

DESCRIPTION

Invention Title: VEHICLE PRODUCTION SYSTEM AND VEHICLE PRODUCTION SYSTEM CONTROL METHOD

Technical Field

- [1] The present invention relates to a vehicle production system and a vehicle production system control method, and more particularly, to an invention that can be applied to a smart factory for producing vehicles.

Background Art

- [2] In general warehouses or factories, as well as in smart factories that manufacture products with different specifications using various parts, smart logistics vehicles are being introduced for flexible and efficient supply and transfer of parts.
- [3] Smart logistics vehicles are a concept collectively referring to autonomous mobile robots (AMR: Autonomous Mobile Robot), automated guided vehicles (AGV: Automated Guided Vehicle), unmanned forklifts, and the like, and these smart logistics vehicles can perform movement and work according to control of a system.
- [4] Meanwhile, smart logistics vehicles transfer parts loaded on pallets to places where processes are performed in the smart factory, and the smart logistics vehicles are called to places where processes are performed in the smart factory when parts are needed.
- [5] Smart logistics vehicles are operated in a number smaller than the number of required processes due to efficiency issues such as cost and space, and multiple parts are contained in pallets for operation.

- [6] However, when call times of smart logistics vehicles overlap due to the need for parts, the number of calls becomes greater than the number of smart logistics vehicles being operated, causing a problem of logistics delay.
- [7] To solve this problem, when the number of smart logistics vehicles in operation is increased, operation cost increases and idle smart logistics vehicles increase, thereby reducing the efficiency of smart logistics vehicle operation, and a method capable of increasing the efficiency of smart logistics vehicle operation is required.
- [8]
- [9] The matters described as the background art are merely for the purpose of enhancing understanding of the background of the present invention, and should not be taken as an acknowledgment that they correspond to prior art already known to those of ordinary skill in the art.

Disclosure

Technical Problem

- [10] The present invention has been proposed to solve these problems, and is intended to provide a vehicle production system and a vehicle production system control method capable of preventing delay in supply of logistics and improving operation efficiency of logistics robots.

[11]

Technical Solution

- [12] The vehicle production system according to the present invention for achieving the above object is a vehicle production system for managing a number of parts loaded on pallets of logistics robots for transporting parts to each of multiple work spots of a smart factory, comprising: a setting unit configured to set a number of parts loaded on each pallet, determine the number of parts loaded on the

pallet to be a maximum number that can be loaded on the pallet or a prime number smaller than the maximum number, and determine multiple combinations of the number of parts loaded on each pallet; and an analysis unit configured to determine an alternative combination among the multiple combinations determined by the setting unit through a transportation simulation of the logistics robots.

- [13] The setting unit may determine one of the maximum number of parts that can be loaded on each pallet or a prime number that is smaller than the maximum number and closest to the maximum number to set the number of parts loaded on the pallet.
- [14] The analysis unit may determine a combination in which a maximum number of calls in which the logistics robots are called at a same time or an average number of calls per logistics robot becomes minimum as the alternative combination through the transportation simulation.
- [15] The analysis unit may determine multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robots are called at a same time except for the alternative combination, or determine multiple substitute combinations in an order of a lower average number of calls per logistics robot, or determine multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.
- [16] The vehicle production system may further comprise: a logistics robot operation system configured to operate the logistics robots; and a management unit configured to receive the alternative combination from the analysis unit and deliver the alternative combination to the logistics robot operation system, wherein the logistics robot operation system may operate the logistics robots based on the alternative combination.

- [17] The logistics robot system may request transmission of the substitute combination to the management unit based on a logistics robot operation result according to the alternative combination, and when there is a substitute combination transmission request, the management unit may transmit the substitute combination to the logistics robot operation system.
- [18] The analysis unit may perform the transportation simulation by setting a least common multiple of a quantity of transportation parts of each pallet or a value obtained by subtracting 1 from the least common multiple as a simulation range.
- [19] When determining a combination in which the maximum number of calls in which the logistics robots are called at a same time becomes minimum as the alternative combination, the simulation range may be a value obtained by subtracting 1 from the least common multiple of the quantity of transportation parts of each pallet.
- [20] When determining a combination in which the average number of calls per logistics robot becomes minimum as the alternative combination, the simulation range may be the least common multiple of the quantity of transportation parts of each pallet.
- [21] The pallets are classified according to a maximum number of parts that can be loaded, and the setting unit may treat pallets classified as same type pallets as identical pallets, and determine a combination of the number of parts loaded on each pallet by setting arbitrarily the maximum number of parts that can be loaded on each pallet or a prime number smaller than the maximum number of parts that can be loaded as the number of parts loaded on the pallet.
- [22] The setting unit may set the maximum number of parts that can be loaded on each pallet or a prime number that is

smaller than the maximum number and closest to the maximum number as the number of parts loaded on the pallet.

[23] When the maximum number of parts that can be loaded on each pallet is 1 or 2, the setting unit may set the number of parts loaded on each pallet to 1 or 2.

[24]

[25] A vehicle production system control method for managing a number of parts loaded on pallets of logistics robots for transporting parts to each of multiple work spots of a smart factory, the method comprising: generating, by a setting unit, multiple combinations of the number of parts loaded on each pallet by determining one of a maximum number of parts that can be loaded on the pallet or a prime number smaller than the maximum number to set the number of parts loaded on the pallet; and determining, by an analysis unit, an alternative combination among the multiple combinations determined by the setting unit by performing a transportation simulation of the logistics robots.

[26] In the generating the multiple combinations of the number of parts loaded on each pallet,

[27] the method may comprise determining one of the maximum number of parts that can be loaded on each pallet or a prime number that is smaller than the maximum number and closest to the maximum number to set the number of parts loaded on the pallet.

[28] In the determining the alternative combination,

[29] the method may comprise determining a combination in which a maximum number of calls in which the logistics robots are called at a same time or an average number of calls per logistics robot becomes minimum as the alternative combination.

- [30] In the determineing the alternative combination,
- [31] the method may further comprise determineing, by the analysis unit, multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robots are called at a same time except for the alternative combination, or determineing multiple substitute combinations in an order of a lower average number of calls per logistics robot, or determineing multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.
- [32] After the determineing the alternative combination,
- [33] the method may comprise operating, by a logistics robot operation system, the logistics robots based on the alternative combination.
- [34]

Advantageous Effects

- [35] According to the vehicle production system and the vehicle production system control method of the present invention, by changing the loading amount per pallet of the logistics robots, it is possible to reduce time points at which the logistics robots are called simultaneously, thereby preventing delay in supply of logistics while maintaining the number of logistics robots in operation.
- [36] In addition, it is possible to improve the operation efficiency of the logistics robots by leveling the number of times the logistics robots are called.
- [37]

Description of Drawings

- [38] FIG. 1 briefly illustrates a part of an interior of a smart factory.

[39] FIG. 2 is a table for explaining reasons why inefficiency of a conventional logistics robot control method is caused.

[40] FIG. 3 illustrates a flowchart of a vehicle production system and a vehicle production system control method according to an embodiment of the present invention.

[41] FIGS. 4 to 6 are data for helping understanding of the present invention.

[42]

Mode for Disclosure

[43] Hereinafter, embodiments disclosed in the present specification will be described in detail with reference to the accompanying drawings, but identical or similar components are given the same reference numbers regardless of reference numerals and redundant description thereof will be omitted.

[44] In describing the embodiments disclosed in the present specification, when it is determined that a detailed description of related known technology may obscure the gist of the embodiments disclosed in the present specification, the detailed description will be omitted. In addition, the accompanying drawings are only for the purpose of easily understanding the embodiments disclosed in the present specification, and the technical idea disclosed in the present specification is not limited by the accompanying drawings, and should be understood to include all changes, equivalents, and substitutes included in the spirit and technical scope of the present invention.

[45] Terms including ordinal numbers such as first, second, etc. may be used to describe various components, but the components are not limited by the terms. The terms are used only for the purpose of distinguishing one component from another component.

- [46] Singular expressions include plural expressions unless the context clearly dictates otherwise.
- [47] In the present specification, terms such as "comprises" or "has" are intended to designate the existence of features, numbers, steps, operations, components, parts, or combinations thereof described in the specification, and should be understood as not precluding the existence or addition possibility of one or more other features, numbers, steps, operations, components, parts, or combinations thereof in advance.
- [48] Hereinafter, among the configurations of the present invention to be described, the setting unit, the analysis unit, the management unit, and the logistics robot operation system may include a communication device for communicating with other controllers or sensors for control of functions in charge, a memory for storing operating systems, logic commands, input/output information, etc., and one or more processors for performing determinations, calculations, decisions, etc. necessary for control of functions in charge.
- [49] In addition, the following logistics robot is used as a concept collectively referring to autonomous mobile robot (AMR: Autonomous Mobile Robot), automated guided vehicle (AGV: Automated Guided Vehicle), unmanned forklift, etc., which are smart logistics vehicles.
- [50]
- [51] FIG. 1 briefly illustrates a part of an interior of a smart factory, and referring to FIG. 1, inside the smart factory 100, there exists a work spot 130 where a process necessary for vehicle production is performed. The logistics robot 170 transfers parts necessary according to the type of process necessary for vehicle production to the work spot 130.

- [52] Specifically, to describe the part transfer procedure, parts are loaded on a pallet, and the logistics robot may support and lift a lower point of the pallet on which the parts are loaded to move the pallet to the work spot.
- [53] That is, when the logistics robot is called, it moves to a place where the parts are loaded on the pallet, lifts the pallet on which the parts are loaded, and moves it again to the work spot.
- [54] A pallet is connected (coupled) to the logistics robot 170, and necessary parts are placed in a tray or the like provided on the pallet. Since there are many types of parts necessary for producing vehicles, there are also many types of pallets.
- [55]
- [56] FIG. 2 is a table for explaining reasons why inefficiency of a conventional logistics robot control method is caused. Referring to FIG. 2, in the "F assembly" process, it is assumed that the necessary parts are X, Y, and Z, and each part can be loaded on A, B, and C type pallets.
- [57] A maximum of 4 parts X can be loaded on the A type pallet, a maximum of 8 parts Y can be loaded on the B type pallet, and a maximum of 2 parts Z can be loaded on the C type pallet.
- [58] In performing the F assembly process through parts X, Y, and Z, the logistics robot is called whenever all of parts X, Y, and Z are exhausted. That is, referring to the process sequence, in sequence 1, X, Y, and Z are exhausted one by one, and in sequence 2, Z is all exhausted, so the logistics robot in charge of transporting part Z will be called to the work spot. Likewise, in sequence 4, parts X and Z are all exhausted, so the logistics robot in charge of parts X and Z will be called to the work spot. In addition, in sequence 8, parts X, Y, and Z are all

exhausted, so the logistics robot in charge of transporting parts X, Y, and Z will be called to the work spot.

[59] As described above, when parts are transported according to the maximum number of parts that can be loaded on the pallet, simultaneous calls of the logistics robot occur in the process sequence corresponding to the least common multiple of the maximum number of parts loaded, which may cause delay in logistics transportation.

[60]

[61] To solve the above problems, in the present invention, by utilizing the characteristics of a prime number having only itself and 1 as divisors, not all pallets transport parts according to the maximum number of parts that can be loaded on the pallet, but some pallets transport parts according to the maximum number of loadings, and some pallets transport parts by a prime number smaller than the maximum number of loadings.

[62] More specifically, when parts are transported according to the maximum number of parts loaded on the pallet, the number of times the logistics robot is called becomes maximum for each process sequence that is the least common multiple of the maximum number of parts loaded of each part, so the characteristics of a prime number having only itself and 1 as divisors are utilized.

[63]

[64] FIG. 3 illustrates a flowchart of a vehicle production system and a vehicle production system control method according to an embodiment of the present invention.

[65] Referring to FIG. 3, the vehicle production system includes a logistics robot operation system 300 and a management system 500 for managing the number of parts loaded on pallets of the logistics robot. The management system 500

determines the number of parts to be loaded on the pallet to be used and delivers it to the logistics robot operation system 300. The logistics robot operation system 300 that receives the number of parts to be loaded on the pallet to be used from the management system 500 may allow other robot devices or workers to load the determined number of parts on the pallet based on it.

- [66] Specific details of the logistics robot operation system 300 will be described later, and the management system 500 will be described in detail.
- [67] The management system 500 is a part of the vehicle production system and corresponds to a system for managing the number of parts loaded on pallets of the logistics robot 170. The management system 500 includes a management unit 510, a setting unit 530, and an analysis unit 550. For efficient operation of the logistics robot, when the management unit 510 requests the setting unit to determine an appropriate number of loadings, the setting unit 530 searches for and determines combinations regarding the number of parts to be loaded for each pallet to be used.
- [68] Specifically, first, the setting unit 530 sets the number of parts loaded on each pallet. The setting of the number of parts may be determined to be the maximum number of parts that can be loaded on the pallet or a prime number smaller than same. Since multiple logistics robots 170 and corresponding multiple pallets are provided in the smart factory 100, the setting unit 530 may determine multiple combinations regarding the number of parts loaded on the pallet.
- [69] By utilizing the characteristics of a prime number having only itself and 1 as divisors, it is intended to reduce the number of logistics robots 170 called simultaneously, but if the number of parts of all pallets is set to a prime number, the number of calls of the logistics robot may

increase simultaneously for each process sequence that is a prime number. Therefore, the maximum number of calls of the logistics robot 170 called at the same time can be reduced through a method of setting some of the pallets used to a prime number and some to the maximum number that can be loaded on the pallet.

[70] Here, the prime number may be smaller than the maximum number of parts that can be loaded on the pallet, but most appropriately, it is preferable that it is a prime number closest to the maximum number of parts that can be loaded on the pallet.

[71]

[72] For example, referring to FIG. 4, in performing the "G process", pallet 1, pallet 2, pallet 3, pallet 4, pallet 5, pallet 6 are used, and it is assumed that the maximum loading amount of parts of pallet 1 is 2, the maximum loading amount of parts of pallets 2 to 4 is 4, and the maximum loading amount of parts of pallets 5 to 6 is 6.

[73] Here, since 2 is itself a prime number, the setting unit 530 may determine the loading amount of parts of pallet 1 as 2 (although 1 is not a prime number, since there is no prime number smaller than 1, when the maximum number of parts that can be loaded on each pallet is 1 or 2, the setting unit sets the number of parts loaded on each pallet to 1 or 2).

[74] Since the maximum loading amount of parts of pallets 2 to 4 is 4, the prime number smaller than 4 and closest to 4 is 3. Therefore, the setting unit 530 may determine the loading amount of parts of pallets 2 to 4 as either 4 or 3.

[75] Since the maximum loading amount of parts of pallets 5 to 6 is 6, the prime number smaller than 6 and closest to 6 is 5. Therefore, the setting unit 530 may determine the loading amount of parts of pallets 5 to 6 as either 6 or 5.

- [76] Through such a series of processes, the combinations of the loading amount of parts per pallet that can be determined are $2^5 = 32$, so a total of 32 can be determined.
- [77]
- [78] The analysis unit 550 included in the management system 500 is a configuration that receives the combinations determined by the setting unit 530, performs a transportation simulation, and determines an alternative combination among the combinations determined by the setting unit 530. Specifically, the analysis unit 550 may receive multiple combinations determined by the setting unit 530 from the setting unit 530 as in the above example and perform a transportation simulation for each combination.
- [79] When the transportation simulation for the multiple combinations determined by the setting unit 530 is completed, the maximum number of calls in which the logistics robot 170 is called at the same time or the average number of calls per logistics robot 170 may be calculated for each combination determined by the setting unit 530.
- [80] For example, referring to FIGS. 4 and 5, combination 2 among the multiple combinations determined by the setting unit 530 will be examined.
- [81] The loading amount of parts of pallet 1 is 2, the loading amount of parts of pallet 2 is 3, the loading amount of parts of pallets 3 to 4 is 4, and the loading amount of parts of pallets 5 to 6 is 6.
- [82] As a result of the transportation simulation for combination 2, in the transportation simulation for the G process, the maximum number of calls is 4 appearing in process sequence 6 (or for each process sequence that is a multiple of 6), and the average number of calls is 1.17.

- [83] Of course, in the 12 process sequence corresponding to the least common multiple of 2, 3, 4, 6, the maximum number of calls of the logistics robot may be 6, but since all combinations have calls of all logistics robots in the sequence corresponding to the least common multiple of the number of parts loaded, all have the maximum number of calls. That is, observing the sequence corresponding to the least common multiple of the number of parts loaded is meaningless, so it should be ignored.
- [84] That is, when observing the maximum number of calls, it is appropriate to determine up to the sequence corresponding to the least common multiple of the number of parts loaded, but when observing the average number of calls, it is preferable to determine up to the sequence corresponding to the least common multiple of the number of parts loaded minus 1.
- [85]
- [86] The average number of calls shown in FIG. 5 means the average of the number called for each number of loadings in the combination. That is, the least common multiple of 2, 3, 4, 6, which is the number of loadings per pallet of combination 2, is 12, which means that repetitive calls are made every 12 times. Therefore, the average number of calls is 14 calls within 12 process sequences, so it has an average number of calls of $14/12 = 1.17$.
- [87]
- [88] Meanwhile, the analysis unit 550 may determine a combination in which the maximum number of calls in which the logistics robot 170 is called at the same time or the average number of calls per logistics robot becomes minimum as the alternative combination through the transportation simulation.

- [89] Preferably, determineing a combination in which the maximum number of calls in which the logistics robot 170 is called at the same time becomes minimum as the alternative combination is in line with the purpose of the invention, but when it is difficult to determine an alternative combination by the maximum number of calls, such as when the maximum number of calls at the same time is the same or when there are combinations with the same maximum number of calls, a combination in which the average number of calls becomes minimum may be determined as the alternative combination.
- [90] That is, referring to FIG. 5, in the case of combination 32, it is a case where the maximum number of calls is 3, and may be determined as an alternative combination for the G process.
- [91] However, as described above, when determineing a combination in which the maximum number of calls in which the logistics robot is called at the same time becomes minimum as the alternative combination, the simulation range is a value corresponding to the least common multiple of the quantity of transportation parts of each pallet minus 1, and when determineing a combination in which the average number of calls per logistics robot becomes minimum as the alternative combination, it is preferable that the simulation range is the least common multiple of the quantity of transportation parts of each pallet.
- [92]
- [93] Meanwhile, the vehicle production system includes a logistics robot operation system 300 for operating the logistics robot 170. The logistics robot operation system 300 communicates directly with the management unit 510 of the management system 500, and the management unit 510 delivers the alternative combination determined by the analysis unit 550 to the logistics robot operation system

300. Accordingly, the logistics robot operation system 300 operates the logistics robot 170 by applying the alternative combination delivered from the management unit 510.

- [94] The alternative combination is determined by a transportation simulation, and is only a result by simulation, so in actual logistics robot operation, unexpected variables may be applied, so the actual result may have a result that does not match the transportation simulation.
- [95] To cope with such a case, the analysis unit 550 may determine multiple substitute combinations for operating the logistics robot 170 in addition to the alternative combination. Specifically, the analysis unit 550 may determine multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robot 170 is called at the same time except for the alternative combination, or determine multiple substitute combinations in an order of a lower average number of calls per logistics robot 170, or determine multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.
- [96] That is, the logistics robot operation system 300 may basically operate the logistics robot 170 based on the alternative combination determined by the analysis unit 550, but determines whether the alternative combination is appropriate or inappropriate based on the result of actual operation by the logistics robot operation system 300, and when it is determined to be inappropriate for the alternative combination, requests transmission of the substitute combination to the management unit 510, and when there is a substitute combination transmission request, the management unit 510 may transmit the substitute combination to the logistics robot operation system 300.

- [97] That is, the substitute combination may be determined based on the maximum number of calls of the logistics robot, the average number of calls per logistics robot, and the standard deviation of the number of calls per logistics robot, and since the purpose of the present invention is to minimize the number of logistics robots called simultaneously, the maximum number of calls of the logistics robot is determined as a priority, and then, within combinations with the same maximum number of calls of the logistics robot, the priority of the combination may be determined by observing the average number of calls per logistics robot.
- [98] If the average number of calls per logistics robot is the same or similar, in this case, the priority may be determined based on the standard deviation.
- [99] That is, in combinations with the same maximum number of calls of the logistics robot and the same average number of calls per logistics robot, a low standard deviation reflects that appropriate distribution of calls of the logistics robot is achieved and efficient operation of the logistics robot is achieved, and a high standard deviation means that the robot that frequently receives calls continues to receive calls, reflecting that some available logistics robots exist.
- [100] Therefore, if the maximum number of calls of the logistics robot and the average number of calls per logistics robot are the same, a combination with a lower standard deviation may have a higher priority.
- [101]
- [102] Meanwhile, even if there is no transmission request for the substitute combination, the management unit 510 may transmit both the alternative combination and the substitute combination to the logistics robot operation

system 300, so the logistics robot operation system 300 may compare the results for the day the logistics robot 170 was operated through the alternative combination and the day the logistics robot 170 was operated by operating the substitute combination to determine which combination is appropriate between the alternative combination and the substitute combination.

[103]

[104] Hereinafter, other embodiments of the transportation simulation for determining the alternative combination performed by the analysis unit 550 will be described.

[105] Referring to FIG. 5, in the transportation simulation according to the first embodiment, the maximum number of calls or the average number of calls was calculated based on the results performed up to the n process sequence for completing the transportation simulation for the G process.

[106] However, according to the second embodiment, it is not necessary to perform up to the n process sequence for completing the simulation, and the transportation simulation may be performed by setting the simulation range to a range smaller than n.

[107] Specifically, the range of the simulation may be determined as a value obtained by subtracting 1 from the least common multiple of the quantity of transportation parts of each pallet. Referring to FIG. 5, the least common multiple of the quantity of transportation parts of each pallet corresponding to combination 2 is 12, which is the least common multiple of 2, 3, 4, 6.

[108] Therefore, since combination 2 is performed up to process sequence n with the movement of the entire logistics robot repeated for every 12 process sequences, there is no problem even if the maximum number of calls or the average number of calls up to process sequence 11 is

calculated, and according to the second embodiment, there is an advantage that the time consumed in calculating the results of the transportation simulation can be reduced.

[109]

[110] Meanwhile, referring to FIGS. 4 and 5, in generating multiple combinations in the setting unit 530 according to the first embodiment, 32 combinations were determined in consideration of the number of cases of all pallets used.

[111] However, according to the third embodiment, in generating multiple combinations in the setting unit 530, the pallets are classified according to the maximum number of parts that can be loaded, and pallets classified as the same type pallets are treated as identical pallets, so the setting unit 530 may determine multiple combinations.

[112] Specifically, according to the first embodiment, in pallets 2 to 4 with a maximum loading amount of parts of 4, a combination in which the loading amount of parts of pallet 2 is 3 and the loading amount of parts of pallets 3 to 4 is 4 and a combination in which the loading amount of parts of pallet 4 is 3 and the loading amount of parts of pallets 2 to 3 is 4 are distinguished as different combinations.

[113] However, according to the third embodiment, such combinations are distinguished as the same combination. That is, according to the third embodiment, pallets 2 to 4 are classified as pallets corresponding to group Q, so pallets 2 to 4 are not distinguished from each other.

[114] According to such a third embodiment, 1 combination is made in group P, 4 combinations in group Q, and 3 combinations in group R, and accordingly, the setting unit 530 may determine $1 \times 3 \times 4 = 12$, a total of 12 combinations.

[115] According to the first embodiment, there is an advantage that the characteristics of the parts loaded on the pallet are also considered, but since the purpose of the present invention is to reduce the maximum number of times the logistics robot 170 is called at the same time, the third embodiment may fit well with the purpose of the invention. In addition, according to the third embodiment, there is an advantage that the time consumed in generating combinations in the setting unit 530 can be reduced.

[116]

[117] Hereinafter, a vehicle production system control method according to an embodiment of the present invention will be described with reference to FIG. 3.

[118] First, a request for setting the number of parts loaded on the pallet necessary for performing the process is delivered from the logistics robot operation system 300 to the management system in step S100. Specifically, a request for setting the number of parts loaded on the pallet is delivered to the management unit in the management system, and at this time, information about the pallet used for performing the process from the logistics robot operation system 300 (the type of parts loaded, the maximum number of parts loaded on the pallet) is delivered together to the management unit 510.

[119] The management unit 510 requests the setting unit 530 to determine multiple combinations for the number of parts loaded per pallet in step S200. At this time, information about the pallet may be delivered together to the setting unit 530.

[120] As described above, the setting unit 530 performs a step of searching for and generating multiple combinations for the number of parts loaded per pallet by determining one of the maximum number of parts that can be loaded on

the pallet or a prime number smaller than same to set the number of parts loaded on the pallet in step S300.

[121] When the generation of multiple combinations is completed, the setting unit 530 delivers the determined multiple combinations to the analysis unit 550 and performs a request for determining an alternative combination in step S400. The analysis unit 550 that receives the multiple combinations performs a step of determining an alternative combination among the multiple combinations determined by the setting unit 530 by performing a transportation simulation of the logistics robot 170 for the multiple combinations in step S500.

[122] In the step of determining the alternative combination by the analysis unit 550 in step S500, the analysis unit 550 may determine a combination in which the maximum number of calls in which the logistics robot is called at the same time or the average number of calls per logistics robot 170 becomes minimum as the alternative combination.

[123] Meanwhile, in the step of determining the alternative combination by the analysis unit 550 in step S500, the analysis unit 550 may further include a step of determining multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robot 170 is called at the same time except for the alternative combination, or determining multiple substitute combinations in an order of a lower average number of calls per logistics robot 170, or determining multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.

[124] That is, as described above, the alternative combination is determined by a transportation simulation, and is only a result by simulation, so in actual operation

of the logistics robot 170, it may have a result that does not match the simulation due to unexpected variables.

[125] To prepare for such a case, the analysis unit 550 may determine multiple substitute combinations for operating the logistics robot 170 in addition to the alternative combination. Specifically, the analysis unit 550 may determine multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robot 170 is called at the same time except for the alternative combination, or determine multiple substitute combinations in an order of a lower average number of calls per logistics robot 170, or determine multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.

[126] Meanwhile, after the step of determining the alternative combination in step S500, it may include a step of operating the logistics robot by the logistics robot operation system 300 based on the alternative combination in step S800.

[127] Specifically, when the alternative combination is determined in step S500, the analysis unit 550 transmits the determined alternative combination to the management unit 510, and when the substitute combination is determined, the substitute combination is also transmitted to the management unit 510.

[128] The management unit 510 that receives the alternative combination transmits the alternative combination to the logistics robot operation system 300 in step S700, and the logistics robot operation system 300 operates the logistics robot 170 by applying the alternative combination in step S800.

[129] When the operation of the logistics robot 170 is completed, the operation result is evaluated to determine

whether the alternative combination is appropriate or inappropriate and transmitted to the management unit 510 in step S1000, and when it is determined that the alternative combination is inappropriate, the logistics robot operation system 300 requests transmission of the substitute combination to the management unit 510, and the management unit 510 may transmit the substitute combination to the logistics robot operation system 300 in step S1100.

[130]

[131] FIG. 6 illustrates the results of an operation simulation applying an embodiment of the present invention. Comparing FIGS. 2 and 6, in the "F assembly" process, referring to FIG. 2 before applying an embodiment of the present invention, the maximum number of calls of the logistics robot 170 is 3 times for every 8 process sequences, but referring to FIG. 6 applying an embodiment of the present invention, the maximum number of calls of the logistics robot 170 appears only 2 times in process sequence 6, and thereafter, the maximum number of calls appears only 3 times in process sequence 42.

[132] That is, although there are cases where the maximum number of calls increases, when considering the entire process sequence, the maximum number of calls occurring in process sequence 42 is at a negligible level.

[133]

[134] As described above, according to the vehicle production system and the vehicle production system control method of the present invention, by changing the loading amount per pallet of the logistics robot 170, it is possible to reduce time points at which the logistics robot 170 is called simultaneously, thereby preventing delay in supply of logistics while maintaining the number of logistics robots 170 in operation.

[135]

[136] Although shown and described in relation to specific embodiments of the present invention, it will be apparent to those of ordinary skill in the art that the present invention may be variously improved and changed within the scope not departing from the technical idea of the present invention provided by the following claims.

[137]

[138] Description of Reference Numerals

[139] 100: smart factory

[140] 130: work spot

[141] 170: logistics robot

[142] 300: logistics robot operation system

[143] 500: management system

[144] 510: management unit

[145] 530: setting unit

[146] 550: analysis unit

CLAIMS

[Claim 1]

A vehicle production system for managing a number of parts loaded on pallets of logistics robots for transporting parts to each of multiple work spots of a smart factory, the system comprising:

a setting unit configured to set a number of parts loaded on each pallet, determine the number of parts loaded on the pallet to be a maximum number that can be loaded on the pallet or a prime number smaller than the maximum number, and determine multiple combinations of the number of parts loaded on each pallet; and

an analysis unit configured to determine an alternative combination among the multiple combinations determined by the setting unit through a transportation simulation of the logistics robots.

[Claim 2]

The vehicle production system of claim 1, wherein the setting unit is configured to determine one of the maximum number of parts that can be loaded on each pallet or a prime number that is smaller than the maximum number and closest to the maximum number to set the number of parts loaded on the pallet.

[Claim 3]

The vehicle production system of claim 1, wherein the analysis unit is configured to determine a combination in which a maximum number of calls in which the logistics robots are called at the same time or an average number of calls per logistics robot becomes minimum as the alternative combination through the transportation simulation.

[Claim 4]

The vehicle production system of claim 3, wherein the analysis unit is configured to determine multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robots are called at the same time except for the alternative combination, or determine multiple substitute combinations in an order of a lower average number of calls per logistics robot, or determine multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.

[Claim 5]

The vehicle production system of claim 4, further comprising:

a logistics robot operation system configured to operate the logistics robots; and

a management unit configured to receive the alternative combination from the analysis unit and deliver the alternative combination to the logistics robot operation system,

wherein the logistics robot operation system is configured to operate the logistics robots based on the alternative combination.

[Claim 6]

The vehicle production system of claim 5, wherein the logistics robot operation system is configured to request transmission of the substitute combination to the management unit based on a logistics robot operation result according to the alternative combination, and based on there is a substitute combination transmission request, the management unit is configured to transmit the substitute combination to the logistics robot operation system.

[Claim 7]

The vehicle production system of claim 3, wherein the analysis unit is configured to perform the transportation

simulation by setting a least common multiple of a quantity of transportation parts of each pallet or a value obtained by subtracting 1 from the least common multiple as a simulation range.

[Claim 8]

The vehicle production system of claim 7, wherein based on determining a combination in which the maximum number of calls in which the logistics robots are called at the same time becomes minimum as the alternative combination, the simulation range is a value obtained by subtracting 1 from the least common multiple of the quantity of transportation parts of each pallet.

[Claim 9]

The vehicle production system of claim 7, wherein based on determining a combination in which the average number of calls per logistics robot becomes minimum as the alternative combination, the simulation range is the least common multiple of the quantity of transportation parts of each pallet.

[Claim 10]

The vehicle production system of claim 1, wherein the pallets are classified according to a maximum number of parts that can be loaded, and the setting unit is configured to treat pallets classified as same type pallets as identical pallets, and determine a combination of the number of parts loaded on each pallet by setting arbitrarily the maximum number of parts that can be loaded on each pallet or a prime number smaller than the maximum number of parts that can be loaded as the number of parts loaded on the pallet.

[Claim 11]

The vehicle production system of claim 8, wherein the setting unit is configured to set the maximum number of parts that can be loaded on each pallet or a prime number that is

smaller than the maximum number and closest to the maximum number as the number of parts loaded on the pallet.

[Claim 12]

The vehicle production system of claim 11, wherein based on the maximum number of parts that can be loaded on each pallet is 1 or 2, the setting unit is configured to set the number of parts loaded on each pallet to 1 or 2.

[Claim 13]

A vehicle production system control method for managing a number of parts loaded on pallets of logistics robots for transporting parts to each of multiple work spots of a smart factory, the method comprising:

generating, by a setting unit, multiple combinations of the number of parts loaded on each pallet by determineing one of a maximum number of parts that can be loaded on the pallet or a prime number smaller than the maximum number to set the number of parts loaded on the pallet; and

determineing, by an analysis unit, an alternative combination among the multiple combinations determined by the setting unit by performing a transportation simulation of the logistics robots.

[Claim 14]

The vehicle production system control method of claim 13, wherein the generating the multiple combinations of the number of parts loaded on each pallet comprises determineing one of the maximum number of parts that can be loaded on each pallet or a prime number that is smaller than the maximum number and closest to the maximum number to set the number of parts loaded on the pallet.

[Claim 15]

The vehicle production system control method of claim 13, wherein the determining the alternative combination comprises determining a combination in which a maximum number of calls in which the logistics robots are called at the same time or an average number of calls per logistics robot becomes minimum as the alternative combination.

[Claim 16]

The vehicle production system control method of claim 15, wherein in the determining the alternative combination, the method further comprises determining, by the analysis unit, multiple substitute combinations in an order of a lower maximum number of calls in which the logistics robots are called at the same time except for the alternative combination, or determining multiple substitute combinations in an order of a lower average number of calls per logistics robot, or determining multiple substitute combinations in an order of a lower standard deviation of the number of calls per logistics robot.

[Claim 17]

The vehicle production system control method of claim 13, further comprising, after the determining the alternative combination, operating, by a logistics robot operation system, the logistics robots based on the alternative combination.