DESCRIPTION

MOVABLE SHELF DEVICE

Technical Field

[0001] The present invention relates to a movable shelf device that includes a first shelf and a second shelf that are movable relative to each other.

Background Art

[0002] JP 2017-43461A discloses a movable shelf device that includes a plurality of shelves in a first direction (in which the shelves are aligned) parallel to a horizontal surface, and in which at least one of the shelves is movable in the first direction. When the shelf is moved, an inter-shelf passage that an operator and the like can enter is formed between the moved shelf and another shelf opposed to this shelf. The movable shelf device is provided with an obstacle detection device that prevents the operator or the like from being clamped between a shelf and a shelf, which are opposed to each other with the inter-shelf passage interposed therebetween, if a shelf is moved in a direction in which the inter-shelf passage is narrowed from a state in which the inter-shelf passage is formed. The detection range of the obstacle detection device is set to the entire region of the inter-shelf passage when the inter-shelf passage is formed. Also, in a state in which an obstacle has been detected by the obstacle detection device, the movable shelf device controls the shelf to be prevented from moving in the direction in which the inter-shelf passage is narrowed. On the other hand, if the entire region of the inter-shelf passage is the obstacle detection range while the shelf is moved in the direction in which the inter-shelf passage is narrowed, the obstacle detection device will detect the shelf as an obstacle. Therefore, while the shelf is moved in the direction in which the inter-shelf passage is narrowed, the obstacle detection range of the obstacle detection device is set in the vicinity of one of the shelves that are opposed to each other.

[0003] When the detection range of the obstacle detection device is set in such a manner, even if the shelf starts moving in the direction in which the inter-shelf passage is narrowed and then an obstacle such as an operator enters the inter-shelf passage, there is a possibility that this entrance position is out of the detection range. As a result, the detection of the obstacle may be delayed,

and there is a risk that an obstacle that has entered the inter-shelf passage may come into contact with the shelf. Thus, it is desirable that an obstacle can be appropriately detected regardless of the state of the shelf being stopped or moving.

Prior Art Document

Patent Document

[0004] Patent Document 1: JP 2017-43461A

Disclosure of the Invention

Problem to be Solved by the Invention

[0005] In view of the above-described circumstances, in a movable shelf device provided with a plurality of shelves that are movable relative to each other, it is desirable to appropriately detect an obstacle present in an inter-shelf passage formed between a shelf and a shelf on a steady basis.

Means for Solving Problem

[0006] In view of the above-described circumstances, as a preferred aspect, a movable shelf device that includes a first shelf and a second shelf that are opposed to each other in a first direction parallel to a horizontal surface, and in which the first shelf and the second shelf are provided so as to be movable relative to each other in the first direction, and an inter-shelf passage is formed between the first shelf and the second shelf in a state in which the first shelf and the second shelf are spaced away from each other, the movable shelf device including: an obstacle sensor configured to detect, when the inter-shelf passage is formed, an obstacle that is present in the inter-shelf passage; and a range sensor configured to detect an inter-shelf distance, which is a distance between the first shelf and the second shelf that are opposed to each other in the first direction, wherein the obstacle sensor and the range sensor are constituted by a single active sensor configured to detect a subject by transmitting light and receiving reflected light from the subject, and a detection range of the obstacle sensor is dynamically and variably set in accordance with the inter-shelf distance.

[0007] With this configuration, the inter-shelf distance that varies with the relative movement between the first shelf and the second shelf is detected, and the detection range is dynamically and variably set in accordance with this

inter-shelf distance. Accordingly, it is possible to set substantially the entire region of the inter-shelf passage that is to be gradually narrowed as the detection range, not only before the first shelf and the second shelf move relative to each other, but also after the start of the relative movement of the first shelf and the second shelf. As a result, it is possible to appropriately detect an obstacle that has entered the inter-shelf passage over the entire period from before the first shelf and the second shelf move relative to each other until the end of the relative movement between the first shelf and the second shelf. Furthermore, since the obstacle sensor and the range sensor are constituted by a single active sensor, the system configuration is also simplified, and the cost can be reduced. Thus, with this configuration, in a movable shelf device provided with a plurality of shelves that are movable relative to each other, it is possible to appropriately detect an obstacle present in an inter-shelf passage formed between a shelf and a shelf on a steady basis.

[0008] Further features and advantages of the movable shelf device will become apparent from the following description relating to embodiments explained with reference to the drawings.

Brief Description of the Drawings

[0009] FIG. 1 is a plan view schematically illustrating a configuration of a movable shelf device.

FIG. 2 is a side view schematically illustrating the configuration of the movable shelf device.

FIG. 3 is a block diagram schematically illustrating the configuration of the movable shelf device.

FIG. 4 illustrates an example of a procedure of setting a detection range.

FIG. 5 illustrates another example of the procedure of setting the detection range.

FIG. 6 illustrates the principle of detecting reflective plates.

FIG. 7 is a plan view of the movable shelf device, illustrating an example in which inter-shelf passages are formed at two positions at the same time.

FIG. 8 illustrates a comparative example of the detection range before movable shelves opposed to each other are moved.

FIG. 9 illustrates a comparative example of the detection range when one of the movable shelves opposed to each other is moved.

FIG. 10 illustrates a comparative example of the detection range when the other one of the movable shelves opposed to each other is moved.

Best Mode for Carrying out the Invention

[0010] Hereinafter, embodiments of a movable shelf device will be described with reference to the drawings. FIG. 1 is a plan view schematically illustrating a configuration of a movable shelf device 10, and FIG. 2 is a side view schematically illustrating the configuration of the movable shelf device 10. As shown in FIGS. 1 and 2, the movable shelf device 10 includes, as shelves 1 for storing articles, fixed shelves 2 fixed to a floor, and movable shelves 3 that are guided by rails 4 laid on the floor and are movable in a moving direction M (first direction) parallel to a horizontal surface. One fixed shelf 2 is provided on each of the two end-sides of the rails 4. A first fixed shelf 21 is provided at the ends of the rails 4 on one side, and a second fixed shelf 22 is provided at the ends of the rails 4 on the other side. In the present embodiment, three movable shelves 3 are provided between the first fixed shelf 21 and the second fixed shelf 22. The movable shelves 3 include a first movable shelf 31, a second movable shelf 32, and a third movable shelf 33 in that order from the first fixed shelf 21 side. Of course, the number of movable shelves 3 may be one, or four or more. Also, instead of the fixed shelves 2 being provided at the two end-sides of the rails 4, a wall may be provided only at either of the end-sides of the rails 4 or at both of the end-sides of the rails 4.

[0011] The fixed shelves 2 each include a storage portion for storing articles only on the side opposed to the movable shelf 3, that is, on one side in the moving direction M. The movable shelves 3 each include storage portions for storing articles on the respective sides opposed to the adjacent shelves 1 in the moving direction M. In other words, each of the movable shelves 3 includes a first storage shelf 3a on which a storage portion directed to the first fixed shelf 21 is formed, and a second storage shelf 3b on which a storage portion directed to the second fixed shelf 22 is formed. As shown in FIG. 2, the first storage shelf 3a and the second storage shelf 3b are fixed to an upper portion of a carriage portion 6. That is to say, the movable shelf 3 is constituted by the first storage shelf 3a, the second storage shelf 3b, and the carriage portion 6. As shown in a block diagram of FIG. 3, the carriage portion 6 includes a motor 12 and wheels 13, and is movable along the rails 4 in the moving direction M. Therefore, the first storage shelf 3a and the second storage shelf 3b move in

accordance with the movement of the carriage portion 6.

[0012] As described above, the movable shelves 3 are guided by the rails 4 and are movable in the moving direction M parallel to the horizontal surface. FIGS. 1 and 2 exemplify a mode in which the first movable shelf 31 is moved to a position closest to the first fixed shelf 21, and the second movable shelf 32 and the third movable shelf 33 are moved to positions closest to the second fixed shelf 22, so that an inter-shelf passage E is formed between the first movable shelf 31 and the second movable shelf 32. The distance between shelves 1 opposed to each other in the moving direction M, when the shelves 1 adjacent in the moving direction M are closest to each other, is defined as a first inter-shelf distance D1, and the first inter-shelf distance D1 is basically about 50 to 100 millimeters. Also, the distance between the shelves 1 opposed to each other in the moving direction M when the inter-shelf passage E is formed is defined as a second inter-shelf distance D2, and the second inter-shelf distance D2 is basically about 1 to several meters. The second inter-shelf distance D2 is set to a length such that a person (operator) or a working vehicle (including both an automatically operated vehicle and a manually operated vehicle) such as a carriage can enter the inter-shelf passage E, and an article can be transferred between the operator or the working vehicle located in the inter-shelf passage E and the storage portion.

[0013] The block diagram of FIG. 3 schematically shows the configuration of the movable shelf device 10. Each of the movable shelves 3 includes the wheels 13 that cause the carriage portion 6 to travel, the motor 12 that drives the wheels 13, a rotation sensor 14 (here, an encoder is exemplified) that detects the rotation of the wheels 13, an open-close control device 11 that controls the motor 12 to activate the corresponding movable shelf 3 and opens/closes the inter-shelf passage E, and an inter-shelf sensor 5, which will be described later. The open-close control device 11 can perform feedback control on the motor 12 based on the detection result of the rotation sensor 14.

[0014] Although not shown in the diagrams, each of the movable shelves 3 also includes an operation switch for moving this movable shelf 3 or stopping the movement thereof, and a display portion (an indicator with an LED or the like, for example) that indicates the state of this movable shelf 3. The display portion preferably indicates the state such as during-movement, stopped, movement possible (stopped), and movement forbidden (stopped).

[0015] The movable shelf device 10 further includes a movable shelf control

device 20, and performs coordinated control on the movable shelves 3. For example, a configuration is also possible in which the movable shelves 3 can be moved in accordance with an instruction from the movable shelf control device 20, without requiring the operator to perform an operation with the operation switches provided on the respective movable shelves 3.

[0016] The movable shelf device 10 includes an obstacle sensor (which is the later-described inter-shelf sensor 5) that detects an obstacle B (see FIG. 6) present in the inter-shelf passage E, the obstacle sensor being described in detail later. For example, in a case where a movable shelf 3 is to be moved in a direction in which the inter-shelf passage E is narrowed, if the presence of the obstacle B in the inter-shelf passage E is detected before the start of the movement, the open-close control device 11 will forbid the movement of the movable shelf 3. Also, if the obstacle B is detected after the start of the movement of the movable shelf 3, the open-close control device 11 will stop the movable shelf 3. That is to say, the open-close control device 11 restricts the movement of the movable shelf 3 in the direction in which the inter-shelf passage E is narrowed if the obstacle B is present in the inter-shelf passage E.

[0017] The inter-shelf sensor 5 is provided on the shelves 1 (here, the movable shelves 3), but as described later, it is not always the case where the obstacle B is detected by the inter-shelf sensor 5 provided on the movable shelf 3 to be moved. Accordingly, the open-close control device 11 preferably transmits information indicating the detection of the obstacle B to the movable shelf control device 20. Alternatively, the information indicating the detection of the obstacle B may be directly transmitted from the inter-shelf sensor 5 to the movable shelf control device 20.

[0018] If the obstacle B is detected by one of the inter-shelf sensors 5 other than the inter-shelf sensor 5 of the movable shelf 3 to be moved, it is preferable that the open-close control device 11 of the movable shelf 3 to be moved be notified of the presence of the obstacle B via the movable shelf control device 20, and forbid the movement of this movable shelf 3. Alternatively, the movable shelf control device 20 may give a movement forbidding command to the movable shelf 3 to be moved. Alternatively, when the information indicating the detection of the obstacle B is directly transmitted from the inter-shelf sensor 5 to the movable shelf control device 20, a configuration is also possible in which the open-close control device 11 of the movable shelf 3 to be moved restricts the movement of this movable shelf 3 in accordance with the

command given from the movable shelf control device 20, regardless of whether or not the inter-shelf sensor 5 that has detected the obstacle B is provided on the movable shelf 3 to be moved. If the obstacle B is detected in the inter-shelf passage E in this manner, either or both of the open-close control device 11 and the movable shelf control device 20 can restrict the movement of the movable shelf 3 (can forbid the movement, or stop the movement if the movable shelf 3 is moving).

[0019] As described with reference to FIGS. 1 to 3, the movable shelf device 10 includes the first shelf and the second shelf that are opposed to each other in the moving direction M (first direction) parallel to the horizontal surface, and has a configuration such that the first shelf and the second shelf are provided so as to be movable relative to each other in the moving direction M, and the inter-shelf passage E is formed between the first shelf and the second shelf in a state in which the first shelf and the second shelf are spaced away from each other. Here, the first shelf and the second shelf correspond to any of the shelves 1. For example, by letting the first shelf be the first fixed shelf 21 and the second shelf be the first movable shelf 31, the inter-shelf passage E is formed between the first fixed shelf 21 and the first movable shelf 31 as shown in FIGS. 1 and 2. Also, by letting the first shelf be the first movable shelf 31 and the second shelf be the second movable shelf 32, the inter-shelf passage E is formed between the first movable shelf 31 and the second movable shelf 32. Similarly, the inter-shelf passage E can be formed between the second movable shelf 32 and the third movable shelf 33, or between the third movable shelf 33 and the second fixed shelf 22. Also, in the mode shown in FIGS. 1 and 2 for example, the correspondence of the first shelf and the second shelf may be inverted by letting the first shelf be the first movable shelf 31 and the second shelf be the first fixed shelf 21. The same applies to the other examples. Also, the present invention does not preclude a configuration in which inter-shelf passages E are formed at two or more positions at the same time. For example, as shown in FIG. 7, the inter-shelf passages E may be formed at two positions between the first movable shelf 31 and the second movable shelf 32, and between the second movable shelf 32 and the third movable shelf 33.

[0020] The movable shelf device 10 includes: the obstacle sensor that detects, when the inter-shelf passage E is formed, the obstacle B (see FIG. 6) that is present in the inter-shelf passage E; and a range sensor that detects an inter-

shelf distance D (see FIG. 4 and the like), which is the distance between the first shelf and the second shelf that are opposed to each other in the moving direction M. As will be described later, a detection range S (see FIGS. 4, 5, and the like) of the obstacle sensor is dynamically and variably set in accordance with the inter-shelf distance D. In the present embodiment, the obstacle sensor and the range sensor are constituted by one inter-shelf sensor 5, which will be described in detail later. Accordingly, it is possible to appropriately detect the inter-shelf distance D and set the detection range S based on the inter-shelf distance D, resulting in a simplification of the system configuration and a reduction in the cost.

[0021] As shown in FIGS. 1 and 2, one inter-shelf sensor 5 is provided between a shelf 1 and a shelf 1 that are adjacent to each other in the moving direction M. That is to say, one inter-shelf sensor 5 is provided on one of two shelves 1 adjacent to each other in the moving direction M. Later-described reflective plates 7 are provided on the other one of the two shelves 1 adjacent to each other in the moving direction M. As shown in FIGS. 1 and 2, the first movable shelf 31 includes the inter-shelf sensors 5 on the respective sides opposed to the first fixed shelf 21 and to the second movable shelf 32. The first fixed shelf 21 includes the reflective plates 7 on the side opposed to the first movable shelf 31, and the second movable shelf 32 includes the reflective plates 7 on the side opposed to the first movable shelf 31.

[0022] The second movable shelf 32 includes the inter-shelf sensor 5 on the side opposed to the third movable shelf 33, and includes the reflective plates 7 on the side opposed to the first movable shelf 31 as described above. That is to say, the second movable shelf 32 includes the inter-shelf sensor 5 on one side in the moving direction M and the reflective plates 7 on the other side. Similarly, the third movable shelf 33 includes the inter-shelf sensor 5 on the side opposed to the second fixed shelf 22, and the reflective plates 7 on the side opposed to the second movable shelf 32. That is to say, similar to the second movable shelf 32, the third movable shelf 33 also includes the inter-shelf sensor 5 on one side in the moving direction M and the reflective plates 7 on the other side. Similar to the first fixed shelf 21, the second fixed shelf 22 includes the reflective plates 7 on the side opposed to the third movable shelf 33. The first fixed shelf 21 and the second fixed shelf 22 only include the reflective plates 7.

[0023] Note here that a mode is exemplified in which the fixed shelves 2 only include the reflective plates 7 but do not include the inter-shelf sensor 5, and

one of the plurality of movable shelves 3 includes the inter-shelf sensors 5 on the respective two sides in the moving direction M, and the remaining movable shelves 3 include the inter-shelf sensor 5 on one side in the moving direction M and the reflective plates 7 on the other side. This is because, as exemplified in FIG. 3, the movable shelves 3 include an electric circuit such as the open-close control device 11 for moving the corresponding movable shelf 3, and has a structure that makes it easy to include the inter-shelf sensor 5. However, the present invention does not preclude a configuration in which the fixed shelves 2 include the inter-shelf sensor 5. For example, a mode is also possible in which one of the two fixed shelves 2 includes only the inter-shelf sensor 5 but does not include the reflective plates 7, and the other fixed shelf 2 includes only the reflective plates 7 but does not include the inter-shelf sensor 5, and all of the movable shelves 3 include the inter-shelf sensor 5 on one side in the moving direction M and the reflective plates 7 on the other side. In this case, all of the movable shelves 3 have a common configuration, and the productivity and the maintenance property are improved.

[0024] As described above, the obstacle sensor and the range sensor are constituted by one inter-shelf sensor 5. Specifically, the obstacle sensor and the range sensor are constituted by a single active sensor that detects a subject by transmitting light and receiving reflected light from the subject. Here, light includes infrared light, visible light, laser light, and the like. Also, as described with reference to FIGS. 1 and 2, the single active sensor (inter-shelf sensor 5) is attached to one of the first shelf and the second shelf, and the reflective plates 7 are attached to the other one of the first shelf and the second shelf. The single active sensor (inter-shelf sensor 5) functions as an obstacle sensor that detects the obstacle B based on reflected light from an object present in the inter-shelf passage E while regarding the object as the subject, and functions as the range sensor that detects the inter-shelf distance D based on reflected light from the reflective plates 7 while regarding the reflective plates 7 as the subjects.

[0025] As an aspect, the inter-shelf sensor 5 is preferably constituted by a three-dimensional laser range scanner. A three-dimensional laser range scanner detects whether or not a subject is present in a detection range S or detects the distance to the subject, by emitting light (for example, laser light) in the horizontal direction and the vertical direction and performing scanning. Typically, the scan angle of the three-dimensional laser range scanner in the

horizontal direction is not equal to the scan angle thereof in the vertical direction. For example, the scan angle in the horizontal direction is about 180 to 210 degrees, and the scan angle in the vertical direction is about 30 to 45 degrees (the depression angle is about 5 to 10 degrees, and the elevation angle is about 20 to 40 degrees). In order to appropriately detect an operator's foot or the like, the inter-shelf sensor 5 is provided at a lower position as shown in FIG. 2, for example, a position at the height of about 200 to 300 millimeters from the floor surface.

[0026] FIG. 6 shows the principle of detecting the reflective plates 7. The reflective plates 7 are configured such that the energy level (in FIG. 6, indicated by a voltage when the reflected light is photoelectrically-converted) of reflected light from the reflective plates 7 is higher than the energy level of reflected light from an object serving as the obstacle B. Specifically, the reflective plates 7 are preferably configured such that the energy level of reflected light from the reflective plates 7 is higher than a reference value TH, which is a value higher than the energy level of, from among conceivable obstacles B, the obstacle B from which the reflected light having the highest energy level is reflected. For example, preferably, the reflective plates 7 are made of a material that realizes a higher reflectance of the reflective plates 7, with respect to light, than that of the conceivable obstacles B, or are made by surface finishing that realizes the same. Also, the reflective plates 7 may be provided at an angle such that the reflection angle (and the incident angle) is smaller than that of the positional relationship between the inter-shelf sensor 5 and the reflective plates 7.

[0027] The reflective plates 7 are provided at lower positions as shown in FIG. 2, for example, positions at the height of about 200 to 300 millimeters from the floor surface. Also, as shown in FIG. 1, the plurality of (two) reflective plates 7 are provided at positions that are distanced from each other in a shelf-width direction W (second direction), which extends parallel to the horizontal surface and is orthogonal to the moving direction M. Here, a mode is exemplified in which two reflective plates 7 are provided in the shelf-width direction W, but the present invention does not preclude a configuration in which three or more reflective plates 7 are provided. Providing a plurality of reflective plates 7 makes it possible to appropriately set the detection range S even when the inter-shelf distance D varies in the shelf-width direction W, as will be described later with reference to FIG. 5. However, one reflective plate 7 may also be

provided when, for example, the movable shelf device 10 is provided with the rails 4, and the inter-shelf distance D hardly varies in the shelf-width direction W, as will be described later.

[0028] The following will describe a procedure in which the inter-shelf sensor 5 detects the inter-shelf distance D based on reflected light from the reflective plates 7 while regarding the reflective plates 7 as the subjects, and dynamically and variably set the detection range S in accordance with this inter-shelf distance D. As shown in FIG. 4, a first reflective plate 71 and a second reflective plate 72 are provided at positions distanced from each other in the shelf-width direction W, namely, at two end portions of the shelf 1 in the shelf-width direction W. The inter-shelf sensor 5 is provided at a position opposed to one of the reflective plates 7, namely, the position opposed to the first reflective plate 71. However, the present invention is not limited to this layout, and the inter-shelf sensor 5 may also be provided at the central position in the shelf-width direction W (the position from which the distances, in the shelf-width direction W, to the first reflective plate 71 and to the second reflective plate 72 are equal to each other, for example). The inter-shelf sensor 5 transmits light, and detects the positions of the first reflective plate 71 and the second reflective plate 72, and the distances to the first reflective plate 71 and to the second reflective plate 72, based on reflected light from the first reflective plate 71 and the second reflective plate 72 (inter-shelf distance detection process).

[0029] The open-close control device 11 sets a virtual straight line L (reference position) based on the detection results of the inter-shelf sensor 5. The virtual straight line L is a straight line parallel to the shelf 1 that is opposed to the shelf 1 (movable shelf 3) on which the inter-shelf sensor 5 is provided with the inter-shelf passage E interposed therebetween. In order to prevent the detection range S, which is set based on the virtual straight line L, from interfering with the shelf 1 provided with the reflective plates 7, the virtual straight line L is set at a position distanced from this shelf 1 (position distanced toward the shelf 1 (movable shelf 3) on which the inter-shelf sensor 5 is provided) by a predetermined distance (about 10 to 20 millimeters) (reference position setting process). As shown in FIG. 4, the open-close control device 11 sets the detection range S to a range from the shelf 1 (movable shelf 3) on which the inter-shelf sensor 5 is provided to the virtual straight line L (detection range setting process).

[0030] When the movable shelf 3 is moved (in the case of FIG. 4, in a direction toward the reflective plates 7), the inter-shelf distance D of the inter-shelf passage E is reduced. The inter-shelf sensor 5 repeatedly detects the inter-shelf distance D with a fixed cycle, and the open-close control device 11 repeatedly sets the virtual straight line L based on the updated inter-shelf distance D, and repeatedly sets the detection range S. That is to say, when the movable shelf 3 is moved in a direction in which the inter-shelf passage E is narrowed, the above-described inter-shelf distance detection process, reference position setting process, and detection range setting process are sequentially and repeatedly executed, and the detection range S of the inter-shelf sensor 5 (obstacle sensor) is dynamically and variably set in accordance with the inter-shelf distance D. In FIG. 4, a mode is exemplified in which the shelf 1 provided with the inter-shelf sensor 5 is moved as a movable shelf 3, but the shelf 1 provided with the reflective plates 7 may also be a movable shelf 3.

[0031] For example, in FIGS. 1 and 2, when the first movable shelf 31 is to be moved in a direction toward the second movable shelf 32, the detection range S of the inter-shelf sensor 5 provided on the first movable shelf 31 to be moved is dynamically and variably set. That is to say, the detection range S of the inter-shelf sensor 5 provided on the shelf 1 (movable shelf 3) to be moved is set. For example, the open-close control device 11 of the first movable shelf 31 controls the motor 12 to move the first movable shelf 31, and dynamically and variably set the detection range S of the inter-shelf sensor 5 provided on the first movable shelf 31.

[0032] On the other hand, in FIGS. 1 and 2, when the second movable shelf 32 is to be moved in a direction toward the first movable shelf 31, the detection range S of the inter-shelf sensor 5 provided on the first movable shelf 31 that is not to be moved is dynamically and variably set. That is to say, the detection range S of the inter-shelf sensor 5 provided on the shelf 1 (movable shelf 3) that is not to be moved is set. For example, the open-close control device 11 of the first movable shelf 31 does not control the motor 12 or stops the motor 12 to stop the first movable shelf 31, and dynamically and variably sets the detection range S of the inter-shelf sensor 5 provided on the first movable shelf 31. The open-close control device 11 of the second movable shelf 32 controls the motor 12 to move the second movable shelf 32, but does not need to dynamically and variably set the detection range S of the inter-shelf

sensor 5 provided on the second movable shelf 32.

[0033] However, when the second movable shelf 32 is moved in the direction toward the first movable shelf 31, the inter-shelf passage E is formed between the second movable shelf 32 and the third movable shelf 33. Therefore, during the formation of the inter-shelf passage E between the second movable shelf 32 and the third movable shelf 33, the open-close control device 11 of the second movable shelf 32 may also variably set the detection range S of the inter-shelf sensor 5 provided on the second movable shelf 32 in accordance with the inter-shelf distance D between the second movable shelf 32 and the third movable shelf 33.

[0034] As exemplified in FIG. 7 for example, it is also possible to provide the inter-shelf passages E at two positions between the first movable shelf 31 and the second movable shelf 32, and between the second movable shelf 32 and the third movable shelf 33. The inter-shelf distance D in this case is a third inter-shelf distance D3, which is a half as large as the second inter-shelf distance D2. In such a case, upon the movement of the second movable shelf 32, it is possible to dynamically and variably set the detection range S of the inter-shelf sensor 5 provided on the first movable shelf 31, and the detection range S of the inter-shelf sensor 5 provided on the second movable shelf 32, at the same time.

[0035] Meanwhile, as exemplified in FIGS. 1 and 2, when the movable shelf device 10 includes the rails 4, and the movable shelves 3 are guided by the rails 4 and are moved in the moving direction M, the movable shelf 3 that is moved to narrow the inter-shelf passage E is likely to be kept as being parallel to the shelf-width direction W. That is to say, the inter-shelf distance D between two shelves 1 (the first shelf and the second shelf) that are opposed to each other with the inter-shelf passage E interposed therebetween has substantially the same value regardless of the positions of the shelves 1 in the shelf-width direction W. Accordingly, the shape of the inter-shelf passage E when viewed in a plan view (when viewed in a direction orthogonal to the horizontal surface) is substantially rectangular, and a substantially rectangular detection range S is set. Accordingly, even if, for example, one reflective plate 7 is provided, the virtual straight line L can be set appropriately. In this case, the reflective plate 7 may be the first reflective plate 71 or the second reflective plate 72.

[0036] On the other hand, although not shown in the diagrams, when the movable shelf device 10 does not include the rails 4, or when the movable shelf device 10 includes a track like the rails 4 but has a high degree of freedom of

the movement of the wheels 13 in the shelf-width direction W within this track, there is a possibility that the movable shelf 3 is moved to narrow the inter-shelf passage E while being non-parallel to the shelf-width direction W. FIG. 5 exemplifies a procedure that is performed in such a case, and in which the inter-shelf sensor 5 detects the inter-shelf distances D based on reflected light from the reflective plates 7 while regarding the reflective plates 7 as the subjects, and dynamically and variably set the detection range S based on the inter-shelf distances D.

[0037] Similar to the mode that has been described with reference to FIG. 4, the inter-shelf sensor 5 transmits light, and detects the positions of the first reflective plate 71 and the second reflective plate 72, and the distances to the first reflective plate 71 and the second reflective plate 72, based on reflected light from the first reflective plate 71 and the second reflective plate 72(inter-shelf distance detection process). The mode that has been described with reference to FIG. 4 indicates an example in which the movable shelf 3 that is moved to narrow the inter-shelf passage E is likely to keep the state of being parallel to the shelf-width direction W, and the inter-shelf distance D between two shelves 1 (the first shelf and the second shelf) that are opposed to each other with the inter-shelf passage E interposed therebetween has substantially a constant value regardless of the positions of the shelves 1 in the shelf-width direction W. However, in a mode shown in FIG. 5, the inter-shelf distance D between two shelves 1 (the first shelf and the second shelf) that are opposed to each other with the inter-shelf passage E interposed therebetween varies according to the positions of the shelves 1 in the shelf-width direction W. Specifically, the inter-shelf distance D between the shelf 1 on which the inter-shelf sensor 5 is provided and the movable shelf 3 on the first reflective plate 71 side differs from the inter-shelf distance D between this shelf 1 and the movable shelf 3 on the second reflective plate 72 side.

[0038] The open-close control device 11 sets the virtual straight line L (reference position) based on the detection results of the inter-shelf sensor 5. As described above, the virtual straight line L is a straight line parallel to the shelf 1 that is opposed to the shelf 1 (movable shelf 3) on which the inter-shelf sensor 5 is provided with the inter-shelf passage E interposed therebetween. Also, the virtual straight line L is set at a position distanced from the shelf 1 (here, movable shelf 3) provided with the reflective plates 7 by a predetermined distance (about 10 to 20 millimeters) toward the shelf 1 on which the inter-

shelf sensor 5 is provided (reference position setting process). In the mode that has been described with reference to FIG. 4, the virtual straight line L is set as a straight line that is parallel to the shelf-width direction W since the inter-shelf distance D between two shelves 1 (the first shelf and the second shelf) opposed to each other with the inter-shelf passage E interposed therebetween has substantially a constant value regardless of the positions of the shelves 1 in the shelf-width direction W. However, in the mode shown in FIG. 5, the inter-shelf distance D between two shelves 1 (the first shelf and the second shelf) opposed to each other with the inter-shelf passage E interposed therebetween varies according to the positions of the shelves 1 in the shelf-width direction W. Accordingly, the virtual straight line L is set as a straight line that is inclined with respect to the shelf-width direction W.

[0039] As shown in FIG. 5, the open-close control device 11 sets the detection range S to a range from the shelf 1 on which the inter-shelf sensor 5 is provided to the virtual straight line L (detection range setting process). The inter-shelf sensor 5 repeatedly detects the inter-shelf distances D with a fixed cycle, and the open-close control device 11 repeatedly sets the virtual straight line L based on the updated inter-shelf distances D and repeatedly sets the detection range S. That is to say, when the movable shelf 3 is moved in a direction in which the inter-shelf passage E is narrowed, the above-described inter-shelf distance detection process, reference position setting process, and detection range setting process are sequentially and repeatedly executed, and the detection range S of the inter-shelf sensor 5 (obstacle sensor) is dynamically and variably set in accordance with the inter-shelf distances D.

[0040] Note that the detection range S is set to be substantially trapezoidal when viewed in a plan view (when viewed in a direction orthogonal to the horizontal surface). In this case, the shape of the inter-shelf passage E when viewed in a plan view is also substantially trapezoidal. Accordingly, the open-close control device 11 can set the detection range S so that the entire region of the inter-shelf passage E is the detection range S. Note that FIG. 5 exemplifies a mode in which the movable shelf 3 provided with the reflective plates 7 is moved, but, of course, a mode is also possible in which the movable shelf 3 provided with the inter-shelf sensor 5 is moved.

[0041] As described above, the movable shelf device 10 can check, before the movable shelf 3 starts moving, whether or not there is the obstacle B in the entire region of the inter-shelf passage E that serves as the detection range S.

Accordingly, the movable shelf 3 can appropriately start moving. Also, when the movable shelf 3 is moved to narrow the inter-shelf passage E, the detection range S is dynamically and variably set so that the entire region of the inter-shelf passage E is the detection range S. Accordingly, even if the obstacle B such as an operator enters the inter-shelf passage E after the movable shelf 3 has started moving, the obstacle B can be detected appropriately. Accordingly, the movable shelf device 10 can promptly stop the movable shelf 3 upon entrance of the obstacle B into the inter-shelf passage E.

[0042] FIGS. 8 to 10 show comparative examples of the detection range S that is set for the inter-shelf passage E. FIG. 8 shows a detection range S (first detection range S1) that is set for the inter-shelf passage E formed between the first movable shelf 31 and the second movable shelf 32 for example, before the first movable shelf 31 or the second movable shelf 32 is moved. The movable shelf device can check whether or not the obstacle B is present by setting the entire region of the inter-shelf passage E as a first detection range S1 before the first movable shelf 31 or the second movable shelf 32 starts moving. With this, it is possible to appropriately start the movement of the movable shelf 3. This is the same as in the above-described embodiment.

[0043] FIG. 9 shows an example in which the first movable shelf 31 is to be moved in a direction in which the inter-shelf passage E is narrowed. In many conventional movable shelf devices, in this case, by setting the vicinity of the first movable shelf 31 to be moved as a detection range S (second detection range S2), the second movable shelf 32 is prevented from being detected as the obstacle B in association with the movement of the first movable shelf 31. For example, the second detection range S2 is set to a range of about 100 to 300 millimeters from the first movable shelf 31 based on the first inter-shelf distance D1 (of about 50 to 100 millimeters). In this case, until the first movable shelf 31 approaches the second movable shelf 32, the obstacle B that enters the vicinity of the moving first movable shelf 31 can be detected appropriately.

Also, if the first movable shelf 31 approaches the second movable shelf 32 and the second movable shelf 32 is detected as the obstacle B, the first movable shelf 31 will be controlled and stopped. However, taking into consideration a time period for which the first movable shelf 31 is stopped, the first movable shelf 31 will be stopped with substantially the first inter-shelf distance D1 left.

[0044] In this case, a region in which the obstacle B cannot be detected is created in the inter-shelf passage E. When the first movable shelf 31 has approached the second movable shelf 32 and the second movable shelf 32 has been detected as the obstacle B, the first movable shelf 31 is located close to the stop position, and thus the first movable shelf 31 is decelerated compared to a case where the first movable shelf 31 is moved at a steady speed. However, the first movable shelf 31 is not decelerated while the first movable shelf 31 is moved at a steady constant speed, and thus there is a possibility that, if the obstacle B enters the inter-shelf passage E, the first movable shelf 31 cannot promptly be stopped and may come into contact with the obstacle B. In the present embodiment, as described above, such a possibility is reduced because the entire region of the inter-shelf passage E serves as the detection range S even while the first movable shelf 31 is moved.

[0045] FIG. 10 exemplifies a case where the second movable shelf 32 is moved in the direction in which the inter-shelf passage E is narrowed. Similar to the mode exemplified in FIG. 9, the second detection range S2 is set in the vicinity of the first movable shelf 31, that is, the shelf 1 that is not moved. That is to say, the second movable shelf 32 will be moved in a state in which the detection range S for detecting the obstacle B is not set in the vicinity of the second movable shelf 32 that is moved. Accordingly, the possibility of the obstacle B that has entered the inter-shelf passage E coming into contact with the second movable shelf 32 is likely to be higher than in the mode exemplified in FIG. 9. As described above, in the present embodiment, such a possibility is reduced because the entire region of the inter-shelf passage E serves as the detection range S even while the first movable shelf 31 is moved.

[0046] The movable shelf device 10 according to the embodiment that has been described above with reference to FIGS. 1 to 7 can appropriately detect an obstacle B that is present in an inter-shelf passage E formed between a shelf 1 and a shelf 1 on a steady basis.

Overview of the Embodiments

[0047] The following will briefly describe an overview of the above-described movable shelf device.

[0048] As a preferable aspect, the movable shelf device that includes a first shelf and a second shelf that are opposed to each other in a first direction parallel to a horizontal surface, and in which the first shelf and the second shelf

are provided so as to be movable relative to each other in the first direction, and an inter-shelf passage is formed between the first shelf and the second shelf in a state in which the first shelf and the second shelf are spaced away from each other, the movable shelf device including: an obstacle sensor configured to detect, when the inter-shelf passage is formed, an obstacle that is present in the inter-shelf passage; and a range sensor configured to detect an inter-shelf distance, which is a distance between the first shelf and the second shelf that are opposed to each other in the first direction, wherein the obstacle sensor and the range sensor are constituted by a single active sensor configured to detect a subject by transmitting light and receiving reflected light from the subject, and a detection range of the obstacle sensor is dynamically and variably set in accordance with the inter-shelf distance.

[0049] In conventional configurations, in many cases, it is determined whether or not an obstacle is present within substantially the entire region of the inter-shelf passage that serves as the detection range, before the first shelf and the second shelf move relative to each other. Then, if it is determined that no obstacle is present, the relative movement between the first shelf and the second shelf is started. On the other hand, once the relative movement between the first shelf and the second shelf is started, the inter-shelf passage becomes narrower than the detection range, and thus the first shelf or the second shelf may be detected as an obstacle. Therefore, in many cases, the detection range is reduced to a range such that the first shelf or the second shelf cannot be detected. Accordingly, a region that is out of the detection range is created within the inter-shelf passage. However, with this configuration, the inter-shelf distance that varies with the relative movement between the first shelf and the second shelf is detected, and the detection range is dynamically and variably set in accordance with this inter-shelf distance. Accordingly, it is possible to set substantially the entire region of the inter-shelf passage that is to be gradually narrowed as the detection range not only of course before the first shelf and the second shelf move relative to each other but also after the start of the relative movement between the first shelf and the second shelf. As a result, it is possible to appropriately detect an obstacle that has entered the inter-shelf passage over the entire period from before the first shelf and the second shelf move relative to each other until the end of the relative movement of the first shelf and the second shelf. Furthermore, since the obstacle sensor and the range sensor are constituted by a single active

sensor, the system configuration is also simplified, and the cost can be reduced. Thus, with this configuration, in a movable shelf device provided with a plurality of shelves that are movable relative to each other, it is possible to appropriately detect an obstacle present in an inter-shelf passage formed between a shelf and a shelf on a steady basis.

[0050] Here, preferably, the single active sensor is attached to one of the first shelf and the second shelf, and a reflective plate is attached to the other one of the first shelf and the second shelf, and the single active sensor detects the obstacle based on the reflected light from an object present in the inter-shelf passage while regarding the object as the subject, and detects the inter-shelf distance based on the reflected light from the reflective plate while regarding the reflective plate as the subject.

[0051] With this configuration, it is possible to appropriately detect the inter-shelf distance and set the detection range based on the inter-shelf distance.

[0052] Also, preferably, the reflective plate is configured such that an energy level of the reflected light from the reflective plate is higher than an energy level of the reflected light from the object that serves as the obstacle.

[0053] If an obstacle is present in the inter-shelf passage, and reflected light from the obstacle is detected as reflected light from the reflective plate, the inter-shelf distance cannot be detected with accuracy. Therefore, preferably, the energy level of the reflected light from the obstacle can be distinguished from the energy level of the reflected light from the reflective plate. The energy level of the reflected light from the obstacle has a large fluctuation range depending on the type of obstacle. Also, if the energy level of the reflected light from the reflective plate is set to be low, it may be difficult to distinguish the reflective plate from the obstacle. If the reflective plate has a common configuration, it is easy to set the energy level of the reflected light from the reflective plate within a predetermined range, and it is also possible to increase the energy level of the reflected light from the reflective plate by employing a material, an attaching method, or the like that realizes a high-reflectance structure thereof. Accordingly, with this configuration, it is possible to appropriately distinguish an obstacle from the reflective plate, and detect the inter-shelf distance.

[0054] Furthermore, preferably, a plurality of the reflective plates are provided at positions that are parallel to the horizontal surface, and are distanced from each other in a second direction that is orthogonal to the first

direction.

[0055] The inter-shelf distance can be detected even with one reflective plate. However, more accurate detection of the inter-shelf distance is possible when a plurality of reflective plates are provided at positions distanced from each other in the second direction.

Description of Reference Signs

[0056] 1: Shelf (first shelf, second shelf)
2: Fixed shelf (first shelf, second shelf)
3: Movable shelf (first shelf, second shelf)
5: Inter-shelf sensor (single active sensor)
7: Reflective plate
10: Movable shelf device
21: First fixed shelf (first shelf, second shelf)
22: Second fixed shelf (first shelf, second shelf)
31: First movable shelf (first shelf, second shelf)
32: Second movable shelf (first shelf, second shelf)
33: Third movable shelf (first shelf, second shelf)
71: First reflective plate (reflective plate)
72: Second reflective plate (reflective plate)
B: Obstacle
D: Inter-shelf distance
E: Inter-shelf passage
M: Moving direction (first direction)
S: Detection range
W: Shelf-width direction (second direction)

CLAIMS

1. A movable shelf device that includes a first shelf and a second shelf that are opposed to each other in a first direction parallel to a horizontal surface, and in which the first shelf and the second shelf are provided so as to be movable relative to each other in the first direction, and an inter-shelf passage is formed between the first shelf and the second shelf in a state in which the first shelf and the second shelf are spaced away from each other, the movable shelf device comprising:

an obstacle sensor configured to detect, when the inter-shelf passage is formed, an obstacle that is present in the inter-shelf passage; and

a range sensor configured to detect an inter-shelf distance, which is a distance between the first shelf and the second shelf that are opposed to each other in the first direction,

wherein the obstacle sensor and the range sensor are constituted by a single active sensor configured to detect a subject by transmitting light and receiving reflected light from the subject, and

a detection range of the obstacle sensor is dynamically and variably set so that the entire region of the inter-shelf passage is the detection range in accordance with the inter-shelf distance.

2. The movable shelf device according to claim 1,

wherein the single active sensor is attached to one of the first shelf and the second shelf, and a reflective plate is attached to the other one of the first shelf and the second shelf, and

the single active sensor detects the obstacle based on the reflected light from an object present in the inter-shelf passage while regarding the object as the subject, and detects the inter-shelf distance based on the reflected light from the reflective plate while regarding the reflective plate as the subject.

3. The movable shelf device according to claim 2,

wherein a plurality of the reflective plates are provided at positions that are parallel to the horizontal surface, and are distanced from each other in a second direction that is orthogonal to the first direction.

4. A movable shelf device that includes a first shelf and a second shelf that are opposed to each other in a first direction parallel to a horizontal surface, and in which the first shelf and the second shelf are provided so as to be movable relative to each other in the first direction, and an inter-shelf passage is formed between the first shelf and the second shelf in a state in which the first shelf and the second shelf are spaced away from each other, the movable shelf device comprising:

an obstacle sensor configured to detect, when the inter-shelf passage is formed, an obstacle that is present in the inter-shelf passage; and

a range sensor configured to detect an inter-shelf distance, which is a distance between the first shelf and the second shelf that are opposed to each other in the first direction,

wherein the obstacle sensor and the range sensor are constituted by a single active sensor configured to detect a subject by transmitting light and receiving reflected light from the subject, and

a detection range of the obstacle sensor is dynamically and variably set in accordance with the inter-shelf distance,

wherein the single active sensor is attached to one of the first shelf and the second shelf, and a reflective plate is attached to the other one of the first shelf and the second shelf, and

the single active sensor detects the obstacle based on the reflected light from an object present in the inter-shelf passage while regarding the object as the subject, and detects the inter-shelf distance based on the reflected light from the reflective plate while regarding the reflective plate as the subject,

wherein a plurality of the reflective plates are provided at positions

that are parallel to the horizontal surface, and are distanced from each other in a second direction that is orthogonal to the first direction.