configured as an aisle with storage locations on either side of the aisle and the vehicles travelling along a path within the aisle. The capacity of the system can be increased by making the aisle taller or longer. Alternatively, additional aisles may be added. However, in many situations, either the space may not be available for such as system or the cost may exceed the benefit of the increased capacity. Accordingly, in some applications there exists a need for an ASR system with that increases the storage density at a lower cost and in a smaller foot print, without significantly affecting throughput of the system.

Summary

[005] In light of the foregoing, in an example, a system provides a method and apparatus for storing and retrieving items. The system includes a plurality of storage locations or destination areas, and a plurality of delivery vehicles for delivering items to or retrieving items from the destination areas. The delivery vehicles follow paths to the destination areas.

[005a] According to an aspect, the present disclosure refers to an automated storage and retrieval system defining a plurality of storage locations for receiving items, comprising: a plurality of independently operable vehicles for delivering and retrieving items, wherein each vehicle comprises an on-board motor for driving the vehicle; a track for guiding the vehicles; a plurality of storage locations disposed along the track so that the track is configured to guide the vehicles to the storage locations, wherein a plurality of the storage locations are vertically spaced apart from one another forming a first vertical column and a plurality of the storage locations are vertically spaced apart from one another forming a second vertical column and the first vertical column is separated from the second vertical column to form an aisle between the first vertical column and the second vertical column and wherein the vehicles are vertically displaceable in the aisle along the track; a plurality of storage containers wherein each storage location is configured to receive a plurality of the storage containers so that a first container positioned in a first storage location is adjacent the aisle and a second container

positioned in the first storage location is spaced from the aisle by the first container; wherein the first storage container comprises a first connector at a first end and the second storage container comprises a second connector at a second end, wherein the second connector is releasably connectable with the first connector to releasably connect the first and second storage containers at the first storage location; wherein each vehicle comprises a transfer mechanism for transferring the first and second storage containers between the vehicle and the first storage location wherein the releasable connection between the first and second containers is operable to displace the second storage container when the transfer mechanism displaces the first storage container.

[005b] According to another aspect, the present disclosure refers to a material handling system for storing or retrieving a plurality of items, comprising: a plurality of vehicles for delivering and retrieving items, wherein each vehicle comprises an on-board motor for driving the vehicle; a first rack of storage locations; a second rack of storage locations spaced apart from the first rack with an aisle between the first and second racks, wherein the vehicles are displaceable vertically and horizontally within the aisle; a plurality of storage containers wherein each storage location is configured to receive a plurality of the storage containers; wherein a first of the storage containers comprises a first connector at a first end and a second of the storage containers comprises a second connector at a second end, wherein the first connector is releasably connectable with the second connector to releasably connect the first and second storage containers at one of the storage locations; wherein each vehicle comprises a transfer mechanism for transferring the first and second storage containers between the vehicle and the one storage locations wherein the releasable connection between the first and second containers is operable to displace the second storage container when the transfer mechanism displaces the first storage container.

[006] In an example, the present disclosure may also provide an improved material handling system in which storage containers in which independently operable vehicles are operable to deliver storage containers into and retrieve storage containers from

storage locations having sufficient depth to accommodate multiple storage containers in a horizontal orientation with one storage container positioned behind another. The system may include a track for guiding the vehicles along the track to the storage locations. Additionally, the storage locations may be arranged so that the storage locations are vertically separated from one another. For example, the storage locations may be configured as an array of storage locations in a plurality of rows or columns. The storage containers may also be releasably connectable with adjacent storage containers so that displacement of a first storage container in a first storage location displaces a second storage container within the first storage location.

[007] In an example, the present disclosure also provides a material handling system for storing or retrieving a plurality of items that includes a plurality of independently operable vehicles for delivering and retrieving items to a destination. Optionally, the system includes a track for guiding the vehicles. The system includes a plurality of storage locations

wherein a plurality of the storage locations are vertically spaced apart from one another. The storage locations may be positioned along the track is the system includes a track. The system also includes a plurality of storage containers. One or more of the storage locations are configured to receive a plurality of the storage containers. The storage containers include connectors for interconnecting connecting storage containers stored adjacent one another in a storage location. The connectors connect the storage containers so that displacement of one of the containers in a storage location discloses the interconnected container or containers in the same storage location. The vehicles may include a transfer mechanism configured to transfer storage containers between the vehicle and storage locations. The transfer mechanism may be operable to displace first and second interconnected containers when the first or second container is displaced relative to the vehicle.

[008] According to another example the material handling system may include a track system having a plurality of generally horizontal track sections spaced apart from one another. The track system may also include a plurality of generally vertical track sections spaced apart from one another. The vertical and horizontal track sections may be interconnected to form a track loop.

[009] According to yet another example, the present invention provides storage containers for a material handling system in which the storage containers have first and second connectors that are connectable to provide a connection that impedes horizontal displacement of a first storage container relative to a second storage container. The connection of the first and second connectors may be sufficient to support the weight of the second container during horizontal displacement such that displacing the first container horizontally displaces the second container horizontally when the first and second connectors are connected. Additionally, the connection of the first and second connectors may permit vertical displacement of the first container relative to the second container.

[0010] According to another example, the system may provide storage containers having first and second connectors for releasably connecting first and second storage

containers wherein the first and second connectors are configured such that displacement of the first connector vertically relative to the second connector disconnects the first connector from the second connector.

[0011] The present disclosure further provides storage containers having first and second connectors for interconnecting the storage containers with one another, wherein the first connector comprises a tongue and the second connector comprises a groove configured to receive the tongue.

[0012] According to another example, the present disclosure provides a storage location in which first and second containers are located and the storage location is configured to house the first and second containers in horizontal alignment in which the first container is positioned in front of the second container. Optionally, the storage location may be configured so that when a delivery vehicle is aligned with the first container, the first container separates the second vehicle from the delivery vehicle.

[0013] The present disclosure further provides a material handling system having a plurality of storage locations each configured to store a plurality of storage containers. Optionally, the storage locations each have a depth and first and second one of the storage containers each have a length and the depth of the one storage location is at least as long as the combined length of the first and second containers.

[0014] According to another example, the present disclosure provides delivery vehicles for a material handling system and each vehicle has a generally planar platform for receiving the containers.

[0015] According to yet another example, the present disclosure provides a material handling system that includes a first rack of storage locations spaced apart from a second rack of storage locations so that an aisle is formed between the first rack and the second rack.

[0016] Optionally, the material handling system may include a pick station disposed at an end of aisle. Vehicles may deliver storage containers to the pick station so that operators can retrieve items from the storage containers at the pick station.

[0017] According to another example, the system may include vehicles that are displaceable within an aisle. The vehicles may comprise drive wheels that engage a track and racks of storage locations may be positioned relative to the track so that storage containers project horizontally into the aisle beyond the track.

[0018] According to a further example, the present disclosure provides containers for a material handling system and the containers contain one or more engagement elements configured to engage a transfer mechanism of vehicles that deliver the containers.

[0019] According to a further example, the present disclosure provides a container for use in a material handling system for storing or retrieving a plurality of items. The container includes a plurality of walls and first and second connectors configured to be connectable to form a releasable connection between two of the storage containers. The storage container may include an engagement element configured to cooperate with a transfer mechanism of the material handling system to displace the storage container horizontally. Additionally, the material handling system may include storage locations and the container may have a length that is at less than or equal to half the depth of the storage location so that two of the containers will fit in the storage location when the two containers are connected together. The first and second connectors may also be connectable to form a releasable connection.

[0020] Still further, the present disclosure may provide a combination of first and second containers for use in a material handling system. The two containers may be similarly configured so that a first connector of the first container is connectable with a second connector of the second container to connect the two containers such that horizontal displacement of the first container by a transfer mechanism of a delivery vehicle displaces the second container. Optionally, the connection of the first connector of the first container and the second connection of the second container impedes horizontal displacement of the first container relative to the second container.

[0021] In an example, the present disclosure also provides a method for storing and retrieving containers from a plurality of storage locations.

The method includes the step of driving a first vehicle with a first storage container along a transport path among a plurality of

storage locations. The first storage container is unloaded from the first vehicle into a first storage location. The first storage container is releasably connected with a second storage container in the first storage location. The first vehicle is then displaced away from the first storage location after the step of unloading.

[0022] According to another example, a method for storing and retrieving containers includes the step of disconnecting a first storage container in a storage location from a second storage container in the storage location. Optionally, the step of releasably connecting comprises displacing the first container vertically relative to the second container.

[0023] According to a further example, a method for storing and retrieving containers using vehicles includes the step of disconnecting first and second connected containers by displacing the first container vertically relative to the second container.

[0024] According to yet another example, a method for storing and retrieving containers using vehicles includes the step of loading a first storage container onto a vehicle after a step of releasably connecting the first storage container and a second storage container such that during the step of loading the first storage container pulls the second storage container toward the vehicle.

[0025] According to a further example, a method for storing and retrieving containers using vehicles includes the step of unloading a first storage container into a storage location. The step of unloading comprises pushing the first storage container against a second storage container to drive the second container deeper into the storage location. The step of unloading may include the step of actuating an unloading mechanism on the first vehicle to drive the first storage container off the first vehicle.

Brief Description of the Drawings

[0026] The foregoing summary and the following detailed description of the preferred embodiments of the present invention will be best understood when read in conjunction with the appended drawings, in which:

CLAIMS

What is claimed is:

1. An automated storage and retrieval system defining a plurality of storage locations for receiving items, comprising:

a plurality of independently operable vehicles for delivering and retrieving items, wherein each vehicle comprises an on-board motor for driving the vehicle;

a track for guiding the vehicles;

a plurality of storage locations disposed along the track so that the track is configured to guide the vehicles to the storage locations, wherein a plurality of the storage locations are vertically spaced apart from one another forming a first vertical column and a plurality of the storage locations are vertically spaced apart from one another forming a second vertical column and the first vertical column is separated from the second vertical column to form an aisle between the first vertical column and the second vertical column and wherein the vehicles are vertically displaceable in the aisle along the track;

a plurality of storage containers wherein each storage location is configured to receive a plurality of the storage containers so that a first container positioned in a first storage location is adjacent the aisle and a second container positioned in the first storage location is spaced from the aisle by the first container;

wherein the first storage container comprises a first connector at a first end and the second storage container comprises a second connector at a second end, wherein the second connector is releasably connectable with the first connector to releasably connect the first and second storage containers at the first storage location;

wherein each vehicle comprises a transfer mechanism for transferring the first and second storage containers between the vehicle and the first storage location wherein the releasable connection between the first and second containers is operable to displace the second storage container when the transfer mechanism displaces the first storage container.

2. The apparatus of claim 1 wherein the track comprises:

a plurality of horizontal track sections spaced apart from one another and extending in a generally horizontal direction;

a plurality of vertical track sections spaced apart from one another and extending in a generally vertical direction, wherein the vertical track sections intersect the horizontal track sections to form a loop; and

an intersection where one of the horizontal track sections intersects one of the vertical track sections, wherein the intersection provides a first path in a generally horizontal direction and a second path in a generally vertical direction.

3. The apparatus of claim 1 wherein the connection of the first and second connectors impedes horizontal displacement of the first container relative to the second container.

4. The apparatus of claim 3 wherein the connection of the first and second connectors is sufficient to support the weight of the second container during horizontal displacement such that displacing the first container horizontally displaces the second container horizontally when the first and second connectors are connected.

5. The apparatus of claim 3 or 4 wherein the connection of the first and second connectors permits vertical displacement of the first container relative to the second container.

6. The apparatus of any of claims 3-5 wherein the first and second connectors are configured such that displacement of the first connector vertically relative to the second connector disconnects the first connector from the second connector.

7. The apparatus of any of claims 1-6 wherein the first connector comprises a tongue and the second connector comprises a groove configured to receive the tongue.

8. The apparatus of any of claims 1-7 wherein the first storage location is configured to house the first and second containers in horizontal alignment wherein the first container is positioned in front of the second container.

9 The apparatus of any of claims 1-8 wherein the first storage location has a depth and the first and second container each have a length, wherein the depth of the first storage location is at least as long as the combined length of the first and second containers.

10. The apparatus of any of claims 1-9 wherein the vehicles comprise a generally planar platform for receiving the containers.

11. The apparatus of claim 10 wherein a pick station is disposed at an end of the aisle, wherein the vehicles deliver containers to the pick station so that operators can retrieve items from the containers at the pick station.

12. The apparatus of claim 10 or 11 wherein the vehicles are displaceable within the aisle.

13. The apparatus of claim 12 wherein the vehicles comprise drive wheels that engage the track and wherein the racks are positioned relative to the track so that the containers project horizontally into the aisle beyond the track.

14. The apparatus of any of claims 1-13 wherein the containers contain one or more engagement elements configured to engage the transfer mechanism of the vehicles.

15. A material handling system for storing or retrieving a plurality of items, comprising:

a plurality of vehicles for delivering and retrieving items, wherein each vehicle comprises an on-board motor for driving the vehicle;

a first rack of storage locations;

a second rack of storage locations spaced apart from the first rack with an aisle between the first and second racks, wherein the vehicles are displaceable vertically and horizontally within the aisle;

a plurality of storage containers wherein each storage location is configured to receive a plurality of the storage containers;

wherein a first of the storage containers comprises a first connector at a first end and a second of the storage containers comprises a second connector at a second end, wherein the first connector is releasably connectable with the second connector to releasably connect the first and second storage containers at one of the storage locations;

wherein each vehicle comprises a transfer mechanism for transferring the first and second storage containers between the vehicle and the one storage locations wherein the releasable connection between the first and second containers is operable to displace the second storage container when the transfer mechanism displaces the first storage container.

16. The apparatus of claim 15 comprising a track for guiding the vehicles, wherein the track comprises:

a plurality of horizontal track sections spaced apart from one another and extending in a generally horizontal direction;

a plurality of vertical track sections spaced apart from one another and extending in a generally vertical direction, wherein the vertical track sections intersect the horizontal track sections to form a loop; and

an intersection where one of the horizontal track sections intersects one of the vertical track sections, wherein the intersection provides a first path in a generally horizontal direction and a second path in a generally vertical direction.

17. The apparatus of claim 15 or 16 wherein the connection of the first and second connectors impedes horizontal displacement of the first container relative to the second container.

18. The apparatus of claim 17 wherein the connection of the first and second connectors is sufficient to support the weight of the second container during horizontal displacement such that displacing the first container horizontally displaces the second container horizontally when the first and second connectors are connected.

19. The apparatus of claim 17 or 18 wherein the connection of the first and second connectors permits vertical displacement of the first container relative to the second container.

20. The apparatus of any of claims 17-19 wherein the first and second connectors are configured such that displacement of the first connector vertically relative to the second connector disconnects the first connector from the second connector.

21. The apparatus of any of claims 15-20 wherein the first connector comprises a tongue and the second connector comprises a groove configured to receive the tongue.

22. The apparatus of any of claims 15-21 wherein the storage location in which the first and second containers are located is configured to house the first and second containers in horizontal alignment wherein the first container is positioned in front of the second container.

23. The apparatus of claim 22 wherein when one of the vehicles is aligned with the first container, the first container separates the second vehicle from the vehicle.

24. The apparatus of any of claims 15-23 wherein the one of the storage locations has a depth and the first and second container each have a length, wherein the depth of the one storage location is at least as long as the combined length of the first and second containers.

25. The apparatus of any of claims 15-24 wherein the vehicles comprise a generally planar platform for receiving the containers.

26. The apparatus of any of claims 15-25 wherein a pick station is disposed at an end of the aisle, wherein the vehicles deliver containers to the pick station so that operators can retrieve items from the containers at the pick station.

27. The apparatus of claim 16 wherein the vehicles comprise drive wheels that engage the track and wherein the racks are positioned relative to the track so that the containers project horizontally into the aisle beyond the track.

28. The apparatus of any of claims 15-27 wherein the containers contain one or more engagement elements configured to engage the transfer mechanism of the vehicles.