit 212 via the SPI bus. The RFID processing unit 212 determines the first location information based on the processed information (e.g., coordinate information). In other words, the RFID radio frequency unit 211 can convert the RFID analog radio frequency signal into the digital signal and digital logic or vice versa, but not limited thereto, and can also perform processing operations such as demodulation and encryption, which are all within the protection scope of the present disclosure.

[0070] As shown in FIG. 6, the IIC bus includes a first IIC bus, which is denoted as an IIC1 bus, and the second control module 22 includes a magnetic sensor processing unit 222. The first IIC bus (IIC1 bus) connects the first magnetic sensor S1 and the magnetic sensor processing unit 222.

[0071] As shown in FIG. 6, the IIC bus further includes a second IIC bus and a third IIC bus, which are denoted as IIC2 bus and IIC3 bus, respectively. The second control module 22 further includes a first switching module T1 and a second switching module T2. The first switching module T1 is connected to the second group of magnetic sensors 122 and the magnetic sensor processing unit 222 via the second IIC bus (IIC2 bus). The second switching module T2 is connected to the third group of magnetic sensors 123 and the magnetic sensor processing unit 222 via the third IIC bus (IIC3 bus). The first switching module T1 can select a magnetic sensor, which communicates with the magnetic sensor processing unit 222, from the second group of magnetic sensors 122, and one or more magnetic sensors may be selected. Similarly, the second switching module T2 can select a magnetic sensor, which communicates with the magnetic sensor processing unit 222, from the third group of magnetic sensors 123, and one or more magnetic sensors may be selected. In other words, the first switching module T1 may select a magnetic sensor, which communicates with the magnetic sensor processing unit 222, from the second magnetic sensor S2, the third magnetic sensor S3, the fourth magnetic sensor S4, and the

fifth magnetic sensor S5. The second switching module T2 may select a magnetic sensor, which communicates with the magnetic sensor processing unit 222, from the sixth magnetic sensor S6, the seventh magnetic sensor S7, the eighth magnetic sensor S8, and the ninth magnetic sensor S9.

[0072] FIG. 6 shows that the second control module 22 includes a first switching module T1 and a second switching module T2, wherein the number of switching modules corresponds to the number of magnetic sensor groups minus 1. For example, as illustrated in FIG. 6, the magnetic sensor group 12 includes three groups of magnetic sensors (the first group of magnetic sensors 121, the second group of magnetic sensors 122, and the third group of magnetic sensors 123), and the second control module 22 includes two switching modules, namely, a first switching module T1 and a second switching module T2. As another example, when the magnetic sensor group 12 includes only two groups of magnetic sensors (the first group of magnetic sensors 121 and the second group of magnetic sensors 122), it is sufficient that the second control module 22 includes the first switching module T1, and does not need to include the second switching module T2. It is easy for those skilled in the art to understand that the first switching module T1 and the second switching module T2 may also be integrated into a switching module to enable the gating of one or more magnetic sensors in the second group of magnetic sensors 122 and the third group of magnetic sensors 123. This is particularly advantageous when it is not necessary to simultaneously gate the second group of magnetic sensors 122 and the third group of magnetic sensors 123.

[0073] In some embodiments, the first switching module T1 and the second switching module T2 may include switches, which may be mechanical switches or semiconductor switches, and the present disclosure does not limit this. The magnetic sensor processing unit 222 enables the gating of the magnetic sensor by controlling the on or off of the switch(s) of the first switching module T1 and/or the second switching module T2.

[0074] In some embodiments, the positioning device also includes a magnetic member (for example, the magnetic member 540 in FIG. 8). The magnetic member can be arranged on a shelf, on the ground, or on a track in the surrounding environment of the automatic guided vehicle. For example, the magnetic member can be arranged on a side close to the automatic guided vehicle. The present disclosure does not limit the number of magnetic members. One shelf can be provided with one or more magnetic members. Magnetic members include but are not limited to magnets, magnetic sheets, magnetic strips, magnetic blocks, magnetic nails, etc. The magnetic member may be stacked with the RFID tag and placed in one place (for example,

on the track). The magnetic sensor can be arranged on a side of the body of the automatic guided vehicle close to the shelf to facilitate sensing the magnetic field strength of the magnetic member, which is conducive to precise positioning.

[0075] Each magnetic sensor can sense the magnetic field strength and send the sensed value to the magnetic sensor processing unit. For example, the first magnetic sensor S1 can sense the first magnetic field strength M1 of the magnetic member, and send the first magnetic field strength M1 to the magnetic sensor processing unit 222 via the IIC1 bus. The first switching module T1 can select one magnetic sensor of magnetic sensors in the second group of magnetic sensors 122 to communicate with the magnetic sensor processing unit 222, and the magnetic sensor can sense the second magnetic field strength M2 of the magnetic member. For example, the first switching module T1 selects the second magnetic sensor S2 to communicate with the magnetic sensor processing unit 222, and the second magnetic sensor S2 can sense the second magnetic field strength M2 of the magnetic member, and can send the second magnetic field strength M2 to the magnetic sensor processing unit 222 via the IIC2 bus. Similarly, the second switching module T2 can select one magnetic sensor of magnetic sensors in the third group of magnetic sensors 123 to communicate with the magnetic sensor processing unit 222, and the magnetic sensor can sense the third magnetic field strength M3 of the magnetic member. For example, the second switching module T2 selects the seventh magnetic sensor S7 to communicate with the magnetic sensor processing unit 222, and the seventh magnetic sensor S7 can sense the third magnetic field strength M3 of the magnetic member, and send the third magnetic field strength M3 to the magnetic sensor processing unit 222 via the IIC3 bus.

[0076] In some embodiments, the automatic guided vehicle may further include an inertial measurement unit (IMU, not shown). The IMU can be coupled to the magnetic sensor processing unit 222 and installed at the center of gravity of the automatic guided vehicle to measure the motion data (for example, angular velocity and acceleration) of the automatic guided vehicle. The magnetic sensor processing unit 222 can determine the motion posture and motion direction of the automatic guided vehicle based on the motion data measured by the IMU. The magnetic sensor processing unit 222 can control the operation of the first switching module T1 and/or the second switching module T2 based on the motion direction of the automatic guided vehicle. For example, as shown in FIGs. 3 to 5, the automatic guided vehicle moves along the positive direction of the X axis, and the magnetic sensor processing unit 222 can control the first switching module T1 to select the second magnetic sensor S2 to sense the second magnetic field

strength M2, control the second switching module T2 to select the sixth magnetic sensor S6 to sense the third magnetic field strength M3, control the second magnetic sensor S2 to send the second magnetic field strength M2 measured by it to the magnetic sensor processing unit 222 via the IIC2 bus, and control the sixth magnetic sensor S6 to send the third magnetic field strength M3 measured by it to the magnetic sensor processing unit 222 via the IIC3 bus.

[0077] According to one embodiment of the present disclosure, the control module 20 is configured to: select a magnetic sensor, which is located in front of the first group of magnetic sensors (along the direction of travel), from the second group of magnetic sensors or the third group of magnetic sensors; detect magnetic field strength information output by the selected magnetic sensor; determine second position information when the output magnetic field strength information reaches a peak value, wherein the second position information includes the alignment of the selected magnetic sensor with the magnetic member; and determine the position of the automatic guided vehicle based on the first position information and the position of the selected magnetic sensor on the automatic guided vehicle.

[0078] Preferably, the third control module 23 connects the RFID processing unit 212 and the magnetic sensor processing unit 222, for example, via the RS422 bus, but not limited thereto. The third control module 23 can control the RFID processing unit 212 and the magnetic sensor processing unit 222 to operate simultaneously to determine the first position information and the second position information, and determine the position of the automatic guided vehicle based on the first position information and the second position information, which is conducive to improving the real-time positioning and the accuracy of the positioning result.

[0079] Specifically, the magnetic sensor processing unit 222 is configured to: control the first switching module T1 to select a magnetic sensor, which is located in front of the first group of magnetic sensors 121, from the second group of magnetic sensors 122, and/or control the second switching module T2 to select a magnetic sensor, which is located in front of the first group of magnetic sensors 121, from the third group of magnetic sensors 123; detect whether the magnetic field strength information output by the selected magnetic sensor reaches a peak value; and determine the second position information when it is determined that the output magnetic field strength information reaches the peak value, the second position information including the alignment of the selected magnetic sensor with the magnetic member. The third control module 23 is configured to: determine the position of the automatic guided vehicle based on the first

position information and the position of the selected magnetic sensor on the automatic guided vehicle.

[0080] According to one embodiment of the present disclosure, the magnetic sensor processing unit 222 selects a magnetic sensor in the second group of magnetic sensors 122 through the first switching module T1, and determines the second position information based on the magnetic field strength information output by the selected magnetic sensor, which is described in detail below.

[0081] Preferably, the first position information stored in the RFID antenna 11 is the coordinate position of the magnetic member. When it is determined that the automatic guided vehicle moves in the positive direction of the X axis, the second magnetic sensor S2 may be selected (because the second magnetic sensor S2 is located in front of the first magnetic sensor S1 along the forward direction), and the magnetic field strength signal output by the second magnetic sensor S2 is continuously monitored. When the magnetic field strength signal output by the second magnetic sensor S2 reaches the maximum value, it can be determined that the second magnetic sensor S2 is substantially aligned with the magnetic member (aligned in the Y direction), that is, the second position information is determined. Since the second magnetic sensor S2 is fixedly arranged on the automatic guided vehicle, the third control module 23 can determine the position of any point on the automatic guided vehicle based on the coordinate position of the magnetic member (from the RFID antenna 11) and the position of the second magnetic sensor S2 on the automatic guided vehicle at the moment. For example, assuming that the position of the first magnetic sensor S1 is taken as the position of the automatic guided vehicle, the coordinate position of the magnetic member is (x1, y1), and the position (or distance) of the second magnetic sensor S2 relative to the first magnetic sensor is d (along the X direction), then the coordinate of the first magnetic sensor S1 along the X direction is (x1-d) (when the automatic guided vehicle runs on the track, its y coordinate is limited by the track, so the Y coordinate is not concerned).

[0082] According to an embodiment of the present disclosure, the output signals of a plurality of magnetic sensors can be used to determine the position of the automatic guided vehicle, to improve the accuracy. For example, as shown in FIGs. 3 to 5, the automatic guided vehicle moves along the positive direction of the X axis, and the magnetic sensor processing unit 222 can control the first switching module T1 to select the second magnetic sensor S2 to sense the second magnetic field strength M2, control the second switching module T2 to select the

sixth magnetic sensor S6 to sense the third magnetic field strength M3, control the second magnetic sensor S2 to send the second magnetic field strength M2 measured by it to the magnetic sensor processing unit 222 via the IIC2 bus, and control the sixth magnetic sensor S6 to send the third magnetic field strength M3 measured by it to the magnetic sensor processing unit 222 via the IIC3 bus. When the automatic guided vehicle is moving along the positive direction of the X axis and approaching the magnetic member, the third magnetic field strength M3 output by the sixth magnetic sensor S6 is stronger than the second magnetic field strength M2 output by the second magnetic sensor S2. When the third magnetic field strength M3 output by the sixth magnetic sensor S6 is equal to or weaker than the second magnetic field strength M2 output by the second magnetic sensor S2 at a certain moment, it can be determined that the second magnetic sensor S2 is substantially aligned with the magnetic member (aligned in the Y direction), that is, the second position information is determined. The position of the automatic guided vehicle can be determined as described above.

[0083] The magnetic sensor processing unit 222 can collect output signals from every magnetic sensor or from the selected magnetic sensors every 10 microsecond, 20 microsecond, 30 microsecond, 40 microsecond, 50 microsecond, 100 microsecond, or 1second.

[0084] The present disclosure also provides an automatic guided vehicle. FIG. 7 shows a schematic diagram of an automatic guided vehicle 400 according to some embodiments of the present disclosure. As shown in FIG. 7, the automatic guided vehicle 400 includes the positioning device 100/200/300 as described above. Preferably, the automatic guided vehicle 400 further includes an inertial measurement unit.

[0085] The automatic guided vehicle of the present disclosure can improve the effectiveness, accuracy and reliability of the positioning result by adopting the above-mentioned positioning device, which is conducive to the automatic guided vehicle to perform delivery tasks more accurately and efficiently.

[0086] The present disclosure also provides a warehousing system. FIG. 8 shows a schematic diagram of a warehousing system 500 according to some embodiments of the present disclosure. As shown in FIG. 8, the warehousing system 500 includes the automatic guided vehicle 400, a track 510, and a shelf 530 as described above. An RFID electronic tag 520 is provided on the track 510, and the automatic guided vehicle 400 travels on the track 510. A magnetic member 540 is disposed on the shelf 530.

[0087] According to one embodiment of the present disclosure, the warehousing system also includes a server 550, which is communicatively connected to the automatic guided vehicle 400.

[0088] The automatic guided vehicle 400 moves along the track 510, and is configured to read the first position information stored in the RFID electronic tag 520 via the RFID antenna, determine the second position information based on the magnetic field strength information output by the magnetic sensors, and determine the position of the automatic guided vehicle 400 based on the first position information and the second position information.

[0089] The warehousing system of the present disclosure can improve the effectiveness, accuracy and reliability of the positioning result by adopting the above-mentioned automatic guided vehicle, which is helpful for the automatic guided vehicle to perform the delivery task more accurately and efficiently.

[0090] The present disclosure also provides a positioning method for an automatic guided vehicle. FIG. 9 shows a flowchart of a positioning method 600 for the automatic guided vehicle 400 according to some embodiments of the present disclosure. As shown in FIG. 9, the positioning method 600 includes steps S610 to S630. The positioning method 600 can be implemented by the positioning device 100/200/300 as described above.

[0091] In step S610, the first position information stored in the RFID electronic tag 520 is read through the RFID antenna 11.

[0092] In step S620, the magnetic field strength is sensed by the magnetic sensor to determine the second position information.

[0093] In step S630, the position of the automatic guided vehicle is determined based on the first position information and the second position information.

[0094] The present disclosure also provides a computer-readable storage medium including computer executable instructions stored thereon, which, when executed by a processor, implement the positioning method 600 as described above.

[0095] The positioning method of the present disclosure can improve the effectiveness, accuracy and reliability of the positioning results of the automatic guided vehicle, which is beneficial for the automatic guided vehicle to perform the delivery task more accurately and efficiently.

[0096] In some embodiments, the computer-readable storage medium can be any tangible medium containing or storing a program, which can be used by or in combination with an

instruction execution system, apparatus or device. Computer-readable storage media include but are not limited to electrical, magnetic, optical, or semiconductor forms or devices, and more specific examples (a non-exhaustive list) include: an electrical connection with one or more wires, a portable computer hard disk, a hard disk, a random access memory (RAM), a non-volatile random access memory (NVRAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or flash memory), an optical fiber, a portable compact disk read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination thereof.

[0097] In some embodiments, the positioning method 600 of the present disclosure may exist in the form of program code. The program code may be contained in a physical medium, such as a floppy disk, a CD, a hard disk, or any other machine-readable (such as computer-readable) storage medium, or a computer program product not limited to an external form, wherein when the program code is loaded and executed by a machine such as a computer, the machine becomes a device for participating in the present disclosure. The program code may also be transmitted through some transmission media such as wires or cables, optical fibers, or any transmission type, wherein when the program code is received, loaded and executed by a machine such as a computer, the machine becomes a device for participating in the present disclosure. When actually operated on a general-purpose processing unit, the program codes provide a unique device that operates similarly to an application-specific logic circuit in combination with the processing unit.

[0098] In some embodiments, the control module/processor/processing unit/server may include a Central ProcessingUnit (CPU), and a Micro Control Unit (MCU), and may also include another general-purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field-Programmable Gate Array (FPGA) or another programmable logic device, a discrete gate or a transistor logic device, a discrete hardware component and other similar devices.

[0099] It should be noted that this specification provides method operation steps as described in the embodiments or schematic diagrams, but more or fewer operation steps may be included based on conventional or non-creative labor. The order of steps listed in the embodiments is only one way of executing the steps, and does not represent the only execution order. When the system or equipment product is executed in practice, it can be executed in sequence or in parallel according to the method shown in the embodiments or flowcharts. In

addition, any embodiment or combination of the positioning device, automatic guided vehicle, warehousing system and positioning method of the present disclosure can be applied to each other.

[0100] It should be noted that although several modules of the positioning device are mentioned in the above detailed description, this division is not mandatory. In fact, according to the embodiments of the present disclosure, the features and functions of two or more modules described above can be implemented in one module. Conversely, the features and functions of a module described above can be further divided into multiple modules for specific implementation.

[0101] Finally, it should be noted that the foregoing description is only a preferred embodiment of the present disclosure and is not intended to limit the present disclosure. While the present disclosure is described in detail with reference to the above embodiments, it is still possible for those skilled in the art to modify the technical solutions recorded in the above embodiments, or to replace some of the technical features therein with equivalents. Any modifications, equivalent substitutions, improvements, etc. made within the spirit and principles of the present disclosure should be encompassed within the protection scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A positioning device for an automatic guided vehicle, comprising:

a sensor module, comprising:

an RFID antenna; and

a magnetic sensor group comprising a plurality of magnetic sensors, the magnetic sensors being configured to sense magnetic field strength; and

a control module communicatively connected to the RFID antenna and configured to read first position information stored in an RFID electronic tag via the RFID antenna; the control module being communicatively connected to the magnetic sensor group to receive magnetic field strength information output by the magnetic sensors and determine second position information, and being configured to determine a position of the automatic guided vehicle based on the first position information and the second position information.

2. The positioning device according to claim 1, wherein the control module comprises a first control module, a second control module and a third control module, wherein the first control module is communicatively connected to the RFID antenna and configured to read the first position information stored in the RFID electronic tag via the RFID antenna; the second control module is communicatively connected to the magnetic sensor group to receive the magnetic field strength information output by the magnetic sensors and determine the second position information; and the third control module is configured to determine the position of the automatic guided vehicle based on the first position information and the second position information.

3. The positioning device according to claim 1, further comprising a magnetic member which is arranged on a shelf, on a ground or on a track around the automatic guided vehicle, wherein the magnetic sensors are configured to sense magnetic field strength of the magnetic member, and the first position information comprises position information of the magnetic member, wherein a shape of the RFID antenna comprises one or more of a circular or polygonal shape, and the magnetic sensor group is arranged on inside or outside of the RFID antenna.

4. The positioning device according to claim 2, wherein the magnetic sensor group comprises a plurality of groups of magnetic sensors which comprise a first group of magnetic sensors and a second group of magnetic sensors, wherein the second group of magnetic sensors are distributed around outside of the first group of magnetic sensors.

5. The positioning device according to claim 4, wherein the plurality groups of magnetic sensors also comprise a third group of magnetic sensors, wherein the third group of magnetic sensors are distributed around outside of the second group of magnetic sensors.

6. The positioning device according to claim 5, wherein the magnetic sensor group comprises nine magnetic sensors, wherein the first group of magnetic sensors comprises a first magnetic sensor, the second group of magnetic sensors comprises a second magnetic sensor, a third magnetic sensor, a fourth magnetic sensor and a fifth magnetic sensor, and the third group of magnetic sensors comprises a sixth magnetic sensor, a seventh magnetic sensor, a eighth magnetic sensor and a ninth magnetic sensor.

7. The positioning device according to claim 6, wherein the second magnetic sensor and the third magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along an X axis; the fourth magnetic sensor and the fifth magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along a Y axis; the sixth magnetic sensor and the seventh magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along the X axis; and the eighth magnetic sensor and the ninth magnetic sensor are symmetrically distributed on both sides of the first magnetic sensor along the Y axis, wherein the X axis is perpendicular to the Y axis.

8. The positioning device according to claim 6, wherein the magnetic sensor group is arranged on inside of the RFID antenna, and the first magnetic sensor is distributed at a center of the RFID antenna.

9. The positioning device according to claim 6, further comprising: a connector connecting the sensor module and the control module, wherein the connector comprises a coaxial cable and an IIC bus, wherein the coaxial cable connects the RFID antenna and the control module, and the IIC bus connects the magnetic sensor group and the control module, wherein the first control module comprises an RFID radio frequency unit and an RFID processing unit, wherein the RFID radio frequency unit is communicatively connected to the RFID antenna via the coaxial cable and is communicatively connected to the RFID processing unit via an SPI bus, and the RFID processing unit is configured to control the RFID radio frequency unit to read the first position information stored in the RFID electronic tag via the RFID antenna.

10. The positioning device according to claim 9, wherein the RFID electronic tag is arranged along a track of the automatic guided vehicle; the RFID processing unit is configured to send a read command to the RFID radio frequency unit; the RFID radio frequency unit is

configured to send the read command to the RFID electronic tag via the RFID antenna; the RFID electronic tag is configured to receive the read command and send the first position information to the RFID radio frequency unit via the RFID antenna; and the RFID radio frequency unit is configured to receive and process the first position information and send the processed first position information to the RFID processing unit.

11. The positioning device according to claim 9, wherein the IIC bus comprises a first IIC bus, the second control module comprises a magnetic sensor processing unit, and the first magnetic sensor and the magnetic sensor processing unit are connected via the first IIC bus.

12. The positioning device according to claim 9, wherein the IIC bus comprises a second IIC bus and a third IIC bus, and the second control module further comprises a first switching module and a second switching module, wherein the first switching module is connected to the second group of magnetic sensors and the magnetic sensor processing unit via the second IIC bus, and is configured to select a magnetic sensor, which communicates with the magnetic sensor processing unit, from the second group of magnetic sensors; and the second switching module is connected to the third group of magnetic sensors and the magnetic sensor processing unit via the third IIC bus, and is configured to select a magnetic sensor, which communicates with the magnetic sensor processing unit, from the third group of magnetic sensors.

13. The positioning device according to any one of claims 4 to 6, wherein the control module is configured to: select a magnetic sensor, which is located in front of the first group of magnetic sensors, from the second group of magnetic sensors or the third group of magnetic sensors; detect magnetic field strength information output by the selected magnetic sensor; determine the second position information when the output magnetic field strength information reaches a peak value, wherein the second position information comprises an alignment of the selected magnetic sensor with the magnetic member; and determine the position of the automatic guided vehicle based on the first position information and the position of the selected magnetic sensor on the automatic guided vehicle.

14. The positioning device according to any one of claims 1 to 4, further comprising: a first circuit board and a second circuit board, wherein the sensor module is arranged on the first circuit board, the control module is arranged on the second circuit board, and the first circuit board is not covered with copper.

15. The positioning device according to claim 10, further comprising: a non-metallic shell, wherein the sensor module, the control module and the connector are located in the non-metallic

shell.

16. An automatic guided vehicle, comprising the positioning device according to any one of claims 1 to 15.

17. A warehousing system, comprising:

an automatic guided vehicle comprising the positioning device according to any one of claims 1 to 15;

a track, on which an RFID electronic tag is arranged, wherein the automatic guided vehicle travels on the track; and

a shelf, on which a magnetic member is arranged.

18. A positioning method for an automatic guided vehicle, comprising:

reading first position information stored in an RFID electronic tag by an RFID antenna;

sensing magnetic field strength by a magnetic sensor to determine second position information; and

determining a position of the automatic guided vehicle based on the first position information and the second position information.

19. The positioning method according to claim 18, wherein the positioning method is implemented by the positioning device according to any one of claims 1 to 15.

20. A computer-readable storage medium comprising computer executable instructions stored thereon, wherein the executable instructions, when executed by a processor, implement the positioning method according to claim 18 or 19.