to customers. Systems that rely upon human effort to store and retrieve products in such situations tend to require more time to pick the required products and tend to have a higher percentage of errors (i.e. retrieval of incorrect items). Therefore, there is a growing need for automated systems designed to automatically store and retrieve items to improve the efficiency of order fulfillment.

Summary of the Invention

[004] In light of the foregoing, a system provides a method and apparatus for handling items, items. According to one embodiment the system includes a plurality of storage locations, and a plurality of delivery vehicles for delivering items to or retrieving items from the storage locations. A track guides the delivery vehicles to the storage locations. The system may also include a controller that controls the operation of the delivery vehicles based on information determined for each item to be stored. Additionally, the track may include a plurality of interconnected vertical and horizontal sections so that the vehicles may travel along a continuous path changing from a horizontal direction to a vertical direction. Further, the vehicles may be driven such that the orientation of an item on the vehicle stays constant as the vehicles changes from a horizontal direction of travel to a vertical direction of travel.

[005] According to another embodiment, the present invention provides a method for storing and retrieving items. The method includes the steps of storing a plurality of items in a plurality of storage locations and retrieving items from the storage locations. The retrieved items are conveyed to transfer locations. The method also includes controlling or driving a plurality of picking vehicle along a track. The track may have interconnected horizontal and vertical sections. The track may form a loop and the loop may be a vertically oriented loop. The step of

controlling the vehicles may comprise the step of circulating the picking vehicles around a track between one or more picking stations and the transfer locations. The step of circulating the picking vehicles may include driving one of the picking vehicles to one of the transfer locations and transferring one of the retrieved items from the transfer location onto the picking vehicle. The picking vehicle may then be driven from the transfer locations to one of the picking stations. At the picking station, the picking vehicle may be stopped so that the item can be picked off the picking vehicle. After an item is picked, the picking vehicle may be advanced away from the picking station to one of the transfer locations. Optionally, the picking vehicle is controlled so that the horizontal orientation of the picking vehicle is maintained as the picking vehicle drives from the first connecting leg to the lower leg.

[006] According to yet another embodiment, the present invention provides a material handling system that includes a storage and retrieval system having a plurality of storage locations for storing items and means for storing and retrieving items operable to retrieve items from the storage locations and move the items to one or more transfer locations. The system further includes mean for picking operable to transfer items to and from transfer locations. Optionally, the means for picking may include a plurality of picking vehicles for transporting items between an input/output station and one of the transfer locations. The means for picking may also include means for controlling the vehicles so that the vehicles are driven to an area adjacent one of transfer locations to transfer items between the picking vehicle and the transfer location. The vehicles may be controlled so that the vehicles are driven to the input/output station and maintained at the input/output station to allow removal of one of the items on the picking vehicle. Optionally, each vehicle may comprise a motor for driving the means for driving the vehicle.

[007] According to a further embodiment, the present invention provides a material handling system that includes a storage and retrieval system for transferring items to a plurality of transfer locations and a separate input/output system for transferring items to and from the transfer locations. Optionally, the storage and retrieval system includes a plurality of storage locations for storing items. The storage and retrieval system may also include a plurality of independently operable displaceable storage and retrieval vehicles operable to retrieve items from the storage locations and convey the items to one or more of the transfer locations. Optionally, the input/output system includes a plurality of picking vehicles for transporting items. The input/output system may also include a picking track for guiding the picking vehicles. Optionally, the track comprises a loop. There may also be an input/output station along the track where an item can be removed from one of the delivery vehicles. Additionally, the picking vehicles may optionally circulate around the loop between the input/output station and the one or more transfer locations. Additionally, optionally the picking vehicles may be configured differently than the optional displaceable storage and retrieval vehicles. The system may control operation of the picking vehicles so that the vehicles are driven along the picking track adjacent one of transfer locations to transfer items between the picking vehicle and the transfer location.

[007a] According to a first aspect, the present invention provides a material handling system, comprising: a storage and retrieval system, comprising: a plurality of storage locations for storing items; a displaceable storage and retrieval device movable between the plurality of storage locations and operable to retrieve items from the storage locations and move the items to one or more transfer locations; a picking system operable to transport items to and from the one or more transfer locations, wherein the picking system comprises: a plurality of picking

vehicles for transporting items; a picking track for guiding the picking vehicles, wherein the track comprises a loop; an input/output station along the track configured so that an item can be removed from one of the delivery vehicles; wherein the picking track is configured so that the picking vehicles are operable to circulate around the loop between the input/output station and one or more of the transfer locations; wherein each vehicle comprises a drive system for driving the vehicle around the picking track and a motor for driving the drive system; wherein the picking system is configured to control operation of the picking vehicles so that the vehicles are driven along the track to an area adjacent one of transfer locations to transfer items between the picking vehicle and the storage and retrieval system at the transfer location; and wherein the picking system is configured to control operation of the picking vehicles so that the picking vehicles are driven from one of the transfer locations to the input/output station to allow removal of items from the picking vehicle.

[007b] According to a second aspect, the present invention provides a material handling system, comprising: a storage and retrieval system, comprising: a plurality of storage locations for storing items; a plurality of independently operable displaceable storage and retrieval vehicles operable to retrieve items from the storage locations and convey the items to one or more transfer locations, wherein the storage and retrieval vehicles are displaceable between the plurality of storage locations; an input/output system operable to transfer items to and from the one or more transfer locations, wherein the input/output system comprises: a plurality of picking vehicles for transporting items; a picking track for guiding the picking vehicles, wherein the track comprises a loop; an input/output station along the track configured to facilitate removal of an item from one of the delivery vehicles; wherein the picking vehicles circulate around the loop between the input/output station and the one or more transfer locations; wherein the picking vehicles are configured

differently than the displaceable storage and retrieval vehicles.

Brief Description of the Drawings

[008] 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:

[009] Figure 1 is a perspective view of a storing and retrieving apparatus