

PICKING SYSTEM

FIELD

[0001] The present invention relates to a picking system including an automated warehouse
5 storing multiple mounts each loaded with multiple articles, multiple work areas in which
picking operations are performed, a transport system that transports the mounts between the
automated warehouse and the multiple work areas, and a control system that controls the
automated warehouse and the transport system. Each picking operation is an operation of
10 retrieving, based on order information specifying types and quantities of articles to be shipped
to each shipping destination, the articles of the types and the quantities specified by the order
information from the mounts transferred from the automated warehouse.

BACKGROUND

[0002] In the picking system used in, for example, a distribution center, the mounts loaded
15 with the articles of the types specified by the order information are transported from the
automated warehouse to the work areas. In the work areas, picking operations are performed
to retrieve the articles of the types and quantities specified by the pieces of order information.
Multiple picking operations generated as tasks in the picking system are allocated to the
respective work areas. An example of the picking system is described in Japanese
20 Unexamined Patent Application Publication No. 2015-199562.

CITATION LIST

PATENT LITERATURE

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2015-
199562
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BRIEF SUMMARY

TECHNICAL PROBLEM

[0004] The automated warehouse in the picking system stores various types of articles, and
the various types of articles have various requests (e.g., shipment frequencies or shipment
30 quantities). Although the request commonly provides a basis for inventory management in
the automated warehouse, the request for articles may change greatly based on changes in the
market environment. For example, a request greater than the originally expected request
causes a delay in article supply from the automated warehouse to the work areas, and picking
operations may not be smoothly performed in the work areas.

35 [0005] Under such circumstances, a picking system that can improve the efficiency of the
picking operations is awaited.

SOLUTION TO PROBLEM

[0006] A picking system according to one or more aspects of the present disclosure includes an automated warehouse storing a plurality of mounts each loaded with a plurality of articles, a plurality of work areas in which a picking operation is performed to retrieve, based on order information specifying types and quantities of articles to be shipped to each shipping destination, the articles of the types and the quantities specified by the order information from at least one mount transferred from the automated warehouse among the plurality of mounts, a transport system that transports the plurality of mounts between the automated warehouse and the plurality of work areas, and a control system that controls the automated warehouse and the transport system. The control system performs a batch generation process of aggregating a set number of pieces of the order information and generating batch operations each including the picking operation corresponding to the aggregated pieces of the order information, an operation allocation process of allocating each of the batch operations generated through the batch generation process to a work area of the plurality of work areas, a transporting process of transporting, to each of the plurality of work areas, at least one mount, among the plurality of mounts, to be used in a corresponding batch operation allocated through the operation allocation process among the batch operations, and an index computation process of computing an overlapping potential index for each of the types as a target type. The overlapping potential index indicates a likelihood of a shortfall in a number of target mounts with respect to a number of work areas in which the picking operation for articles of a target type is performed. Each of the target mounts is a mount loaded with an article of the target type. In the batch generation process, the control system aggregates pieces of the order information to cause a number of potentially overlapping batch operations to be less than or equal to a total transferable number in response to the number of potentially overlapping batch operations being reducible to less than or equal to the total transferable number. The number of potentially overlapping batch operations is a number of the batch operations each including the picking operation corresponding to a piece of the order information which piece specifies a potentially overlapping type being a type having the overlapping potential index less than a predetermined determination threshold. The total transferable number is a total number of the target mounts transferable from the automated warehouse. In the batch generation process, the control system aggregates pieces of the order information in such a manner as to minimize the number of potentially overlapping batch operations in response to the number of potentially overlapping batch operations being not reducible to less than or equal to the total transferable number.

[0007] This structure aggregates the pieces of order information specifying the potentially overlapping type that may cause a shortfall in the total transferable number with respect to the

order count. As a result, the picking operations for the articles of the potentially overlapping type are likely to be performed in fewer work areas. Thus, a shortfall in the number of mounts with respect to the number of work areas is less likely to cause operation wait of waiting for the target mounts to be used in the picking operations in the respective work areas. This structure is likely to reduce operation wait in the respective work areas and improve the operation efficiency.

[0008] Further features and advantageous effects of the technique according to one or more embodiments of the present disclosure will be apparent from exemplary and nonlimiting embodiments described below with reference to the drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. 1 is a plan view of a picking system.

FIG. 2 is a control block diagram of the picking system.

FIG. 3 is a diagram describing a picking operation.

FIG. 4 is a diagram describing batch operations.

FIG. 5 is a table showing examples of the order count for different types of articles.

FIG. 6 is a table showing computation of a primary overlapping potential index and a secondary overlapping potential index.

FIG. 7 is a time chart showing the duration of operations in a work area.

FIG. 8 is a time chart showing the duration of operations in work areas.

FIG. 9 is a time chart showing the duration of operations in the work areas.

FIG. 10 is a diagram describing a total transferable number increasing process.

FIG. 11 is a diagram describing similarity index computation process.

FIG. 12 is a diagram describing similarity index-based rearrangement of pieces of order information.

FIG. 13 is a table showing multiple pieces of order information aggregated through a batch generation process.

FIG. 14 is a time chart showing the duration of operations in work areas in another embodiment.

DETAILED DESCRIPTION

[0010] A picking system according to an embodiment will be described below with reference to the drawings.

[0011] As shown in FIGs. 1 to 3, a picking system 100 includes an automated warehouse 1 storing multiple mounts 5 each loaded with multiple articles W, multiple work areas 2 in which picking operations are performed, a transport system 7 that transports the mounts 5

between the automated warehouse 1 and the multiple work areas 2, and a control system 3 that controls the automated warehouse 1 and the transport system 7. Each picking operation is an operation of retrieving, based on order information In specifying types and quantities of articles W to be shipped to each shipping destination, the articles W of the types and the quantities specified by the order information In from the mounts 5 transferred from the automated warehouse 1.

[0012] The articles W include industrial products, household items, and food products. The articles W may include finished products or half-finished products. The articles W loaded on the mounts 5 are stored in the automated warehouse 1 and are transported to various destinations by the transport system 7.

[0013] The mounts 5 include containers and pallets. The containers include foldable containers and cardboard boxes. In the present embodiment, the mounts 5 are storage containers to be stored in the automated warehouse 1 (refer to FIG. 3). In this example, a single mount 5 is loaded with a single type of articles W. However, a single mount 5 may be loaded with multiple types of articles W.

[0014] Although not shown in detail, the automated warehouse 1 includes storage shelves for storing the mounts 5 and an intra-shelf transporter that transports the mounts 5 in the automated warehouse 1. Examples of the intra-shelf transporter may include a stacker crane, a lifter, a transport cart disposed in each tier of the storage shelf, and a conveyor. The intra-shelf transporter is a part of the transport system 7. In the present embodiment, the picking system 100 includes multiple automated warehouses 1. The automated warehouse 1 including a conveyor as the intra-shelf transporter may store the mounts 5 on the conveyor. In this case, the automated warehouse 1 may not include a stacker crane or a transport cart.

[0015] In the present embodiment, the transport system 7 includes a conveyor 70. The conveyor 70 is a transport path for the mounts 5, connecting the multiple automated warehouses 1 and the multiple work areas 2. Each mount 5 transferred from one of the multiple automated warehouses 1 is transported through the transport path of the conveyor 70 to one of the multiple work areas 2. In the picking operations in the work areas 2, the articles W to be shipped are retrieved from the mounts 5. Each mount 5 is then transported through the transport path of the conveyor 70 to one of the multiple automated warehouses 1 and stored. The transport system 7 may include another type of transporter such as an automated guided vehicle in place of or in addition to the conveyor 70. As described above, the transport system 7 includes intra-shelf transporters that transport the mounts 5 in the automated warehouses 1.

[0016] In the present embodiment, the transport system 7 includes a first transport path 71 for transporting the mounts 5 between the automated warehouses 1 and the multiple work areas 2. The transport system 7 includes, in addition to the first transport path 71, a second transport

path 72 for transporting the mounts 5 between the multiple work areas 2.

[0017] The second transport path 72 is not connected to the respective automated warehouses 1. In this example, the second transport path 72 is dedicated to connecting the multiple work areas 2. The second transport path 72 is, as described later, a path used in a direct transporting process that involves no automated warehouses 1.

[0018] As shown in FIG. 2, the control system 3 controls the automated warehouses 1, the work areas 2, and the transport system 7 based on the order information In. The control system 3 also controls, for example, instruction output devices (e.g., monitors) or picking robots disposed in the work areas 2.

[0019] The order information In specifies types and quantities of articles W to be shipped to each shipping destination. The order information In is pieces of information generated based on customer requests and accumulated in a server 4. The control system 3 obtains the order information In from the server 4.

[0020] The control system 3 performs inventory management of the articles W in the automated warehouses 1. The control system 3 at least manages the types and the quantities of the articles W loaded on the respective mounts 5 stored in the automated warehouses 1.

[0021] The control system 3 selects, based on the order information In, one or more mounts 5 to be used in the picking operation in the respective work areas 2. The one or more selected mounts 5 are transported to the respective work areas 2 by the transport system 7. The mounts 5 are transported from the automated warehouses 1 to the work areas 2 using the first transport path 71 described above.

[0022] The control system 3 may include multiple items of hardware or multiple items of software. The control system 3 includes, for example, a processor such as a microcomputer and peripheral circuitry such as a memory. The functions of the components are implemented by the above hardware and a program executable on a processor such as a computer operating in cooperation with each other.

[0023] The picking operations performed in the work areas 2 will now be described.

[0024] As shown in FIG. 3, each picking operation is performed based on the order information In. The picking operation aggregates one or more articles W specified by the order information In. For example, a piece of order information In is generated for each shipping destination. Each picking operation may thus be an operation of aggregating the articles W requested for the corresponding shipping destination.

[0025] One or more mounts 5 loaded with the articles W of the types and the quantities specified by the piece of order information In are transported to a particular work area 2. The articles W corresponding to the piece of order information In are retrieved and aggregated into a shipping container 6 in the picking operation.

[0026] When all articles W on a mount 5 are retrieved in the picking operation, the mount 5 becomes empty. In the present embodiment, each work area 2 includes an empty mount holder 20 that holds empty mounts 5 generated in the picking operations. In this manner, empty mounts 5 can be stored in the work areas 2. When the mounts 5 are foldable containers, the multiple mounts 5 may be folded and stacked. This can improve space efficiency. In this example, the empty mounts 5 stored in the work area 2 are used in a mount dividing operation as described later.

[0027] In the example shown in FIG. 3, a piece of order information In specifies three articles W of type A (hereafter may be referred to as articles A), two articles W of type B (hereafter may be referred to as articles B), and one article W of type C (hereafter may be referred to as an article C). In this example, each mount 5 is loaded with a single type of articles W. The mount 5 loaded with three or more articles A, the mount 5 loaded with two or more articles B, and the mount 5 loaded with one or more articles C are transported to a work area 2. The picking operation in the work area 2 aggregates three articles A, two articles B, and one article C into the shipping container 6. The picking operation may be performed by an operator or autonomously by, for example, a picking robot. The picking operation may be performed by both an operator and a picking robot.

[0028] In FIG. 3, the mount 5 for transporting the articles C is loaded with the same number of articles C as the number specified by the piece of order information In (one article C in the shown example). Thus, the mount 5 after the picking operation is empty, and is held by the empty mount holder 20.

[0029] As shown in FIG. 4, the control system 3 (refer to FIG. 2) performs a batch generation process of aggregating a set number of pieces of order information In and generating batch operations each including the picking operations corresponding to the aggregated pieces of order information In, an operation allocation process of allocating each of the multiple batch operations generated through the batch generation process to one of the multiple work areas 2, and a transporting process of transporting, to each of the multiple work areas 2, the mounts 5 to be used in the corresponding batch operation allocated through the operation allocation process.

[0030] Each batch operation includes the picking operations associated with the set number of pieces of order information In. In other words, each batch operation includes the set number of picking operations. In the present embodiment, the set number is the greatest number for the number of picking operations that can be included in a single batch operation. In this example, the set number is 4. In this case, the number of picking operations that can be included in a single batch operation is any of 1 to 4. The set number may be other than 4 and may be, for example, 1. The set number is thus a fixed number in the present embodiment,

but may be a value that is changeable based on the situation.

[0031] In the example shown in FIG. 4, four batch operations are shown. The four batch operations each include a set of four picking operations. Each set of the four batch operations is allocated to one of four work areas 2 through the operation allocation process. As described above, the number of picking operations included in each batch operation may not exceed the set number and may be any of 1 to 3 in this example.

[0032] The automated warehouses 1 in the picking system 100 store various types of article W. Different types of article W have different requests.

[0033] As shown in, for example, FIG. 5, the articles W include types A to Z. The right column of the table shows the number of pieces of order information In to be processed in a unit period (hereafter referred to as an order count Na) for each type of articles W. In other words, the order count Na indicates the number of pieces of order information In associated with a particular type of articles W and to be processed in the unit period. In the example shown in the figure, type A is included in each of 200 pieces of order information In. In other words, the articles W of type A are requested in the picking operations associated with the respective 200 pieces of order information In. For types X, Y, and Z, the order count Na is relatively smaller. The order count Na is 6 for type X, 5 for type Y, and 16 for type Z.

[0034] The picking system 100 includes inventory management in the automated warehouses 1. In this inventory management, stock quantities for the articles W (in other words, quantities of the articles W stocked in the automated warehouses 1) are greater for high-request types that tend to have relatively greater order counts Na. The stock quantities are smaller for the articles W of low-request types that tend to have relatively smaller order counts Na. This can easily improve the storage efficiency of the articles W in the automated warehouses 1.

[0035] In this example, the multiple types are each referred to as a target type. A mount 5 loaded with the articles W of the target type is referred to as a target mount 5. The total number of target mounts 5 transferable from the automated warehouses 1 is referred to as a total transferable number Nb. The total transferable number Nb is, for example, the total number of target mounts 5 currently stored in the automated warehouses 1. The target types are at least one or all of the types, among the types handled in the picking system 100, subjected to the batch generation process or a total transferable number increasing process described later.

[0036] As shown in FIG. 6, the control system 3 performs an index computation process to compute a primary overlapping potential index N1 (corresponding to an overlapping potential index) for all types. Each primary overlapping potential index N1 indicates the likelihood of a shortfall in the number of target mounts 5 loaded with the articles W of a target type with respect to the number of work areas 2 in which picking operations for the articles W

of the target type are performed. In the present embodiment, a lower primary overlapping potential index N1 indicates that the likelihood is greater.

[0037] In the present embodiment, the number of pieces of order information In specifying the articles W of the target type in the multiple pieces of order information In to be processed in the unit period is referred to as a target order count Na. Each primary overlapping potential index N1 is a value obtained by dividing the total transferable number Nb by the target order count Na.

[0038] The control system 3 identifies a type with the primary overlapping potential index N1 less than a predetermined primary determination threshold (corresponding to a determination threshold) as a potentially overlapping type. In the present embodiment, the primary determination threshold is 1.00. The primary determination threshold can be set as appropriate. The control system 3 computes the primary overlapping potential index N1 for all types, and identifies the types each having a primary overlapping potential index N1 less than 1.00 as a potentially overlapping type.

[0039] FIG. 6 shows an example with types X, Y, and Z each being a potentially overlapping type.

[0040] For type X, the total transferable number Nb is 2. The number is divided by the target order count Na, or 6. The resultant primary overlapping potential index N1 is 0.33, which is less than the primary determination threshold, or 1.00. The control system 3 thus extracts type X as the potentially overlapping type from all types.

[0041] For type Y, the total transferable number Nb is 1. The number is divided by the target order count Na, or 5. The resultant primary overlapping potential index N1 is 0.20, which is less than the primary determination threshold, or 1.00. The control system 3 thus extracts type Y as the potentially overlapping type from all types.

[0042] For type Z, the total transferable number Nb is 1. The number is divided by the target order count Na, or 16. The resultant primary overlapping potential index N1 is 0.06, which is less than the primary determination threshold, or 1.00. The control system 3 thus extracts type Z as the potentially overlapping type from all types.

[0043] A batch operation including a picking operation corresponding to a piece of order information In specifying a potentially overlapping type is referred to as a potentially overlapping batch operation. The number of potentially overlapping batch operations is referred to as a potentially overlapping batch operation number Nc. The control system 3 computes the potentially overlapping batch operation number Nc for each of the extracted potentially overlapping types. The potentially overlapping batch operation number Nc is the number of batch operations to be performed to handle all orders specifying the articles W of the potentially overlapping types. The potentially overlapping batch operation number Nc is a

value obtained by dividing the target order count Na by the set number (4 in this example). When the value resulting from the division includes decimals, the resultant value is rounded up to a nearest whole number. This reliably obtains the number of batch operations to be performed to handle all orders specifying the articles W of the potentially overlapping type.

5 [0044] The example in FIG. 6 shows that the target order count Na is 6 for type X. The value is divided by the set number, or 4, and rounded up to a nearest whole number. The resultant potentially overlapping batch operation number Nc is 2. In other words, the number of batch operations to be performed to handle all orders specifying the articles W of type X is 2.

10 [0045] For type Y, the target order count Na is 5. The value is divided by the set number, or 4, and rounded up to a nearest whole number. The resultant potentially overlapping batch operation number Nc is 2. In other words, the number of batch operations to be performed to handle all orders specifying the articles W of type Y is 2.

[0046] For type Z, the target order count Na is 16. The number is divided by the set number, or 4. The resultant potentially overlapping batch operation number Nc is 4. In other words, the number of batch operations to be performed to handle all orders specifying the articles W of type Z is 4.

[0047] In this example, the control system 3 changes the number of pieces of order information In to be aggregated (hereafter referred to as an order aggregation number) without the order aggregation number exceeding the set number. In this manner, the potentially overlapping batch operation number Nc is increased or decreased. As in Formula 1 below, the potentially overlapping batch operation number Nc is calculated by dividing the target order count Na by the order aggregation number.

Potentially overlapping batch operation number Nc = Target order count Na/Order aggregation number (1)

In the formula, the order aggregation number is less than or equal to the set number.

For a greater order aggregation number, the potentially overlapping batch operation number Nc is smaller. For a smaller order aggregation number, the potentially overlapping batch operation number Nc is greater. The control system 3 controls an increase or a decrease in the potentially overlapping batch operation number Nc to set an appropriate potentially overlapping batch operation number Nc for the total transferable number Nb.

[0048] In the batch generation process, the control system 3 aggregates pieces of order information In to cause the potentially overlapping batch operation number Nc to be less than or equal to the total transferable number Nb in response to the potentially overlapping batch operation number Nc being reducible to be less than or equal to the total transferable number Nb that is the total number of target mounts 5 transferable from the automated warehouses 1.

In other words, the control system 3 sets the order aggregation number to cause the potentially overlapping batch operation number N_c to be less than or equal to the total transferable number N_b . In this manner, a shortfall in the number of target mounts 5 with respect to the number of the work areas 2 is less likely to cause operation wait of waiting for the target mounts 5 to be used in the picking operations in the respective work areas 2 (hereafter simply referred to as operation wait). The potentially overlapping batch operation number N_c reducible to be less than or equal to the total transferable number N_b indicates that the potentially overlapping batch operation number N_c is reducible to be less than or equal to the total transferable number N_b by increasing the order aggregation number within the limit of the set number and decreasing the potentially overlapping batch operation number N_c .

[0049] In the batch generation process, the control system 3 aggregates pieces of order information I_n to minimize the potentially overlapping batch operation number N_c in response to the potentially overlapping batch operation number N_c being not reducible to be less than or equal to the total transferable number N_b . In other words, the control system 3 minimizes the potentially overlapping batch operation number N_c by setting the order aggregation number to the set number that is the maximum number for aggregatable pieces of order information I_n .

[0050] In the present embodiment, the control system 3 further computes a secondary overlapping potential index N_2 for the extracted potentially overlapping types. Each secondary overlapping potential index N_2 indicates the likelihood of a shortfall in the number of target mounts 5 loaded with the articles W of the potentially overlapping type with respect to the number of work areas 2 in which the picking operations for the articles W of the potentially overlapping type are performed. In the present embodiment, a lower secondary overlapping potential index N_2 indicates that the likelihood is greater.

[0051] The secondary overlapping potential index N_2 is a value obtained by dividing the total transferable number N_b by the potentially overlapping batch operation number N_c . The control system 3 identifies a potentially overlapping type having a secondary overlapping potential index N_2 less than the secondary determination threshold as a type for further action. In this example, the secondary determination threshold is 1.00. The secondary determination threshold can be set as appropriate.

[0052] In the example shown in FIG. 6, the total transferable number N_b for type X is 2. The number is divided by the potentially overlapping batch operation number N_c , or 2. The resultant secondary overlapping potential index N_2 is 1.00. The secondary overlapping potential index N_2 for type X is thus not less than the secondary determination threshold, or 1.00. The control system 3 thus does not identify type X as a type for further action.

[0053] For type Y, the total transferable number N_b is 1. The number is divided by the potentially overlapping batch operation number N_c , or 2. The resultant secondary overlapping

potential index N2 is 0.50. The secondary overlapping potential index N2 for type Y is less than the secondary determination threshold, or 1.00. The control system 3 thus identifies type Y as a type for further action.

[0054] For type Z, the total transferable number Nb is 1. The number is divided by the potentially overlapping batch operation number Nc, or 4. The resultant secondary overlapping potential index N2 is 0.25. The secondary overlapping potential index N2 for type Z is less than the secondary determination threshold, or 1.00. The control system 3 thus identifies type Z as a type for further action.

[0055] The secondary overlapping potential index N2 being less than the secondary determination threshold, or 1.00, can be paraphrased as the potentially overlapping batch operation number Nc exceeding the total transferable number Nb.

[0056] In the present embodiment, in response to the potentially overlapping batch operation number Nc exceeding the total transferable number Nb, the control system 3 causes, in the operation allocation process, the number of work areas 2 to which potentially overlapping batch operations are allocated to be less than or equal to the total transferable number Nb. In other words, when the secondary overlapping potential index N2 is less than the secondary determination threshold, or 1.00, the control system 3 causes the number of work areas 2 to which potentially overlapping batch operations are allocated to be less than or equal to the total transferable number Nb.

[0057] For type Y in FIG. 6, for example, the potentially overlapping batch operation number Nc is 2, which exceeds 1 that is the total transferable number Nb. The secondary overlapping potential index N2 is 0.50, which is less than the secondary determination threshold, or 1.00. Type Y is thus identified as a type for further action. In this case, the control system 3 allocates two potentially overlapping batch operations each including a picking operation for type Y to a single work area 2 to cause the number of work areas 2 to which the potentially overlapping batch operations are allocated to be less than or equal to the total transferable number Nb.

[0058] In the present embodiment, the control system 3 performs the operation allocation process as shown in FIG. 7 with the multiple potentially overlapping batch operations performed in each of the work areas 2 starting and ending within a predicted duration that is not exceeding a predetermined time limit T. The time limit T is provided based on, for example, the time at which the articles W are shipped from the picking system 100. The picking operations associated with the respective pieces of order information In are to be complete within the time limit T.

[0059] In the example shown in FIG. 7, the control system 3 allocates two potentially overlapping batch operations each including a picking operation for type Y to a first work area

2 that is one of the multiple work areas 2. The bars in the diagram each indicate a single potentially overlapping batch operation. The two bars each have four sections. This indicates that the single potentially overlapping batch operation includes four picking operations (in other words, picking operations associated with four pieces of order information
5 In). The operations shown in black each indicate a picking operation for type Y that is a potentially overlapping type. In FIG. 7, the duration of a period in which the picking operation for the potentially overlapping type (type Y in this example) is performed is a quarter of the duration of a period in which the single potentially overlapping batch operation is performed. Thus, one of the four sections in the bar is shown as a period in which the picking operation for
10 the potentially overlapping type is performed. The same applies to FIGs. 8, 9, and 14 that are referred to later.

[0060] As shown in FIG. 7, the total duration of a predicted duration T1 for one operation of the two potentially overlapping batch operations and a predicted duration T2 for the other operation does not exceed the time limit T ($T1 + T2 < T$). The control system 3 can thus
15 allocate the two potentially overlapping batch operations each including the picking operation for type Y to the first work area 2.

[0061] The control system 3 may allocate multiple potentially overlapping batch operations to multiple work areas 2 when the predicted duration from the start to the end of the multiple potentially overlapping batch operations does not exceed the time limit T.

[0062] In the present embodiment, as shown in FIG. 8, in response to the potentially overlapping batch operation number Nc exceeding the total transferable number Nb, the control system 3 allocates, in the operation allocation process, the potentially overlapping batch operations to respective work areas 2 among the multiple work areas 2 to cause the picking operation in one of the respective work areas 2 for the articles W of the potentially overlapping type to be at least performed in a period different from a period in which the picking operation in another of the respective work areas 2 for the articles W of the potentially overlapping type is performed. In this manner, the potentially overlapping batch operations for the articles W of a particular potentially overlapping type can be performed in multiple work areas 2 without an overlap between the periods in which the picking operations for the articles W of the
25 potentially overlapping type are performed. This can avoid operation wait.

[0063] In the example shown in FIG. 8, the control system 3 allocates two potentially overlapping batch operations each including a picking operation for type Y to the first work area 2 and a second work area 2. In this example, the control system 3 allocates, as shown in FIG. 8, the potentially overlapping batch operations to the respective work areas 2 to cause the
30 potentially overlapping batch operation in the first work area 2 and the potentially overlapping batch operation in the second work area 2 to be performed in different periods. The total

transferable number N_b for type Y is 1 (refer to FIG. 6). Thus, the same target mount 5 loaded with the articles W of type Y is provided to the first work area 2 and the second work area 2 at different times.

[0064] In the example shown in FIG. 8, the target mount 5 loaded with the articles W of type Y is first provided to the first work area 2 and then to the second work area 2. The control system 3 can allocate the potentially overlapping batch operations to the multiple work areas 2 when the potentially overlapping batch operation in the work area 2 to which the target mount 5 is provided last among the multiple work areas 2 can end within the time limit T. In the example shown in the figure, the predicted duration T2 for the potentially overlapping batch operation in the second work area 2 is within the time limit T. The control system 3 can thus allocate the two potentially overlapping batch operations each including a picking operation for type Y to the first work area 2 and the second work area 2.

[0065] In the present embodiment, the control system 3 allocates the multiple potentially overlapping batch operations to the multiple work areas 2 while maximizing the interval between the periods in which the picking operations for the potentially overlapping type are performed in the respective potentially overlapping batch operations.

[0066] In the example shown in FIG. 8, the control system 3 performs the potentially overlapping batch operation in the first work area 2 by performing the picking operation for type Y that is a potentially overlapping type first among the multiple picking operations (four picking operations for four types of articles W) included in the potentially overlapping batch operation. The control system 3 performs the potentially overlapping batch operation in the second work area 2 by performing the picking operation for type Y that is the potentially overlapping type last among the multiple picking operations (four picking operations for four picking types of articles W) included in the potentially overlapping batch operation. This structure is likely to provide the time for transporting the articles W of the potentially overlapping type (type Y) that are common in the potentially overlapping batch operation in the first work area 2 and the potentially overlapping batch operation in the second work area 2 from the first work area 2 to the second work area 2.

[0067] For type Z in the example shown in FIG. 6, the potentially overlapping batch operation number N_c is 4, and the total transferable number N_b is 1. FIG. 9 is a time chart showing four potentially overlapping batch operations each including a picking operation for type Z. In the chart, each bar has four sections including a hatched section. This section indicates the picking operation for type Z that is the potentially overlapping type.

[0068] As shown in FIG. 9, when the four potentially overlapping batch operations are all performed in series along the time axis, the predicted duration from the start to the end of the four potentially overlapping batch operations exceeds the time limit T. In the example shown

in the figure, the number of potentially overlapping batch operations that can be complete within the time limit T is limited to 3. In this case, the remaining one of the potentially overlapping batch operations that is outside the time limit T is allocated to another work area 2. The remaining one of the potentially overlapping batch operations can thus be complete within the time limit T as well. However, the total transferable number Nb for type Z is 1 (refer to FIG. 6). Thus, the potentially overlapping batch operations each including a picking operation for type Z are physically to be performed in a single work area 2 alone.

[0069] In the present embodiment, when the predicted duration from the start to the end of the multiple potentially overlapping batch operations performed in each work area 2 exceeds the predetermined time limit T as shown in FIG. 9, the control system 3 performs the total transferable number increasing process to increase the total transferable number Nb. This can increase the number of target mounts 5 to be used in the potentially overlapping batch operations in the work areas 2.

[0070] In the example shown in FIG. 9, the control system 3 allocates three of the four potentially overlapping batch operations for type Z to the first work area 2 and the remaining one operation to the second work area 2. The number of potentially overlapping batch operations allocated to each work area 2 can be set as appropriate. The control system 3 provides a target mount 5 loaded with the articles W of type Z to the first work area 2 and, at the same time, provides another target mount 5 added through the total transferable number increasing process to the second work area 2. In this manner, different potentially overlapping batch operations can be performed in different work areas 2 in the same period of time. As shown in FIG. 9, the four potentially overlapping batch operations that take more than the time limit T when performed in the first work area 2 alone can also be distributed to the second work area 2. The four potentially overlapping batch operations for type Z can thus be complete within the time limit T.

[0071] The total transferable number increasing process will be additionally described. Type Z is continuously described in this example.

[0072] In the present embodiment, the total transferable number increasing process includes a mount dividing operation as shown in FIG. 10. In the mount dividing operation, multiple articles W of a target type loaded on a single target mount 5 are divided and loaded on multiple mounts 5.

[0073] In the present embodiment, the mount dividing operation is performed in one of the multiple work areas 2. The control system 3 specifies one of the multiple work areas 2 and provides an instruction to an operator or a picking robot working in the specified work area 2. For example, the control system 3 provides the instruction to the operator through an instruction output device (e.g., a monitor) located in the work area 2. For the picking robot, the control

system 3 transmits an instruction signal to a control device controlling the picking robot. The work area 2 in which the mount dividing operation is performed may be hereafter referred to as a target work area 2.

[0074] In the target work area 2, empty mounts 5 resulting from picking operations are held by the empty mount holder 20 as described above (refer to FIG. 3). In the mount dividing operation, the multiple articles W of the target type on the target mount 5 are distributed among the empty mounts 5 held by the empty mount holder 20.

[0075] The example shown in FIG. 10 includes the first work area 2 in which the picking operation for the articles W of type Z is performed and, additionally, the second work area 2 in which the picking operation for the articles W of type Z is to be performed. In the first work area 2 provided with the target mount 5 loaded with the articles W of type Z, the mount dividing operation is performed to transfer a part of the multiple articles W loaded on the target mount 5 to an empty mount 5 held in the first work area 2. This increases the total transferable number Nb of mounts 5 loaded with the articles W of type Z from 1 to 2.

[0076] In the present embodiment, the control system 3 controls the transport system 7, after the mount dividing operation is complete in the first work area 2, to transport at least one mount 5 loaded with the articles W of the target type to the second work area 2 using the second transport path 72. The second work area 2 is an area other than the first work area 2. In the second work area 2, the batch operation including a picking operation for the articles W of the target type is performed. The control system 3 performs the direct transporting process to transport the mounts 5 between different work areas 2 without involving the automated warehouses 1. In this manner, the mounts 5 prepared through the mount dividing operation are transported along the second transport path 72. The mounts 5 (target mounts 5) prepared through the mount dividing operation are loaded with the article W that has been on the target mount 5 transferred from the automated warehouses 1. The target mounts 5 prepared through the mount dividing operation can also be used in the work areas 2 in the same manner as the target mounts 5 transferred from the automated warehouses 1. Thus, increasing the total number of target mounts 5 usable in the work areas 2 through the mount dividing operation is equivalent to increasing the total transferable number Nb that is the total number of target mounts 5 transferable from the automated warehouses 1. In other words, the total number of target mounts 5 usable in the work areas 2 is the total transferable number Nb.

[0077] In the example shown in FIG. 10, one of the two mounts 5 loaded with the articles W of type Z is transported from the first work area 2 to the second work area 2 through the second transport path 72.

[0078] In the present embodiment, the articles W of the target type are transferred to the mount 5 to be transported to another work area 2 (second work area 2) other than the target

work area 2 (first work area 2) in the mount dividing operation. The number of transferred articles W is the number of articles W of the target type to be used in the other work area 2 (second work area 2).

[0079] In the example shown in FIG. 10, the piece of order information In in the second work area 2 specifies two articles W of type Z. In other words, the number of article W of type Z to be used in the second work area 2 is 2. In the mount dividing operation performed in the first work area 2, two articles W are transferred to empty mounts 5 from the target mount 5 loaded with 10 articles W of type Y. The mount 5 loaded with the two articles W of type Z is transported from the first work area 2 to the second work area 2 through the second transport path 72. In this structure, the picking operations for the articles W of type Z can be performed in both the first work area 2 and the second work area 2 in the same period of time (refer to FIG. 9).

[0080] As described above, the control system 3 aggregates the pieces of order information In specifying the potentially overlapping types (types X, Y, and Z in this example) in the batch generation process. The process of aggregating the pieces of order information In related to the potentially overlapping types is herein referred to as a first aggregation process. In the present embodiment, the control system 3 performs a second aggregation process in which pieces of order information In specifying the types that are not aggregated in the first aggregation process (types other than types X, Y, and Z in this example). In other words, the control system 3 performs, after the first aggregation process of aggregating the pieces of order information In specifying the potentially overlapping types as targets in the picking operations, the second aggregation process in the batch generation process. The second aggregation process aggregates, from the multiple pieces of order information In to be processed in the unit period, the pieces of order information In that have not been aggregated in the first aggregation process in order of closeness in similarity index Ex (described later).

[0081] The second aggregation process is described with reference to FIGs. 11 to 13.

[0082] As shown in FIG. 11, the control system 3 computes, in the index computation process, the similarity index Ex that indicates similarity between multiple pieces of order information In.

[0083] In the present embodiment, the control system 3 assigns, in the index computation process, type values Va to the types being handled (the types other than the types with overlapping risks in this example) to rank the types, in addition to computing the primary overlapping potential index described above. The control system 3 sets type values Va for all types being handled in the index computation process to cause a type value Va for a target type to be greater than the sum of the type values Va for all types ranked lower than the target type.

[0084] As shown in, for example, FIG. 11, the articles W include types A to F that are

ranked 1 to 6, respectively. For type A, the type value V_a is 32. For types B to F that are ranked lower than type A, the sum of the type values V_a is 31 ($= 16 + 8 + 4 + 2 + 1$), which is less than 32. For type D, for example, the type value V_a is 4. For types E and F that are ranked lower than type D, the sum of the type values V_a is 3 ($= 2 + 1$), which is less than 4. In other words, the control system 3 sets the type values V_a for the types being handled by setting a type value V_a for each type that is referred to as a target type (featured type) to cause the type value V_a to be greater than the sum of the type values V_a for all types ranked lower than the target type.

[0085] In the present embodiment, each type value V_a is M to the power of N , where M is an integer of 2 or greater and N is an integer of 0 or greater. N is a value corresponding to a ranked place. In this manner, the type values V_a can be set easily with a type value V_a for each type of the multiple types being greater than the sum of the type values V_a for all types ranked lower than the type. In this example, M is 2. N is a value greater for a type ranked higher, and is any of 0 to 5 in this example. Specifically, N is the number of types of the articles W being handled (6 in this example) minus the number indicating the place of the articles W of each type in the order (e.g., 1 for the highest-ranked type). The type values V_a for the respective types are thus expressed as 2 to the power of 0 to 5.

[0086] In the present embodiment, the ranking is based on order of shipment frequency specified by the pieces of order information In . A type shipped more frequently is ranked higher, and a type shipped less frequently is ranked lower. In other words, the types are ranked based on requests. A type requested more frequently is ranked higher, and a type requested less frequently is ranked lower.

[0087] In the index computation process, the control system 3 computes a total value of the type values V_a for all types included in each piece of order information In as a similarity index Ex for the piece of order information In . Each type value V_a is a decimal number. Thus, the sum of the type values V_a is a decimal number.

[0088] In the present embodiment, the control system 3 provides a similarity index Ex of a binary number in the index computation process. In the present embodiment, the control system 3 converts the total value of the type values V_a from a decimal number to a binary number. This can simplify the similarity index Ex for computation, and is likely to reduce the computation load on the control system 3.

[0089] In the example shown in FIG. 11, a piece of order information In specifies four articles W of type A, two articles W of type C, and one article W of type D. In this case, the piece of order information In includes the articles W of types A, C, and D. The table in an upper part of FIG. 11 shows that type A has a type value V_a of 32, type C has a type value V_a of 8, and type D has a type value V_a of 4. Thus, the sum of these type values V_a is 44. The

control system 3 converts the sum to a binary number and obtains a six-digit similarity index EX of 101100. In this example, N is any of 0 to 5. Thus, the value converted to a binary number is a six-digit value.

[0090] In the present embodiment, the control system 3 performs a stable sort in the batch generation process as shown in FIG. 12 to sequentially arrange the binary similarity indices Ex of the multiple pieces of order information In to be processed in a unit period in descending order starting from the least significant digit.

[0091] In the example in FIG. 12, seven pieces of order information In are to be processed in the unit period. The control system 3 performs the index computation process to compute a binary similarity index Ex for each of the seven pieces of order information In. The similarity indices Ex of the respective pieces of order information In, or the six-digit similarity indices Ex in binary numbers in this example, are sequentially compared starting from the values in the first digit from the right. A similarity index Ex with a greater value is moved to a higher place. This processing is performed until the values in the last sixth digit from the right are processed.

[0092] In the example shown in FIG. 12, the similarity indices Ex of the seven pieces of order information In are compared for the values in the first digit from the right. The similarity index Ex of the second piece of order information In (a piece of order information In labeled with circled 2 in the figure) has the greatest value and is shifted to the uppermost place.

[0093] The values in the second digit from the right are then compared. The similarity index Ex of the fourth piece of order information In (a piece of order information In labeled with circled 4 in the figure) and the similarity index Ex of the fifth piece of order information In (a piece of order information In labeled with circled 5 in the figure) have the greatest values. These similarity indices Ex are shifted to the uppermost places without changing the order between these similarity indices Ex.

[0094] In the example shown in the figure, this processing is performed until the values in the sixth digit are processed. Finally, the similarity index Ex of the fifth piece of order information In is ranked highest, and the similarity index Ex of the third piece of order information In (a piece of order information In labeled with circled 3 in the figure) is ranked lowest.

[0095] In the batch generation process, the control system 3 aggregates, as shown in FIG. 13, the multiple pieces of order information In to be processed in the unit period (the first to seventh pieces of order information In in this example) in order of closeness in the similarity index Ex. For example, the multiple pieces of order information In are aggregated in descending or ascending order of the similarity index Ex by a set aggregation number (two in the example shown in FIG. 13). In the present embodiment, the control system 3 aggregates

the multiple pieces of order information In that are close in the order obtained through the stable sort. The batch generation process generates batch operations each including the picking operations associated with the aggregated pieces of order information In.

[0096] In the present embodiment, the control system 3 performs the batch generation process of aggregating pieces of order information In ranked adjacent to one another in order of the similarity index Ex and generating batch operations each including the picking operations associated with the respective pieces of order information In. The control system 3 then performs the operation allocation process to allocate the batch operation to one of the multiple work areas 2.

[0097] In the example shown in FIG. 13, the multiple pieces of order information In are aggregated in descending order of the similarity index Ex, and two aggregated pieces of order information In are included in a single batch operation. Specifically, the fifth piece of order information In and the sixth piece of order information In (a piece of order information In labeled with circled 6 in the figure) are ranked adjacent to each other in order of the similarity index Ex. The picking operations associated with these pieces of order information In are included in a single batch operation and allocated to a third work area 2.

[0098] The seventh piece of order information In (a piece of order information In labeled with circled 7 in the figure) and the second piece of order information In are ranked adjacent to each other in order of the similarity index Ex. The picking operations associated with these pieces of order information In are included in a single batch operation and allocated to a fourth work area 2.

[0099] In this manner, the multiple batch operations generated through the batch generation process are each allocated to one of the multiple work areas 2 through the operation allocation process.

Other Embodiments

[0100] Other embodiments will now be described.

[0101] (1) In the above embodiment, when allocating multiple potentially overlapping batch operations to multiple work areas 2, the control system 3 allocates the potentially overlapping batch operations to the respective work areas 2 to cause the potentially overlapping batch operations to be performed in different periods (refer to FIG. 8). However, the present disclosure is not limited to this example. As shown in, for example, FIG. 14, the control system 3 may allow the respective potentially overlapping batch operations to be partially performed in the same period. In this case, the control system 3 causes the picking operations for the articles W of the potentially overlapping type that is common in the multiple potentially overlapping batch operations to be performed in different periods. This can provide the time for transporting the articles W of the potentially overlapping type between the multiple work

areas 2. In the example shown in the figure, the period for the potentially overlapping batch operation in the first work area 2 overlaps the period for the potentially overlapping batch operation in the second work area 2. However, of the multiple picking operations (four picking operations when picking four types of articles W) included in the potentially overlapping batch operation, the picking operation for type Y, which is the potentially overlapping type, is performed first in the first work area 2 and last in the second work area 2. In this manner, the two picking operations are performed in different periods.

[0102] (2) In the above embodiment, the control system 3 performs the total transferable number increasing process to increase the total transferable number Nb when the predicted duration from the start to the end of the multiple potentially overlapping batch operations to be performed in each work area 2 exceeds the predetermined time limit T. However, the present disclosure is not limited to this example. The control system 3 may, instead of increasing the total transferable number, extend the time limit T to allow the multiple potentially overlapping batch operations to be complete within the time limit T.

[0103] (3) In the above embodiment, the control system 3 computes the secondary overlapping potential index N2 after computing the primary overlapping potential index N1 in the index computation process. However, the present disclosure is not limited to this example. The control system 3 may perform at least one of the computation of the primary overlapping potential index N1 or the computation of the secondary overlapping potential index N2 in the index computation process. For example, when the control system 3 computes the secondary overlapping potential index N2, this secondary overlapping potential index N2 corresponds to the overlapping potential index.

[0104] (4) In the above embodiment, the mount dividing operation is performed using the empty mounts 5 held by the empty mount holder 20 in the target work area 2 in which the mount dividing operation is performed. However, the present disclosure is not limited to this example. The mount dividing operation may be performed using empty mounts 5 transported to the target work area 2 from a place other than the target work area 2 (e.g., an unused space in an automated warehouse 1).

[0105] (5) In the above embodiment, the mount dividing operation increases the total transferable number Nb. However, the present disclosure is not limited to this example. The total transferable number Nb may be increased by supplying a target mount 5 loaded with the articles W of the target type to an automated warehouse 1 from a place other than the automated warehouse 1 (e.g., an auxiliary warehouse).

[0106] (6) In the above embodiment, the types of the articles W are ranked based on order of shipment frequency specified by the pieces of order information In. However, the present disclosure is not limited to this example. The types may be ranked based on the specific

characteristics (shapes or wrapping aspects) of the articles W.

[0107] (7) In the above embodiment, the types are ranked with a type shipped more frequently being ranked higher and a type shipped less frequently being ranked lower. However, the present disclosure is not limited to the above example. In contrast to the above example, the types may be ranked to cause a type shipped more frequently to be ranked lower and a type shipped less frequently to be ranked higher.

[0108] (8) The structure described in each of the above embodiments may be combined with any other structures described in the other embodiments unless any contradiction arises. For other structures as well, the embodiments described herein are mere examples in all aspects. The embodiments may thus be modified variously as appropriate without departing from the spirit and scope of the present disclosure.

Overview of Embodiments

[0109] An overview of the present embodiment is provided below.

[0110] A picking system includes an automated warehouse storing a plurality of mounts each loaded with a plurality of articles, a plurality of work areas in which a picking operation is performed to retrieve, based on order information specifying types and quantities of articles to be shipped to each shipping destination, the articles of the types and the quantities specified by the order information from at least one mount transferred from the automated warehouse among the plurality of mounts, a transport system that transports the plurality of mounts between the automated warehouse and the plurality of work areas, and a control system that controls the automated warehouse and the transport system. The control system performs a batch generation process of aggregating a set number of pieces of the order information and generating batch operations each including the picking operation corresponding to the aggregated pieces of the order information, an operation allocation process of allocating each of the batch operations generated through the batch generation process to a work area of the plurality of work areas, a transporting process of transporting, to each of the plurality of work areas, at least one mount, among the plurality of mounts, to be used in a corresponding batch operation allocated through the operation allocation process among the batch operations, and an index computation process of computing an overlapping potential index for each of the types as a target type. The overlapping potential index indicates a likelihood of a shortfall in a number of target mounts with respect to a number of work areas in which the picking operation for articles of a target type is performed. Each of the target mounts is a mount loaded with an article of the target type. In the batch generation process, the control system aggregates pieces of the order information to cause a number of potentially overlapping batch operations to be less than or equal to a total transferable number in response to the number of potentially overlapping batch operations being reducible to less than or equal to the total transferable

number. The number of potentially overlapping batch operations is a number of the batch operations each including the picking operation corresponding to a piece of the order information which piece specifies a potentially overlapping type being a type having the overlapping potential index less than a predetermined determination threshold. The total transferable number is a total number of the target mounts transferable from the automated warehouse. In the batch generation process, the control system aggregates pieces of the order information in such a manner as to minimize the number of potentially overlapping batch operations in response to the number of potentially overlapping batch operations being not reducible to less than or equal to the total transferable number.

[0111] This structure aggregates the pieces of order information specifying the potentially overlapping type that may cause a shortfall in the total transferable number with respect to the order count. As a result, the picking operations for the articles of the potentially overlapping type are likely to be performed in fewer work areas. Thus, a shortfall in the number of mounts with respect to the number of work areas is less likely to cause operation wait of waiting for the target mounts to be used in the picking operations in the respective work areas. This structure is likely to reduce operation wait in the respective work areas and improve the operation efficiency.

[0112] The overlapping potential index may be a value obtained by dividing the total transferable number by a target order count. The target order count is a number of pieces of the order information each specifying an article of the target type among a plurality of pieces of the order information to be processed in a unit period.

[0113] In this structure, simple computation can determine the overlapping potential index that indicates the likelihood of a shortfall in the number of target mounts loaded with the articles of the target type with respect to the number of work areas in which the picking operations for the articles of the target type are performed.

[0114] In response to the number of potentially overlapping batch operations exceeding the total transferable number, the control system may cause, in the operation allocation process, a number of work areas to which the potentially overlapping batch operations are allocated to be less than or equal to the total transferable number.

[0115] In this structure, multiple potentially overlapping batch operations (less than or equal to the number of potentially overlapping batch operations) for a particular potentially overlapping type can be allocated to a single work area. The multiple potentially overlapping batch operations can be processed in series in the single work area. This can avoid the operation wait. This structure is likely to reduce operation wait in the respective work areas and improve the operation efficiency.

[0116] In response to the number of potentially overlapping batch operations exceeding the

total transferable number and simultaneously the control system being to perform the operation allocation process in such a manner as to allocate the potentially overlapping batch operations to respective work areas among the a plurality of work areas, the control system allocates the potentially overlapping batch operations to the respective work areas in such a manner as to
5 cause the picking operation in one of the respective work areas for the articles of the potentially overlapping type to be at least performed in a period different from a period in which the picking operation in another of the respective work areas for the articles of the potentially overlapping type is performed.

[0117] In this structure, potentially overlapping batch operations for the articles of a particular potentially overlapping type can be performed in multiple work areas without causing
10 an overlap between the periods for the picking operations for the articles of the potentially overlapping type. This can avoid the operation wait described above. This structure is likely to reduce operation wait in the respective work areas and improve the operation efficiency.

[0118] In response to a predicted duration from a start of potentially overlapping batch operations to be performed in each of the plurality of work areas to an end of the plurality of
15 potentially overlapping batch operations exceeding a predetermined time limit, the control system may increase the total transferable number.

[0119] In this structure, when the time from the start to the end of the multiple potentially overlapping batch operations exceeds the predetermined time limit, the number of mounts
20 transferable from the automated warehouse is increased for mounts of the articles of the potentially overlapping type. The multiple potentially overlapping batch operations are thus less likely to have a major delay as a system as a whole.

[0120] In the index computation process, the control system may compute a similarity index indicating similarity between a plurality of pieces of the order information, assign type
25 values to respective types as handling targets to rank the types, in addition to computing the overlapping potential index, set the type values for all the types as the handling targets to cause a type value for the target type to be greater than a sum of the respective type values for all types ranked lower than the target type, and compute the sum of respective type values for all types included in each piece of the order information as the similarity index for the piece of the
30 order information. In the batch generation process, the control system may perform a first aggregation process of aggregating pieces of the order information each specifying the potentially overlapping type for the picking operation, and then aggregate, in order of closeness in the similarity index, those pieces of the order information among a plurality of pieces of the order information to be processed in a unit period which the control system did not aggregate
35 in the first aggregation process.

[0121] This structure reduces the likelihood of operation wait described above by

aggregating the pieces of order information specifying a potentially overlapping type and can increase the likelihood of aggregating the multiple picking operations to be performed for the articles of a particular type into the same batch operation by aggregating the pieces of order information specifying no potentially overlapping types and being close in the similarity index.

- 5 When multiple picking operations for the articles of the same type are aggregated in the same batch operation, the multiple picking operations can be performed in a single work area. This can improve the efficiency for transporting the mounts in the transporting process and the efficiency of operations in the work areas as well.

10 INDUSTRIAL APPLICABILITY

[0122] The technique according to one or more embodiments of the present disclosure is applicable to a picking system.

REFERENCE SIGNS LIST

- 15 [0123]
100 picking system
1 automated warehouse
2 work area
3 control system
20 5 mount
7 transport system
W article
In order information
Na order count
25 Nb total transferable number
Nc potentially overlapping batch operation number
T time limit
Va type value
Ex similarity index

CLAIMS

1. A picking system, comprising:
 - an automated warehouse storing a plurality of mounts each loaded with a plurality of articles;
 - 5 a plurality of work areas in which a picking operation is performed, the picking operation being an operation of retrieving, based on order information specifying types and quantities of articles to be shipped to each shipping destination, the articles of the types and the quantities specified by the order information from at least one mount transferred from the automated warehouse among the plurality of mounts;
 - 10 a transport system configured to transport the plurality of mounts between the automated warehouse and the plurality of work areas; and
 - a control system configured to control the automated warehouse and the transport system, the control system being configured to perform
 - a batch generation process of aggregating a set number of pieces of the order
 - 15 information and generating batch operations each including the picking operation corresponding to the aggregated pieces of the order information,
 - an operation allocation process of allocating each of the batch operations generated through the batch generation process to a work area of the plurality of work areas,
 - a transporting process of transporting, to each of the plurality of work areas, at least
 - 20 one mount, among the plurality of mounts, to be used in a corresponding batch operation allocated through the operation allocation process among the batch operations, and
 - an index computation process of computing an overlapping potential index for each of the types as a target type, the overlapping potential index indicating a likelihood of a shortfall in a number of target mounts with respect to a number of work areas in which the picking
 - 25 operation for articles of a target type is performed, the target mounts each being a mount loaded with an article of the target type,
 - the control system being configured to, during the batch generation process,
 - aggregate pieces of the order information to cause a number of potentially overlapping batch operations to be less than or equal to a total transferable number in response to the number
 - 30 of potentially overlapping batch operations being reducible to less than or equal to the total transferable number, the number of potentially overlapping batch operations being a number of the batch operations each including the picking operation corresponding to a piece of the order information which piece specifies a potentially overlapping type being a type having the overlapping potential index less than a predetermined determination threshold, the total
 - 35 transferable number being a total number of the target mounts transferable from the automated warehouse, and

aggregate pieces of the order information in such a manner as to minimize the number of potentially overlapping batch operations in response to the number of potentially overlapping batch operations being not reducible to less than or equal to the total transferable number.

5 2. The picking system according to claim 1, wherein
the overlapping potential index is a value obtained by dividing the total transferable number by a target order count, and
the target order count is a number of pieces of the order information each specifying an article of the target type among a plurality of pieces of the order information to be processed in
10 a unit period.

3. The picking system according to claim 1, wherein
in response to the number of potentially overlapping batch operations exceeding the total transferable number, the control system causes, in the operation allocation process, a number
15 of work areas to which the potentially overlapping batch operations are allocated to be less than or equal to the total transferable number.

4. The picking system according to claim 1, wherein
in response to the number of potentially overlapping batch operations exceeding the total
20 transferable number and simultaneously the control system being to perform the operation allocation process in such a manner as to allocate the potentially overlapping batch operations to respective work areas among the plurality of work areas, the control system allocates the potentially overlapping batch operations to the respective work areas in such a manner as to cause the picking operation in one of the respective work areas for the articles of the potentially
25 overlapping type to be at least performed in a period different from a period in which the picking operation in another of the respective work areas for the articles of the potentially overlapping type is performed.

5. The picking system according to any one of claims 1 to 3, wherein
30 in response to a predicted duration from a start of a plurality of potentially overlapping batch operations to be performed in each of the plurality of work areas to an end of the plurality of potentially overlapping batch operations exceeding a predetermined time limit, the control system increases the total transferable number.

35 6. The picking system according to any one of claims 1 to 3, wherein
in the index computation process, the control system

computes a similarity index indicating similarity between a plurality of pieces of the order information,

assigns type values to respective types as handling targets to rank the types, in addition to computing the overlapping potential index,

5 sets the type values for all the types as the handling targets to cause a type value for the target type to be greater than a sum of the respective type values for all types ranked lower than the target type, and

computes a sum of respective type values for all types included in each piece of the order information as the similarity index for the piece of the order information, and

10 in the batch generation process, the control system performs a first aggregation process of aggregating pieces of the order information each specifying the potentially overlapping type for the picking operation, and then aggregates, in order of closeness in the similarity index, those pieces of the order information among a plurality of pieces of the order information to be processed in a unit period which the control system did not aggregate in the first aggregation

15 process.