

A POSITIONING SYSTEM

Field of Invention

The present invention relates generally to a positioning system.

Background

There are many known positioning systems, for example pick-and-place apparatuses or automation systems, for use with racking and storage systems. Such conventional equipment generally includes an end-effector coupled to a robotic arm or actuator assemblies to convey multiple degrees-of-freedom (DOFs) positioning to the end-effector to allow articles to be placed thereby at various locations on the rack and storage systems. The actuator assemblies typically utilise motors with stepping or incremental counters for positional feedback. Issues from inertia and over-shoot do still occur which resulted in approaches utilising closed-loop control. However, for positional accuracy, mechanical switches may still be employed to convey positional feedback with better accuracy. However, installation of these switches into actuator assemblies, for example linear stages or translational stages is inefficacious and impractical. Hence, there is an apparent need for an improved positioning system for addressing the foregoing issues.

Summary

In accordance with a first aspect of the invention, there is disclosed a positioning system comprising a carriage for supporting at least one article, an actuator assembly defining a first path and being operable for displacing and positioning the carriage along the first path, a radio frequency identification (RFID) reader and a plurality of RFID tags. The radio frequency identification (RFID) reader is coupled to the carriage and configured to travel along a second path when the carriage is displaced along the first path, the second path being substantially parallel the first path. The plurality of RFID tags positioned along the second path with each of the plurality of RFID tags having a unique address being readable by the RFID reader when the RFID reader is positioned adjacent thereto, such that the location of the carriage along the first path is indicatable by the unique address readable by the RFID reader from each of the plurality of RFID tag. The actuator assembly is signal communicable with a controller for control thereby to displace the carriage along the first path, and the RFID

reader is signal communicable with the controller for providing the unique address readable from each of the plurality of RFID tags thereto to determine location of the carriage along the first path.

In accordance with a second aspect of the invention, there is disclosed a positioning system comprising a carriage for supporting at least one article, a first actuator assembly defining a first path and a second path therealong and being operable for displacing and positioning the carriage along the first path, a first radio frequency identification (RFID) reader, a first plurality of RFID tags, a second actuator assembly defining a third path and a fourth path therealong and being operable for displacing and positioning the first actuator assembly along the third path, a second radio frequency identification (RFID) reader and a second plurality of RFID tags. The first radio frequency identification (RFID) reader is coupled to the carriage and configured to travel along the second path when the carriage is displaced along the first path, the second path being substantially parallel the first path. The first plurality of RFID tags positioned along the second path with each of the first plurality of RFID tags having a unique address being readable the first RFID reader when the first RFID reader is positioned adjacent thereto, such that the location of the carriage along the first path is indicatable by the unique address readable by the first RFID reader from each of the first plurality of RFID tags. The second radio frequency identification (RFID) reader is coupled to the first actuator assembly and configured to travel along the fourth path when the first actuator assembly is displaced along the third path, the fourth path being substantially parallel the third path. The second plurality of RFID tags are positioned along the fourth path with each of the second plurality of RFID tags having a unique address being readable by the second RFID reader when the second RFID reader is positioned adjacent thereto, such that the location of the first actuator assembly along the third path is indicatable by the unique address readable by the second RFID reader from each of the second plurality of RFID tags. Each of the first actuator assembly and the second actuator assembly is signal communicable with a controller for control thereby to displace the carriage along the first path and the first actuator assembly along the third path, and the first RFID reader and the second RFID reader is signal communicable with the controller for providing the unique address readable from each of the first plurality of RFID tags and each of the second plurality of RFID tags thereto to determine

location of the carriage along the first path and the first actuator assembly along the third path.

Brief Description of the Drawings

FIG. 1 shows a perspective view of a positioning system comprising a first actuator assembly and a second actuator assembly in accordance with an aspect of the invention;

FIG. 2 shows a partial perspective view of the positioning system of FIG. 1 with an article being supported by a manipulator;

FIG. 3 shows a partial front view of an upper portion of the first actuator assembly of the positioning system of FIG. 1;

FIG. 4 shows a partial front view of a lower portion of the first actuator assembly of the positioning system of FIG. 1;

FIG. 5 shows a partial side view of a lower portion of the first actuator assembly of the positioning system of FIG. 1;

FIG. 6 shows a partial side view of a middle portion of the first actuator assembly of the positioning system of FIG. 2 with the manipulator interacting with the article supported on a racked storage;

FIG. 7 shows a partial perspective view of a middle portion of the first actuator assembly of the positioning system of FIG. 2 with the manipulator retrieving the article from the racked storage; and

FIG. 8 shows a system diagram of the positioning system of FIG. 1.

Detailed Description

Reference will now be made in detail to an exemplary embodiment of the present invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the embodiment, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of embodiments of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the embodiments of the present invention

An exemplary embodiment of the invention, a positioning system 20, is described with reference to FIGS 1 to 5. The positioning system 20 is preferably used for positioning and spatially manipulating articles. More specifically, the positioning system 20 is for handling of articles in warehousing and resource planning and handling systems.

The positioning system 20 comprises a carriage 22 for supporting at least one article 24. The carriage 22 is coupled to and supported by a first actuator assembly 26. The first actuator assembly 26 defines a first path 28 and a second path 30 and is operable for displacing and positioning the carriage 22 along the first path 28. The first path 28 and the second 30 are substantially parallel a y-axis 32 defined by the positioning system 20. The positioning system 20 further comprises a first radio frequency identification (RFID) reader 34 coupled to the carriage 22. The first RFID reader 34 is configured to travel along the second path 30 when the carriage 22 is displaced along the first path 28 which is substantially parallel the second path 30.

Preferably, the positioning system 20 comprises a first plurality of RFID tags 36 positioned along the second path. Each of the first plurality of RFID tags 36 has a unique address being readable by the first RFID reader 34 when the first RFID reader 34 is positioned adjacent thereto, such that the location of the carriage 22 along the first path 28 is indicatable by the unique address readable by the first RFID reader 34 from each of the first plurality of RFID tags 36.

The positioning system 20 further comprises a second actuator assembly 40, a second RFID reader 42 and a second plurality of RFID tags 44. The second actuator assembly 40 defines a third path 46 and a fourth path 48 therealong and is operable for displacing and positioning the first actuator assembly 26 along the third path 46. The third path 46 and the fourth path 48 are substantially parallel an x-axis 50. Preferably, the x-axis 50 is substantially perpendicular to the y-axis 32. This allows the x-axis 50 and the y-axis 32 to facilitate definition of a typical Cartesian coordinate system. Alternatively, the x-axis 50 can be off-perpendicular to the y-axis 32 to define other forms of coordinate systems.

The second RFID reader 42 is coupled to the first actuator assembly 26 and is configured to travel along the fourth path 48 when the first actuator assembly 26 is displaced along the third path 46. The fourth path 48 is substantially parallel to the third path 46.

The second plurality of RFID tags 44 are positioned along the fourth path 48. Each of the second plurality of RFID tags 44 has a unique address being readable by the second RFID reader 42 when the second RFID reader 42 is positioned adjacent thereto, such that the location of the first actuator assembly 26 along the third path 46 is indicatable by the unique address readable by the second RFID reader 42 from each of the second plurality of RFID tags 44.

Each of the first actuator assembly 26 and the second actuator assembly 40 is signal communicable with a controller 52 for control thereby to displace the carriage 22 along the first path 28 and the first actuator assembly 26 along the third path 48. Further, the first RFID reader 34 and the second RFID reader 42 is signal communicable with the controller 52 for providing the unique address readable from each of the first plurality of RFID tags 36 and each of the second plurality of RFID tags 44 thereto to determine location of the carriage 22 along the first path 28 and the first actuator assembly 26 along the third path 48.

Each of the first actuator assembly 26 and the second actuator assembly 40 comprises a guideway 54a/54b and an actuator 56a/56b. The guideway 54a/54b is for guiding the respective one of the carriage 22 along one of the first path 28 and the first actuator assembly 26 along the third path 46. The actuator 56a/56b is operable for cooperating with the respective guideway 54a/54b for displacing and positioning one of the carriage 22 along the first path 28 and the first actuator assembly 26 along the third path 46.

The actuator 56a/56b of at least one of the first actuator assembly 26 and the second actuator assembly 40 is an electrical motor, a servo motor and a stepper motor. The guideway 54a/54b of at least one of the first actuator assembly 26 and the second actuator assembly 40 being a leadscrew rotationally displaceable about its length by the actuator 56a/56b for displacing one of the carriage 22 and the first actuator assembly 26 therealong. The guideway 54a/54b of at least one of the first actuator assembly 26 and the second actuator assembly 40 can be implemented as using a rackrail coupled to the actuator 56a/56b in a rack-and-pinion configuration. Alternatively or in addition, the guideway 54a/54b of at least one of the first actuator assembly 26 and the second actuator assembly 40 comprises one of a belt-pulley assembly and a cable-pulley assembly configured with the actuator 56a/56b and coupled to one of the carriage 22 for displacing the carriage 22 along the first path 28 and the first actuator assembly 26 for displacing the first actuator assembly 26 along the third path 46.

Each of the first plurality of RFID tags 36 and each of the second plurality of RFID tags 44 is one of a chip-based and a chipless tag. Preferably, the positioning system 20 further comprises a first panel 60 defining the second path 30 and whereto the first plurality of RFID tags 36 are coupled for detection by the first RFID reader 34 and a second panel 62 defining the fourth path 48 and whereto the second plurality of RFID tags 44 are coupled for detection by the second RFID reader 42.

Preferably, the positioning system 20 further comprises a manipulator 64 coupled to the carriage 22 for receiving the at least one article 24 and for spatially manipulating the at least one article 24. It is preferred that the manipulator is adapted for loading and unloading the at least one article 24 from a surface 66 whereon the at least one article 24 is disposable. It is further preferred that the manipulator 64 is in data communication with the controller 52 for being controller thereby.

In an implementation of the positioning system 20, the guideway 54a of the first actuator assembly 26 is a vertically orientated I-beam structure 70 defining a rail with the carriage 22 being roller coupled to the rail to enable a first degree-of-freedom (DOF) along the rail which defines the first path 28. The first panel 60 is formed as a portion of the I-beam structure 70. A belt-and-pulley assembly 74 inter-couples the actuator 56a of the first actuator assembly 26 to the carrier 22 for conveying displacement to and positioning the carrier 22 along the rail.

The guideway 54b of the second actuator assembly 40 is formed by a pair of horizontal beams 76 spaced apart to enable the I-beam structure 70 straddle the pair of horizontal beams 76. The I-beam structure 70 is roller-coupled at both extremities thereof to the pair of horizontal beams 76 to convey a second DOF to the carrier 22. Preferably, the actuator 56b of the second actuator assembly 40 is coupled to one end of the I-beam structure 70 and roller-coupled to one of the pair of horizontal beams 76 for conveying displacement to and positioning the I-beam structure 70 along the pair of horizontal beams 76. Preferably, the second panel 62 is formed as part of one of the pair of horizontal beams 76. One of the pair of horizontal beams 76 is implementable as a rail laid on or into the floor while the other of the pair of horizontal beams 76 is implementable as a rail laid on or into a ceiling.

The positioning system 20 is for pick-and-place operations to and from a racked storage system 78 defining a plurality of storage locations. Each of the storage locations can define the surface 66 where to the article 24 can be placed and wherefrom the article 24 can be retrieved by the manipulator 64. Preferably, the plurality of storage locations are configured in a matrix with each of the plurality storage locations being indicated and locatable along the y-axis 32 by the unique address of one of the first plurality of RFID tags 36 and along the x-axis 50 by the unique address of one of the second plurality of RFID tags 44.

Preferably, the racked storage system 78 comprises a plurality of horizontal platforms 82 for defining the surface 66 wherefrom the article 24 is disposable. Further, the plurality of horizontal platforms 82 are spatially stratified for defining the plurality of storage locations.

It is preferred that each of the plurality of horizontal platforms 82 comprises gratings spaced apart for forming slots therebetween. Each of the plurality of horizontal platforms 82 are shaped and dimensioned for supporting articles 24 thereon. The manipulator 64 preferably comprises a plurality of fingers 84 shaped and dimensioned to nestle between the gratings of each of the plurality of horizontal platforms 82.

It is preferred that the manipulator 64 independently has at least one DOF in addition to the two DOFs provided by the first actuator assembly 26 and the second actuator assembly 40 in combination.

For an article 24 being carried by the manipulator 64, the article 24 will sit on the plurality of fingers 84. To place the article 24 on the racked storage 78, the first actuator assembly 26 and the second actuator assembly 40 first positions the article 24 adjacent the intended one of the storage location. Next, the manipulator 64 positions the article 24 above the corresponding one of the plurality of horizontal platforms 82 before lowering the plurality of fingers 84 into the slots with the article 24 still being supported by plurality of fingers 84. As the plurality of fingers 84 starts to interleave the gratings and passage further into the slots, the article abuts the gratings to be supported thereby as the plurality of fingers 84 displaces away from the article 24. The manipulator 64 then displaces the plurality of fingers 84 away

from the gratings in a direction parallel the longitudinal axis of each of the gratings to leave the article 24 supported on the racked storage 78.

To pick the article 24 from the racked storage 78, the steps for placing the article 24 thereon is reversed. In picking the article 24, the manipulator will first insert the plurality of fingers 84 between the gratings to thereby position the plurality of fingers 84 with the slots and below the article 24. Next, the plurality of fingers 84 are then lifted towards the article 24 until the plurality of fingers 84 abuts the article 24 and the article 24 unseating from the gratings. The manipulator 64 then displaces the article 24 away from the gratings before the first actuator assembly 26 and the second actuator assembly 40 positions the carriage 22, and hence the article 24, to a subsequent location.

The controller 52 is preferably a computing device with a memory module for storing a look-up table or look-up matrix of the plurality of storage locations with the corresponding unique address unique address of one of the first plurality of RFID tags 36 along the y-axis 32 and the corresponding unique address of one of the second plurality of RFID tags 44 along the x-axis 50. This enable the controller 52 know the position of the carrier 22 and manipulator 64 relative the plurality of storage locations from the unique address of each of the first plurality of RFID tags 36 and each of the second plurality of RFID tags 44 and to provide positional feedback of the carrier 22 to the controller 52 when the carrier travels from one to another of the plurality storage locations.

The use of the unique address of each of the first plurality of RFID tags 36 and each of the second plurality of RFID tags 44 enables actual positional/locational feedback to the controller rather than using relative displacement feedback derived from the actuators 56a/56b of the first actuator assembly 26 and the second actuator assembly 40. The controller 52 may be further coupled to a resource planning system for executing article placement and storage strategies/algorithms.

In a forgoing manner, a positioning system is described according to an exemplary embodiment of the invention. Although only one embodiment of the invention is disclosed in this document, it will be apparent to one skilled in the art in view of this disclosure that

numerous changes and/or modifications can be made to the disclosed embodiment without departing from the scope and spirit of the invention.

Claims

1. A positioning system comprising:
 - a carriage for supporting at least one article;
 - an actuator assembly defining a first path and being operable for displacing and positioning the carriage along the first path;
 - a radio frequency identification (RFID) reader coupled to the carriage and configured to travel along a second path when the carriage is displaced along the first path, the second path being substantially parallel the first path; and
 - a plurality of RFID tags positioned along the second path, each of the plurality of RFID tags having a unique address being readable by the RFID reader when the RFID reader is positioned adjacent thereto, such that the location of the carriage along the first path is indicatable by the unique address readable by the RFID reader from each of the plurality of RFID tag,
 - wherein the actuator assembly is signal communicable with a controller for control thereby to displace the carriage along the first path, and the RFID reader is signal communicable with the controller for providing the unique address readable from each of the plurality of RFID tags thereto to determine location of the carriage along the first path.
2. The positioning system as in claim 1, the actuator assembly comprising:
 - a guideway for guiding the carriage along the first path; and
 - an actuator operable for cooperating with the guideway for displacing and positioning the carriage along the first path.
3. The positioning system as in claim 2, the actuator being an electrical motor, a servo motor and a stepper motor.
4. The positioning system as in claim 2, the guideway being a leadscrew rotationally displaceable about its length by the actuator for displacing the carriage therealong.
5. The positioning system as in claim 2, the guideway being a rackrail coupled to the actuator in a rack-and-pinion configuration.

6. The positioning system as in claim 2, the guideway comprising one of a belt-pulley assembly and a cable-pulley assembly configured with the actuator and coupled to the carriage for displacing the carriage along the first path.
7. The positioning system as in claim 1, each of the plurality of RFID tags being one of a chip-based and a chipless tag.
8. The positioning system as in claim 1, further comprising:
a panel defining the second path and whereto the plurality of RFID tags are coupled for detection by the RFID reader.
9. The positioning system as in claim 1, further comprising:
a manipulator coupled to the carriage for receiving at least one article and for spatially manipulating the at least one article.
10. The positioning system as in claim 1, the manipulator being adapted for loading and unloading the at least one article from a surface whereon the at least one article is disposable.

11. A positioning system comprising:

- a carriage for supporting at least one article;
 - a first actuator assembly defining a first path and a second path therealong and being operable for displacing and positioning the carriage along the first path;
 - a first radio frequency identification (RFID) reader coupled to the carriage and configured to travel along the second path when the carriage is displaced along the first path, the second path being substantially parallel the first path;
 - a first plurality of RFID tags positioned along the second path, each of the first plurality of RFID tags having a unique address being readable the first RFID reader when the first RFID reader is positioned adjacent thereto, such that the location of the carriage along the first path is indicatable by the unique address readable by the first RFID reader from each of the first plurality of RFID tags;
 - a second actuator assembly defining a third path and a fourth path therealong and being operable for displacing and positioning the first actuator assembly along the third path;
 - a second radio frequency identification (RFID) reader coupled to the first actuator assembly and configured to travel along the fourth path when the first actuator assembly is displaced along the third path, the fourth path being substantially parallel the third path; and
 - a second plurality of RFID tags positioned along the fourth path, each of the second plurality of RFID tags having a unique address being readable by the second RFID reader when the second RFID reader is positioned adjacent thereto, such that the location of the first actuator assembly along the third path is indicatable by the unique address readable by the second RFID reader from each of the second plurality of RFID tags,
- wherein each of the first actuator assembly and the second actuator assembly is signal communicable with a controller for control thereby to displace the carriage along the first path and the first actuator assembly along the third path, and the first RFID reader and the second RFID reader is signal communicable with the controller for providing the unique address readable from each of the first plurality of RFID tags and each of the second plurality of RFID tags thereto to determine location of the carriage along the first path and the first actuator assembly along the third path.

12. The positioning system as in claim 11, each of the first actuator assembly and the second actuator assembly comprising:
 - a guideway for guiding the respective one of the carriage along one of the first path and the first actuator assembly along the third path; and
 - an actuator operable for cooperating with the guideway for displacing and positioning one of the carriage along the first path and the first actuator assembly along the third path.
13. The positioning system as in claim 12, the actuator of at least one of the first actuator assembly and the second actuator assembly being an electrical motor, a servo motor and a stepper motor.
14. The positioning system as in claim 12, the guideway of at least one of the first actuator assembly and the second actuator assembly being a leadscrew rotationally displaceable about its length by the actuator for displacing one of the carriage and the first actuator assembly therealong.
15. The positioning system as in claim 12, the guideway of at least one of the first actuator assembly and the second actuator assembly being a rackrail coupled to the actuator in a rack-and-pinion configuration.
16. The positioning system as in claim 12, the guideway of at least one of the first actuator assembly and the second actuator assembly comprising one of a belt-pulley assembly and a cable-pulley assembly configured with the actuator and coupled to the carriage for displacing the carriage along the first path.
17. The positioning system as in claim 11, each of the first plurality of RFID tags and each of the second plurality of RFID tags being one of a chip-based and a chipless tag.

18. The positioning system as in claim 11, further comprising:
 - a first panel defining the second path and where to the first plurality of RFID tags are coupled for detection by the first RFID reader; and
 - a second panel defining the fourth path and where to the second plurality of RFID tags are coupled for detection by the second RFID reader.
19. The positioning system as in claim 11, further comprising:
 - a manipulator coupled to the carriage for receiving at least one article and for spatially manipulating the at least one article.
20. The positioning system as in claim 11, the manipulator being adapted for loading and unloading the at least one article from a surface whereon the at least one article is disposable.